EIR APPENDIX 1

Visual Resources Technical Report (SWCA 2026)

Visual Resources Technical Report for the Castle Mountain Mine Phase II Expansion Project, San Bernardino County, California, and Clark County, Nevada

MARCH 2026

PREPARED FOR

Equinox Gold Corp-Castle Mountain Mine Venture

SUBMITTED TO

Bureau of Land Management, Needles Field Office

PREPARED BY

SWCA Environmental Consultants

VISUAL RESOURCES TECHNICAL REPORT FOR THE CASTLE MOUNTAIN MINE PHASE II EXPANSION PROJECT, SAN BERNARDINO COUNTY, CALIFORNIA, AND CLARK COUNTY, NEVADA

Prepared for

Equinox Gold Corp-Castle Mountain Mine Venture
980 American Pacific Drive, Suite 102
Henderson, NV 89014

Submitted to

Bureau of Land Management – Needles Field Office
1303 US-95
Needles, CA 92363

Prepared by

SWCA Environmental Consultants
8235 South Eastern Avenue, Suite 100
Las Vegas, NV 89123
(702) 248-3880
www.swca.com

SWCA Project No. 86259

February 2026

CONTENTS

1 Introduction 1

2 Regulatory Framework 2

2.1 Bureau of Land Management 2
2.1.1 California Desert Conservation Area Plan 3
2.1.2 Desert Renewable Energy Conservation Plan 3
2.1.3 Las Vegas and Pahrump Field Offices Resource Management Plan 3
2.1.4 Avi Kwa Ame National Monument Proclamation and Interim Management 4
2.1.5 National Scenic and Historic Trails 5
2.2 National Park Service 5
2.3 Local 5
2.3.1 San Bernardino Countywide Plan 5
2.3.2 San Bernardino County Development Code – Title 8 Mountain and Desert Requirements 7
2.3.3 Clark County Master Plan 8

3 Existing Conditions 8

3.1 Existing Landscape Character and Visual Resource Inventory 8
3.1.1 Landscape Character 8
3.1.2 Visual Resource Inventory 10
3.1.3 Dark Night Skies 13
3.2 Viewing Locations and Key Observation Points 19
3.3 Bureau of Land Management Visual Resource Management Classes and Resource Management Plan 28

4 Impact Assessment 30

4.1 Analysis Methods 30
4.2 Impacts of Alternative A: No Action Alternative 35
4.3 Impacts of Alternative B: Proposed Action Alternative 36
4.3.1 Construction 36
4.3.2 Operation 37
4.3.3 Decommissioning 47
4.4 Impacts of Alternative C: Alternative Configurations of Mine Components 47
4.5 Impacts of Alternative D: Backfilling to Avoid Surface Expression of South Pit Lake 47
4.6 Impacts of Alternative E: Small Solar Facility for Supplementation 48

5 Selective Mitigation Measures 48

6 Glossary 50

7 Literature Cited 53

Appendices

Appendix A Visual Simulations
Appendix B Key Observation Point Contrast Rating Worksheets
Appendix C Non-Simulated Key Observation Point Photographs

Figures

Figure 1. Project location. 6
Figure 2. Bureau of Land Management scenic quality rating units. 14
Figure 3. Bureau of Land Management sensitivity level rating units. 15
Figure 4. Bureau of Land Management distance zones. 16
Figure 5. Bureau of Land Management visual resource inventory classes. 17
Figure 6. Bortle classes. 18
Figure 7. Proposed transmission line viewshed. 20
Figure 8. Proposed water pipeline viewshed. 21
Figure 9. Proposed mining expansion viewshed. 22
Figure 10. Viewing locations and key observation points. 27
Figure 11. Bureau of Land Management Visual Resource Management classes. 29
Figure 12. Conformance with Bureau of Land Management Visual Resource Management classes. 46

Tables

Table 1. Bureau of Land Management Visual Resource Management Classes 2
Table 2. Bureau of Land Management Scenic Quality Ratings Crossed by the Project 10
Table 3. Bureau of Land Management Sensitivity Levels Crossed by the Project 11
Table 4. Bureau of Land Management Distance Zones Crossed by the Project 11
Table 5. Bureau of Land Management Visual Resource Inventory Classes Crossed by the Project 12
Table 6. Bureau of Land Management Scenic Quality Rating Units and Associated Sensitivity Levels Crossed by the Project 13
Table 7. Key Observation Point Locations 23
Table 8. Bureau of Land Management Visual Resource Management Classes Crossed by the Project 28
Table 9. Criteria for Assessing Level of Impacts on Visual Resources 31
Table 10. Impacts on Views from Key Observation Points 39

ACRONYMS AND ABBREVIATIONS

ACEC	Area of Critical Environmental Concern
Applicant	Castle Mountain Venture
AVE	area of visual effects
BLM	U.S. Bureau of Land Management
BMP	best management practice
CDCA	*California Desert Conservation Area Plan*
CMM	Castle Mountain Mine
CMV	Castle Mountain Venture
DRECP	*Desert Renewable Energy Conservation Plan*
FAA	Federal Aviation Administration
GIS	geographic information system
KOP	key observation point
Las Vegas RMP	*Las Vegas and Pahrump Field Offices Updated Record of Decision for the Approved Las Vegas Resource Management Plan and Final Environmental Impact Statement*
LUPA	Land Use Plan Amendment
LVFO	Las Vegas Field Office
MPO	Mine Plan of Operations
NEPA	National Environmental Policy Act
NFO	Needles Field Office
NPS	National Park Service
POD	Plan of Development
Project	Castle Mountain Mine Phase II Expansion Project
Proposed Action	Castle Mountain Mine Phase II Expansion Project
ROD	Record of Decision
ROW	right-of-way
SLRU	sensitivity level rating unit
SQRU	scenic quality rating unit
SR	State Route
VRI	visual resource inventory
VRM	visual resource management
VRP	Visual Resource Program

This page intentionally left blank.

1 INTRODUCTION

Castle Mountain Venture (CMV; Applicant) has submitted a proposal for the second expansion of the Castle Mountain Mine (CMM) known as the "Phase II Expansion." CMM is an open-pit gold mine/heap leach operation located on lands administered by the U.S. Bureau of Land Management (BLM) Needles Field Office (NFO) and privately owned lands. The mine is located approximately 60 miles south of Las Vegas, Nevada, and 40 miles northwest of Needles, California, in both Clark County, Nevada and San Bernardino County, California. The Phase II Expansion Project (Project or Proposed Action) includes expansion of the mine pits, overburden sites, and heap leach pad and installation of a pipeline and powerline (i.e., the utilities). The utilities would occur largely within existing rights-of-way (ROWs) and would cross public lands managed by the NFO and the BLM Las Vegas Field Office (LVFO), with small (0.20-mile and 0.65-mile) portions within National Park Service (NPS)-administered and privately owned lands, respectively.

Visual resources consist of the physical features that make up the visible landscape (i.e., natural features such as land, water, vegetation, and topography and human-made features such as buildings, roads, utilities, and structures). These elements of the landscape can be described in terms of their form, line, color, and texture. Additionally, visual resources considers the effect of the landscape on viewers and their response to changes to the visual environment.

Agency Project scoping resulted in the identification of the following visual resources issues for detailed analysis:

- How would the existing visual character and scenic quality of the analysis area be impacted by the introduction of Project components?
- How would the introduction of Project components in the analysis area impact sensitive viewing platforms (key observation points [KOPs])?
- Where would the Project components meet (or not meet) BLM visual resource management (VRM) class objectives?

Agency Project scoping also identified the following issue to be analyzed in brief:

- How would the Project's proposed construction and operations and maintenance activities, in addition to current operations, affect dark night skies?

The purpose of this report is to identify the visual resources regulatory framework pertinent to the Phase II Expansion; establish the existing condition of visual resources in the analysis area; assess potential visual impacts from the construction, operation, and decommissioning of the Phase II Expansion; determine conformance with applicable land management plans; and identify measures to mitigate impacts to the extent possible. This report has been prepared with the intention of gathering, to the extent possible, data on the visual resources in the Project Area and providing the information needed to advance the Phase II Expansion through the BLM's National Environmental Policy Act (NEPA) and ROW permitting processes.

2 REGULATORY FRAMEWORK

2.1 Bureau of Land Management

As directed by the Federal Land Policy and Management Act of 1976, the BLM is required to consider public land scenic value as a resource that merits management and preservation, where appropriate, as determined though the land use process. Visual resources on BLM-administered land are managed in the context of the VRM system, as described in the BLM Manual 8400 Series – *Visual Resource Management* (BLM 1984).

The VRM system includes an inventory of scenic values (BLM Manual H-8410-1 – *Visual Resource Inventory* [BLM 1986a]) based on the following factors: 1) diversity of landscape features that define and characterize landscapes in a given planning area (scenic quality), 2) public concern for the landscapes that make up a planning area (sensitivity levels), and 3) landscape visibility from public viewing locations (distance zones). These factors are collectively described as the visual resource inventory (VRI) and are referred to as the VRI for BLM-administered land. Although the BLM has jurisdiction only over the land the agency manages, VRI data are often collected for most, if not all, of the land within a given BLM field office, district office, or planning area. Combined, the three VRI factors determine the VRI class of a given area. VRI classes indicate the overall existing scenic values of the visual landscape, including BLM-administered land. The VRI classes and individual factors provide baseline visual resources data that are then used, in combination with other resource needs and uses, to determine VRM classes.

VRM classes are established to provide management objectives in terms of allowable levels of disturbance and noticeability (i.e., visual contrast), with the VRM class for a given area established through the BLM's land use planning process, as described in BLM Manual H-8410-1 (BLM 1986a). As such, the BLM only has jurisdiction on BLM-administered lands for management of visual resources. The objectives, which are associated with BLM national policy for each VRM class, are defined in Table 1.

Table 1. Bureau of Land Management Visual Resource Management Classes

VRM Class	Objective
Class I	Preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and must not attract attention.
Class II	Retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen but should not attract attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
Class III	Partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
Class IV	Provide for management activities that require major modifications of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

Source: BLM (1986a).

2.1.1 California Desert Conservation Area Plan

The *California Desert Conservation Area Plan* (CDCA Plan) established by the BLM in 1980, provides management guidance for over 12 million acres of public lands across multiple BLM field offices in the Southern California desert. In 2016, the *Desert Renewable Energy Conservation Plan* (DRECP; BLM 2016) amended portions of the CDCA Plan, and in 2022, the BLM published a consolidated version that incorporates all major amendments through 2020 (BLM 2022a). For those areas of the CDCA Plan not amended by the DRECP, conformance with the original CDCA Plan requirements remains necessary.

2.1.2 Desert Renewable Energy Conservation Plan

The portion of the Phase II Expansion area that is within California is managed under the DRECP (BLM 2016), which establishes VRM classes for its administered areas according to the objectives described in Table 1. The DRECP was developed as an interagency plan by the BLM, U.S. Fish and Wildlife Service, California Energy Commission, and California Department of Fish and Wildlife to streamline renewable energy and conservation planning at the landscape level in the California desert region.

In 2016, the BLM signed the Record of Decision approving its Land Use Plan Amendment (LUPA), which completed Phase I of the DRECP. The DRECP LUPA establishes VRM classes for all lands under its direction. VRM measures from the DRECP LUPA include the following (BLM 2016):

> **LUPA-VRM-1:** Manage visual resources in accordance with the VRM classes I through IV.
>
> **LUPA-VRM-2:** Ensure that activities with each of the VRM class polygons meets the VRM objectives described above, as measured though a visual contrast rating process.
>
> **LUPA-VRM-3:** Ensure that transmission facilities are designed and located to meet the VRM Class objectives for the area in which they are located. New transmission lines routed through designated corridors where they do not meet VRM Class Objectives will require RMP amendments to establish a conforming VRM Objective. All reasonable effort must be made to reduce visual contrast of these facilities in order to meet the VRM Class before pursing RMP amendments. This includes changes in routing, using lattice towers (vs. monopole), color treating facilities using an approved color from the BLM Environmental Color Chart CC-001 (dated June 2008, as updated on April 2014, or the most recent version) (vs. galvanized) on towers and support facilities, and employing other BMPs to reduce contrast.

2.1.3 Las Vegas and Pahrump Field Offices Resource Management Plan

The portion of the Phase II Expansion area that is within Nevada is managed under the *Las Vegas and Pahrump Field Offices Updated Record of Decision for the Approved Las Vegas Resource Management Plan and Final Environmental Impact Statement* (Las Vegas RMP) (BLM 1998). This RMP includes additional management direction regarding visual resources as follows, with the bolded text identifying the differences between the RMP's direction and BLM Manual H-8410-1 (BLM 1986a):

Objective

VS-1. Limit future impacts on the visual and aesthetic character of the public lands.

Management Direction

VS-1-a. Designate 968,890 acres of public lands as VRM Class II and manage to retain the landscape's existing character. **In these areas, authorized actions may not modify existing landscapes or attract the attention of casual viewers**.

VS-1-b. Designate 1,727,870 acres of public lands as VRM Class III for partial retention of the existing character of the landscape. **In these areas, authorized actions may alter the existing landscape, but not to the extent that they attract or focus attention of the casual viewer**.

VS-1-c. Designate 635,135 acres of public lands as VRM Class IV, which allows activities involving major modification of the landscape's existing character. **Authorized actions may create significant landscape alterations and would be obvious to casual viewers**.

VS-1-d. Continue to refine the VRM inventory to refine the database, viewsheds, and scenic ratings.

2.1.4 Avi Kwa Ame National Monument Proclamation and Interim Management

BLM memorandum for management of the Avi Kwa Ame National Monument (BLM 2025) serves as interim guidance for the monument. Although it is not considered a land use planning document, it provides a framework for managing the monument until formal guidance can be established. The memorandum directs the BLM to prioritize the protection and restoration of the monument's significant cultural, ecological, and historic resources, while preserving its undeveloped character and minimizing surface disturbances. It continues application of the 1998 Las Vegas RMP where consistent, restricts motorized vehicle use to existing routes, and requires that recreational and restoration activities support the monument's protective goals. Specifically, the following items in the interim management identify the sensitivity of the area for both visual resources and dark night skies (BLM 2025):

> The Proclamation also describes the unique geology of the area, particularly the mountain ranges within the Monument boundary that support significant biological diversity and ecology, as well as the importance of the exceptional soundscape and dark night skies that exist across the landscape. Further, the Proclamation tells the story of Euro-American settlers' and traders' use and occupation of the area including the historic Walking Box Ranch site, which is listed on the National Register of Historic Places.
>
> In preparing the management plan, the Proclamation directs the Secretary [of the Interior] to take into account, to the maximum extent practicable, maintaining the undeveloped character of the lands within the Monument, minimizing impacts from surface-disturbing activities, providing appropriate access for hunting and wildlife management, and emphasizing the retention of natural quiet, dark night skies, and visual resources.

2.1.5 National Scenic and Historic Trails

The Phase II Expansion area is approximately 10 miles from the Old Spanish National Historic Trail, and the proposed utilities are located more than 5 miles away. No federally protected components (i.e., high potential historic sites or route segments) as identified in the *Old Spanish National Historic Trail Comprehensive Administrative Strategy* (BLM and NPS 2017) occur around the Project Area, and visual impacts are not expected to occur at the distance the two areas are apart from each other. A detailed analysis of the Old Spanish National Historic Trail or other evaluations for Project consistency with trail management objectives are not included in this technical report.

2.2 National Park Service

The Castle Mountain National Monument and Mojave National Preserve, located in California and administered by the NPS, are directly adjacent to portions of the utilities and are in the vicinity of the Phase II Expansion area (Figure 1). The *Mojave National Preserve Long-Range Interpretive Plan* (NPS 2004) determines goals for visitor experience, interpretation, education, and resource stewardship and makes recommendations for achieving those goals. The plan establishes that the preserve contains "outstanding scenic resources" due to a diversity of landscape types and that the preserve intends to preserve and protect those scenic resources.

The NPS has developed VRM strategies through the Visual Resource Program (VRP), which provides a systematic approach for inventorying and understanding scenic views (Sullivan and Meyer 2016). The VRP also provides tools and support for collaborative conservation efforts to protect shared views beyond NPS boundaries. The NPS VRI describes visual elements inside and outside NPS-administered lands, assesses scenic quality, and evaluates the importance of scenery to park visitors.

In 2016, the NPS developed a VRI for the Mojave National Preserve—*Enjoy the View – Visual Resource Inventory Report* (NPS 2016). The report identified a series of viewpoints throughout the preserve with viewsheds, photographs, and a description of each viewpoint. As part of the identification of Project-specific viewpoints for this Project, these locations were reviewed and noted in Table 7 where aligned with this report.

2.3 Local

2.3.1 San Bernardino Countywide Plan

The *San Bernardino County Policy Plan* (Policy Plan), an update and expansion of the County of San Bernardino's (County) General Plan, contains long-term policies and goals that guide County decisions, investments, and improvements toward achieving the countywide vision (County of San Bernardino 2026). The Policy Plan serves as the County's General Plan for unincorporated areas and includes policy direction for public safety, healthcare, and other regional services administered by the County in both incorporated and unincorporated areas. The Policy Plan contains 11 elements organized by section including the built environment, resources and conservation, safety and security, and economy and wellness.

The following policies are applicable to this assessment:

- **Policy LU-2.3 Compatibility with natural environment.** The County requires that new development is located, scaled, buffered, and designed for compatibility with the surrounding natural environment and biodiversity.

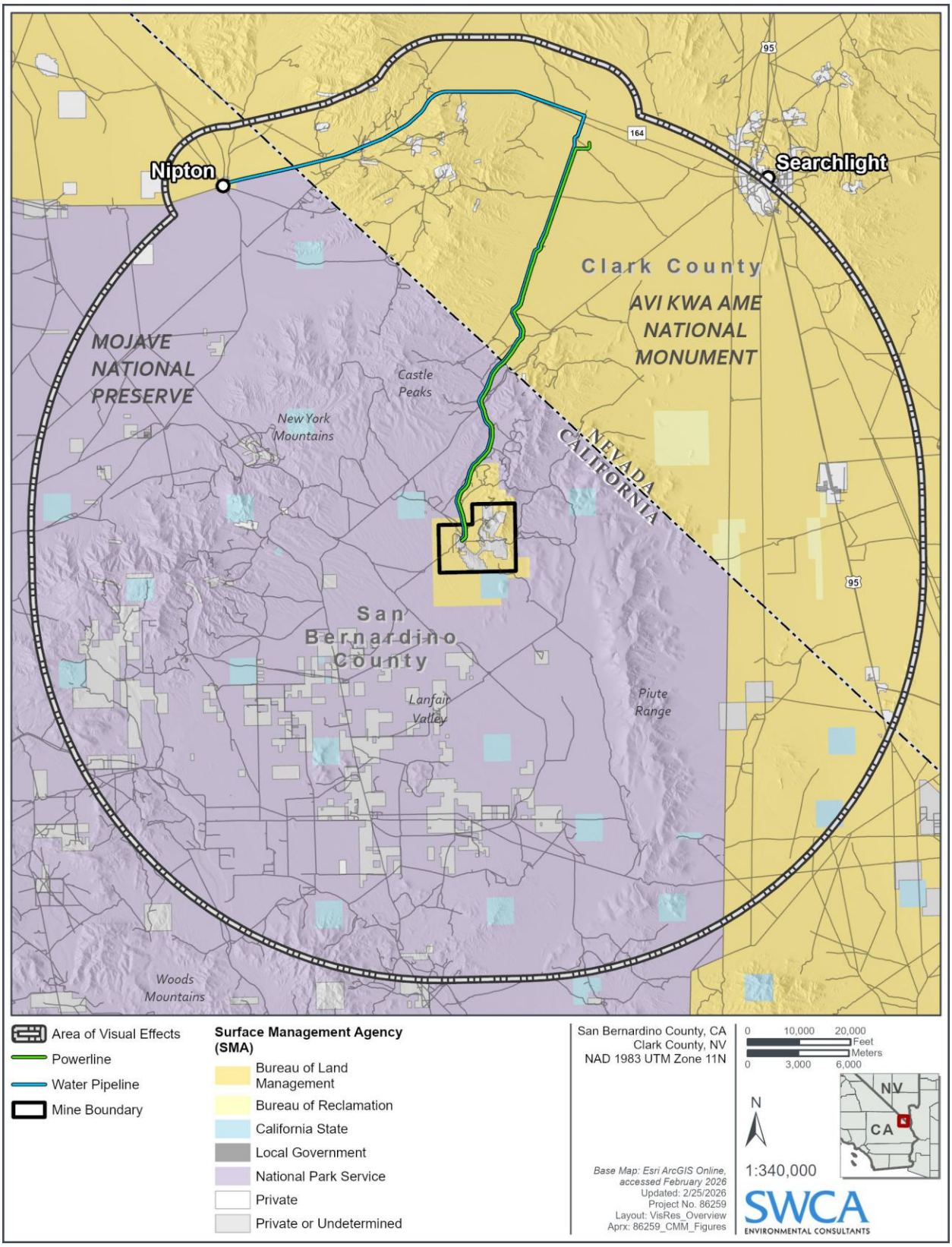


Figure 1. Project location.

- **Policy LU-4.1 Context-sensitive design in the Mountain/Desert Regions.** The County requires new development to employ site and building design techniques and use building materials that reflect the natural mountain or desert environment and preserve scenic resources.
- **Policy LU-4.7 Dark skies.** The County minimizes light pollution and glare to preserve views of the night sky, particularly in the Mountain and Desert regions where dark skies are fundamentally connected to community identities and local economies. The County also promotes the preservation of dark skies to assist the military in testing, training, and operations.
- **Policy NR-4.1. Preservation of scenic resources.** The County considers the location and scale of development to preserve regionally significant scenic vistas and natural features, including prominent hillsides, ridgelines, dominant landforms, and reservoirs.
- **Policy NR-4.2. Coordination with agencies.** The County coordinates with adjacent federal, state, local, and tribal agencies to protect scenic resources that extend beyond the County's land use authority and are important to countywide residents, businesses, and tourists.
- **Policy NR-4.3: Off-site signage**. We prohibit new off-site signage and encourage the removal of existing off-site signage along or within view of County Scenic Routes and State Scenic Highways.

2.3.2 San Bernardino County Development Code – Title 8 Mountain and Desert Requirements

San Bernardino County Development Code Section 83.07.060, *Mountain and Desert Requirements*, provides standards for outdoor lighting in the Mountain and Desert regions of San Bernardino County. Applicable standards include the following:

(a) *Shielding Required.* All outdoor light fixtures shall be fully shielded, installed and maintained in such a manner that the shielding does not permit light trespass in excess of amounts set forth in subdivision (f).

(b) *Light Pollution Standards.* Light pollution and trespass shall be minimized through the use of directional lighting, fixture location, height and the use of shielding and/or motion sensors and timers in such a manner that the light source does not permit light trespass in excess of amounts set forth in subdivision (f).

(c) *Automated Controls.* Automated control systems, such as motion sensors and timers, shall be used to meet curfew requirements set forth in subdivision (d). Photocells or photo controls shall be used to extinguish all outdoor lighting automatically when sufficient daylight is available. Automated controls should be fully programmable and supported by battery or similar backup.

(d) *Dark Sky Curfew.* All outdoor lighting shall be extinguished by 11:00 p.m., close of business, or when people are no longer present in exterior areas, whichever is later, except for the following:

(1) Lighting used for entry and exit points of a structure, parking areas, driveways and driveway ingress/egress points; or

(2) Lighting activated by a motion sensor that extinguishes no later than five minutes after activation.

(e) *Lighting Color.* The correlated color temperature of all outdoor lighting shall be 3,000 Kelvin or less except for seasonal lighting.

(f) *Allowable Light Trespass.* Outdoor lighting shall not cause light trespass exceeding one-tenths foot-candles measured with a light meter oriented vertically or horizontally either at the property line of the adjacent property or measured from some other point on the property where light trespass may be reasonably determined to occur due to differences in property or improvement elevations.

(g) *Blinking, Flashing, or High Intensity Lighting.* Permanently installed lighting that blinks, flashes or is of high intensity or brightness that causes a light trespass is prohibited.

2.3.3 Clark County Master Plan

The *Transform Clark County Master Plan* (Clark County 2021) does not contain any visual resource–related goals or policies relevant to the Phase II Expansion.

3 EXISTING CONDITIONS

Based on the issues typically identified for visual resources, this report focuses on three components: 1) existing landscape character, including the BLM VRI data; 2) viewing locations and KOPs; and 3) conformance with BLM VRM class objectives and the DRECP (BLM 2016) and Las Vegas RMP (BLM 1998). Additionally, analysis related to dark night skies is included as an issue analyzed in brief. These components were inventoried within the area of visual effects (AVE), or analysis area, defined as the area within 15 miles of the mine expansion area and 2 miles around the utilities. The AVE corresponds to the analysis area determined through viewshed analysis, comparison to similar scaled projects, and confirmation through development of visual simulations to identify the threshold for where the Project could become noticeable in the landscape.

3.1 Existing Landscape Character and Visual Resource Inventory

3.1.1 Landscape Character

The term *landscape character* refers to the overall visual and cultural impression of the landscape based on the distinct landscape attributes that exist throughout an area. Landscape character is a product of both natural and human influences on the landscape. The term landscape character is often confused with the term *scenic quality*, which instead is a measure of the intrinsic beauty of landforms, water forms, or vegetation in the landscape. Describing landscape character at the Project-level relies, in part, on understanding how the landscapes within the Project AVE fit into the regional scale. Information on physiographic provinces (Fenneman 1931) and U.S. Environmental Protection Agency ecoregions (Griffith et al. 2016) provide a starting point for examining scenery at this scale.

The AVE is within the Sonoran Desert section of the larger Basin and Range physiographic province (Fenneman 1931). The Sonoran Desert section is characterized by mountain ranges and intervening desert plains; however, the ranges are smaller, rock pediments are much more prevalent, and undrained basins are less common than typically characterized by the Basin and Range province, such as in the Great Basin section.

Further dissecting the AVE, the Level IV ecoregions identified in the AVE include Eastern Mojave Basins and Eastern Mojave Low Ranges and Arid Footslopes. The Eastern Mojave Basins ecoregion is described as creosotebush (*Larrea tridentata*)-dominated valleys below Mojave Desert mountain ranges, with white bursage (*Ambrosia dumosa*) and galleta grass (*Pleuraphis* spp.) as additional common species. The Eastern Mojave Low Ranges and Arid Footslopes ecoregion is described as having variable topography consisting of alluvial fans, basalt flows, and hills to low mountains with sparse vegetation composed of typical Mojave Desert species and cactus and yucca where conditions are suitable.

The AVE is a generally undeveloped, intact land of the Mojave Desert, predominantly comprising open space land uses. The surrounding desert landscape encompasses mountains and valleys, modern and historic mines, and far-reaching scenic vistas with elevations ranging from less than 1,000 feet to approximately 8,000 feet above sea level. Lanfair Valley exhibits characteristics consistent with the visual quality of the Mojave Desert region and is enclosed by surrounding mountains, including the Castle Mountains forming the northeastern boundary of the valley, the New York Mountains to the west, and the Piute Mountains to the southeast. Notable peaks within the surrounding area include Hart Peak at approximately 5,400 feet above sea level and Castle Mountain Peaks at approximately 5,500 feet above sea level. The existing scenery in the AVE is characterized as generally flat or gently sloping with variable topography and generally sparse vegetation ranging from Joshua tree woodland to creosote bush and blackbush scrub. Human development in the surrounding area includes the historic Barnwell and Searchlight Railroad grade, which intersects the Castle Mountains Grasslands Trail, improved and unimproved dirt roads, campgrounds, and features related to historic and present agriculture, grazing, and mining activities. Ranching features, including corrals, water tanks, and fencing, are dispersed throughout the valley and mining activities have occurred in the Castle Mountains, New York Mountains, and surrounding area.

Human modifications in the Project Area are primarily a result of past and present mining activities and development. Gold, silver, and clay mining occurred in the historic Hart Mining District since the early 1900s with commercial-scale gold mining beginning in the 1980s. CMM, including the open-pit mine and facilities to support ore extraction, crushing, milling, and heap leaching, was constructed in 1991 with interim reclamation and revegetation occurring by 2012. Reclaimed areas included the overburden rock pile and heap leach pad before mining activities resumed in 2020. Under prior mine permitting, a transmission line was approved by the BLM along the same route as the proposed but was removed in 2011, resulting in the current landscape appearing largely natural in character with limited evidence of this prior transmission line. Additional human modifications include development within the town of Nipton, California. Nipton Road (State Route [SR] 164) is a two-lane, paved state highway, intersecting the town of Nipton, with existing overhead power and communications lines running parallel to the road. The Union Pacific Railroad also intersects Nipton Road in the north–south direction.

The proposed water line extends from the town of Nipton to CMM and is sited parallel to existing linear disturbances, including the paved Nipton Road (SR 164) and the unpaved, graded Walking Box Ranch Road. The proposed transmission line extends along Walking Box Ranch Road from the ranch to CMM. An existing transmission line corridor containing two large-scale transmission lines, with galvanized steel lattice structures, crosses Nipton Road approximately 2 miles into Nevada from the California–Nevada state line, which has modified the existing setting along this portion of the highway. Most of the AVE around the mine footprint is lands within the Mojave National Preserve, which are undeveloped desert lands open for dispersed recreation and accessed by unpaved roads. The towns of Nipton and Cal-Nev-Ari, which have small residential areas and limited services, are within the AVE.

Specially designated areas, such as the Avi Kwa Ame National Monument, Wee Thump Joshua Tree Wilderness Study Area, Walking Box Ranch area of interest, and Castle Mountain, Ivanpah, Crescent Townsite, Piute-Fenner, and Piute-Eldorado Areas of Critical Environmental Concern (ACECs), occur within the AVE.

3.1.2 Visual Resource Inventory

The BLM inventories scenic values for the land the agency manages in accordance with BLM Manual H-8410-1 and specifically based on the following inventory factors: 1) scenic quality rating units (SQRUs), which range from a rating of A where landscapes are distinctive to a rating of C where landscapes are indistinctive and have a low degree of visual variety; 2) sensitivity level rating units (SLRUs), which range from high to low associated with the public's anticipated tolerance for change in the visual environment; and 3) distance zones, which include a foreground–middle ground zone (0–5 miles), background zone (5–15 miles), and seldom seen (more than 15 miles). Together, these factors determine VRI classes and the existing scenic values of the visual landscape, including BLM-administered land. For more detail regarding the BLM VRI, including the factors of scenic quality, sensitivity levels, and distance zones, refer to BLM Manual H-8410-1 (BLM 1986a). The BLM Nevada State Office updated its VRI in 2022 (BLM 2022b) and the BLM NFO established its VRI in 2010 (BLM 2010) for the lands within the AVE.

To provide the BLM with pertinent information associated with each factor of the VRI, including VRI classes, Tables 2, 3, 4, and 5 identify the acres of each VRI factor crossed by the Proposed Action (Alternative B) and Alternatives C, D, and E.

Table 2. Bureau of Land Management Scenic Quality Ratings Crossed by the Project

Project Component	Scenic Quality A Rating	Scenic Quality B Rating	Scenic Quality C Rating	N/A
Alternative B: Proposed Action				
Mine (acres)*	0.0	1,428.9	0.0	0.0
Road reroute (miles)	0.0	0.7	0.0	<0.1
Powerline (miles)	0.0	16.8	0.0	<0.1
Water pipeline (miles)	0.0	27.0	4.9	<0.1
Alternative C: Alternative Configurations of Mine Components (Difference from Proposed Action)				
Mine (acres)	--	+24.8†	--	--
Utilities (miles)	--	--	--	--
Alternative D: Backfilling to Avoid Surface Expression of South Pit Lake (Difference from Proposed Action)				
Mine (acres)	--	--	--	--
Utilities (miles)	--	--	--	--
Alternative E: Small Solar Facility for Supplementation (Difference from Proposed Action)				
Mine (acres)	--	--	--	--
Utilities (miles)	--	--	--	--
Solar site (acres)	0.0	89.6	0.0	0.0

Source: BLM (2010, 2022b)

* This value is the total acreage of permanent disturbance proposed for the mine facility within the Mine Boundary and includes acreages for the southernmost portions of the powerline and water pipeline which overlap with the Mine Boundary, but which are otherwise quantified linearly in this table (i.e., the portion of the utilities within the Mine Boundary are quantified twice in this table).

† This value was calculated from the area of the North Overburden Alternative C Expansion Area (25.4 acres) minus the North Overburden Alternative C Avoidance Area, which overlaps with an area of proposed disturbance (0.6 acre) that was quantified under the Proposed Action.

Table 3. Bureau of Land Management Sensitivity Levels Crossed by the Project

Project Component	High	Moderate	Low	N/A
Alternative B: Proposed Action				
Mine (acres)*	1,428.9	0.0	0.0	0.0
Road reroute (miles)	0.7	0.0	0.0	<0.1
Powerline (miles)	16.5	0.0	0.3	<0.1
Water pipeline (miles)	27.9	0.0	3.9	<0.1
Alternative C: Alternative Configurations of Mine Components (Difference from Proposed Action)				
Mine (acres)	+24.8†	--	--	--
Utilities (miles)	--	--	--	--
Alternative D: Backfilling to Avoid Surface Expression of South Pit Lake (Difference from Proposed Action)				
Mine (acres)	--	--	--	--
Utilities (miles)	--	--	--	--
Alternative E: Small Solar Facility for Supplementation (Difference from Proposed Action)				
Mine (acres)	--	--	--	--
Utilities (miles)	--	--	--	--
Solar site (acres)	89.6	0.0	0.0	0.0

Source: BLM (2010, 2022b)

* This value is the total acreage of permanent disturbance proposed for the mine facility within the Mine Boundary and includes acreages for the southernmost portions of the powerline and water pipeline which overlap with the Mine Boundary, but which are otherwise quantified linearly in this table (i.e., the portion of the utilities within the Mine Boundary are quantified twice in this table).

† This value was calculated from the area of the North Overburden Alternative C Expansion Area (25.4 acres) minus the North Overburden Alternative C Avoidance Area which overlaps with an area of proposed disturbance (0.6 acre) that was quantified under the Proposed Action.

Table 4. Bureau of Land Management Distance Zones Crossed by the Project

Project Component	Foreground/ Middleground	Background	Seldom Seen	N/A
Alternative B: Proposed Action (Difference from Proposed Action)				
Mine (acres)*	0.0	0.0	1,303.0	125.9
Road reroute (miles)	0.0	0.0	0.7	<0.1
Powerline (miles)	5.3	4.0	7.3	0.2
Water pipeline (miles)	20.1	4.0	7.3	0.4
Alternative C: Alternative Configurations of Mine Components (Difference from Proposed Action)				
Mine (acres)	--	--	+24.8†	--
Utilities (miles)	--	--	--	--
Alternative D: Backfilling to Avoid Surface Expression of South Pit Lake (Difference from Proposed Action)				
Mine (acres)	--	--	--	--
Utilities (miles)	--	--	--	--

Project Component	Foreground/ Middleground	Background	Seldom Seen	N/A
Alternative E: Small Solar Facility for Supplementation (Difference from Proposed Action)				
Mine (acres)	--	--	--	--
Utilities (miles)	--	--	--	--
Solar site (acres)	0.0	0.0	88.2	1.4

Source: BLM (2010, 2022b)

* This value is the total acreage of permanent disturbance proposed for the mine facility within the Mine Boundary and includes acreages for the southernmost portions of the powerline and water pipeline which overlap with the Mine Boundary, but which are otherwise quantified linearly in this table (i.e., the portion of the utilities within the Mine Boundary are quantified twice in this table).

† This value was calculated from the area of the North Overburden Alternative C Expansion Area (25.4 acres) minus the North Overburden Alternative C Avoidance Area which overlaps with an area of proposed disturbance (0.6 acre) that was quantified under the Proposed Action.

Table 5. Bureau of Land Management Visual Resource Inventory Classes Crossed by the Project

Project Component	Class II	Class III	Class IV	N/A
Alternative B: Proposed Action				
Mine (acres)*	0.0	1,303.0	0.0	125.9
Road reroute (miles)	0.0	0.7	0.0	<0.1
Powerline (miles)	5.1	11.3	0.3	0.2
Water pipeline (miles)	11.7	15.9	3.9	0.4
Alternative C: Alternative Configurations of Mine Components (Difference from Proposed Action)				
Mine (acres)	--	+24.8†	--	--
Utilities (miles)	--	--	--	--
Alternative D: Backfilling to Avoid Surface Expression of South Pit Lake (Difference from Proposed Action)				
Mine (acres)	--	--	--	--
Utilities (miles)	--	--	--	--
Alternative E: Small Solar Facility for Supplementation (Difference from Proposed Action)				
Mine (acres)	--	--	--	--
Utilities (miles)	--	--	--	--
Solar site (acres)	0.0	88.2	0.0	1.4

Source: BLM (2010, 2022b)

* This value is the total acreage of permanent disturbance proposed for the mine facility within the Mine Boundary and includes acreages for the southernmost portions of the powerline and water pipeline which overlap with the Mine Boundary, but which are otherwise quantified linearly in this table (i.e., the portion of the utilities within the Mine Boundary are quantified twice in this table).

† This value was calculated from the area of the North Overburden Alternative C Expansion Area (25.4 acres) minus the North Overburden Alternative C Avoidance Area which overlaps with an area of proposed disturbance (0.6 acre) that was quantified under the Proposed Action.

Since the VRI distance zones delineated by the BLM are not specific to the viewing locations associated with this Project (see Section 3.2, *Viewing Locations and Key Observation Points*), the following focuses more specifically on the SQRUs and SLRUs crossed by the Project. Together, SQRUs and SLRUs identify the landscape's diversity and visual appeal as well as the public's concern for maintaining the area's scenic quality. The concept of distance zones has been incorporated into the viewing location and KOP portion of the visual impact assessment (see Section 4.1, *Analysis Methods*). Table 6 provides a list of the SQRUs crossed by the Project, along with the associated levels of sensitivity (based on overlapping SLRUs), and the SQRUs are illustrated in Figures 2 through 5.

Table 6. Bureau of Land Management Scenic Quality Rating Units and Associated Sensitivity Levels Crossed by the Project

SQRU Name	SQRU Rating (A, B, C)	Associated Sensitivity Levels (high, moderate, low)
Castle Flats	B	High
Castle Mountains	B	High
Ivanpah Valley	C	High
McCullough Range	B	High, Low
New York Mountain	B	High
Piute Valley	B	High, Low
Primm Valley	C	High

Source: BLM (2010, 2022b)

3.1.2.1 NATIONAL PARK SERVICE

The VRI for the Mojave National Preserve (NPS 2016) found that visitors can experience expansive landscape views that characterize the scenery of the Mojave Desert. Of the six views that were inventoried, five are free of significant visual disturbances from industrial developments and retain very high scenic inventory values. One view is impacted by the Ivanpah Solar Facility, which reduces its scenic inventory value to low. The Project is visible from two views, but its distance from viewers reduces its visual contrast and the overall very high scenic inventory value of those areas is retained.

3.1.3 Dark Night Skies

Dark night skies contribute to the recreation experience that many people seek when they visit BLM-managed areas. Light pollution diminishes the aesthetic and wilderness values of the night sky by making it difficult to see fainter stars or other faint celestial objects (BLM 2023). Optimal night skies are free of scattered light or skyglow, which is generated by anthropogenic light from development, transportation, or industrial operations. The scattering of artificial light in the atmosphere increases night sky luminance and erodes the visual appearance of stars and planets. In review of *The New World Atlas of Artificial Night Sky Brightness* (Falchi et al. 2016) in the context of the AVE, the Project would be located in an area with Bortle Class 2 and 3 plus night skies (Figure 6). These are defined as:

- Bortle Class 2 (0.01–0.11 ratio of artificial sky brightness to natural brightness): Typical truly dark-sky site where the background sky has a slightly gray shade due to atmospheric scattering or distant airglow on the horizon, where some deep sky objects are visible to the naked eye.
- Bortle Class 3 (0.11–0.33 ratio of artificial sky brightness to natural brightness): Some evidence of light pollution is evident and clouds appear fainty illuminated near the horizon, with the Milky Way still appearing complex and with a few deep sky objects being visible to the naked eye.

The closest certified Dark Sky Park is Death Valley National Park, which is located approximately 70 miles from the Project Area. Proclamation 10533 established the Avi Kwa Ame National Monument, which overlays with all of the BLM-administered land crossed in Nevada by the proposed utilities, and identified the following language regarding dark night skies:

> The Avi Kwa Ame area's desert location and geography also allow for a soundscape that is among the most naturally quiet in the United States. Additionally, the area’s exceptional dark skies, rare in highly populated Clark County, have been noted for the excellent stargazing opportunities they offer and for benefits to migratory birds (BLM 2023).

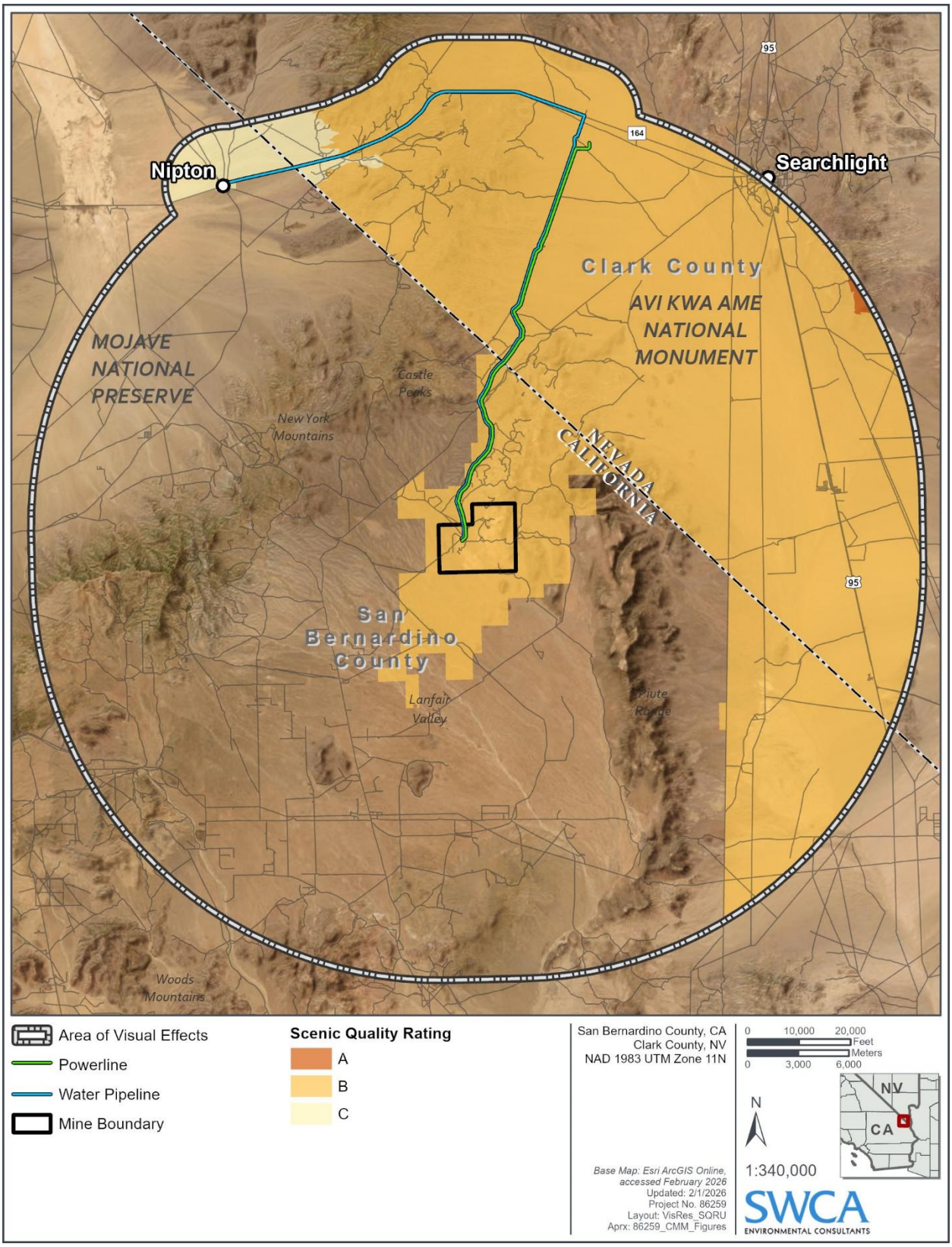


Figure 2. Bureau of Land Management scenic quality rating units.

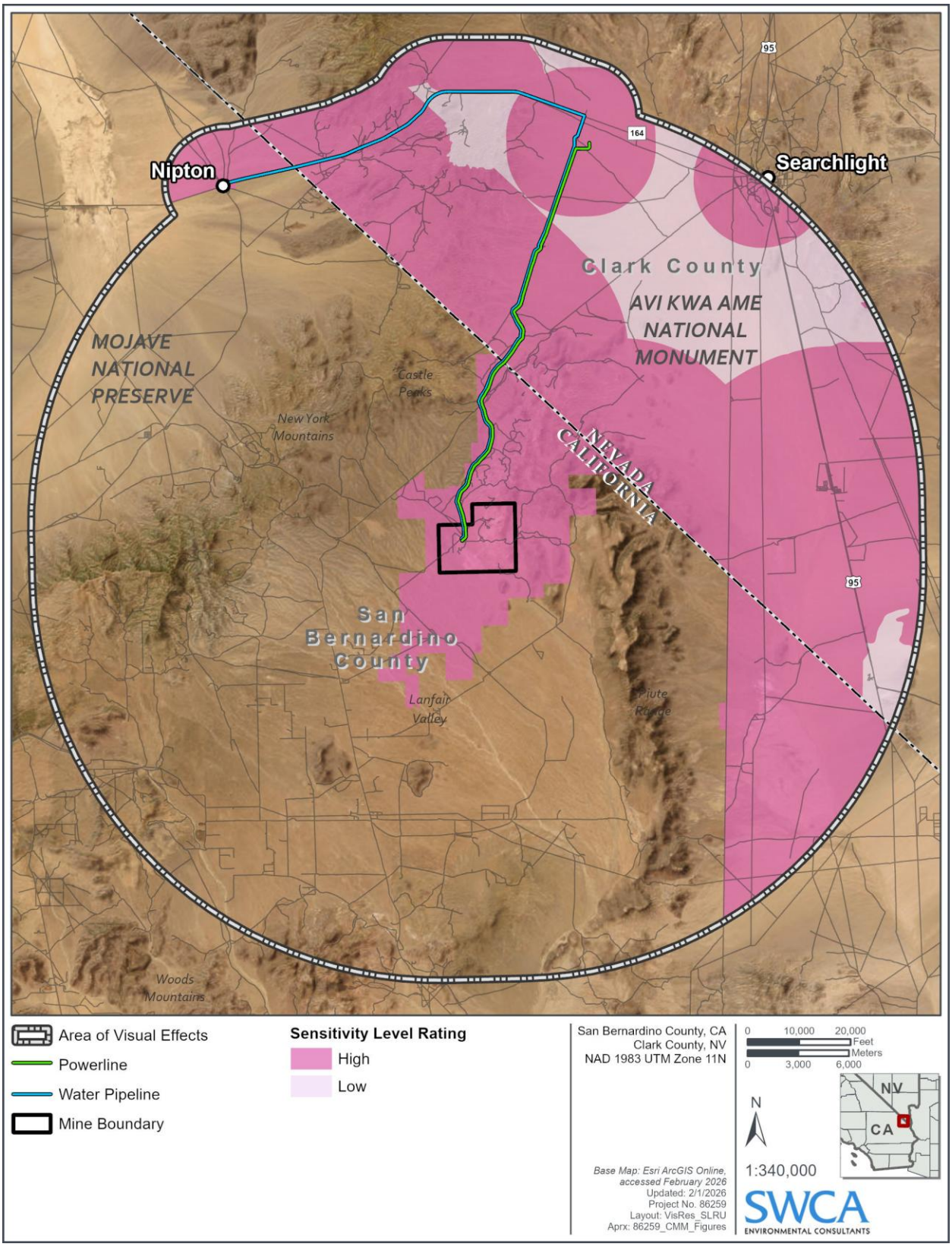


Figure 3. Bureau of Land Management sensitivity level rating units.

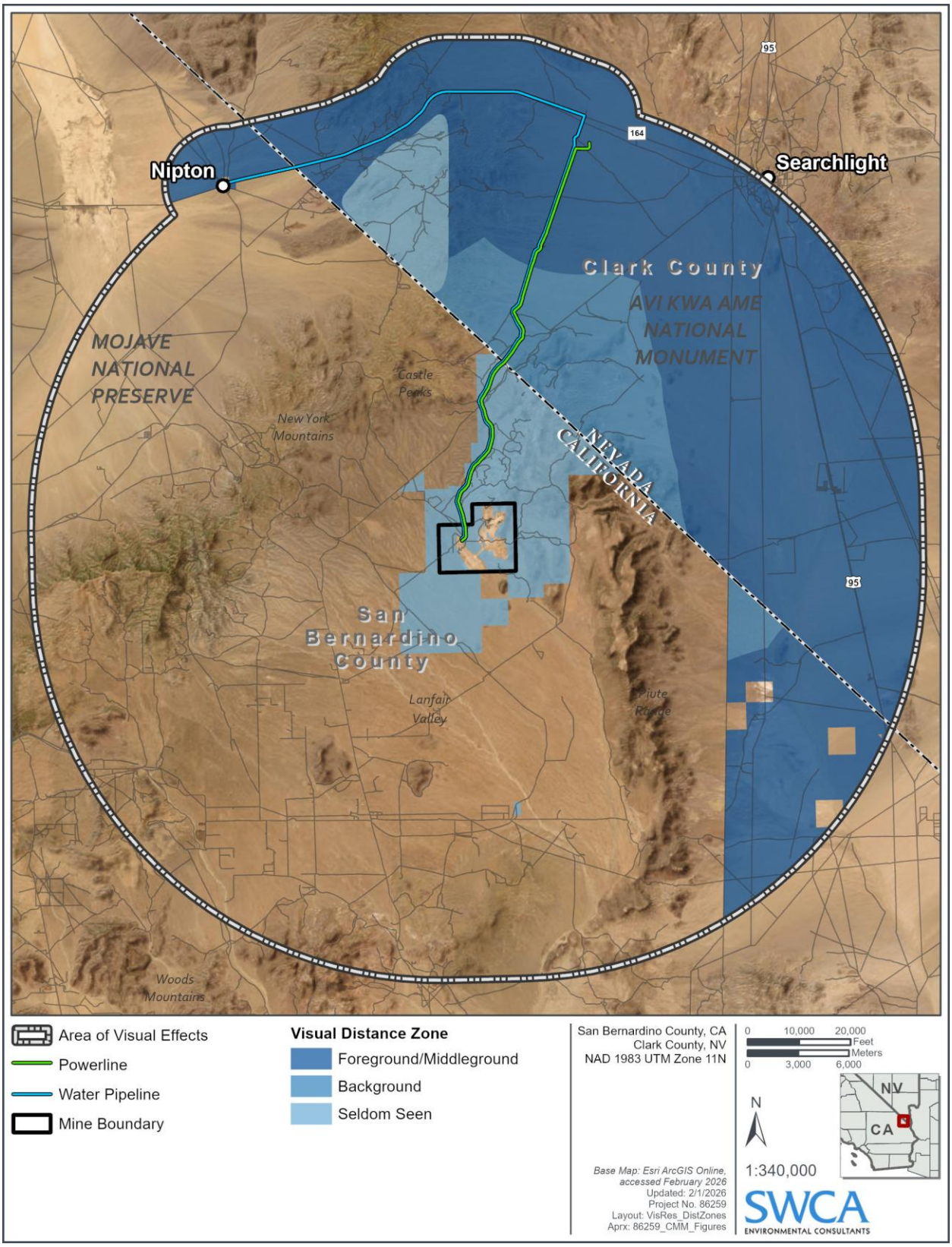


Figure 4. Bureau of Land Management distance zones.

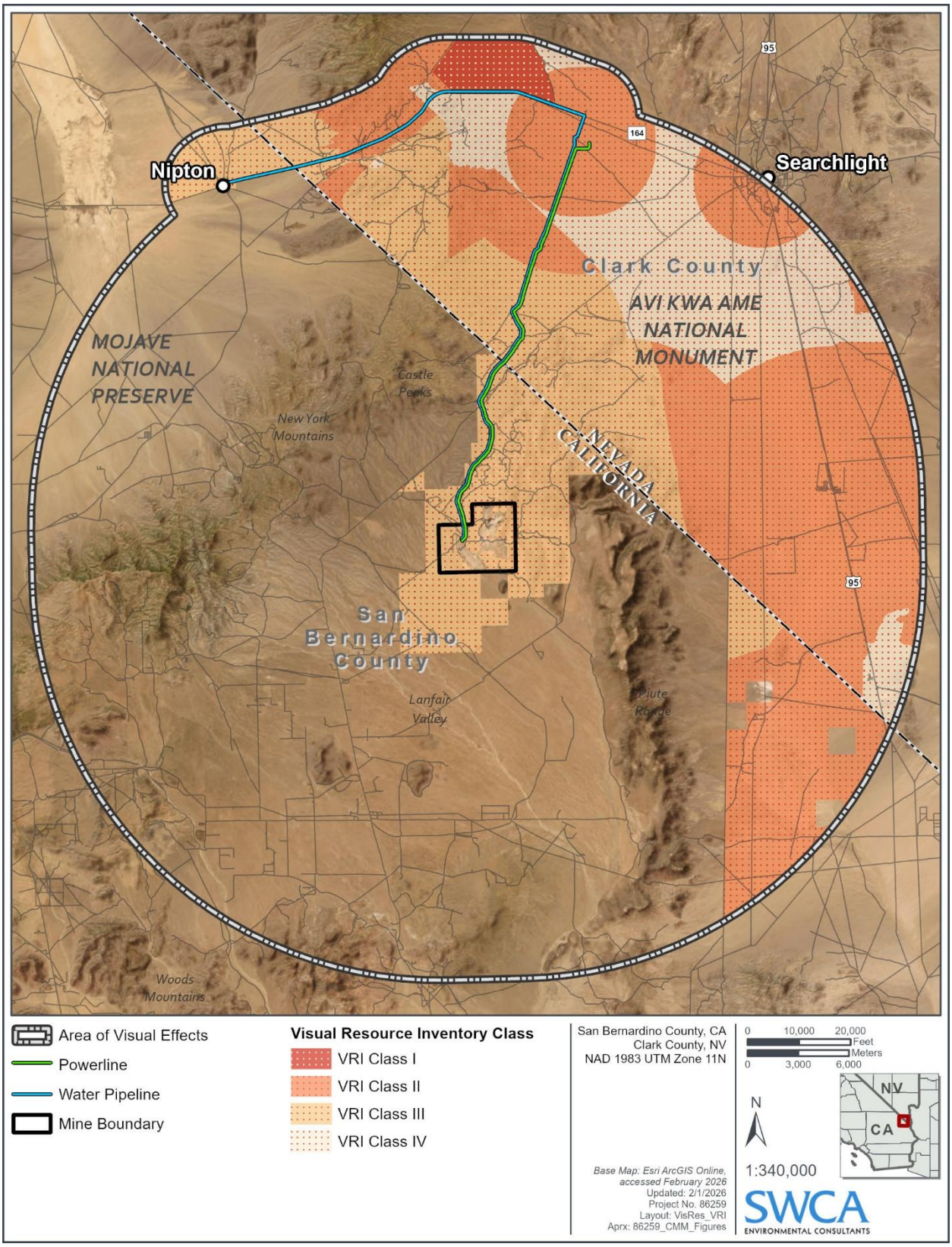


Figure 5. Bureau of Land Management visual resource inventory classes.

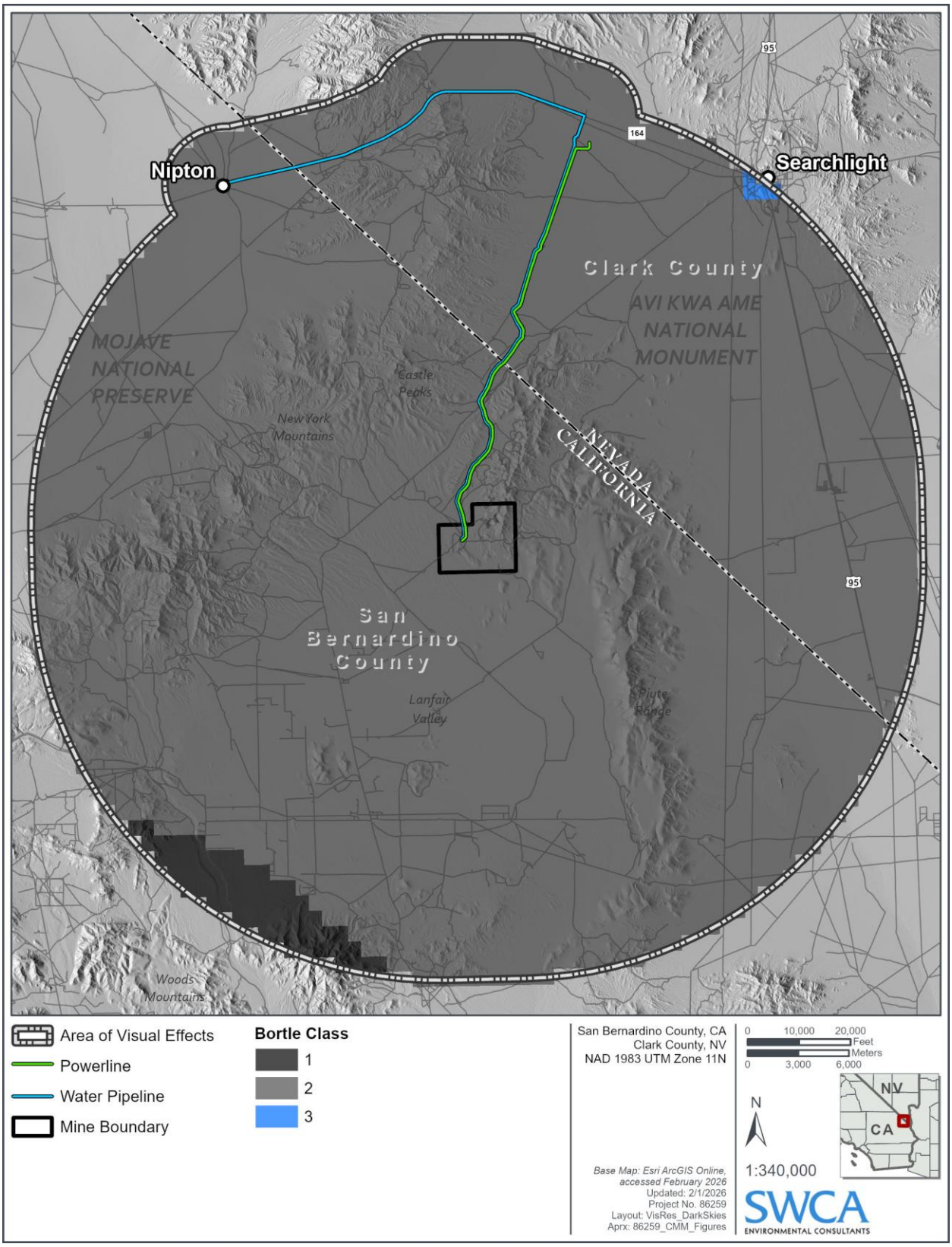


Figure 6. Bortle classes.

Additionally, through coordination with the BLM, it was identified that the friends of Avi Kwa Ame began the process to designate the Avi Kwa Ame National Monument as a Dark Sky Park in 2024, including light monitoring that was conducted in 2025. This is based on the limited extent of light pollution within this portion of Clark County Nevada, with dark night skies primarily being impacted by sky glow from the communities of Las Vegas, Bullhead City, Searchlight, and Primm.

Since the proposed utilities do not include lighting during operations, impacts would be primarily during construction. The mining portion of the Project would include lighting but would follow the same best management practices (BMPs) from the 1998 Record of Decision (ROD), which current mining operations are operating under, and *BLM Technical Note 457, Night Sky and Dark Environments: Best Management Practices for Artificial Light at Night on BLM-Managed Lands* (BLM 2023) are employed on any new lighting sources, no detailed analysis is needed.

Through application of these BMPs, long-term impacts to dark night skies would be minimized through the application of BMPs, which will be detailed in the Project's Lighting Plan. Impacts on dark night skies are further detailed in Section 4, *Impact Assessment*, of this report.

3.2 Viewing Locations and Key Observation Points

The identification of viewing locations and KOPs form the basis for determining impacts on viewers and their views as well as the assessment of conformance with BLM VRM classes. KOPs are defined in BLM Manual 8400 as "one or a series of points on a travel route or at a use area or potential use area, where the view of a management activity would be most revealing" (BLM 1984:8). BLM Manual 8431 – *Visual Resource Contrast Rating* expands on this definition for assessing linear projects (BLM 1986b:2):

> Linear projects such as power lines should be rated from several viewpoints representing:
>
> - Most critical viewpoints (e.g., views from communities, road crossings)
> - Typical views encountered in representative landscapes, if not covered by critical viewpoints
> - Any special project or landscape features such as skyline crossing, river crossings, substations, etc."

For this analysis, viewing locations were identified where the public would potentially have views of the Project, including from residential areas, travel routes, recreation areas, and specially designated areas, represented both by static viewpoints (e.g., campground, scenic overlook, etc.) and from linear viewpoints (e.g., highways, trails, etc.). A viewshed analysis was prepared from the Project Area looking outward to determine from where in the landscape the Project could be visible, to assist in identifying the location of Project KOP locations. Separate viewsheds were run for the proposed transmission line, water pipeline, and mining areas, which are included in this report as Figures 7, 8, and 9. Note, the viewshed associated with the mining areas was completed by Westland with the viewsheds associated with the water pipeline and transmission line were developed by SWCA Environmental Consultants (SWCA). Visibility was determined through a geographic information system (GIS) line-of-sight analysis using proposed Project elevations and digital elevation models. The viewshed analysis was prepared using a bare earth modeling approach, which is a conservative assessment of Project visibility as the analysis does not account for screening effects from vegetation or buildings that could block or partially block some views.

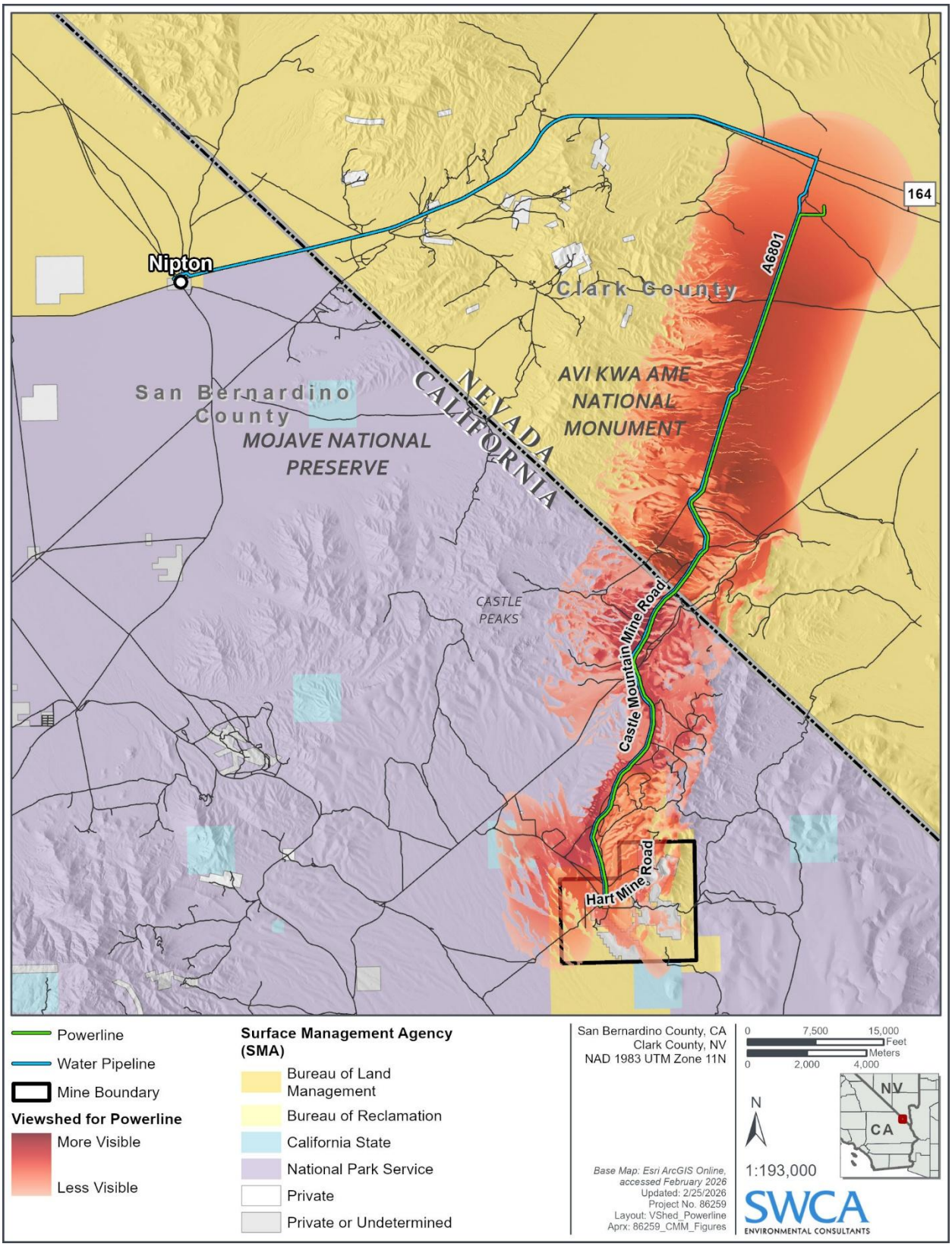


Figure 7. Proposed transmission line viewshed.

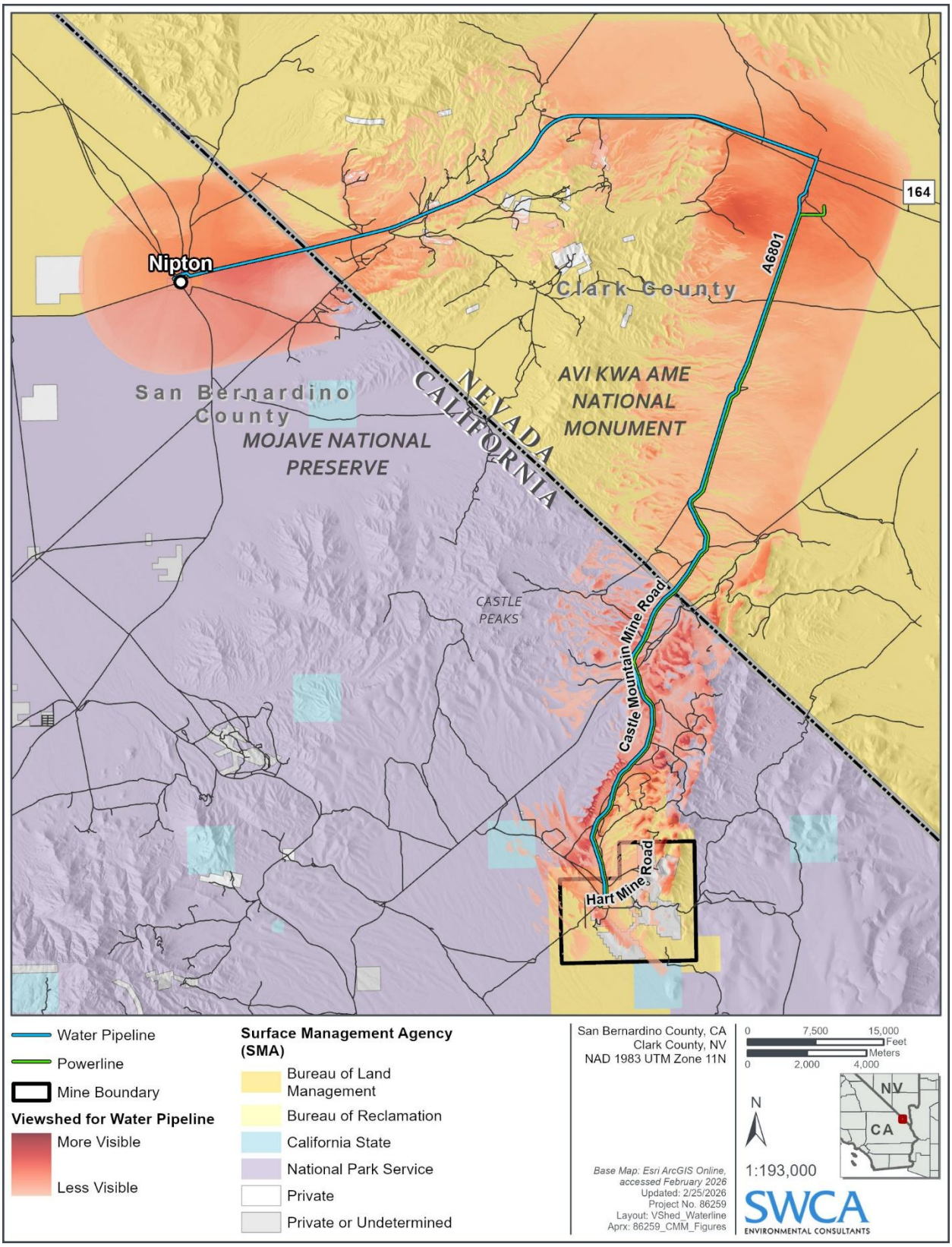


Figure 8. Proposed water pipeline viewshed.

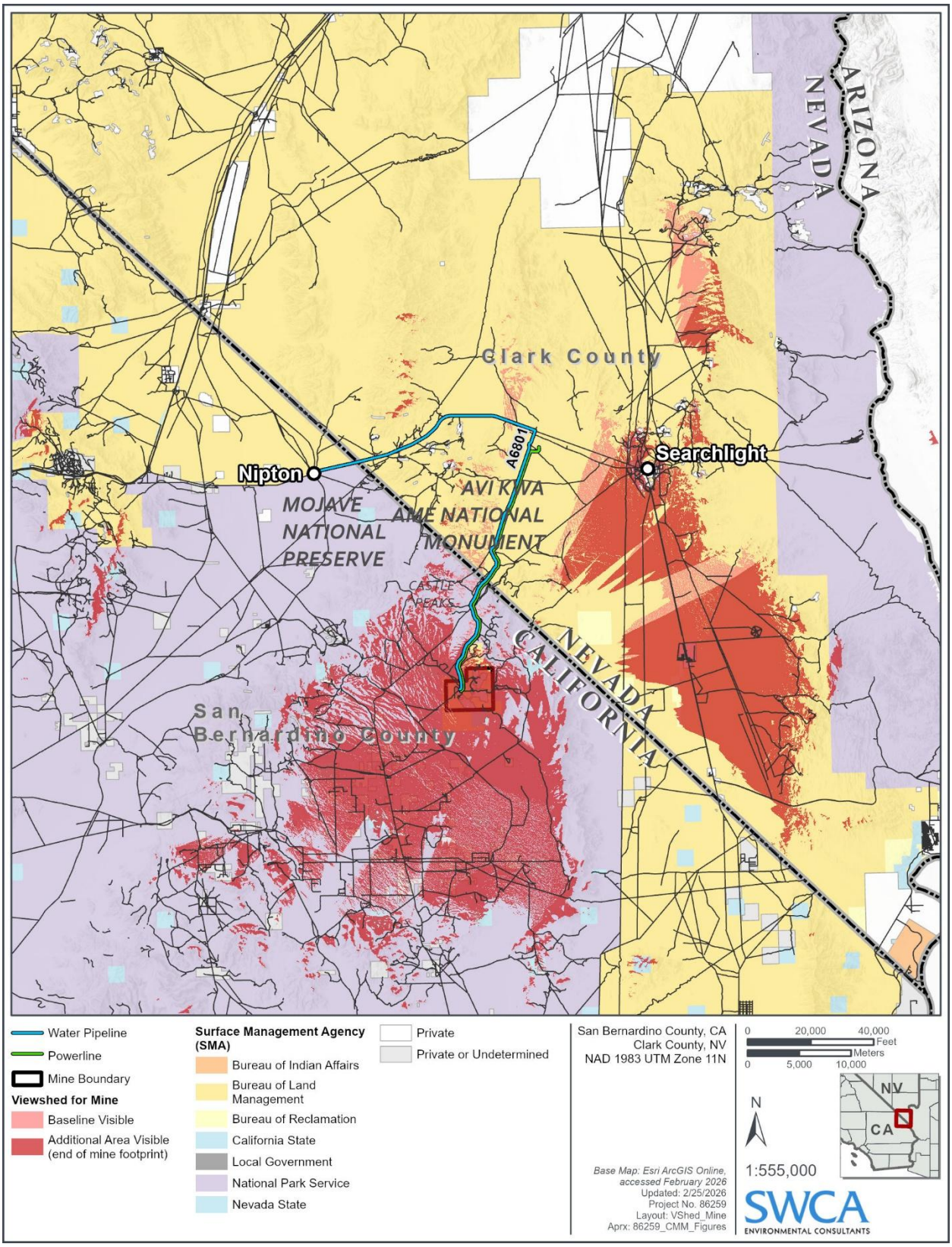


Figure 9. Proposed mining expansion viewshed.

Responding to BLM Manual 8431 (BLM 1986b) requirements, and to form a consistent baseline for the Project, 15 KOP locations were identified throughout the AVE, including views from BLM, NPS, and private land. The Old Spanish National Historic Trail roughly parallels U.S. Highway 95 in this area, located more than 5 miles east of the proposed transmission line and water line, but occurs in an area with no federal protection components such as high potential historic sites, high potential historic route segments, or auto tour routes. Therefore, no additional analysis was conducted in response to the requirements of BLM Manual 6280 – *Management of National Scenic and Historic Trails and Trails Under Study or Recommended as Suitable for Congressional Designation* (BLM 2012).

A total of 13 visual simulations were prepared from 12 of the agency-approved KOP locations to illustrate impacts on viewing locations and to assess conformance with agency visual management objectives; simulations are included in Appendix A.

Integral to the identification of KOPs is the determination of viewer sensitivity associated with each KOP, which corresponds to their expected sensitivity to changes in the viewshed. The process for assigning viewer sensitivity for the Project KOP locations was based on the sensitivity levels criteria in BLM Manual H-8410-1 (BLM 1986a). In general, views from residential areas and along designated scenic roads (e.g., national, state, or local scenic byways and other scenic drives) were assigned a high sensitivity, as it is anticipated that there would be a greater desire and expectation for viewing intact, naturalistic landscapes. Views from U.S., interstate, and state highways, not designated as scenic, and other travel routes were assigned a moderate sensitivity, as the landscape would be viewed in key locations but would not be dependent on the use of these viewing locations. Table 7 summarizes the agency-approved KOP locations, the viewer type and viewer sensitivity, the rationale for selection, and whether a visual simulation was developed. The KOP locations, in context with the Project, and land ownership are displayed on Figure 10.

Table 7. Key Observation Point Locations

KOP Number	KOP Name	Viewer Type	Viewer Sensitivity	Distance to Project Area	BLM VRM Class Crossed	Rationale for Selection	Visual Simulation
Proposed Action (Alternative B) and Alternatives C–E							
1	Ivanpah Road (NPS)	Travel Route/ Recreation	High	5 miles	Class III and IV (CA)	Existing KOP, similar to a location from the Mojave Preserve Inventory Report, views of the proposed mining area, with some activities occurring on VRM Class III lands.	Yes
2	Hart Mine Road (NPS)	Travel Route/ Recreation	High	2 miles	Class III and IV (CA)	Existing KOP with views of the proposed mining area, with some activities occurring on VRM Class III lands.	Yes

KOP Number	KOP Name	Viewer Type	Viewer Sensitivity	Distance to Project Area	BLM VRM Class Crossed	Rationale for Selection	Visual Simulation
Proposed Action (Alternative B) and Alternatives C–E							
3	Lanfair Buttes (NPS)	Recreation	High	6 miles	Class III and IV (CA)	Existing KOP with views of the proposed mining area, with some activities occurring on VRM Class III lands. This location is also near the Eagle Well KOP from the Mojave Preserve Inventory Report, but the NPS site was selected with the focus on the petroglyph site, and the NPS viewshed map indicates no visibility of the mine area.	Yes
4	Castle Mountain Mine Road	Travel Route	Moderate	Adjacent to Project Area	Class III and IV (CA)	Existing KOP with views of the proposed mining area, with some activities occurring on VRM Class III lands.	Yes
5	Spirit Mountain	Recreation	Moderate	18 miles	Class III and IV (CA viewed from NV)	Existing KOP (within Avi Kwa Ame National Monument) with distant views of the proposed mining area, with some activities occurring on VRM Class III lands.	Yes
6	Walking Box Ranch Road	Travel Route/ Recreation	Moderate	Adjacent to Project Area	Class II (NV)	Existing KOP adjacent to Walking Box Ranch with views of the proposed pipeline and transmission line, occurring on VRM Class II lands within the Avi Kwa Ame National Monument.	Yes
7	SR 164 (Wee Thump Joshua Tree Wilderness Study Area [WSA])	Travel route	Moderate	Adjacent to Project Area	Class II (NV)	Existing KOP with views of the proposed pipeline occurring on VRM Class II lands within the Avi Kwa Ame National Monument. Note: KOP photographs were taken from the proposed ROW and not from the roadway.	Yes

KOP Number	KOP Name	Viewer Type	Viewer Sensitivity	Distance to Project Area	BLM VRM Class Crossed	Rationale for Selection	Visual Simulation
Proposed Action (Alternative B) and Alternatives C–E							
8	Walking Box Ranch (near entrance)	Recreation	High	Adjacent to Project Area	Class II (NV)	Existing KOP with views of the proposed pipeline, occurring on VRM Class II lands within the Avi Kwa Ame National Monument.	Yes
9	Walking Box Ranch (Big House - south)	Recreation	High	0.25 mile	Class II (NV)	Existing KOP with views of the proposed pipeline and transmission line, occurring on VRM Class II lands within the Avi Kwa Ame National Monument.	Yes
10	Walking Box Ranch (Big House - southwest)	Recreation	High	0.25 mile	Class II (NV)	Existing KOP with views of the proposed pipeline and transmission line, occurring on VRM Class II lands within the Avi Kwa Ame National Monument.	Yes
11	Nipton Road	Travel route	Moderate	Adjacent to Project Area	Class III (CA)	Proposed KOP from Nipton Road with views of Nipton and the proposed pipeline paralleling the road on VRM Class III lands.	No
12	SR 164 (near NV/CA border)	Travel route	Moderate	Adjacent to Project Area	Class II (NV)	Proposed KOP from the highway with views of the proposed pipeline adjacent to an existing transmission corridor on VRM Class II lands within the Avi Kwa Ame National Monument.	No
13	SR 164 (McCullough Range)	Travel route	Moderate	Adjacent to Project Area	Class II (NV)	Proposed KOP from the highway with views of the proposed pipeline traversing rolling terrain with limited visual influence from the existing transmission line corridor on VRM Class II lands within the Avi Kwa Ame National Monument.	Yes

KOP Number	KOP Name	Viewer Type	Viewer Sensitivity	Distance to Project Area	BLM VRM Class Crossed	Rationale for Selection	Visual Simulation
Proposed Action (Alternative B) and Alternatives C–E							
14	Castle Mountain Mine Road (realignment area)	Travel route	Moderate	Adjacent to Project Area	Class III and IV (CA)	Proposed KOP from the roadway with views of the proposed road realignment, pipeline, and transmission line on VRM Class III and IV lands. Under Alternative E, also includes views of the proposed solar facility.	Yes
Alternative E Only							
15	Castle Mountain recreation road	Recreation	Moderate	Adjacent to Project Area	Class III and IV (CA)	Proposed KOP from the recreation route with views of the proposed solar facility under Alternative E on VRM Class III and IV lands.	No

Another consideration for assessing impacts on views from KOPs associated with proposed solar facilities is the influence of lighting conditions and the consideration of the intensity of reflection or shadowing (discussed in further detail in Section 4.1, *Analysis Methods*).

Since the Project would be located more than 7 miles from any existing public airport and based on direction from *Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports* (Federal Aviation Administration [FAA] 2021), a glint and glare analysis was not completed as part of this technical report.

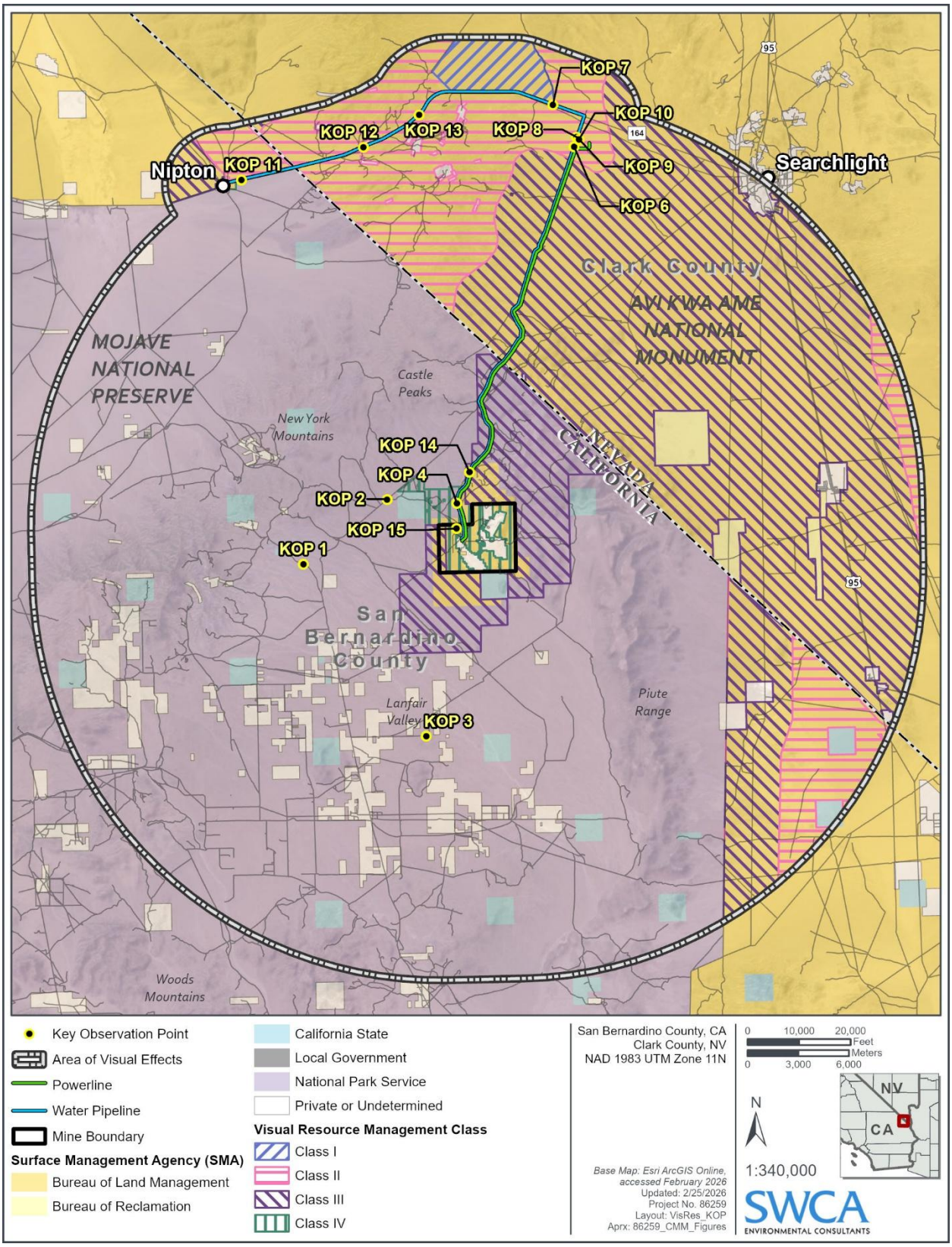


Figure 10. Viewing locations and key observation points.

3.3 Bureau of Land Management Visual Resource Management Classes and Resource Management Plan

The BLM identifies VRM classes on land the agency administers through the land use planning process to guide project-level decisions. The BLM manages visual resource values in accordance with VRM objectives designated in RMPs. BLM Manual 8431 (BLM 1986b) defines four VRM class objectives (Classes I through IV; see Table 1 for definitions) that describe an allowable level of change that can occur to the landscape character and the allowable amount of attention the change can attract. For this Project, based on specific VRM Class objective language contained in the Las Vegas RMP (BLM 1998), conformance was assessed using the more restrictive definitions contained in the RMP instead of those in BLM Manual H-8410-1 for the portion of the Project in Nevada. Conformance with VRM class objectives is assessed from Project-specific KOPs using a contrast rating analysis to evaluate the level of contrast resulting from the Project, compared with the existing landscape character and the definition of the applicable VRM class objective. Contrast rating worksheets were prepared using BLM Form 8400-4 – *Visual Contrast Rating Worksheet* from each KOP and are included in Appendix B. Photographs, taken at KOP locations where no visual simulations were prepared, are included in Appendix C. The acres of each BLM VRM class occupied by the Project are listed in Table 8.

Table 8. Bureau of Land Management Visual Resource Management Classes Crossed by the Project

Project Component	Class II	Class III	Class IV	N/A
Alternative B: Proposed Action				
Mine (acres)*	0.0	62.4	1,239.9	126.6
Road reroute (miles)	0.0	0.4	0.2	<0.1
Powerline (miles)	1.1	13.4	2.1	0.2
Water pipeline (miles)	13.1	15.9	2.1	0.6
Alternative C: Alternative Configurations of Mine Components (Difference from Proposed Action)				
Mine (acres)	--	--	+24.8†	--
Utilities (miles)	--	--	--	--
Alternative D: Backfilling to Avoid Surface Expression of South Pit Lake (Difference from Proposed Action)				
Mine (acres)	--	--	--	--
Utilities (miles)	--	--	--	--
Alternative E: Small Solar Facility for Supplementation (Difference from Proposed Action)				
Mine (acres)	--	--	--	--
Utilities (miles)	--	--	--	--
Solar site (acres)	--	32.3	56.0	1.3

Source: BLM (1998, 2016).

* These values are the total acreage of permanent disturbance proposed for the mine facility within the Mine Boundary and includes acreages for the southernmost portions of the powerline and water pipeline which overlap with the Mine Boundary, but which are otherwise quantified linearly in this table (i.e., the portion of the utilities within the Mine Boundary are quantified twice in this table).

† This value was calculated from the area of the North Overburden Alternative C Expansion Area (25.4 acres) minus the North Overburden Alternative C Avoidance Area which overlaps with an area of proposed disturbance (0.6 acre) that was quantified under the Proposed Action.

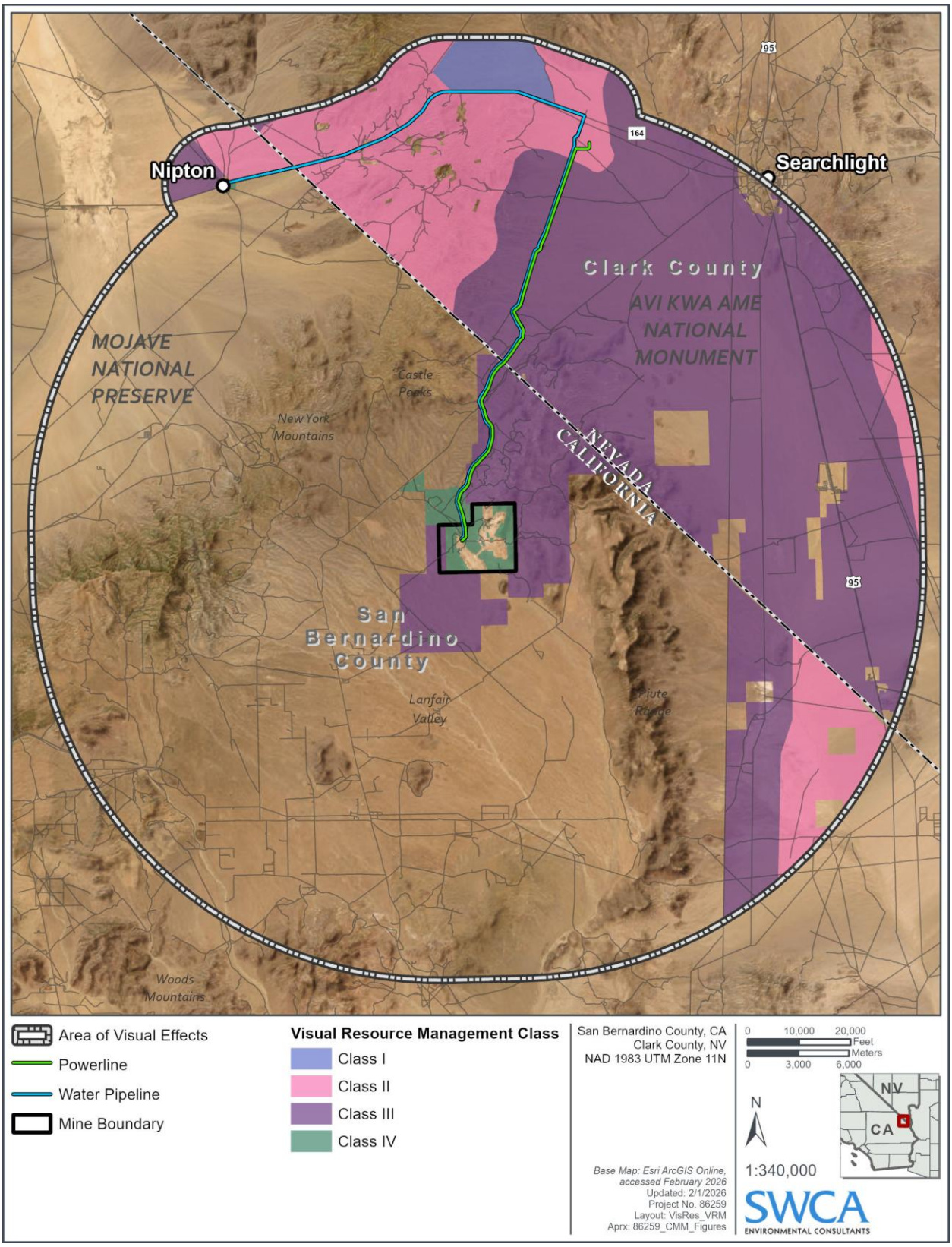


Figure 11. Bureau of Land Management Visual Resource Management classes.

4 IMPACT ASSESSMENT

Based on the existing conditions, this section outlines the methods used to conduct the visual impact assessment and describes the visual impacts resulting from the construction, operation, and decommissioning of the Project.

4.1 Analysis Methods

The assessment of impacts on visual resources includes three components: 1) landscape character, including the BLM VRI; 2) viewing locations and KOPs; and 3) conformance with BLM VRM class objectives. Additionally, a brief analysis related to dark night skies is included in the following landscape character impact discussions.

The evaluation of impacts was based on the level of visual contrast. Visual contrast is defined as the degree of visual change introduced by a Project, as indicated by modifications to basic design elements (form, line, color, and texture), compared to the existing visual setting. Visual contrast was assessed based on a range of contrast from strong to weak using the criteria from BLM Manual 8431 (BLM 1986b):

- None – the element contrast (the Project) is not visible or perceived
- Weak – the element contrast (the Project) can be seen but does not attract attention
- Moderate – the element contrast (the Project) begins to attract attention and begins to dominate the characteristics landscape
- Strong – the element contrast (the Project) demands attention, will not be overlooked, and is dominant in the landscape

Specifically, the level of visual contrast was determined through comparison of the Project's proposed structural elements with structures in the existing landscape (structure contrast), the extent of anticipated ground disturbance (landform contrast), and modifications to existing vegetation patterns (vegetation contrast). This concept of visual contrast, made up of landform, vegetation, and structure contrast, parallels the KOP contrast rating process as described in BLM Manual 8431 and as depicted on BLM Form 8400-4. For example, the Project would have a stronger level of structure contrast where no existing transmission lines would be paralleled, compared to areas where the Project would parallel existing transmission lines or be in proximity to other built elements in the landscape. Likewise, if the Project is located in or traverses steep terrain, requiring the construction of new access roads and additional earthwork for Project development, the level of landform contrast would be higher than if the Project is located in or traverses a flat basin landscape where less extensive earthwork would be required. Similarly, if the Project requires removal of dense overstory vegetation, the proposed change would result in a higher level of contrast compared to clearing a grassland or shrub community, which could be blended with existing vegetation patterns. In regard to visual contrast produced by proposed mining activities, the level of contrast would be higher where existing mining activities are not visible compared to areas where the proposed mining activities would appear as an expansion of existing activities.

After assessing the level of visual contrast introduced by the Project, impacts on landscape character and on views from identified viewing locations (KOPs) were identified using the following approach. Impacts on landscape character were assessed by comparing the level of visual contrast with the delineated BLM scenic quality rating (A, B, or C) and sensitivity level (high, moderate, and low) to determine the magnitude of visual impacts as described in Table 9. Impacts on viewing locations were assessed by evaluating visual contrast and viewshed analysis in context with the distance to the Project and viewer sensitivity (moderate or high) based on the criteria outlined in Table 9. If impacts were found to be

between the low, moderate, and high impacts identified in Table 9, low-moderate and moderate-high impact levels were identified to provide additional impact thresholds to describe the intensity of impacts. The assessment to determine conformance with BLM VRM classes and BLM RMPs was conducted from BLM-approved KOPs using BLM Form 8400-4 (see Appendix B).

The NPS does not have the equivalent of VRM classes that must be met for regulatory purposes. For consistency, the same contrast rating process to assess impacts is used for KOPs within the Mojave National Preserve and Castle Mountain National Monument.

Table 9. Criteria for Assessing Level of Impacts on Visual Resources

Impact Level	Impacts on Landscape Character	Impacts on Viewing Locations	Conformance with BLM VRM Classes
Negligible	Landscape would appear unaltered, and Project elements would not be visually evident. Project elements would repeat the form, line, color, texture, or scale common in the landscape.	Project components would repeat form, line, color, texture, or scale common in the landscape and would not be visually evident to the casual observer.	Would meet VRM Class I
Low	Landscape would appear slightly altered. Project elements would introduce form, line, color, texture, or scale common in the landscape would be visually subordinate, and would not attract attention.	Project elements would introduce form, line, color, texture, or scale common in the landscape and would create weak contrast compared with other features in the landscape when viewed. The Project would be seen but would not attract the attention of the casual observer.	Would meet VRM Class II
Moderate	Landscape would appear to be moderately altered, and Project elements would begin to dominate the visual setting. Project elements would introduce form, line, color, texture, or scale not common in the landscape and would be visually prominent in the landscape.	Project elements would introduce form, line, color, and texture that would attract the attention of the casual observer and would create moderate contrast compared with other features in the landscape when viewed.	Would meet VRM Class III
High	Landscape would appear to be heavily altered, and Project elements would dominate the visual setting. Project elements would be out of scale or contain detail that is out of character with the existing landscape.	Project elements would introduce form, line, color, and texture that would be visually dominant for the casual observer and would dominate the visual setting, creating strong contrast compared with other features in the landscape.	Would meet VRM Class IV

To support the visual impact discussions, the following visual terminology is used in this report:

- Viewer position (angle of observation)
    - Inferior: Viewer is below the Project in elevation.
    - Level (or neutral): Viewer is at the same elevation as the Project.
    - Superior: Viewer is above the Project in elevation.
- Project visibility factors
    - Screening: A visual barrier consisting of earth, vegetation, structures, or other materials that blocks a particular view or the actual blocking of a view through the use of a visual barrier.
    - Intervening screening: A visual barrier located between a viewer and the Project and consisting of earth, vegetation, structures, or other materials that block a particular view.

  - Unobstructed: Views of the Project would not be screened by landforms, vegetation, or structures, allowing for the extent of the Project to be visible.
  - Skylining: Siting of a structure on or near a ridgeline so that it is silhouetted against the sky as seen from a specified viewpoint.
  - Backdropped: The landscape, seascape, or sky visible directly behind the elements of a facility, as seen from a particular viewpoint.
- Scale: The proportionate size relationship between an object and the surroundings in which the object is placed.
- Glare: The sensation produced by luminance within the visual field that is sufficiently greater than the luminance to which the eyes are adapted, which causes annoyance, discomfort, or loss in visual performance and visibility.
- Glint: A momentary flash of light resulting from a spatially localized reflection of sunlight.

Photorealistic simulations (simulations) were developed from 12 of the 15 identified KOP locations. Visual simulations are included in Appendix A with simulations from KOPs 1 through 10 produced by Truescape, and downloaded from https://equinox-castle-mountain.truescape.com/1.13/index.html#/, with the simulations from KOPs 13 and 14 developed by SWCA using the following methodology. Existing condition photographs were taken using a camera with standard focal lengths to represent the human field of view to the extent possible. To create photographic simulations, a 3D to-scale digital model of mining activities, transmission lines, and other Project features was developed using engineering data and was placed in the photographic view, taking into consideration Project topography (elevation) and distance from the observation point. Within the simulated 3D environment, realistic materials and textures were applied to the proposed Project design data. The time of day and date were set within the simulated environment, so the lighting and shadows cast on the models represent the same conditions within the site photographs. Simulated mining activities, transmission lines, and other Project features were then aligned to the photographs, and the model was rendered and composited to create the visualizations.

The Project's Utility Plan of Development (POD) and Mine Plan of Operations (MPO) contain a series of Applicant-committed design features intended to reduce impacts on visual resources, including specific aspects of the Project design. The Project design and mitigation measures were developed considering measures and techniques identified in BLM Manual 8431 (BLM 1986b). The proposed visual impact–reducing measures and design elements include the following:

- Utilities:
  - **AQ-1:** During Project construction, the disturbed soil will be wetted, chemically treated, or treated by other means satisfactory to the Authorized Officer, sufficiently to effectively reduce airborne dust and reduce soil erosion. Additionally, prudent vehicle speeds will be maintained to minimize fugitive dust created by travel.
  - **AQ-2:** Construction and maintenance activities will be conducted to minimize disturbance to vegetation adjacent to the ROWs.
  - **AQ-3:** All construction vehicle movement outside the ROWs will be restricted.
  - **SOIL-1:** To minimize erosion from storm water runoff, construction areas will be maintained consistent with the best management practices (BMPs).
  - **DF-1:** Water will be used during construction activities to minimize fugitive dust to the extent practicable. Additionally, prudent vehicle speeds will be maintained to minimize fugitive dust created by travel on unpaved surfaces.
  - **DF-10:** Following construction, the short-term water line ROW will be recontoured and revegetated, as necessary, and CMV will maintain the long-term ROWs, as necessary.

Reclamation activity is described below in Section 6 [of the POD]. Standard water pipeline maintenance and repair activities will occur with a minimal frequency of approximately one inspection per month and mainly to check for leaks. Repair activities will occur as needed to maintain or replace existing equipment. Regular maintenance of the overhead powerline is not anticipated and any post-construction activities will most likely be power line or pole repairs. CMV will utilize water to control fugitive dust to the extent practicable during maintenance.

- **RECL-1:** Powerline closure includes removing and recycling the overhead wiring, cutting the wood poles at or near ground level, and removing cable supports or other ancillary surface equipment.
- **RECL-2:** Water pipeline closure includes draining the water line, excavating both ends of the pipeline, and sealing the pipeline at those locations, followed by reburial. This closure technique is the industry standard for buried utilities known as closure-in-place. Any surface equipment or vaults will also be removed, and the pipeline will be sealed and reburied at those locations.
- **RECL-3:** During initial ground preparation and construction, affected vegetation will be crushed rather than bladed when it is feasible to do so. Vegetation that is not salvaged will be removed and stockpiled out of the way. This material can be reapplied during reclamation for use as a vertical mulch; it has also proven beneficial for seed stabilization during the germination period.
- **RECL-5:** Plant salvage will focus on the (eastern) Joshua tree, Mojave yucca, and (red) barrel cactus. All these species of a reasonable size will be salvaged by the bare root method and placed in temporary furrows adjacent to the project work area. Salvage may also be limited in the higher elevations that exhibit surface bedrock conditions. It could be possible to augment or replace some plant salvaging with the planting of these species from stock propagated at the greenhouse facility located at the CMM. This will be further defined in a final reclamation plan approved by the BLM.
- **RECL-6:** Following the construction of the proposed facilities, stockpiled growth media will be reapplied to areas of surface disturbance. Any salvaged plants will also be transplanted within the short-term ROW areas during this step.
- **RECL-7:** The short-term water line ROW area will be seeded with a local certified weed-free seed mixture. The seed mix and application method will be pre-approved by the BLM and included in a final reclamation plan. Seed will either be collected locally or purchased from a commercial vendor. Prior to beginning reclamation, a post-reclamation watering and monitoring schedule will be provided to the BLM for review and approval.
- **RECL-9:** Monitoring for reclamation success will follow the methods stated in the Castle Mountain Mine 2022 MPO and Reclamation Plan (2022 Plan). Standardized linear transects or plots (typically two meters by ten meters in size) will be used to record perennial plant density and diversity. Revegetation monitoring will be conducted to qualitatively evaluate native plant establishment and vigor, to identify and make recommendations for correcting problems (weeds, lack of progress), and to quantitatively measure the development of the reclaimed habitat to determine its progress to the established success criteria. An Annual Revegetation Monitoring Report will be prepared to summarize revegetation and monitoring efforts for ten years or until deemed successful by the observed results and review by the BLM. Based on the monitoring results, and upon consultation with the BLM, additional remedial activities may include additional seeding, plant protections, and/or a change of seed mix.

- Mining Area:
    - **5.10.1-2:** The South Extension pit will only have a minor portion backfilled. Specifically, the existing approved South Extension pit will be backfilled. The remaining South Extension pit will be the only one left open post-mining. Reclamation of the open portion of the South Extension pit includes ripping the pit floors and haul roads, applying growth media, and seeding and/or replanting nursery stock. The focus will include seeding pit floors and benches with native vegetation preferred by local fauna, including desert bighorn sheep.
    - **5.10.1-4:** Rock staining will not be applied since prior rock staining investigations carried out at the site during past reclamation proved unsuccessful, and the lead agencies previously waived this requirement. *Note: See Section 5,* Selective Mitigation Measures*, of this report regarding suggested selective mitigation measures.*
    - **5.10.1-8:** Growth media will be distributed to form soil hammocks across the tops of overburden sites. Outside these islands, growth media will be blended with the course overburden to present the optimal growing medium that produced the best results from the interim reclamation completed at CMM. As part of the final recontouring of these areas before revegetation, the micro-catchment basins would be formed to channel rainfall into specific areas, trap seeds, and reduce erosion.
    - **5.10.2-1:** When mining has been completed and ore stockpiles processed, structures and equipment will be disassembled for salvage and removal. Since the Processing Plant and solution handling facilities will have to remain in service until the Heap Leach Pad has been rinsed and decommissioned, the unneeded facilities will be the first to be dismantled.
    - **5.10.2-3:** The foundations for primary facilities have large reinforced concrete structures. These foundations will be buried in place during decommissioning using growth media or rinsed heap leach material. Foundations for the other minor structures will be buried in place whenever practical or broken up and buried in the basins at the heap leach site before they are filled in and topped with growth media.
    - **5.10.3-2:** Solution storage tanks will be disassembled and sold for salvage or scrap value. When the basins are backfilled, concrete ring foundations beneath the tanks will be buried in place.
    - **5.10.3-3:** After the tanks have been removed, the liners in the basins will be freed from anchor trenches, folded in on themselves, and covered with broken concrete from building foundations, slabs, and water-well pads. These materials will then be covered with fill materials, primarily overburden. Final grading of the surface, including the application of "soil islands" of growth media, will reestablish approximate pre-mining contours, thus restoring pre-mining drainage patterns in this area.
    - **5.10.4-1:** Spent ore material on the heap leach piles will be detoxified by circulating rinse water or a neutralizing solution through the heaps until the residual cyanide concentrations are reduced to levels stipulated in the RWQCB [Regional Water Quality Control Board] waste discharge permit. Extensive sampling (per a RWQCB approved closure plan) will confirm the pile detoxified and spent ore piles will be graded to 2.5H:1.0V slope to assure long-term stability. During grading, micro-catchment basin depressions will define the slopes of the heap leach pile. The effect from these micro-basins is included in Figure 5-8 [of the MPO], showing the initial formation of the contouring and resulting vegetation success. These have been used extensively and to great effect at the project site; they benefit seed germination and vegetation survival by locking seeds in place, promoting rain retention on the pile (versus run-off), and preventing the otherwise resulting erosion.

- **5.10.4-3:** Some mounding of the heap tops will be done during regrading. This will serve two purposes: (1) small-scale reduction of visual contrast with surrounding landforms and (2) micro-catchment hollows and depressions to direct surface flows to selected sites for revegetation purposes.
- **5.10.5-1:** Unneeded buildings and structures will be dismantled and removed to continue reclamation and monitoring. Concrete footings, slabs, and foundations will be buried in place or in the basins near the Process Area.
- **5.10.6-3:** Aboveground utilities will be removed. Underground utilities will be drained, sealed, and covered, and all other equipment and materials will be removed from the site.
- **5.10.7-1:** Site roads, parking lots, and portions of access roads designated by the BLM for closure will be reworked, ripped, and revegetated. As directed by the BLM and the County, other roads will remain open to the public following the mine closure. Roads assumed to stay open for post-mining use are identified in Figure 2-9 [of the MPO**]**.
- **5.12.1-1:** Perimeter fencing around the mine site will remain following reclamation to restrict access and protect revegetated areas.
- **5.12.2-1:** CMV and regulatory agencies, including the BLM, State, and County, annually review the reclamation plan to evaluate progress and establish bonding requirements for the ensuing year. The county must also conduct an annual inspection of the site to review reclamation activities.
- **5.12.2-3:** Vegetation inventories will be performed on reclaimed areas. These inventories will measure perennial species' density, diversity, and other biometric information using ten linear quadrats (each 6 x 100 feet). Photo point transects will be established to measure visual aspects. Revegetation success on each reclaimed area will be monitored annually for the first two years after planting and at three-year intervals after that or until success.
- **5.13.1 -4:** This Plan and the Conditions of Approval provide for alternative slopes as described in Section 5.9.1 [of the MPO]. Having the option to place overburden at the angle of repose, with intermediate benches, provides an alternative that offers long-term stability, disturbs less land, maximizes the amount of growth media available for use in other areas, and resembles other existing topographic features in the area.
- **5.13.2-3:** When revegetation standards have been achieved, the BLM will determine when fencing should be removed to provide access for authorized uses.

4.2 Impacts of Alternative A: No Action Alternative

Under the No Action Alternative, the BLM would not issue the ROW grant and the Project would not be constructed. There would be no Project-specific impacts to visual resources. However, existing and reasonably foreseeable trends and actions would continue to affect these resources in the AVE. Anticipated actions in the AVE include the remediation of the Eldorado-Pisgah-Lugo transmission line, the renewal of a communication tower ROW, and the construction of an access road. The fine, angular appearance of mining disturbance; linear, continuous roadways; columnar powerline monopoles; and geometric structures associated with the communities of Nipton and Cal-Nev-Ari and the Walking Box Ranch area of interest are evident in the AVE and would continue to influence viewers and the area’s landscape character.

4.3 Impacts of Alternative B: Proposed Action Alternative

This section describes the effects of the Proposed Action during construction, operation, and decommissioning of the Project.

4.3.1 Construction

4.3.1.1 LANDSCAPE CHARACTER AND VISUAL RESOURCE INVENTORY

Impacts on visual resources during construction would primarily be associated with dust and with increased activity (e.g., the movement of vehicles and equipment) that would attract attention from the viewpoints nearest the Project and would not attract attention where it is concealed from the casual viewer. During construction, the removal of vegetation and earthwork would introduce areas of exposed soil, which would contrast with the existing setting until vegetation has been restored.

Construction of the underground water pipeline in generally level terrain, with slightly rolling terrain near mountain passes, would require some ground modification, resulting in moderate short-term visual impacts. The pipeline ROW parallels Nipton Road and Walking Box Ranch Road and would be in the foreground of the residents of Nipton and travelers on those roadways. Construction of the pipeline would require 18 months.

Similarly, construction of the powerline would occur over generally level terrain until its terminus into the mine area where the terrain is slightly undulating around the Castle Mountains. Some ground modification would be required, which would result in moderate short-term visual impacts. The powerline ROW parallels Walking Box Ranch Road and would be in the foreground of travelers on that roadway. Powerline construction would require 1 year.

Construction of the mine's ancillary facilities, such as administrative offices, in level and rolling terrain would require low ground modification, resulting in negligible short-term visual impacts. Construction of the mine's ancillary facilities would occur over a period of up to 24 months. Most of the ancillary facilities would be located centrally within the Project Area and would be screened from viewers around the mine by topography and vegetation.

It is assumed that the majority of the viewers of the Project would be travelers on Nipton Road. The period of time that construction of the utilities would occur near Nipton Road and in the foreground of viewers would be a shorter timeframe than the entire duration of the construction period. The mine facility is screened from view from Nipton Road and construction activities would not be generally perceivable, apart from viewpoints nearest the Project.

4.3.1.2 VIEWING LOCATIONS AND KEY OBSERVATION POINTS

Impacts common to all KOPs during construction include views of additional vehicular traffic, associated dust, and areas of exposed soil after the removal of vegetation and during earthwork activities. These impacts would occur for 12 to 18 months for the utilities and up to 24 months for construction of the mine's ancillary facilities. Impacts would cease after construction is complete and vegetation has been restored.

Views from KOP 4 would be most affected as it is in the immediate foreground of both the mine expansion area and utilities and views of those areas would be unobstructed. Views from KOPs 6 through 14 would be moderately affected, as they are adjacent to the proposed utilities, which would be in the foreground of travelers on the roadways and views of the activities would be unobstructed. Views from

KOPs 1, 2, 3, and 5 looking toward the mine would be less affected, as the distance of the viewpoints on recreational roads and the presence of tall vegetation (e.g., Joshua trees) provides visual screening and construction activities would be obscured.

4.3.2 Operation

4.3.2.1 LANDSCAPE CHARACTER AND VISUAL RESOURCE INVENTORY

The Project would introduce forms, lines, colors, and textures associated with the underground water pipeline, overhead powerline, and mine expansion that would alter the characteristic landscape during the operational phase of the Project. The visual impact would range from low to moderate depending on viewer location around the AVE. In general, the utilities are sited near existing linear roadway developments, but in areas where no existing underground utility scars or overhead utility infrastructure occur, which increases visual impact. The mine expansion areas are relatively large in scale but are sited next to visually similar landforms (existing topography and mining disturbance), which decreases the visual impact from that component of the Project.

The underground water pipeline would be located within a 31.6-mile-long, 6-foot-deep, and up to 30-inch-wide trench, which would create a long, low ground surface scar along its alignment for several years until the salvaged plants and native vegetation recover. The overhead powerline would include repetitive wooden monopole structures up to 70 feet tall along a 16.8-mile-long alignment. The mine expansion would increase the surface area disturbance by 1,428.9 acres and would create visual contrast through exposed soils and landform changes. The utilities would introduce vegetation patterns and structure contrasts, which are not present in the existing landscape. The utilities and mine expansion would occur within scenic quality Class B and C landscapes and within high and low sensitivity viewing areas (see Figures 2 and 3). The mine expansion and overhead powerline would have a greater impact on scenic quality and viewership than the pipeline since its low profile would compose a more subtle feature. The Project would have a minor impact on the VRI components, since the utilities are small in scale compared to the overall landscape and the mine expansion area would be visually congruent with the existing mining disturbance. The presence of the Project expands the footprint of human-made disturbances within the AVE and may impact recreational viewers in the area if they are seeking to experience intact desert landscapes in the vicinity of the Project. Most of the AVE is publicly accessible land with minimal development, which would retain its remote feel and unique scenery of the Mojave Desert while the Project is operating.

The Project is sited amid rolling topography, which screens its components from view in some areas. From viewpoints adjacent to the Project, the mine components would occur in the foreground of the viewer and would attract attention. Alternatively, viewpoints setback from the Project would not be as affected as the visibility of the components would be diminished. CMV would implement design features and mitigations (see Section 4.1, *Analysis Methods*) to reduce the visual impact of the Project to the extent practicable.

The Project would not result in any specific impacts to the BLM VRI beyond those identified on the Class B- and C-rated SQRUs and on views described in Section 4.3.2.2, *Viewing Locations and Key Observation Points*, associated with the inventoried high and low sensitivity SLRUs. Similarly, the Project would not modify the identification of the BLM foreground/middle ground visual distance zone in the AVE or determination of VRI Class II, III, and IV based on the other VRI factors.

Impacts to night skies associated with development of the Project would include the addition of lighted facilities within the mine area for safety and functionality. Mining operations would occur continuously (24 hours per day), so some light sources, including on buildings, vehicles, and equipment, would be

illuminated overnight. The utilities would not require lighting. The long-term nighttime lighting required for mining operations would contribute to sky glow and adversely affect night skies which would last for the duration of the Project. The scale of lighting effects would vary based on conditions such as cloud cover and weather, including precipitation events.

The nearest Dark Sky Park in the vicinity of the Project is Death Valley National Park, which is located 70 miles to the northwest at its nearest border. The lighting associated with the Project would not be expected to impact the park from that distance. However, the lighting sources may have the potential to slightly increase brightness in recreation areas in the vicinity of the Project Area (i.e., the public lands within the NPS- and BLM-administered areas).

Impacts related to light pollution of night skies would be mitigated and minimized through development of a lighting plan, including the planning principles and the identification of BMPs, as detailed in *Night Sky and Dark Environments: Best Management Practices for Artificial Light at Night on BLM-Managed Lands* (BLM 2023). Six principles frame the selection and presentation of artificial light at night, as follows:

1. Light only if needed: Use alternatives to permanent lighting.
2. Light only when needed: Use lighting control technologies.
3. Light only where needed: Shield lights and direct them properly.
4. Light color matters: Select amber, orange, or red whenever possible.
5. Use the minimum level of illumination necessary: Avoid over-illumination.
6. Use energy-efficient lights and advanced lighting controls: Save energy while adding useful lighting capabilities.

Specific BMPs suggested by the BLM include having a lighting plan prepared by a qualified lighting designer, selecting luminaires certified to minimize light pollution, identifying light-sensitive receptors, conducting a baseline study of existing light pollution and night sky conditions, and establishing a lighting and light pollution monitoring program. At the time of preparing this report, Applicant-committed design (mitigation) measures to reduce impacts to night skies associated with the Project included in the 1998 ROD include shielding night lighting to direct illumination to the area of the activity requiring the lighting. A set of selective mitigation measures have been identified in Section 5, *Selective Mitigation Measures*, of this report. The application of BLM BMPs, Applicant-committed design measures, and selective mitigation measures would mitigate, limit, and prevent impacts on night skies associated with development of the Project.

The Las Vegas RMP does not mention night skies as a resource and does not provide any direction or management for the leases identified; therefore, conformance with that RMP is not applicable. The DRECP identified standard practices to protect resource values within its administered lands. The Conservation and Management Actions **LUPA-BIO-13** and **LUPA-BIO-16** include the following guidelines developed to protect wildlife, but which are applicable to night lighting and will be incorporated into Project design:

- Long-term nighttime lighting on Project features will be limited to the minimum necessary for Project security, safety, and compliance with FAA requirements and will avoid the use of constant-burn lighting.
- All long-term nighttime lighting will be directed away from riparian and wetland vegetation, occupied habitat, and suitable habitat areas for Focus and BLM Special Status Species. Long-term nighttime lighting will be directed and shielded downward to avoid interference with the

navigation of night-migrating birds and to minimize the attraction of insects as well as insectivorous birds and bats to Project infrastructure.

- Using lighting that does not attract birds and bats or their prey to Project sites including using non-steady burning lights (red, dual red and white strobe, strobe-like flashing lights) to meet FAA requirements, using motion or heat sensors and switches to reduce the time when lights are illuminated, using appropriate shielding to reduce horizontal or skyward illumination, and avoiding the use of high-intensity lights (e.g., sodium vapor, quartz, and halogen).

4.3.2.2 VIEWING LOCATIONS AND KEY OBSERVATION POINTS

Table 10 summarizes the assessment of impacts on KOPs, including the distance to the Project Area, viewer position, level of visual contrast, magnitude of impact, and impact description, and more thorough impact descriptions for each KOP are provided below. The visual simulations are presented in Appendix A. The visual contrast rating worksheets prepared for KOPs 1 through 15 are presented in Appendix B. Non-simulated photographs as captured from KOPs 11, 12, and 15 are presented in Appendix C.

Table 10. Impacts on Views from Key Observation Points

KOP Number	KOP Name	Viewer Type	Distance to Project Area	Viewer Position	Level of Visual Contrast	Magnitude of Impact	Impact Description
Proposed Action (Alternative B) and Alternatives C–E							
1	Ivanpah Road (NPS)	Travel Route/ Recreation	5 miles	Superior	Weak-moderate	Low-moderate	The Project would be visible from this KOP and would increase the extent of the existing mining disturbance with similar but larger features. The Project would attract attention but would not dominate views from this KOP.
2	Hart Mine Road (NPS)	Travel Route/ Recreation	2 miles	Level/ superior	Weak-moderate	Low-moderate	The Project would be visible from this KOP and would increase the extent of the existing mining disturbance with similar but larger features. The Project would attract attention but would not dominate views from this KOP.
3	Lanfair Buttes (NPS)	Recreation	6 miles	Level	Weak-moderate	Low-moderate	The Project would be visible from this KOP and would increase the extent of the existing mining disturbance with similar but larger features. The Project would not attract attention from this KOP.

KOP Number	KOP Name	Viewer Type	Distance to Project Area	Viewer Position	Level of Visual Contrast	Magnitude of Impact	Impact Description
Proposed Action (Alternative B) and Alternatives C–E							
4	Castle Mountain Mine Road	Travel Route	Adjacent to Project Area	Level	Moderate-strong	Moderate-high	The mine expansion areas and utilities are in the foreground of viewers from this KOP. Because of the close proximity, the introduced features appear relatively tall and would dominate viewer attention.
5	Spirit Mountain	Recreation	18 miles	Inferior (mine)	Weak	Low	The Project would alter the appearance of the landforms around the Project Area with the introduction of expanded mine facilities. However, from this viewing distance, the contrast of the Project is diminished and would not attract attention.
6	Walking Box Ranch Road	Travel Route/ Recreation	Adjacent to Project Area	Level	Weak	Low	The utilities are sited parallel with the roadway. The introduction of the overhead powerline and underground water pipeline ground surface scar would be in the foreground of viewers for around 16 miles within generally undeveloped desert scenery. This component of the Project would be visible but would repeat the patterns associated with the previously authorized and constructed transmission line, which was removed in 2011.
7	SR 164 (Wee Thump Joshua Tree Wilderness Study Area [WSA])	Travel route	Adjacent to Project Area	Level	Weak	Low	The underground water pipeline ROW is sited parallel to the roadway, and the ground surface scar would be in the foreground of viewers for around 14 miles. This component of the Project would attract attention until the restoration efforts are successful and vegetation is reestablished in the cleared areas.

KOP Number	KOP Name	Viewer Type	Distance to Project Area	Viewer Position	Level of Visual Contrast	Magnitude of Impact	Impact Description
Proposed Action (Alternative B) and Alternatives C–E							
8	Walking Box Ranch (near entrance)	Recreation	Adjacent to Project Area	Level	Weak	Low	The utilities occur around the Walking Box Ranch area. The underground water pipeline ROW is generally concealed from view by intervening vegetation, and the powerline structures are somewhat visible. The Project would not attract attention.
9	Walking Box Ranch (Big House - south)	Recreation	0.25 mile	Level	Weak	Low	The utilities occur around the Walking Box Ranch area. The underground water pipeline ROW is generally concealed from view by intervening vegetation, and the powerline structures are somewhat visible. The Project would not attract attention.
10	Walking Box Ranch (Big House - southwest)	Recreation	0.25 mile	Level	Weak	Low	The utilities occur around the Walking Box Ranch area. The underground water pipeline ROW is generally concealed from view by intervening vegetation, and the powerline structures are visible. The Project would be visible but would repeat the patterns associated with the previously authorized and constructed transmission line, which was removed in 2011.
11	Nipton town	Residential	Adjacent to Project Area	Level	Weak	Low	The underground water pipeline ROW is sited parallel to the roadway, and the ground surface scar would be in the foreground of viewers for around 14 miles. This component of the Project would attract attention until the restoration efforts are successful and vegetation is reestablished in the cleared areas.

KOP Number	KOP Name	Viewer Type	Distance to Project Area	Viewer Position	Level of Visual Contrast	Magnitude of Impact	Impact Description
Proposed Action (Alternative B) and Alternatives C–E							
12	SR 164 (near NV/CA border)	Travel route	Adjacent to Project Area	Level	Weak	Low	The underground water pipeline ROW is sited parallel to the roadway, and the ground surface scar would be in the foreground of viewers for around 14 miles. This component of the Project would attract attention until the restoration efforts are successful and vegetation is reestablished in the cleared areas.
13	SR 164 (McCullough Range)	Travel route	Adjacent to Project Area	Level	Weak	Low	The underground water pipeline ROW is sited parallel to the roadway, and the ground surface scar would be in the foreground of viewers for around 14 miles. This component of the Project would generally attract attention until the restoration efforts are successful and vegetation is reestablished in the cleared areas.
14	Castle Mountain Mine Road (realignment area)	Travel route	Adjacent to Project Area	Level	Weak-moderate	Low-moderate	The utilities and road realignment area are adjacent to the roadway. The introduction of the overhead powerline and ground surface scars for the underground water pipeline and road realignment would be in the foreground of viewers within generally undeveloped desert scenery. This component of the Project would begin to attract attention.
Alternative E Only							
15	Castle Mountain recreation road	Recreation	Adjacent to Project Area	Level	Moderate	Moderate	The mine expansion areas, utilities, and solar facility are visible from this KOP. The solar facility would be somewhat visually compatible with the existing structures in view but would introduce new structural elements that do not exist in the current viewshed, and which would attract attention.

KOP 1 – Ivanpah Road: The Project would be visible to recreational viewers using Ivanpah Road within the Mojave National Preserve. The expanded heap leach pile and overburden sites are apparent from this area where they would appear as trapezoidal landforms composed of unvegetated, exposed soils and which expand the overall mining disturbance on the landscape. The juxtaposition of the mounded, exposed soils above a continuous vegetation canopy would introduce noticeable contrast. The expansion areas are adjacent to the existing mining footprint, which is visually congruent to the proposed developments, reducing contrast of the proposed Project. This KOP is located approximately 5 miles west of the Project and distance and intervening vegetation somewhat diminish the overall impact of the Project on the viewer. The mine expansion would attract, but not dominate, viewer attention and the visual contrast and magnitude of impact would be weak-moderate and low-moderate, respectively. The interim, concurrent, and final reclamation phases of the Project would include grading and revegetation on the landforms, which would reduce the visual contrast of those components over time.

KOP 2 – Hart Mine Road: Similar to KOP 1, the Project would be visible to recreational viewers using Hart Mine Road within the Mojave National Preserve. This KOP looks southeast 2 miles toward the Project, with tall Joshua trees in the foreground interrupting views of the trapezoidal expanded heap leach pile and overburden sites. Exposed soils of the expansion areas would introduce visual contrast where visible between and above the vegetation canopy. The expansion of the mining footprint would be visually congruent with the existing disturbance, which is partially visible from this location. The mine expansion would attract, but not dominate, viewer attention and the visual contrast and magnitude of impact would be weak-moderate and low-moderate, respectively. The interim, concurrent, and final reclamation phases of the Project would include grading and revegetation on the landforms, which would reduce the visual contrast of those components over time.

KOP 3 – Lanfair Buttes: The Project would be visible to recreational viewers visiting the Lanfair Buttes petroglyph area within the Mojave National Preserve. Similar to KOP 2, existing mining disturbance and the proposed Project are visible from this location, but the views are partially screened by viewer distance (6 miles) and intervening vegetation. The trapezoidal expanded heap leach pile and overburden sites would be adjacent to and visually congruent with the existing mining operation. Visual contrast would be greatest while the expansion areas are composed of exposed soils before reclamation is performed to make the landforms appear more natural with grading and revegetation. The mine expansion would influence views but would not attract viewer attention, and the visual contrast and magnitude of impact would be weak-moderate and low-moderate, respectively.

KOP 4 – Castle Mountain Mine Road: From this KOP, the Project would be in the foreground of travelers on the roadway. Castle Mountain Mine Road is the access road to the Project Area, so it is assumed that most of the travelers viewing the Project from this KOP are associated with the mine with some recreation traffic. The existing mining disturbance present on the landscape is somewhat visible from this location but is a minor component of the viewshed as the landform modifications are mostly screened from view. The Project would introduce tall, unvegetated trapezoidal landforms associated with the heap leach pile and overburden site expansions and columnar transmission structures associated with the overhead powerline, as well as the geometrically cleared pipeline corridor. The structures would repeat the patterns associated with the previously authorized and constructed transmission line, which was removed in 2011. This KOP is located directly adjacent to the utilities and 0.5 mile from the mine expansion areas. Due to the close proximity, the Project would dominate views, and visual contrast and magnitude of impact would be moderate-strong and moderate-high, respectively. The reclamation phases would include regrading and revegetating the modified landforms and removing the overhead powerline, which would reduce the visual effects of the Project. Castle Mountain Road is adjacent to the Project for approximately 1 mile before entering the Mine Boundary, and the driving duration of 1 mile at a speed of 35 miles per hour (mph) would last around 1.75 minutes, in which the visual impact of this component of

the Project would be the greatest. The overall impact of the Project on the landscape diminishes as viewer distance increases and vegetation and topography create visual screening.

KOP 5 – Sprit Mountain: This KOP views the Project Area from a distance of 18 miles. The appearance of both the existing mining disturbance and the proposed expansion are diminished by viewer distance and screening from intervening topography. The Project would alter the existing landforms due to the expansion of the mine facilities and expand the influence of mining activity on the landscape, but those changes would not attract attention from this KOP and the visual contrast and magnitude of impact would be weak and low, respectively.

KOP 6 – Walking Box Ranch Road: This KOP is adjacent to the alignment of the utilities where they are parallel to Walking Box Ranch Road. From this perspective, the existing mining disturbance and proposed mine facility expansion areas are screened by topography. The existing landscape is primarily desert scenery, with an unpaved roadway as a primary development, and the occurrence of a linear fenceline and the Walking Box Ranch area in the vicinity. The utilities would introduce repetitive, skylined columnar transmission structures for the powerline and a low, linear ground surface scar from the underground water pipeline. The transmission line structures would introduce visible elements that repeat existing patterns associated with distribution line structures near Walking Box Ranch and the previously authorized and constructed transmission line, which was removed in 2011.The introduction of the Project into the landscape would be noticeable but would not dominate views and cause weak visual contrast and a low magnitude of impact. The water pipeline ROW would be revegetated after it is installed and the powerline would be removed during final reclamation, which would decrease the overall visual impact of the utilities. The powerline and water pipeline parallel Walking Box Ranch Road for approximately 15.5 and 16.7 miles, respectively, until the ROWs are within the Mine Boundary. Walking Box Ranch Road is driven at a speed of 35 mph, so the approximately 16 miles of utilities parallel to the road would be perceived by travelers for approximately 27.5 minutes. The powerline ROW is located south of the Walking Box Ranch area, so it is assumed that most of the travelers perceiving the greatest impact of the utilities would be to travelers associated with the mine.

KOP 7 - SR 164 (Wee Thump Joshua Tree Wilderness Study Area [WSA]), KOP 11 – Nipton Town, KOP 12 – SR 164 (near NV/CA Border), KOP 13 – SR 164 (McCullough Range): These KOPs are adjacent to the alignment of the underground water pipeline ROW where it parallels Nipton Road (SR 164). The Project's mining area is screened from view and no existing or proposed mining disturbance is visible from along the approximately 14 miles of roadway between KOP 7 to the east and KOP 11 to the west. The landscape in the vicinity of these KOPs features desert scenery and the paved roadway. Around KOP 11, structures associated with the town of Nipton and geometric solar areas associated with the Ivanpah Solar Facility are visible within the valley floor. At KOP 12, geometric transmission structures are visible paralleling the roadway. The construction of the underground water pipeline would create a low, linear ground surface scar, and the visual contrast and magnitude of impact of this feature would be weak and low, respectively, at KOPs 7, 11, 12, and 13. The vegetation clearing in the water pipeline area would initially be noticeable and would generally begin to attract attention, except in areas where variable topography would conceal its extent, such as around the McCullough Range. These effects would last for several years after reclamation until the vegetation becomes reestablished and similar in composition to the adjacent undisturbed areas and the visual contrast of the ground surface scar is diminished. These KOPs represent a linear roadway, and the approximately 14 miles of the water pipeline would be visible for around 15 minutes of driving at a speed of 55 mph.

KOP 8 – Walking Box Ranch (Near Entrance), KOP 9 – Walking Box Ranch (Big House – South), KOP 10 – Walking Box Ranch (Big House – Southwest): These KOPs represent the Walking Box Ranch area of interest. The underground water pipeline ROW parallels Walking Box Ranch Road, which provides access to the area, and the overhead powerline ROW is approximately 0.3 mile south of the

ranch. The Project Area is screened from view and no existing or proposed mining disturbance is visible from the area. The landscape in the vicinity of these KOPs features desert scenery; ranch structures, such as buildings, fencing, unpaved roads, and tanks; and a monopole distribution line. The vegetation clearing required within the water pipeline ROW is generally screened from intervening vegetation but is visible from viewpoints nearest the road. Similarly, the columnar transmission structures for the powerline are generally screened by vegetation, but are visible from some perspectives. The visual contrast and magnitude of impact of the utilities would be weak and low, respectively, at KOPs 8, 9, and 10. The structures would repeat the patterns associated with the previously authorized and constructed transmission line which was removed in 2011 and would be noticeable but would not dominate views from KOPs 8, 9, and 10.

KOP 14 - Castle Mountain Mine Road (Realignment Area): This KOP is adjacent to the alignment of the utilities where they are parallel to Castle Mountain Mine Road and views the roadway where it would be rerouted to avoid occurring on NPS-administered lands. From this perspective, the existing mining disturbance and proposed mine facility expansion areas are not visible due to topographic screening. The existing landscape is primarily desert scenery, with the unpaved roadway in the foreground. The utilities would introduce repetitive, skylined columnar transmission structures for the powerline and a low, linear ground surface scars from the underground water pipeline and road realignment. Their introduction into the landscape would begin to attract attention and cause weak-moderate visual contrast and low-moderate magnitude of impact. The structures would repeat the patterns associated with the previously authorized and constructed transmission line, which was removed in 2011. The water pipeline ROW and old road alignment would be reclaimed through revegetation, and the powerline would be removed during final reclamation, which would decrease the overall visual impact of these components of the Project over time.

KOP 15 – Castle Mountain Recreation Road: Analysis from KOP 15 is associated with proposed solar facility under Alternative E, which is not included under the Proposed Action.

4.3.2.3 CONFORMANCE WITH BLM VISUAL RESOURCE MANAGEMENT CLASSES AND RESOURCE MANAGEMENT PLAN

The assessment of conformance with BLM VRM class objectives, as well as the DRECP (BLM 2016) and Las Vegas RMP (BLM 1998), was based on the results of the KOP contrast rating worksheets contained in Appendix B and an assessment of impacts to viewers. The results of this analysis are displayed on Figure 12 in the context of the identified KOP locations and VRM class objectives for the Proposed Action.

Based on the KOP contrast rating worksheets completed at KOPs 1, 2, 3, 4, 11, 14, and 15, it was determined that the Project would meet VRM class objectives where BLM-administered lands are occupied by the Project within California. This includes both the proposed mining activities and the utility component of the Project within the NFO within VRM Class III and IV. Management activities in VRM Class III may attract attention but should not dominate the view of the casual observer and in VRM Class IV, management activities may dominate the view and be the major focus of viewer attention. Therefore, based on this assessment of visual contrast, the Project would meet BLM VRM Class III and IV objectives and no amendment to the DRECP (BLM 2016) would be required for the Project within California.

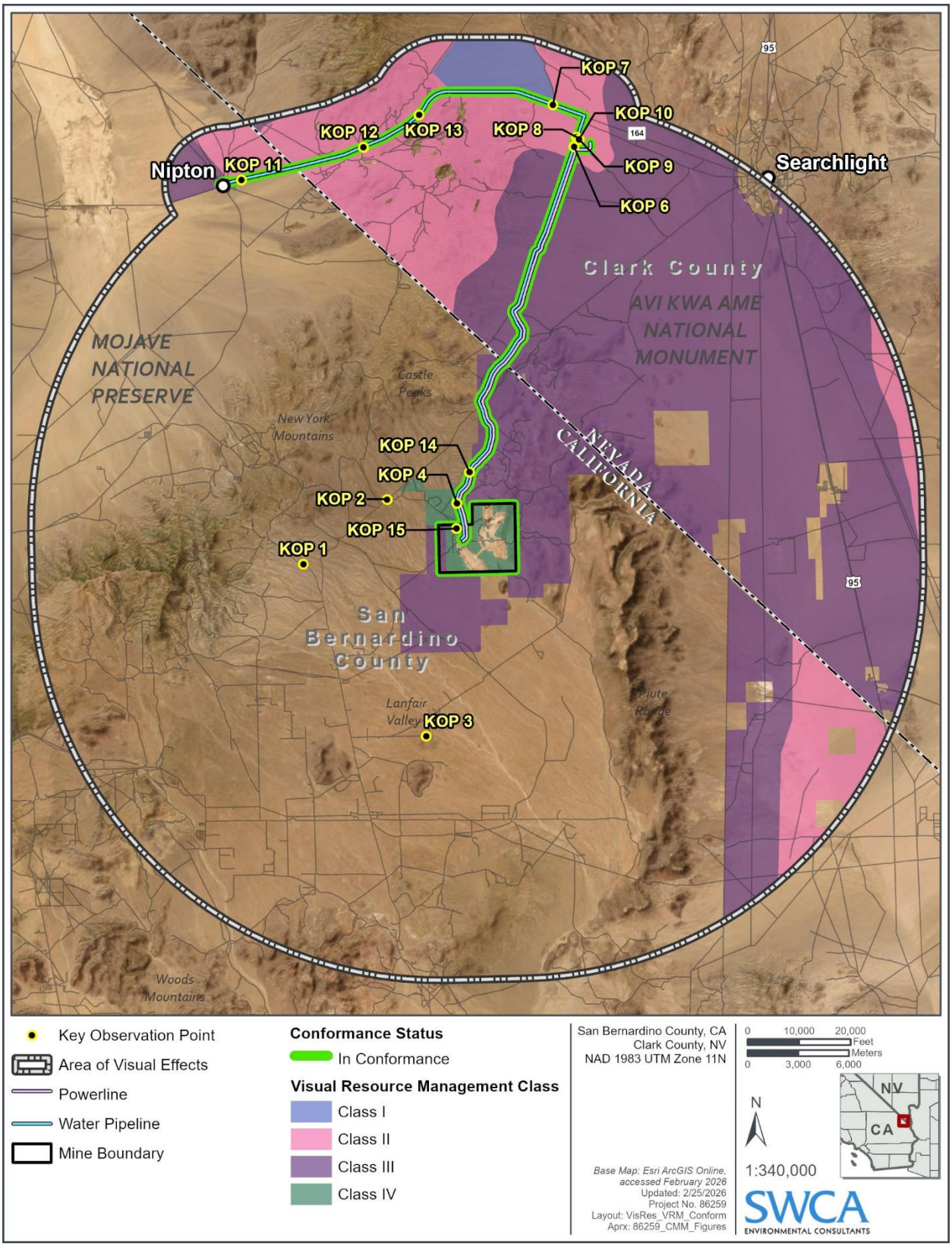


Figure 12. Conformance with Bureau of Land Management Visual Resource Management classes.

Based on the KOP contrast rating worksheets completed at KOPs 6, 7, 8, 9, 10, 12, and 13, it was determined that the proposed pipeline portion of the Project would meet VRM Class II and III objectives where BLM-administered lands are occupied within the LVFO in Nevada. The Project's proposed transmission line would visible from KOPs 6, 8, 9, and 10 within lands designated by the LVFO as BLM VRM Class II and III for approximately 9.5 miles near Walking Box Ranch and along Walking Box Ranch Road in the LVFO (see Appendix A for visual simulations and Appendix B for KOP contrast rating worksheets). The transmission line structures would introduce visible elements that repeat existing patterns associated with distribution line structures near Walking Box Ranch and the previously authorized and constructed transmission line, which was removed in 2011. The transmission line structures would be visible to the casual viewer without dominating the view. Following reclamation, the Project would remain noticeable, with the resulting visual contrast expected to be weak. Under VRM Class II and III standards within the LVFO, which require projects to retain the existing character of the landscape and minimize visual contrast, the Project would meet management objectives from this KOP. This also meets direction from the BLM regarding management associated with Avi Kwa Ame National Monument to minimize impacts from surface-disturbing activities and emphasize retention of visual resources.

4.3.3 Decommissioning

Decommissioning would include concentrated activities with increased vehicle and construction equipment movement similar to the construction and operation phase of the Project. Ground disturbance associated with these activities and the vehicular traffic on-site would increase short-term visual contrast and attract attention from KOPs, including from KOPs 4 and 6 through 14 where these activities would occur directly adjacent to Nipton Road (SR 164), Walking Box Ranch Road, and Castle Mountain Mine Road. After the Project has been decommissioned, there would be increased visual contrast between the color of the exposed soil and adjacent vegetated areas until site reclamation is successful. The reclamation of vegetation in these areas would take several years due to the area's arid climate, but over time, the landscape, where impacted by the Proposed Action, would begin to more closely resemble preconstruction conditions.

4.4 Impacts of Alternative C: Alternative Configurations of Mine Components

Impacts on visual resources under Alternative C would be similar to Alternative B as the avoidance area and proposed North Overburden Expansion would occur adjacent to existing mining areas. Based on this, the expansion of the mining area under Alternative C would not attract further attention in the landscape, would not introduce additional contrast in views from KOP locations, and would occur within VRM Class IV areas where management activities may dominate the view and be the major focus of viewer attention.

4.5 Impacts of Alternative D: Backfilling to Avoid Surface Expression of South Pit Lake

Impacts on visual resources under Alternative D would be similar to Alternative B as the backfilling of the South Pit Lake would not introduce additional contrast in views from KOP locations and would occur within VRM Class IV areas where management activities may dominate the view and be the major focus of viewer attention.

4.6 Impacts of Alternative E: Small Solar Facility for Supplementation

Impacts on visual resources under Alternative E would be similar to Alternative B, except under Alternative E, a small solar facility would be sited west and north of the existing mining areas. The addition of the solar facility would create a geometric array of rectangular solar panels bordered by a low, angular perimeter fence, which would modify landscape character but would appear adjacent to existing landscape modifications and in an area burned during the 2023 York Fire. Two KOPs would have views of the solar facility under this alternative, with impacts described below.

KOP 14 – Castle Mountain Mine Road (Realignment Area): Impacts would be the same as Alternative B except the introduction of the low, geometric solar arrays would be noticeable approximately 2 miles away. The addition of the solar facility would not attract attention in consideration of the proposed utilities and road alignment shift within foreground views and weak-moderate impacts would remain under this alternative.

KOP 15 – Castle Mountain Recreation Road: The Project would be visible to recreational viewers along a road near CMM. Existing mining disturbance and the proposed Project are visible from this location, with the KOP focused on views of the proposed solar facility under Alternative E. Views of the proposed solar facility would be unobstructed from this location, with the organized solar arrays attracting attention resulting in a moderate level of visual contrast. The proposed spoil piles and expanded mining areas would be viewed as an expansion of existing mining operations, increasing the influence of these activities on views. Visual contrast would be greatest while the expansion areas are composed of exposed soils before reclamation is performed to make the landforms appear more natural with grading and revegetation. Considering the proposed solar facility, utilities, and expanded areas of mining activities, Alternative E from this location would attract attention and may begin to dominate the view before application of mitigation measures as described below resulting in moderate impacts.

Conformance with VRM class objectives is the same as Alternative B except for the solar facility portion of the alternative. The solar facility would be noticeable as viewed from KOP 14 and would attract attention from KOP 15 within VRM Class III and IV areas, but would not dominate views from either KOP. The portion of VRM Class III occupied by the solar facility would be located approximately 0.5 mile from the road and based on the 2024 Western Solar Plan (BLM 2024) and other BLM direction, the Applicant will coordinate with the BLM to determine the applicability of the visual resource–related design features on the solar facility alternative. Based on the level of contrast and application of mitigation, the solar facility portion of Alternative E would meet BLM VRM Class III and IV objectives and no amendment to the DRECP (BLM 2016) would be required for the Project within California.

5 SELECTIVE MITIGATION MEASURES

Mitigation measures are defined as actions taken to avoid, eliminate, or reduce potential adverse impacts. As described in Section 4.1, *Analysis Methods*, the Project POD contains a series of Applicant-committed design (mitigation) measures, as well as aspects of the Project design, intended to reduce impacts on visual resources. Additionally, to further reduce impacts on visual resources and the level of visual contrast, the following selective mitigation measures were identified for consideration and may be required by the BLM:

- Nonspecular conductors would be used to reduce visual impacts associated with potential glint and glare associated with typical conductors.

- As described in the Project's 1998 ROD, include that site reclamation shall include modification of final overburden and heap leach pile shapes to reduce the impact of straight-line geometrics and potential contrast in form and line.
- As described in the Project's 1998 ROD, rock-staining solutions shall be used on the upper mine pit walls where necessary, as determined by the BLM and the County, to reduce the contrast of light-colored rock exposed by mining activities and where visible above prevailing grade. These solutions shall be specifically colored to reduce the contrast between the pit walls and the surrounding undisturbed slopes.
- The Applicant will coordinate with the BLM to determine the applicability of the visual resource–related design features on the solar facility alternative, including those from the 2024 Western Solar Plan (BLM 2024) or other applicable BLM direction.

6 GLOSSARY

Area of Visual Effects (AVE)	The geographic extent in which the Project could be visible, as indicated by viewshed analysis, and could be influenced by Project features.
Backdropped	The landscape, seascape, or sky visible directly behind the elements of a facility, as seen from a particular viewpoint.
Basic Design Elements	The four design elements (form, line, color, and texture) that determine how the character of a landscape is perceived; also called dominance elements.
Contrast Rating Process	BLM's required systematic process for analyzing the potential visual impacts of proposed management activities through comparison of contrast in form, line, color, and texture between a proposed project and the existing landscape.
Distance Zone	A subdivision of the landscape as viewed from an observer position. The subdivision (zones) includes foreground, middleground, background, and seldom seen.
Ecoregion	A large unit of land or water containing a geographically distinct assemblage of species, natural communities, and environmental conditions.
Glare	The sensation produced by luminance within the visual field that is sufficiently greater than the luminance to which the eyes are adapted, which causes annoyance, discomfort, or loss in visual performance and visibility.
Glint	A momentary flash of light resulting from a spatially localized reflection of sunlight.
Inferior (viewing position)	Viewer is below the Project in elevation.
Intervening screening	A visual barrier, located between a viewer and the Project, consisting of earth, vegetation, structures, or other materials that block a particular view.
Key Observation Point (KOP)	A point at a use area or a potential use area, or a series of points or a segment on a travel route, where there may be views of a management activity. KOPs are typically used as viewpoints for assessing potential visual impacts resulting from a proposed activity, such as the construction and operation of a facility.
Landscape Character	An overall visual and cultural impression of the landscape based on the distinct landscape attributes that exist throughout an area. It is a product of both the natural and human influences on the landscape.
Landscape Modification	Any human-caused change from the naturalistic character of a landform, waterbody, or vegetation through the addition of an element that creates a visual contrast in the basic design elements (form, line, color, and texture).
Level (viewing position)	Viewer is at the same elevation as the Project.

Mitigation	Actions taken to avoid, eliminate, or reduce potential adverse impacts on scenic resources.
Scale	The proportionate size relationship between an object and the surroundings in which the object is placed. Also refers to the geographic extent and context of a particular analysis.
Scenic Quality	A measure of the intrinsic beauty of landforms, waterforms, or vegetation in the landscape, as well as any visible human additions or alterations to the landscape.
Screening	A visual barrier consisting of earth, vegetation, structures, or other materials that blocks a particular view, or the actual blocking of a view through the use of a visual barrier.
Sensitivity Level	Measures of public concern for the maintenance of scenic quality (e.g., high, medium, and low).
Skylining	Siting of a structure on or near a ridgeline so that it is silhouetted against the sky as seen from a specified viewpoint.
Superior (viewing position)	Viewer is above the Project in elevation.
Unobstructed	Views of the Project would not be screened by landforms, vegetation, or structures, allowing for the extent of the Project to be visible.
View Duration	The estimated time a visitor typically experiences the view.
Viewing Locations	A location from which the public commonly views the landscape, including residences, travel routes, and recreation areas.
Viewshed Analysis	A spatial analysis that uses elevation data, such as a Digital Elevation Model or Surface Elevation Model, to determine which parts of the surrounding landscape are likely to be visible from a designated point or points.
Visual Contrast	The degree of visual change introduced by a proposed action, as indicated by modifications to basic design elements (form, line, color, and texture), compared to the existing visual setting.
Visual Resource Inventory (VRI) Class	A systematic assessment of the visual resources present within a specified landscape that provides BLM managers with a means for determining relative baseline visual values. The BLM VRI consists of a scenic quality evaluation, sensitivity level analysis, and delineation of distance zones. Based on these three factors, BLM-administered lands are placed into one of four VRI classes.
Visual Resource Management (VRM)	BLM's system for minimizing the visual impacts of surface-disturbing activities and maintaining scenic values for the future; specifically, the inventory and planning actions taken to identify visual values and to

	establish objectives for managing those values; also, the management actions taken to achieve the visual management objectives.
Visual Resource Management (VRM) Class	A land use planning decision for the management of visual values. VRM classes are spatially delineated management categories designated to BLM-administered public lands during the land use planning process. These classes prescribe management objectives for the amount of physical and visible change allowed in the characteristic landscape. There are four VRM classes, each with a management objective: I (most protected); II, III, and IV (least protected).VRM class designations are made on all BLM-administered public lands and are based on scenic quality, sensitivity level, and distance zones and in consideration of land use allocations, other resource protections, desired outcomes, and desired future conditions.
Visual Resources	The physical features that make up the visible landscape (i.e., natural features such as land, water, vegetation, and topography and human-made features such as buildings, roads, utilities, and structures), as well as the response of viewers to those features.
Visual Simulation	A pictorial representation of a proposed project in its landscape setting, as it would be seen from a specified viewpoint, and used to visualize the Project before it is built, typically in order to determine its potential visual contrasts and associated visual impacts.

7 LITERATURE CITED

Clark County. 2021. *Transform Clark County Master Plan*. Available at: https://www.clarkcountynv.gov/adobe/assets/urn:aaid:aem:0f13cbf0-6d0c-438e-b340-52c720a1433b/original/as/cc-masterplan-web.pdf. Accessed January 5, 2025.

County of San Bernardino. 2026. *San Bernardino County Countywide Plan – County Policy Plan*. December. Available at: https://countywideplan.sbcounty.gov/policy-plan/. Accessed January 14, 2026.

Falchi, F., P. Cinzano, D. Duriscoe, C.M. Kyba, C.D. Elvidge, K. Baugh, B. Portnov, N.A. Rybnikova, and R. Furgoni. 2016. *Supplement to: The New World Atlas of Artificial Night Sky Brightness*. Available at: https://doi.org/10.5880/GFZ.1.4.2016.001. Accessed January 14, 2026.

Federal Aviation Administration (FAA). 2021. *Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports*. U.S. Department of Transportation Federal Aviation Administration. *Federal Register* 86(89):25801-25803. May 11. Available at: https://www.govinfo.gov/content/pkg/FR-2021-05-11/pdf/2021-09862.pdf. Accessed January 5, 2025.

Fenneman, N.M. 1931. *Physiography of the Western United States*. New York and London: McGraw Hill, Book Company Inc.

Griffith, G.E., Omernik, J.M., Smith, D.W., Cook, T.D., Tallyn, E., Moseley, K., and Johnson, C.B., 2016, Ecoregions of California (poster): U.S. Geological Survey Open-File Report 2016–1021, with map, scale 1:1,100,000, http://dx.doi.org/10.3133/ofr20161021.

National Park Service (NPS). 2004. *Mojave National Preserve Long-Range Interpretive Plan*. Available at: https://npshistory.com/publications/moja/lrip-2004.pdf. Accessed February 2026.

———. 2016. *Enjoy the View – Visual Resources Inventory Report*. Mojave National Preserve. https://irma.nps.gov/DataStore/DownloadFile/560107. Accessed January 15, 2026.

Sullivan, R., and M. Meyer. 2016. *Documenting America's Scenic Treasures: The National Park Service Visual Resource Inventory*. Argonne, Illinois: U.S. Department of the Interior, National Park Service.

U.S. Bureau of Land Management (BLM). 1984. *Visual Resource Management*. Manual 8400. Available at: https://www.blm.gov/sites/blm.gov/files/uploads/mediacenter_blmpolicymanual8400.pdf. Accessed January 14, 2026.

———. 1986a. *Visual Resource Inventory*. Manual H-8410-1. Available at: https://blmwyomingvisual.anl.gov/docs/BLM_VRI_H-8410.pdf. Accessed January 14, 2026.

———. 1986b. *Visual Resource Contrast Rating*. Manual 8431. Available at: https://blmwyomingvisual.anl.gov/docs/BLM_VCR_8431.pdf. Accessed January 14, 2026.

———. 1998. *Las Vegas and Pahrump Field Offices Updated Record of Decision for the Approved Las Vegas Resource Management Plan and Final Environmental Impact Statement*. BLM/LV/LP-99/002+1610. Prepared by U.S. Department of the Interior, Bureau of Land Management, Las Vegas and Pahrump Field Offices (Southern Nevada District Office). Available at: https://eplanning.blm.gov/public_projects/lup/78155/128947/156899/1998_LV_RMP_ROD.pdf. Accessed January 5, 2025.

———. 2010. *Needles Field Office Visual Resource Inventory*. Needles, California: Bureau of Land Management Needles Field Office.

———. 2012. *Management of National Scenic and Historic Trails and Trails Under Study or Recommended as Suitable for Congressional Designation*. Manual 6280. Washington, D.C. Available at: https://www.blm.gov/sites/blm.gov/files/uploads/mediacenter_blmpolicymanual6280.pdf. Accessed January 5, 2025.

———. 2016. *Desert Renewable Energy Conservation Plan, Land Use Plan Amendment to the California Desert Conservation Area Plan, Bishop Resource Management Plan, and Bakersfield Resource Management Plan.* BLM/CA/PL-2016/03+1793+8321. Prepared by the U.S. Bureau of Land Management. Available at: https://eplanning.blm.gov/public_projects/lup/66459/133474/163144/DRECP_BLM_LUPA.pdf. Accessed January 5, 2025.

_____. 2022a. *The California Desert Conservation Area Plan*. 1980, as amended. Available at: https://eplanning.blm.gov/public_projects/66949/200132088/20134047/251034027/The%202022%20Consolidated%20California%20Desert%20Conservation%20Area%20Plan%201980%20as%20amended.pdf. Accessed on January 2, 2026.

———. 2022b. *Southern Nevada District Office Updated Visual Resource Inventory*. Las Vegas, Nevada: Bureau of Land Management Southern Nevada District Office.

———. 2023. *BLM Technical Note 457, Night Sky and Dark Environments: Best Management Practices for Artificial Light at Night on BLM-Managed Lands*. Available at: https://www.blm.gov/policy/2023-038. Accessed January 5, 2025.

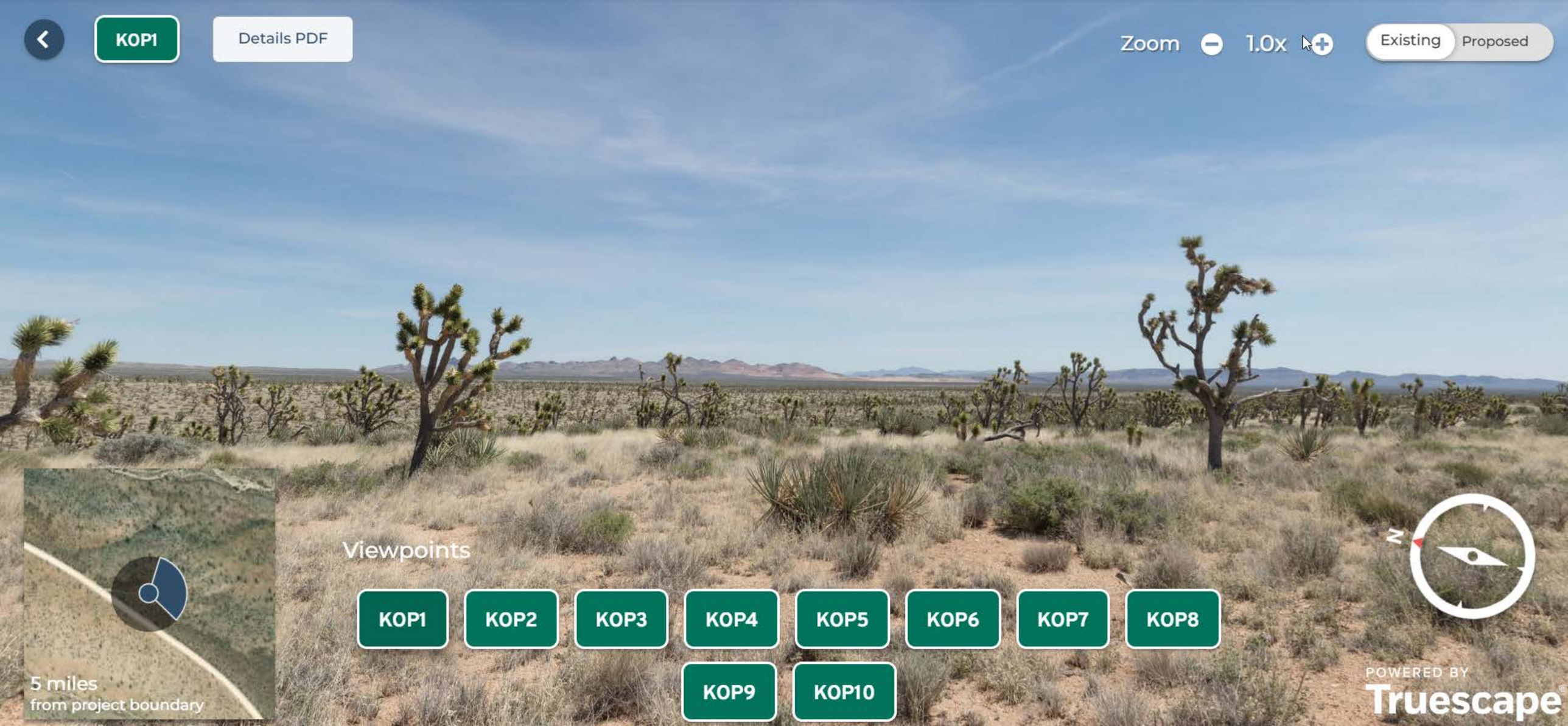
———. 2024. *Approved Record of Decision and Amendments/Record of Decision for Utility-Scale Solar Energy Development*. Available at: https://eplanning.blm.gov/eplanning-ui/project/2022371/570. Accessed February 20, 2026.

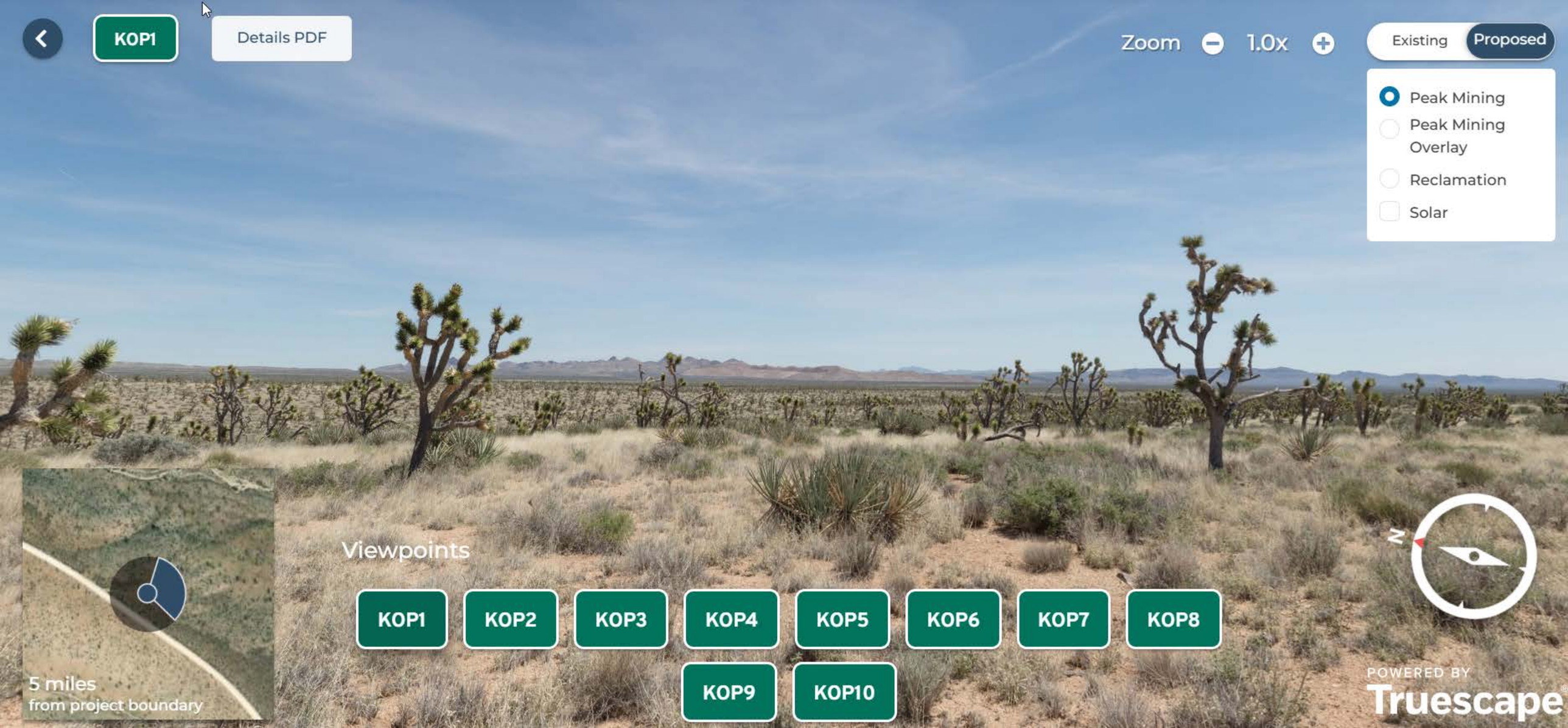
_____. 2025. *Memorandum: BLM Interim Management of the Avi Kwa Ame National Monument*. Available at: https://www.blm.gov/sites/default/files/docs/2025-01/01.15.2025%20-%20AKANM%20Interim%20Guidance.pdf. Accessed on 1/14/2025.

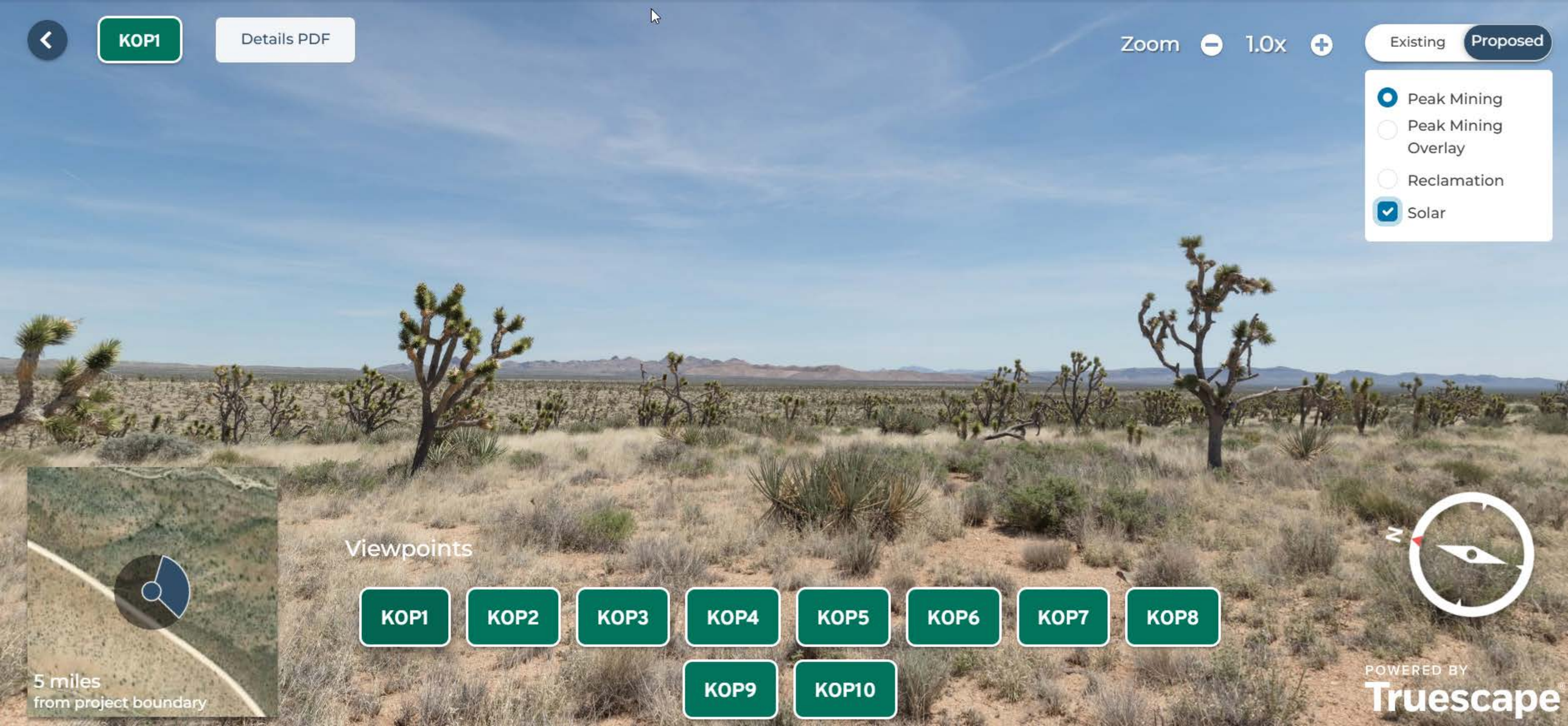
U.S. Bureau of Land Management (BLM) and National Park Service (NPS). 2017. *Old Spanish National Historic Trail Comprehensive Administrative Strategy*. Available at: https://parkplanning.nps.gov/document.cfm?documentID=83540. Accessed January 5, 2026.

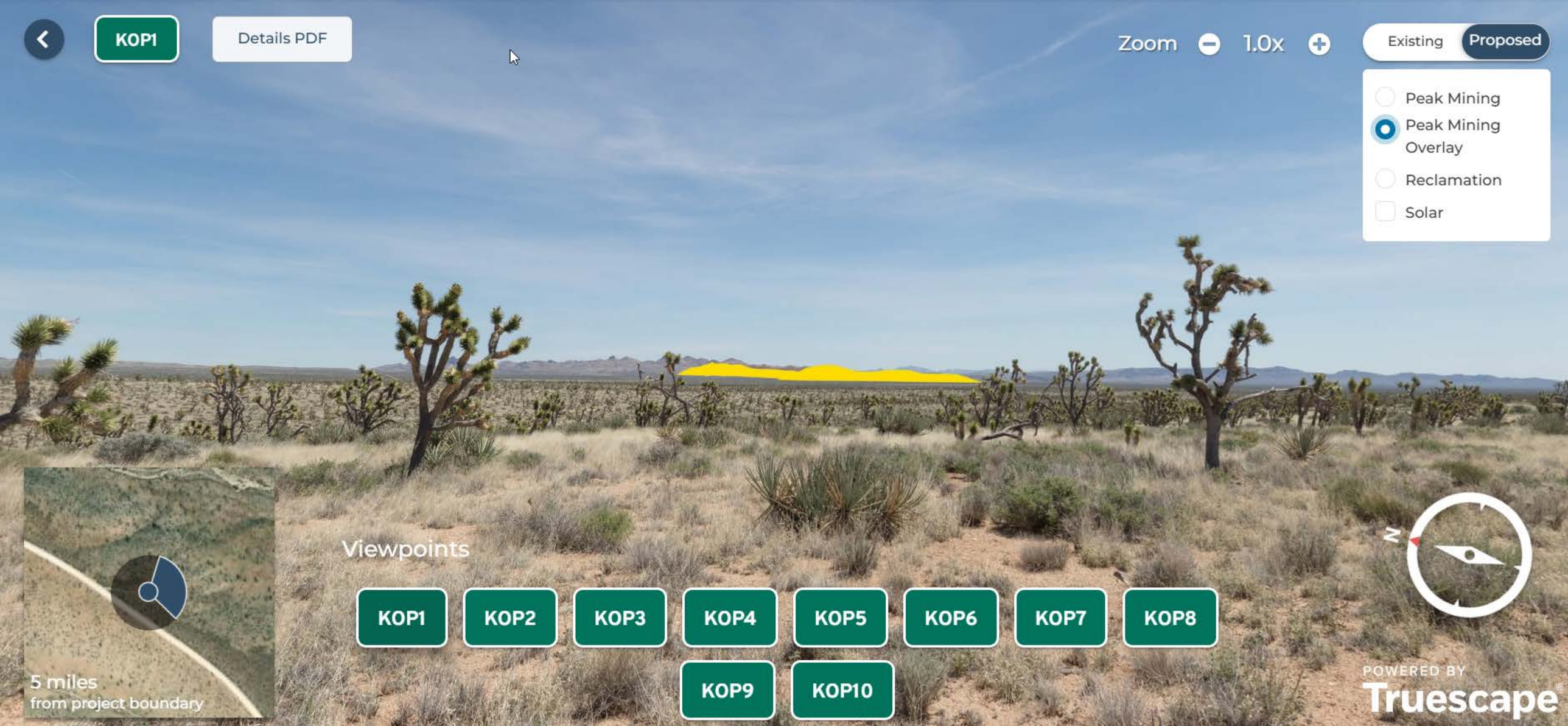
APPENDIX A

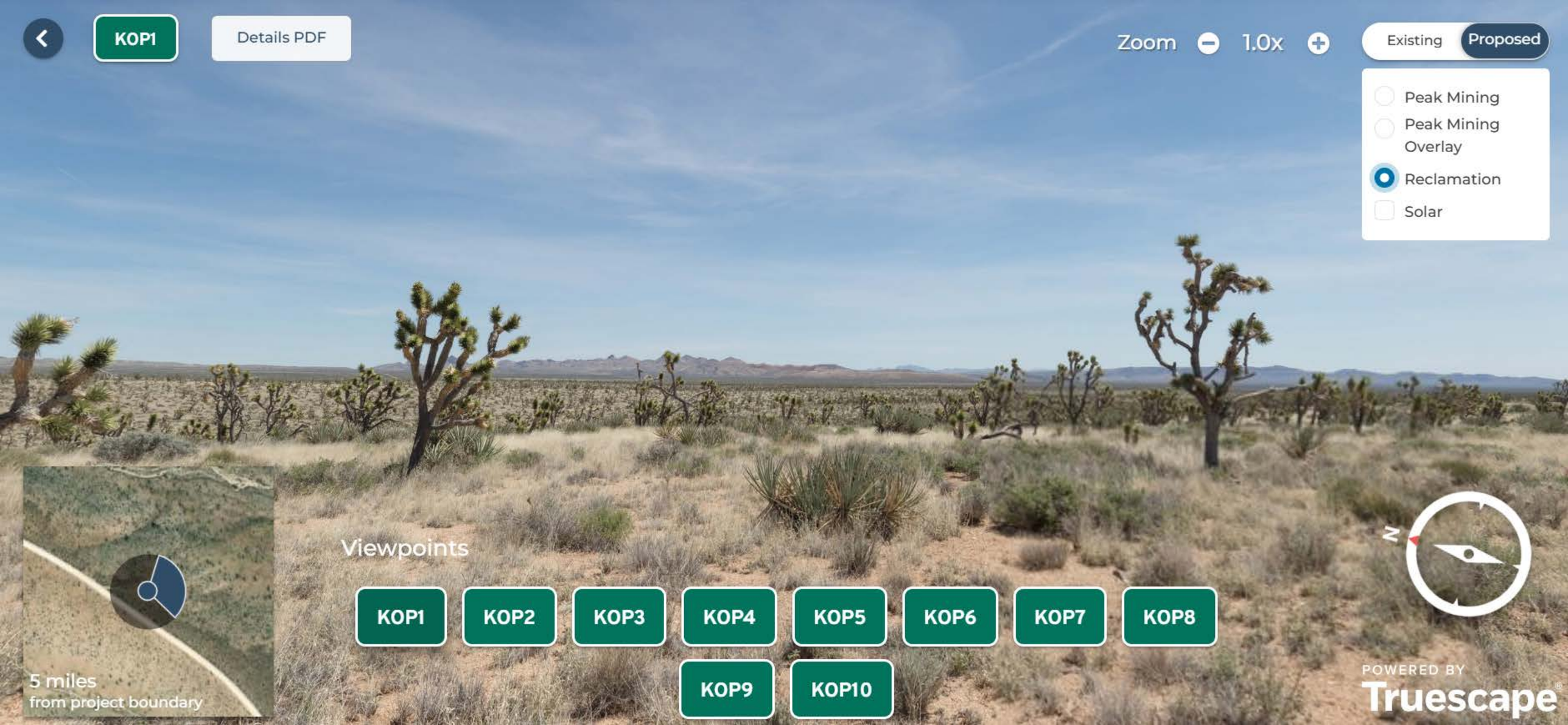
Visual Simulations


KOP1
Details PDF
Zoom
1.0x
Existing
Proposed
5 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape


KOP1
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
Solar
5 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape


KOP1
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
Solar
5 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape


KOP1
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
Solar
5 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape


KOP1
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
Solar
5 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

KOP2

Details PDF

Zoom 1.0x

Existing Proposed



Viewpoints

KOP1 KOP2 KOP3 KOP4 KOP5 KOP6 KOP7 KOP8

KOP9 KOP10

N

POWERED BY Truescape®

KOP2

Details PDF

Zoom 1.0x

Existing | Proposed

- Peak Mining
- Peak Mining Overlay
- Reclamation
- Solar



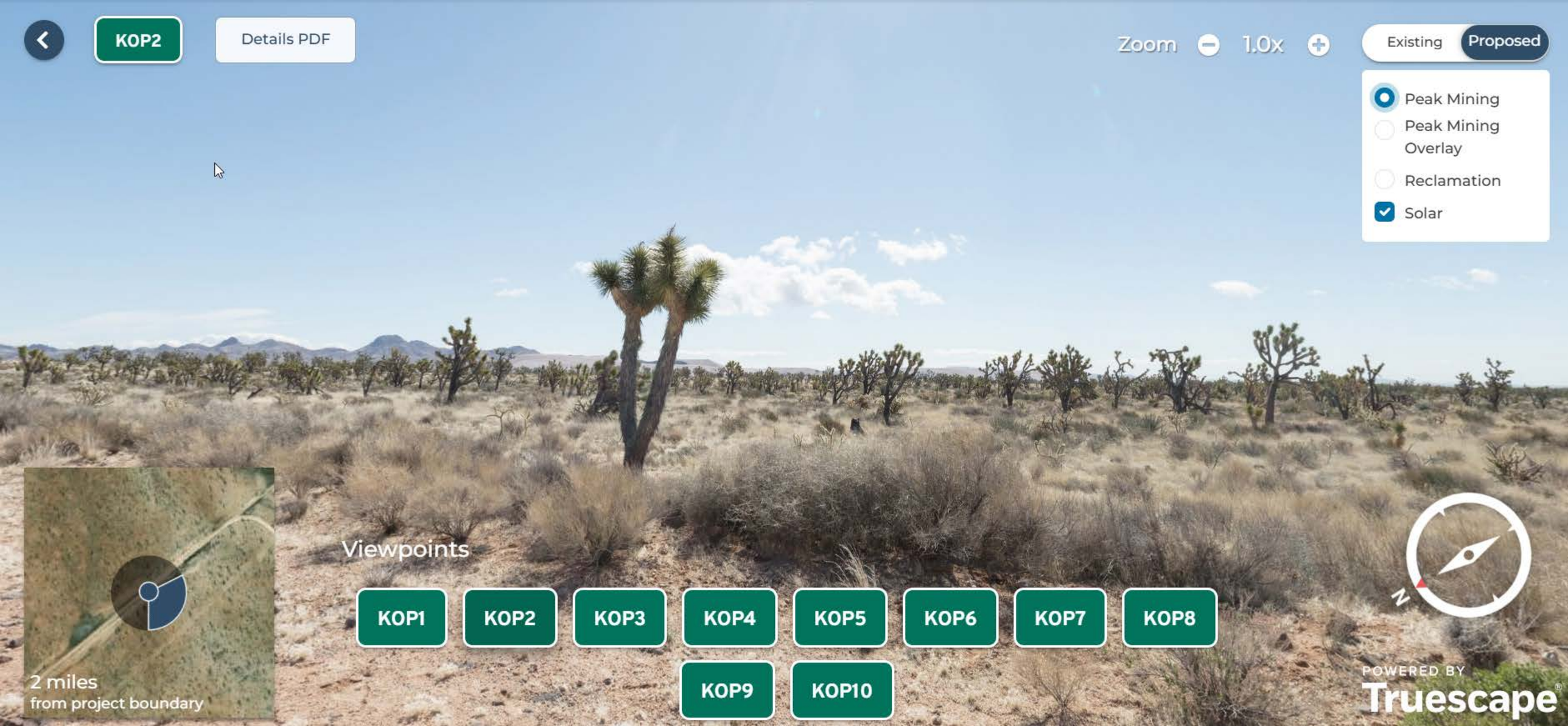
Viewpoints

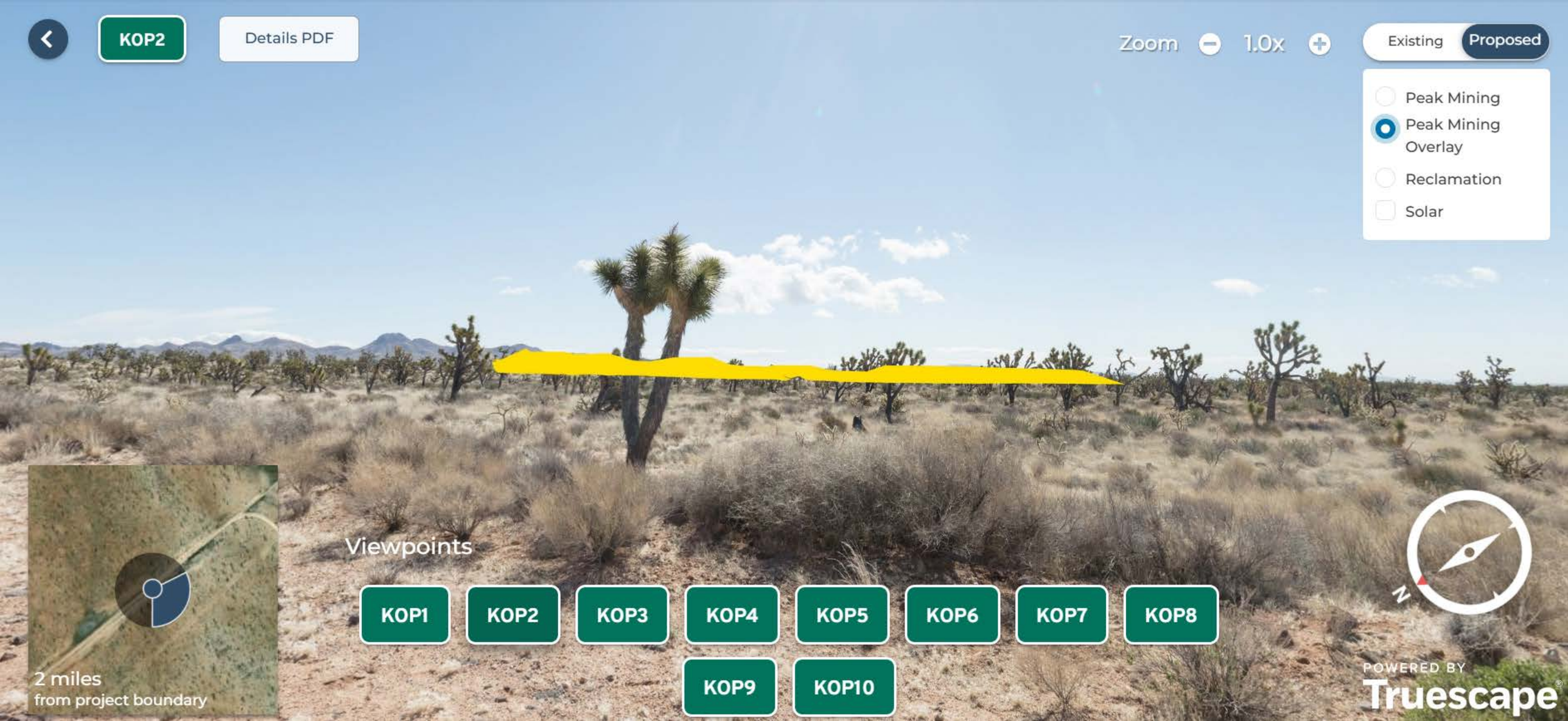
KOP1 KOP2 KOP3 KOP4 KOP5 KOP6 KOP7 KOP8

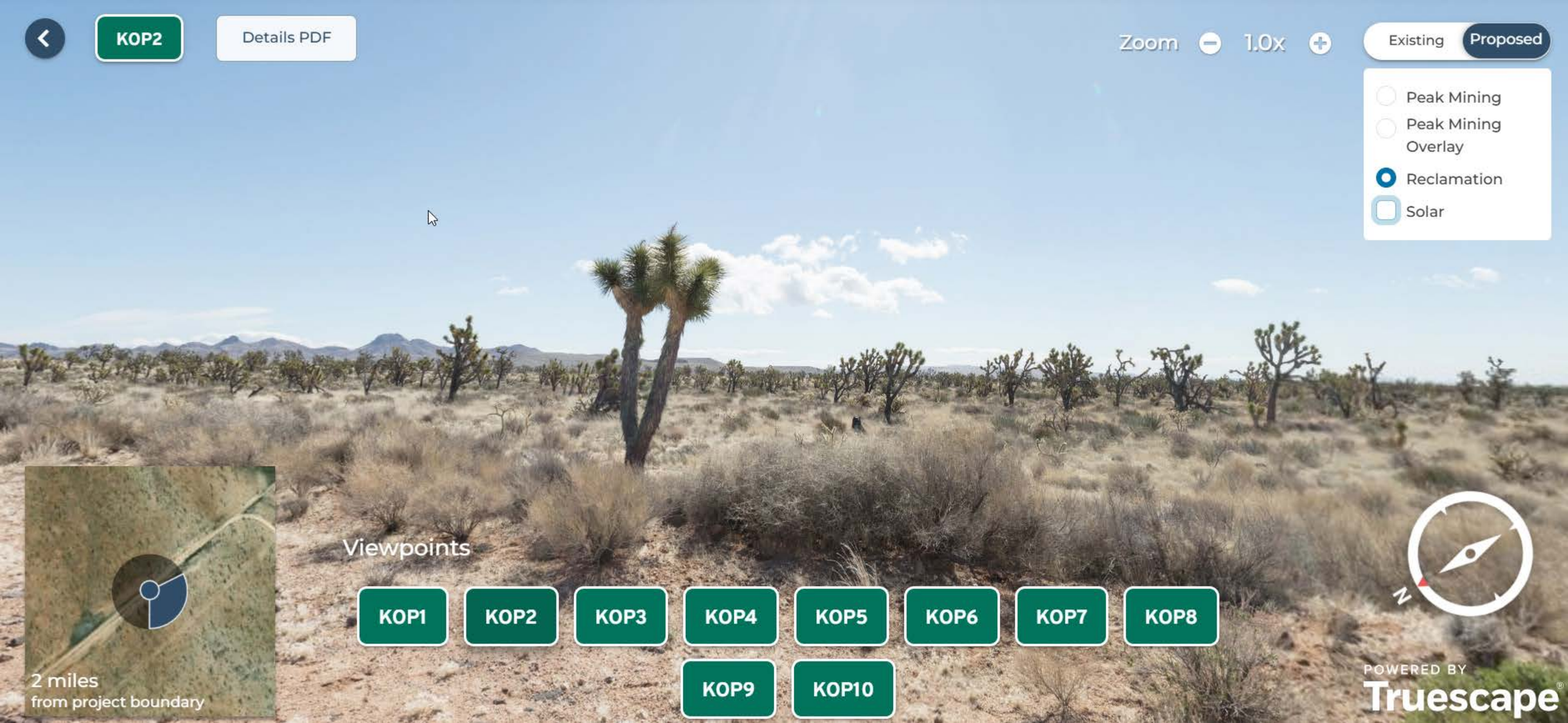
KOP9 KOP10

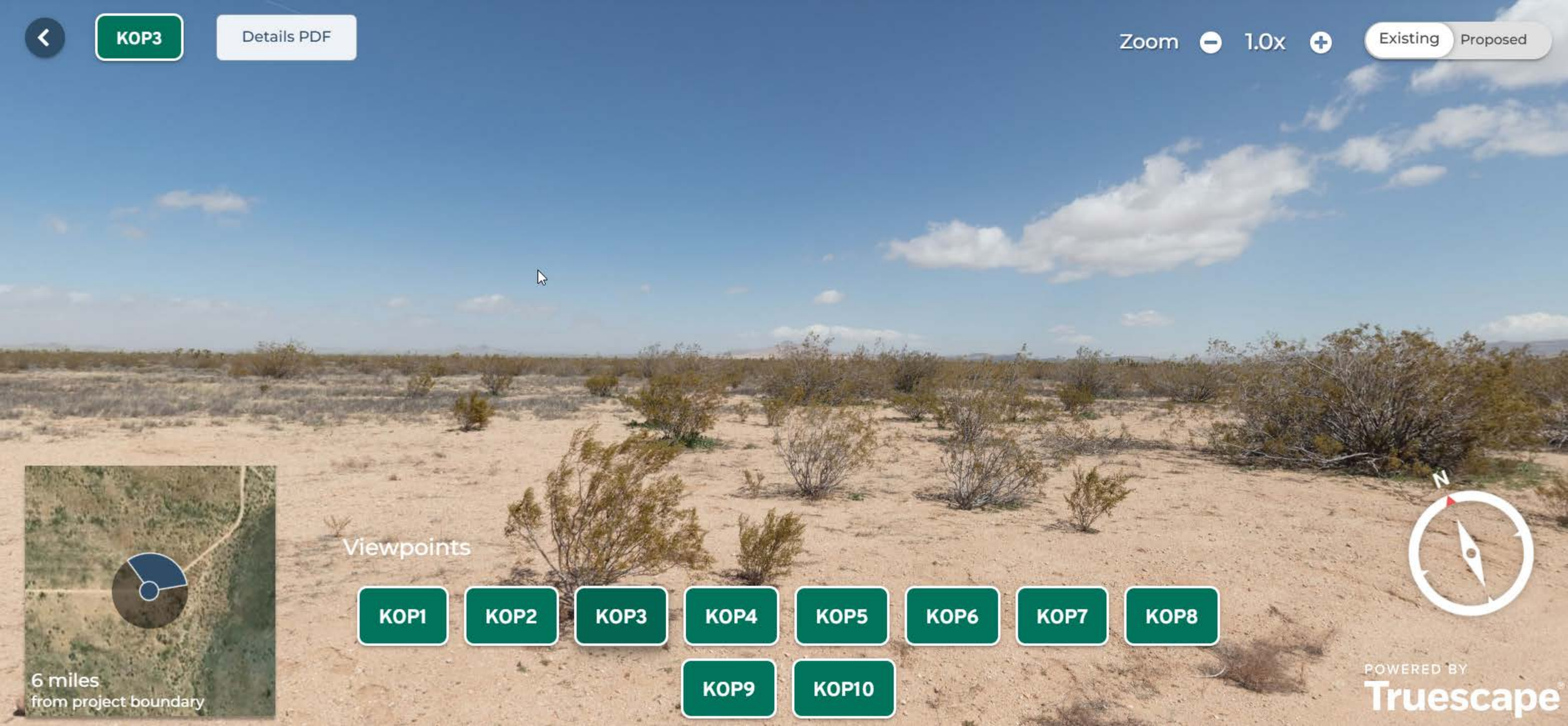
N

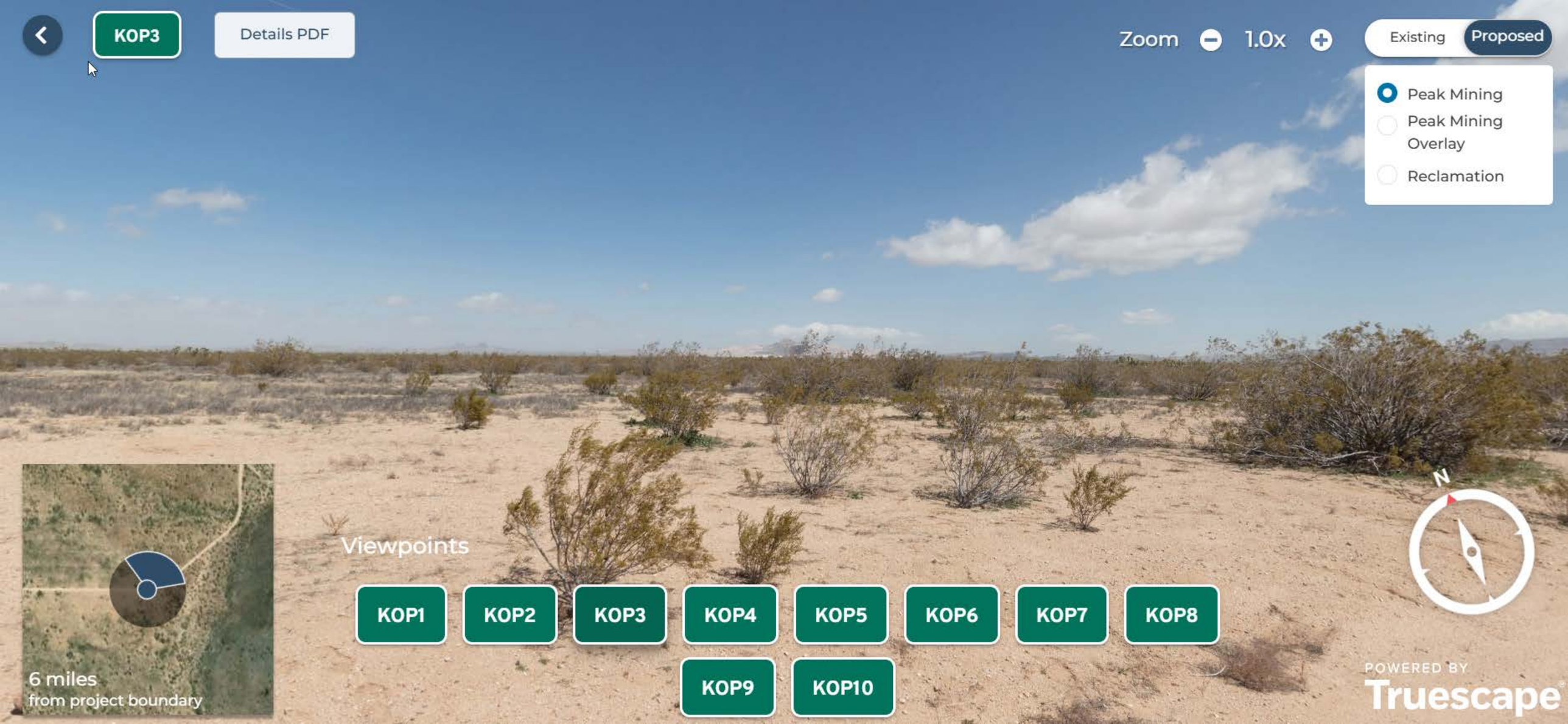
POWERED BY Truescape®

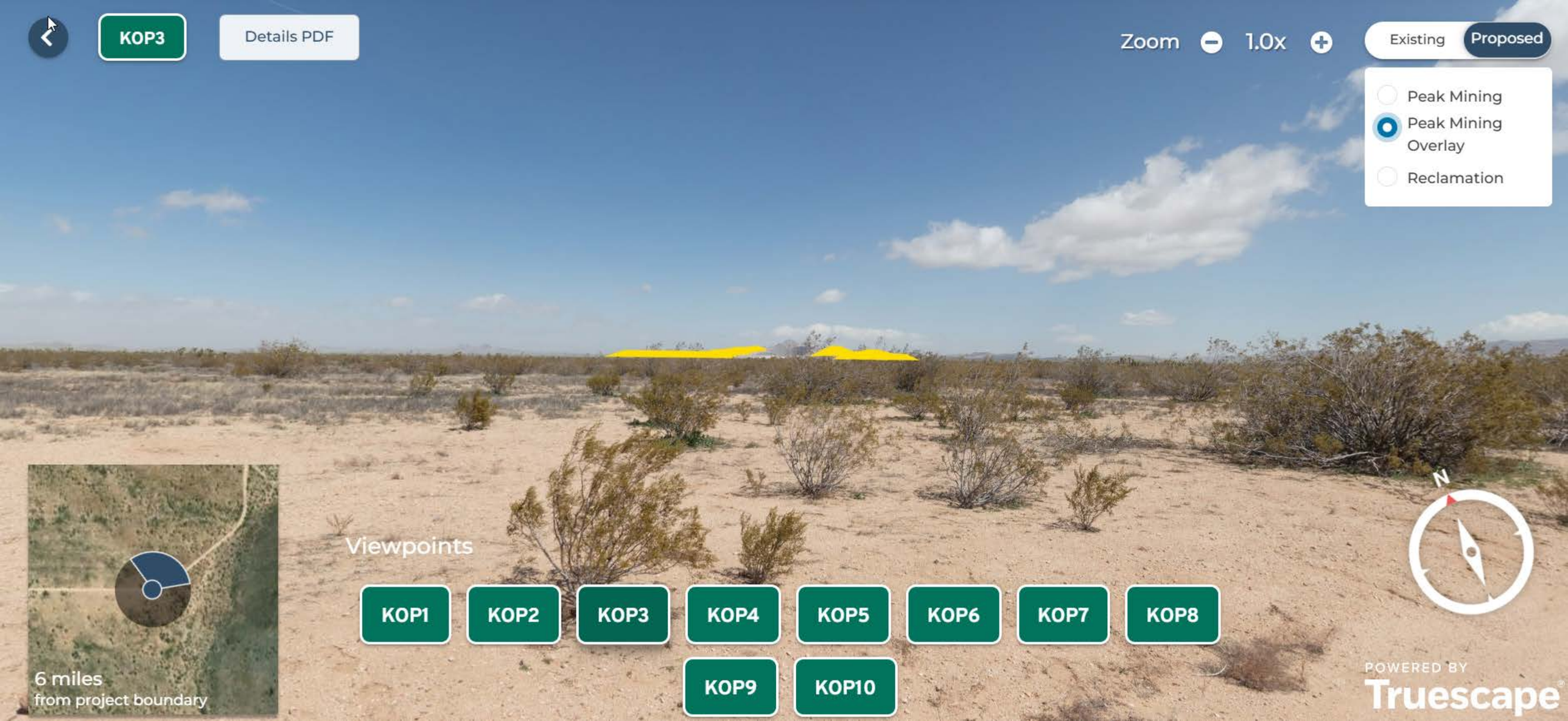

KOP2
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
Solar
2 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

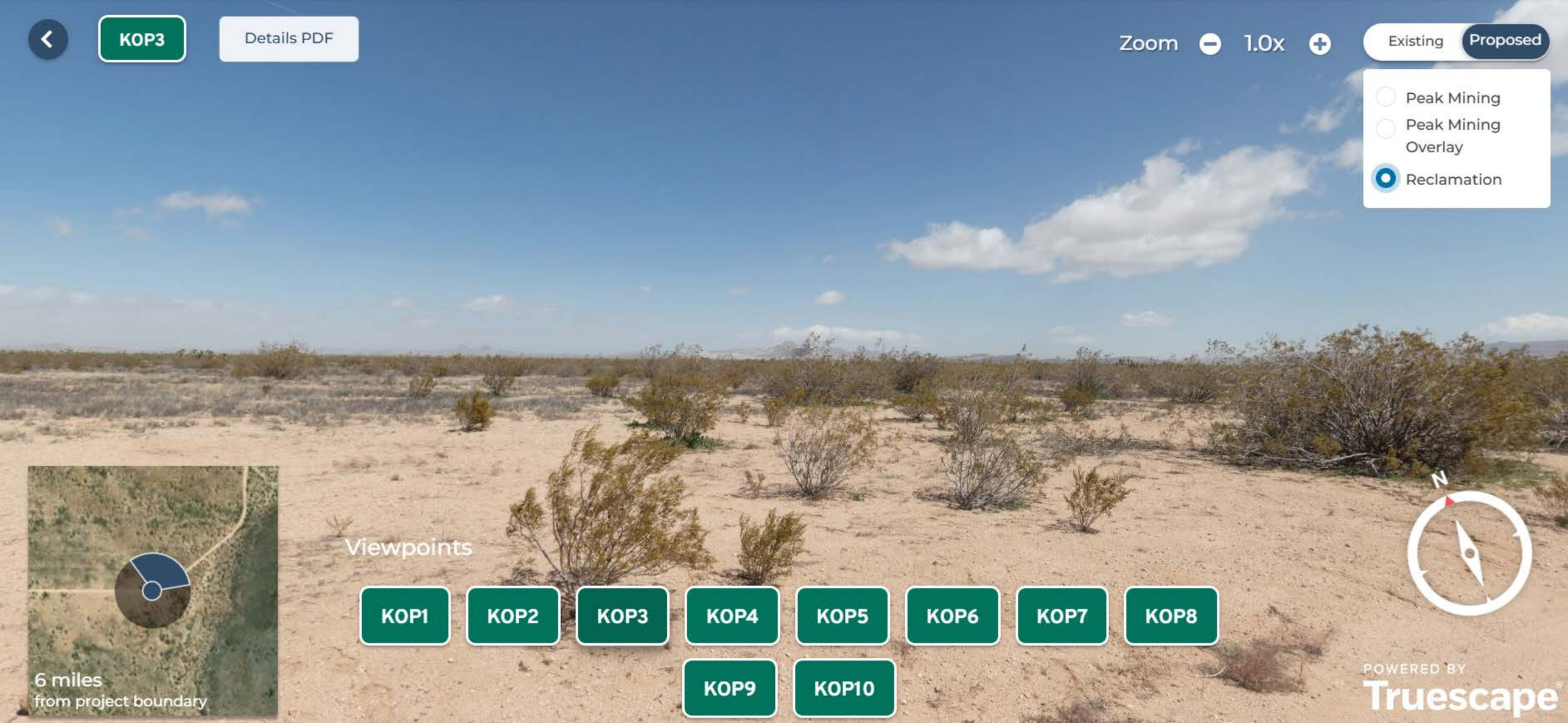

KOP2
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
Solar
2 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

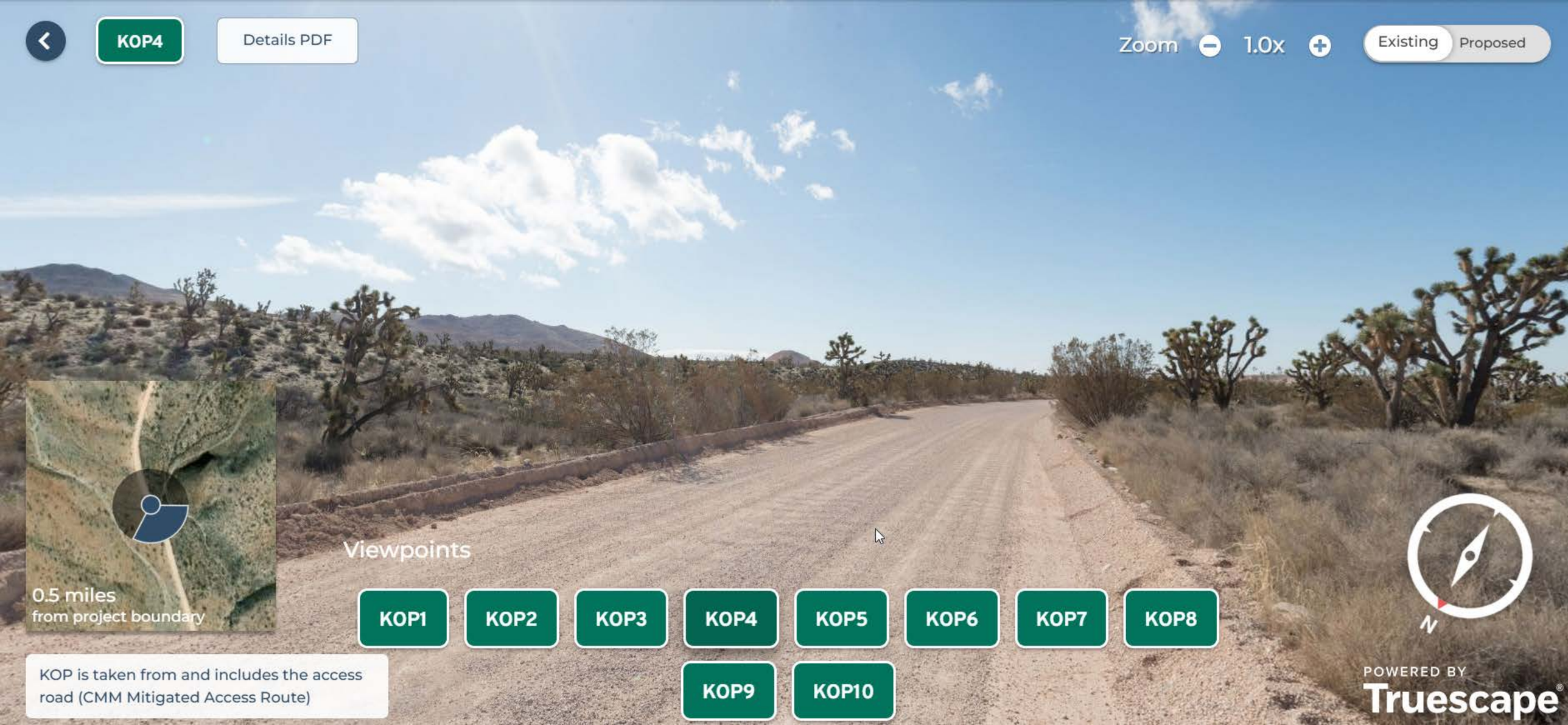

KOP2
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
Solar
2 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

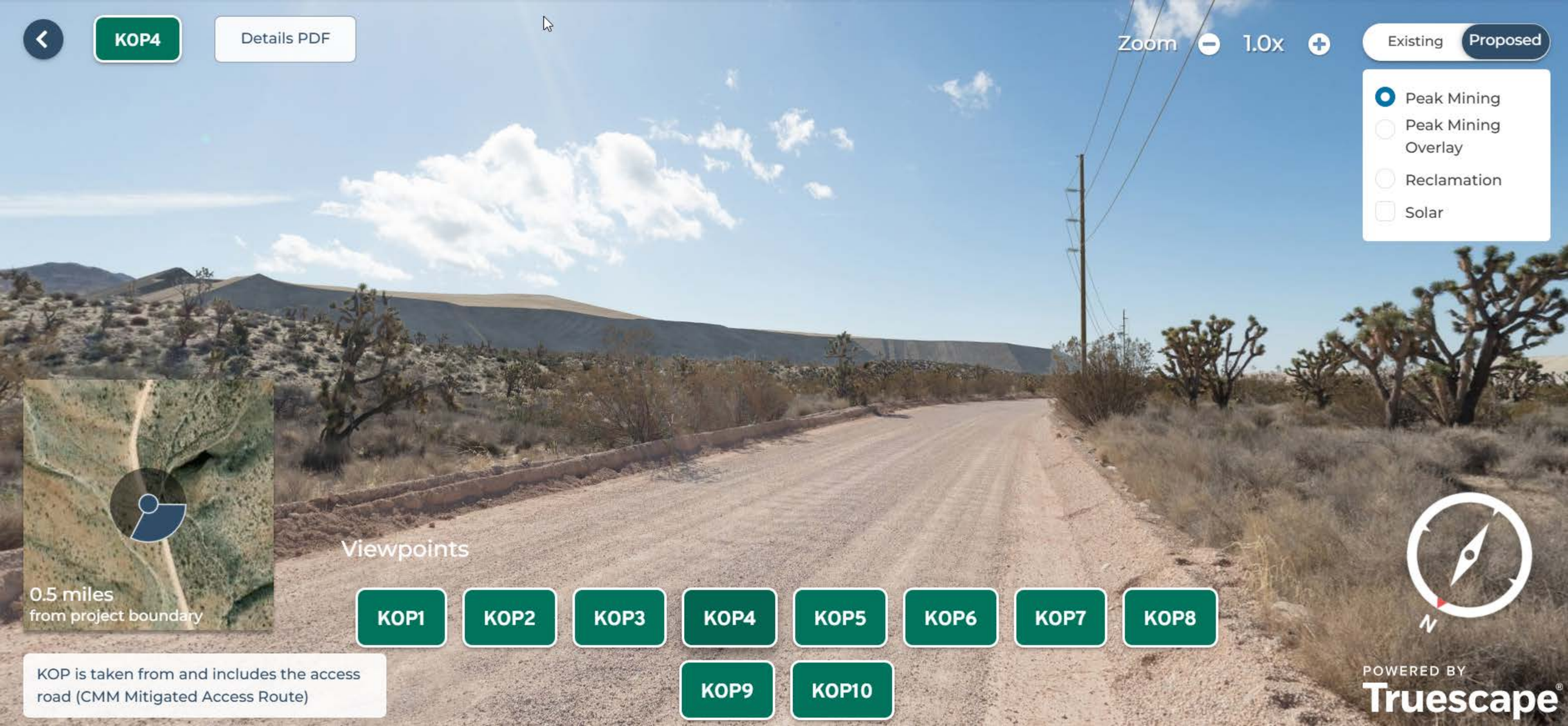

KOP3
Details PDF
Zoom
1.0x
Existing
Proposed
6 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

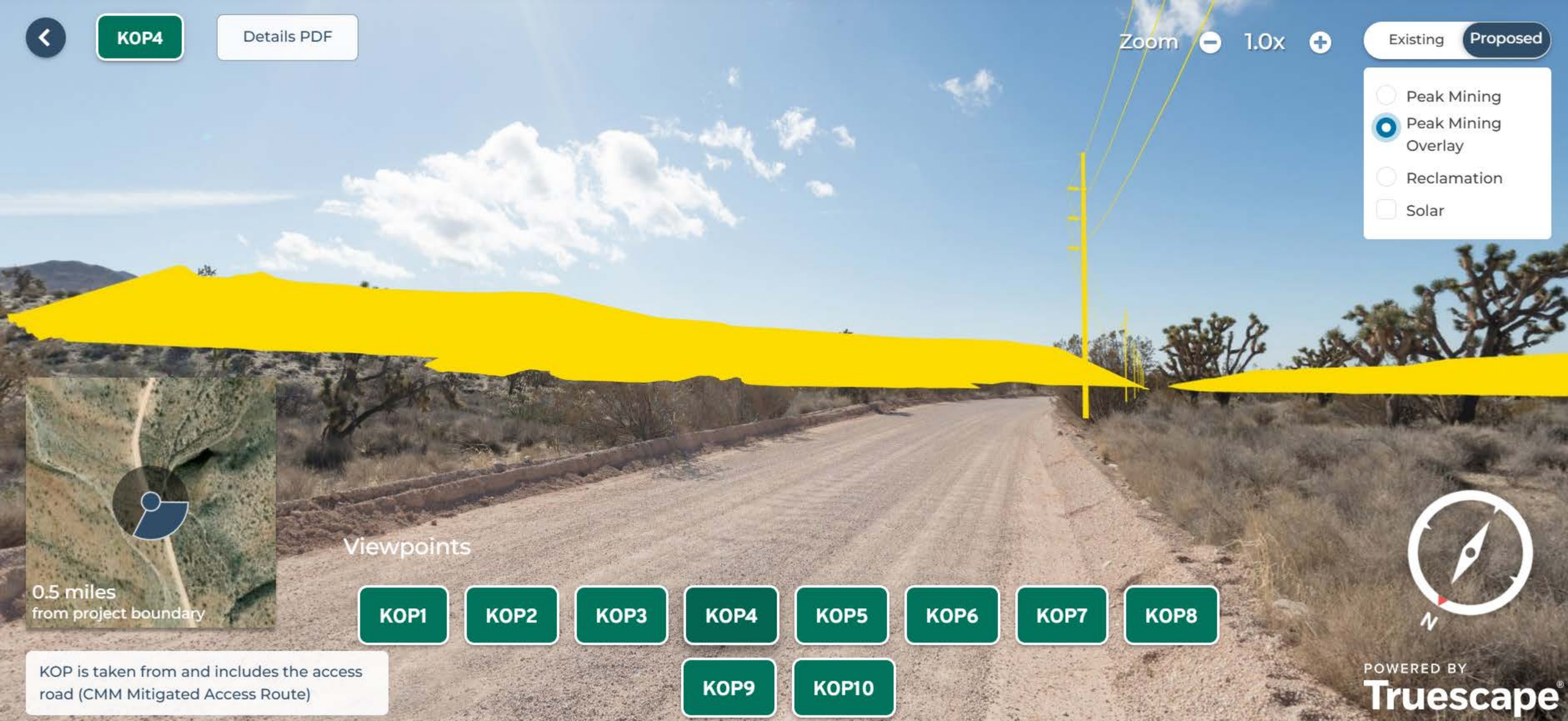

KOP3
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
6 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

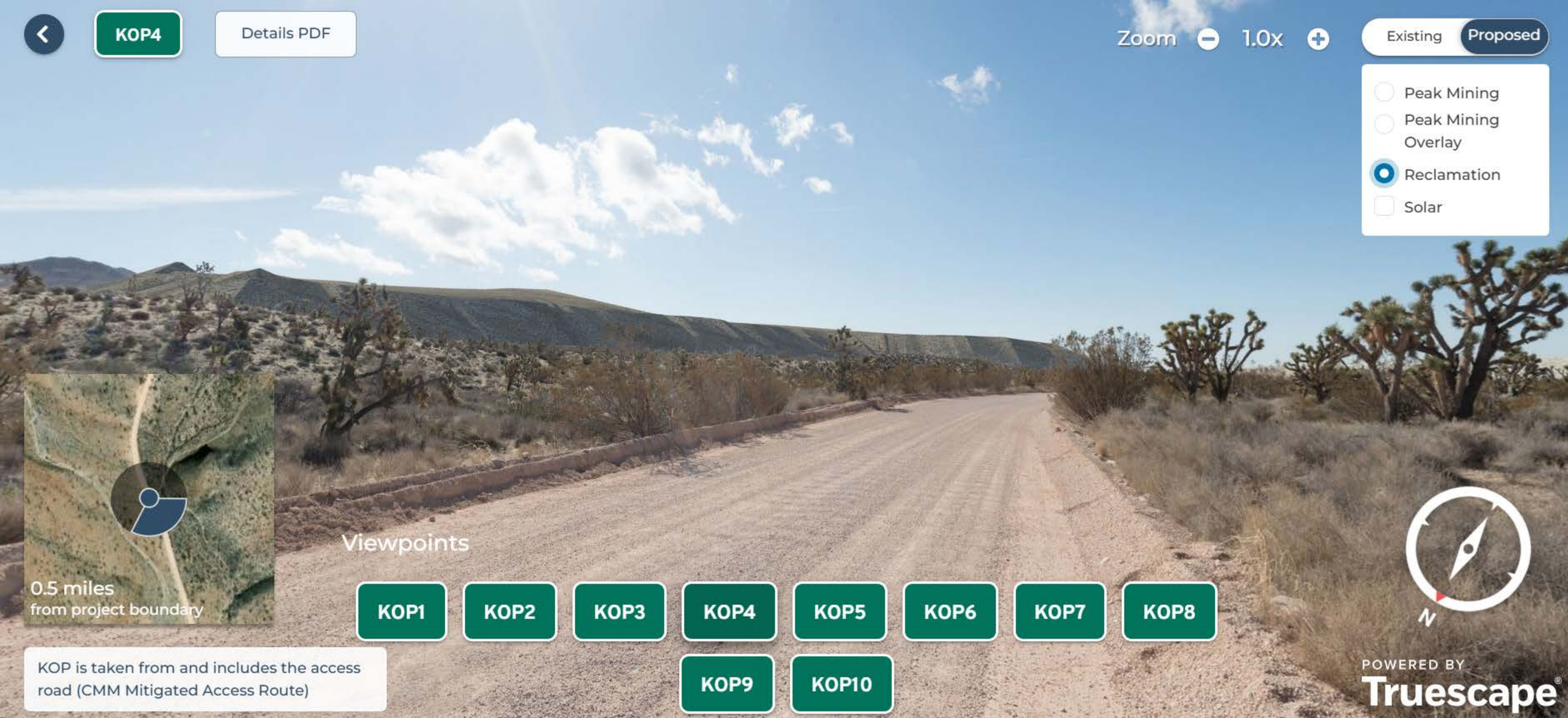

KOP3
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
6 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

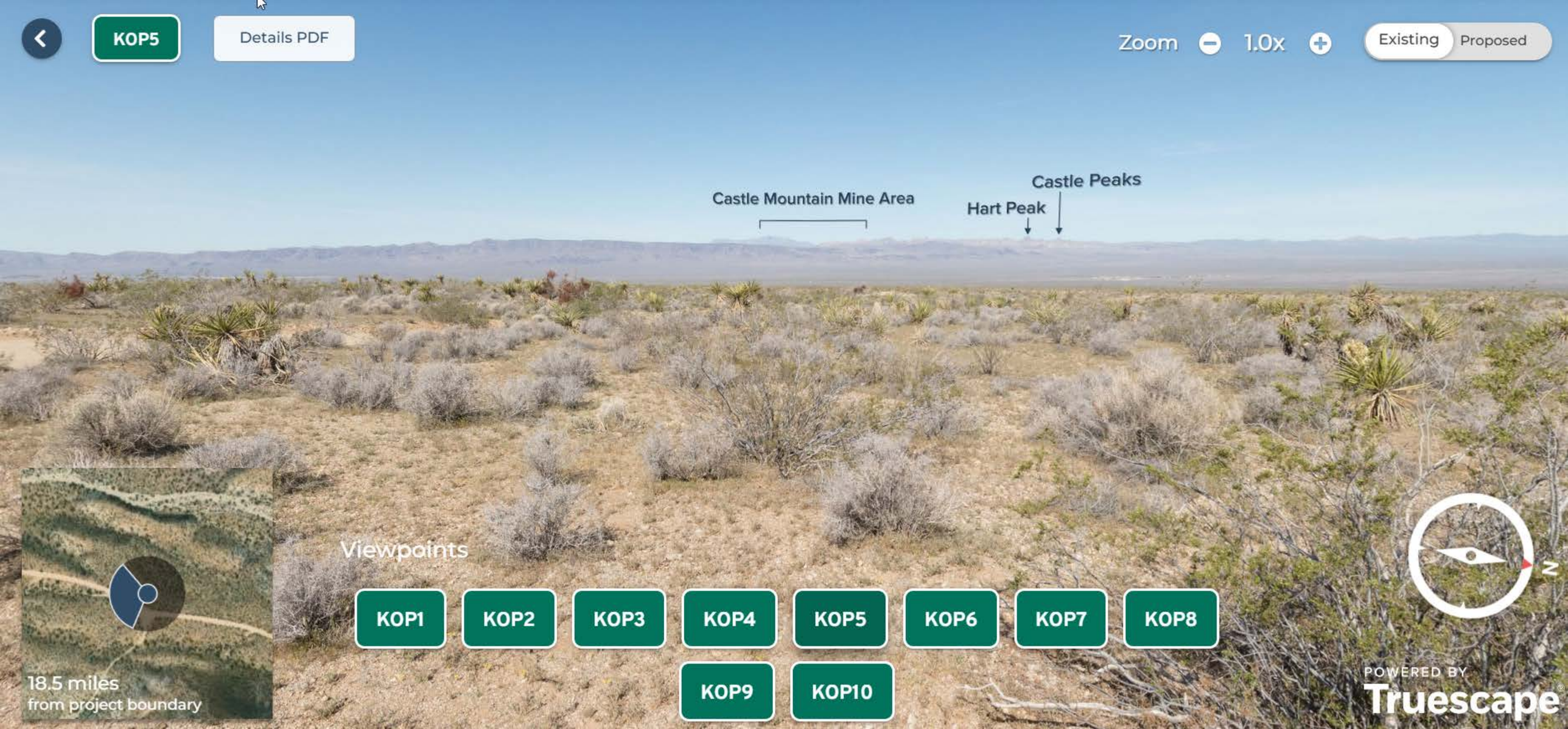

KOP3
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
6 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

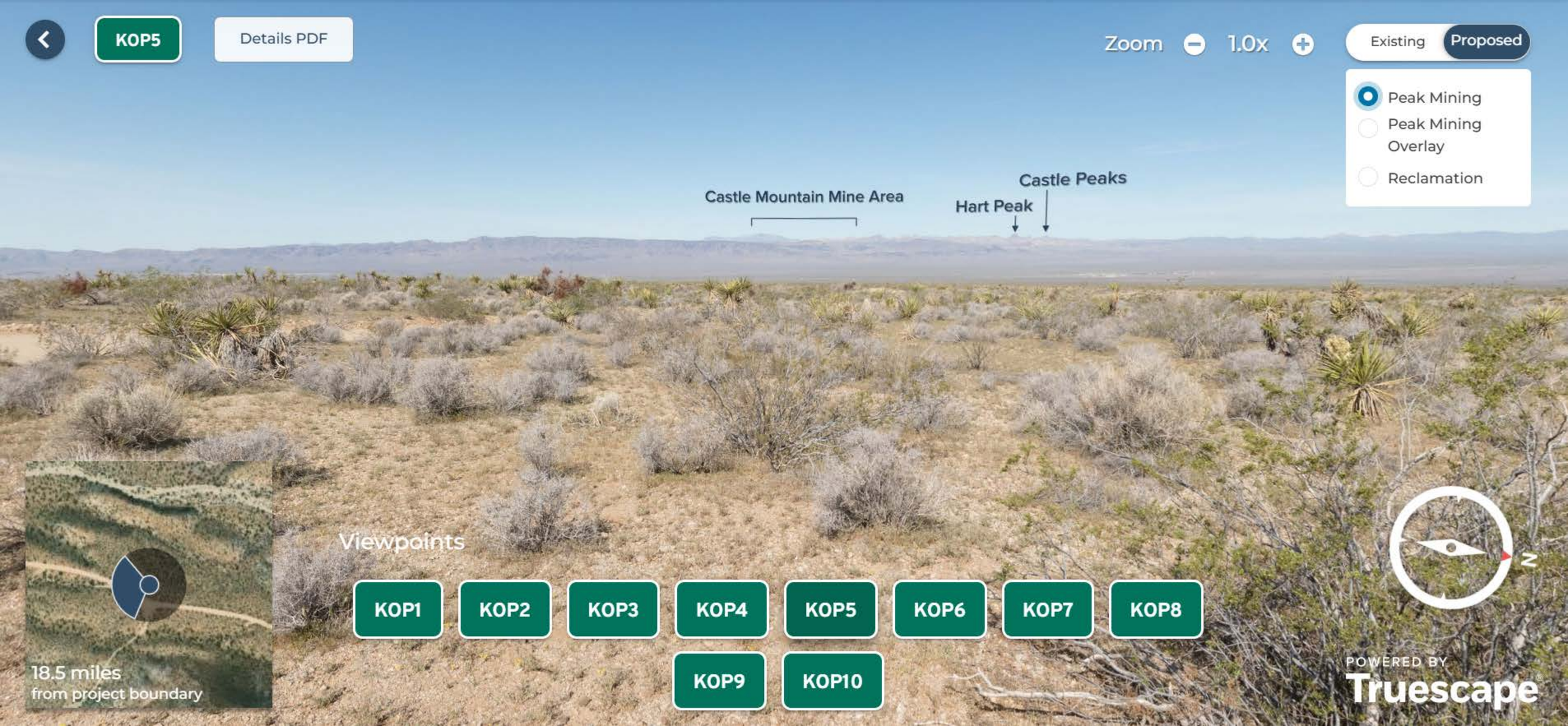

KOP4
Details PDF
Zoom
1.0x
Existing
Proposed
0.5 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
KOP is taken from and includes the access road (CMM Mitigated Access Route)
N
POWERED BY
Truescape

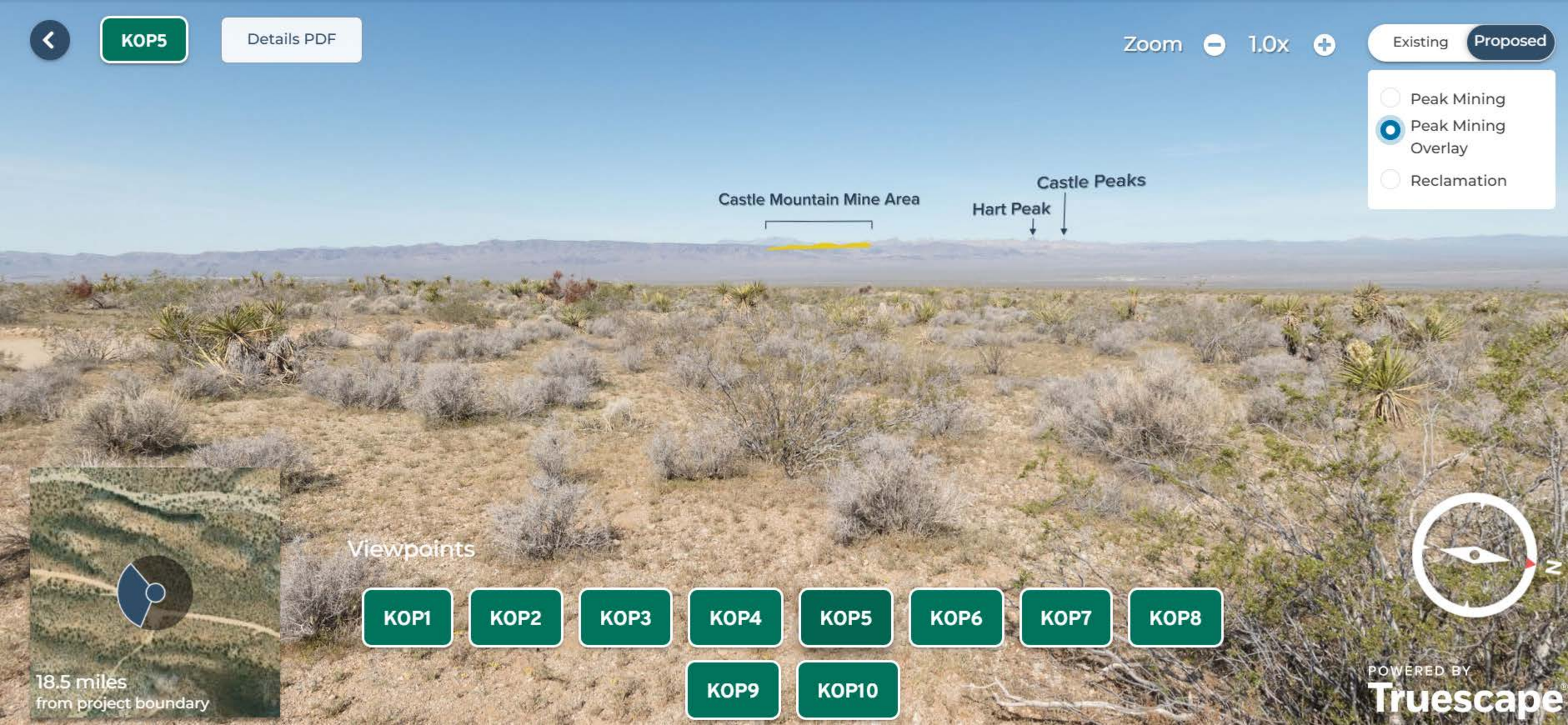

KOP4
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
Solar
0.5 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
KOP is taken from and includes the access road (CMM Mitigated Access Route)
N
POWERED BY
Truescape®

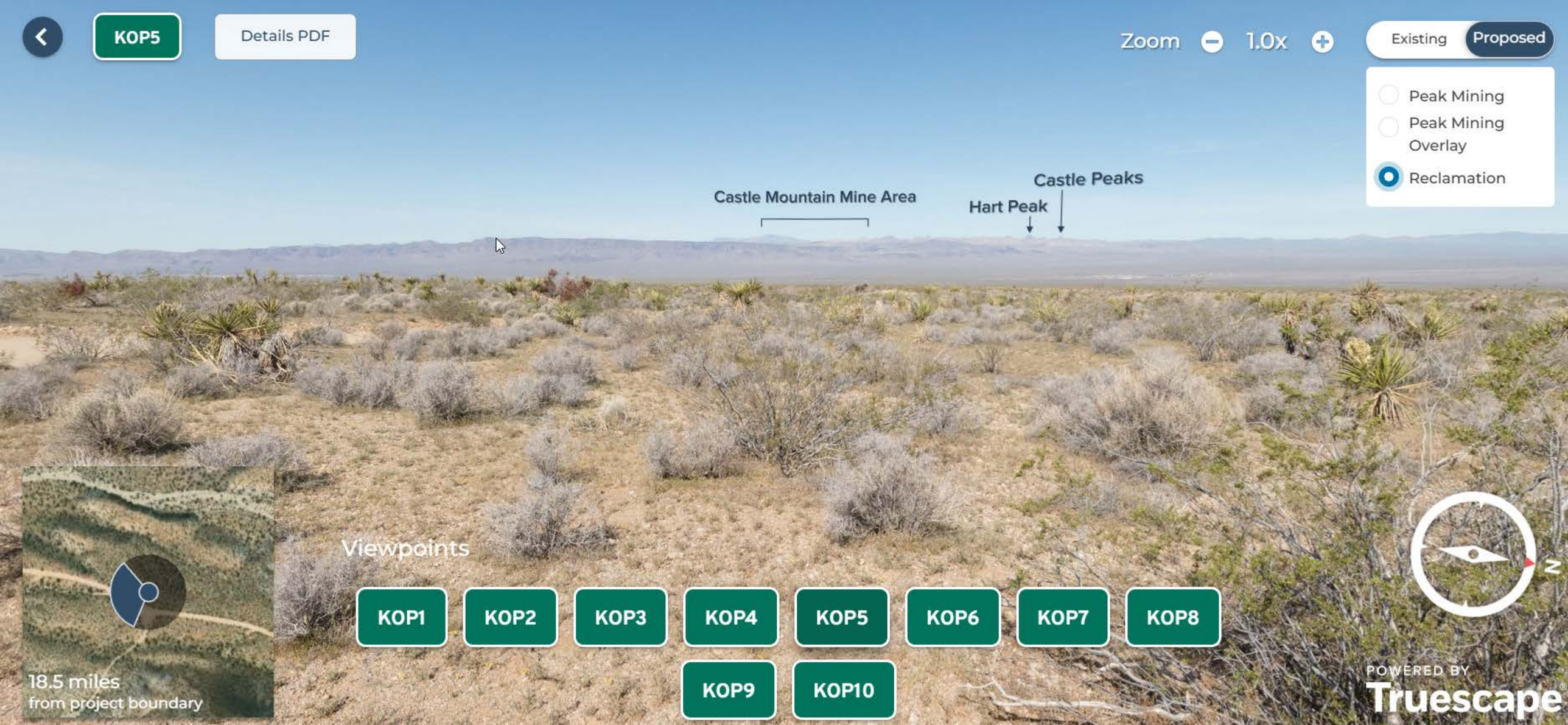

KOP4
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
Solar
0.5 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
KOP is taken from and includes the access road (CMM Mitigated Access Route)
N
POWERED BY
Truescape

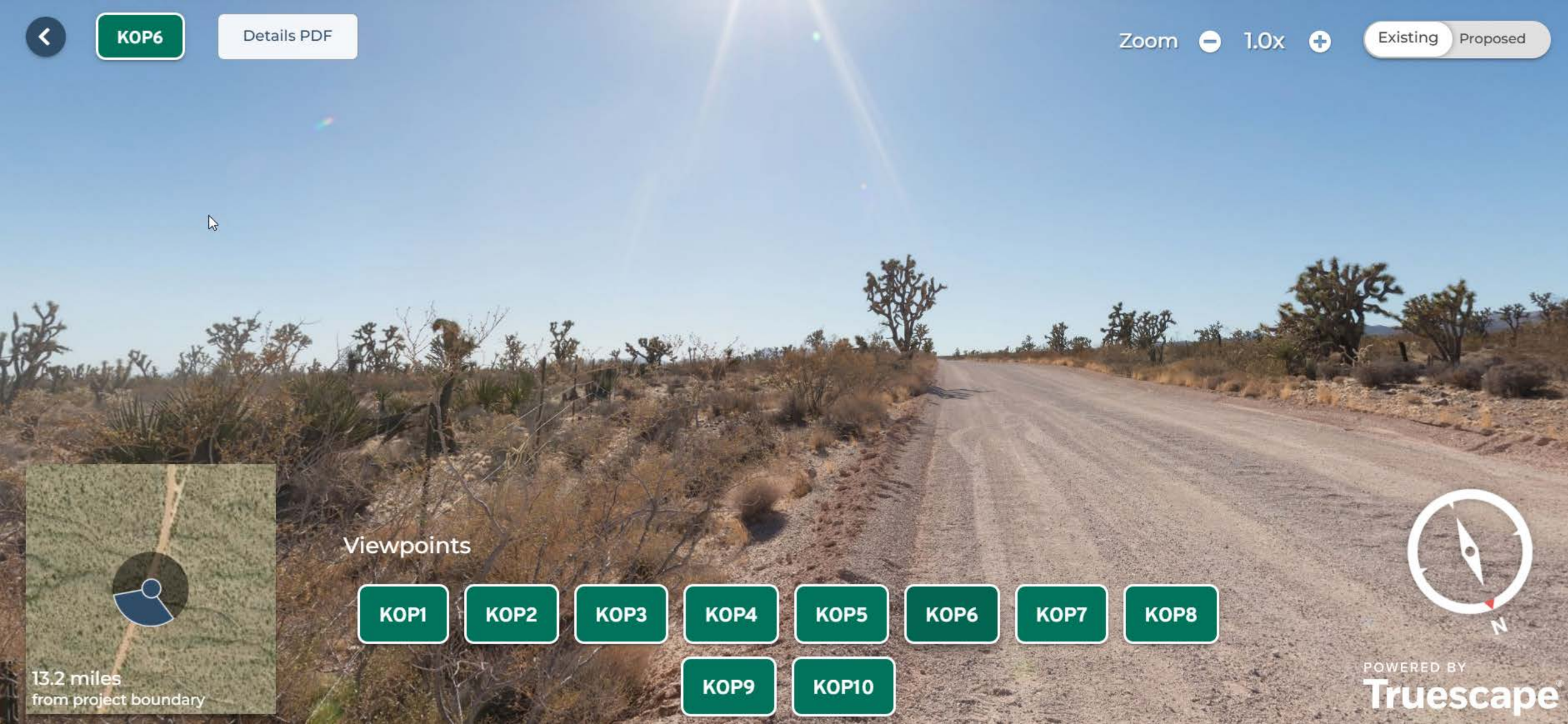

KOP4
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
Solar
0.5 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
KOP is taken from and includes the access road (CMM Mitigated Access Route)
POWERED BY
Truescape

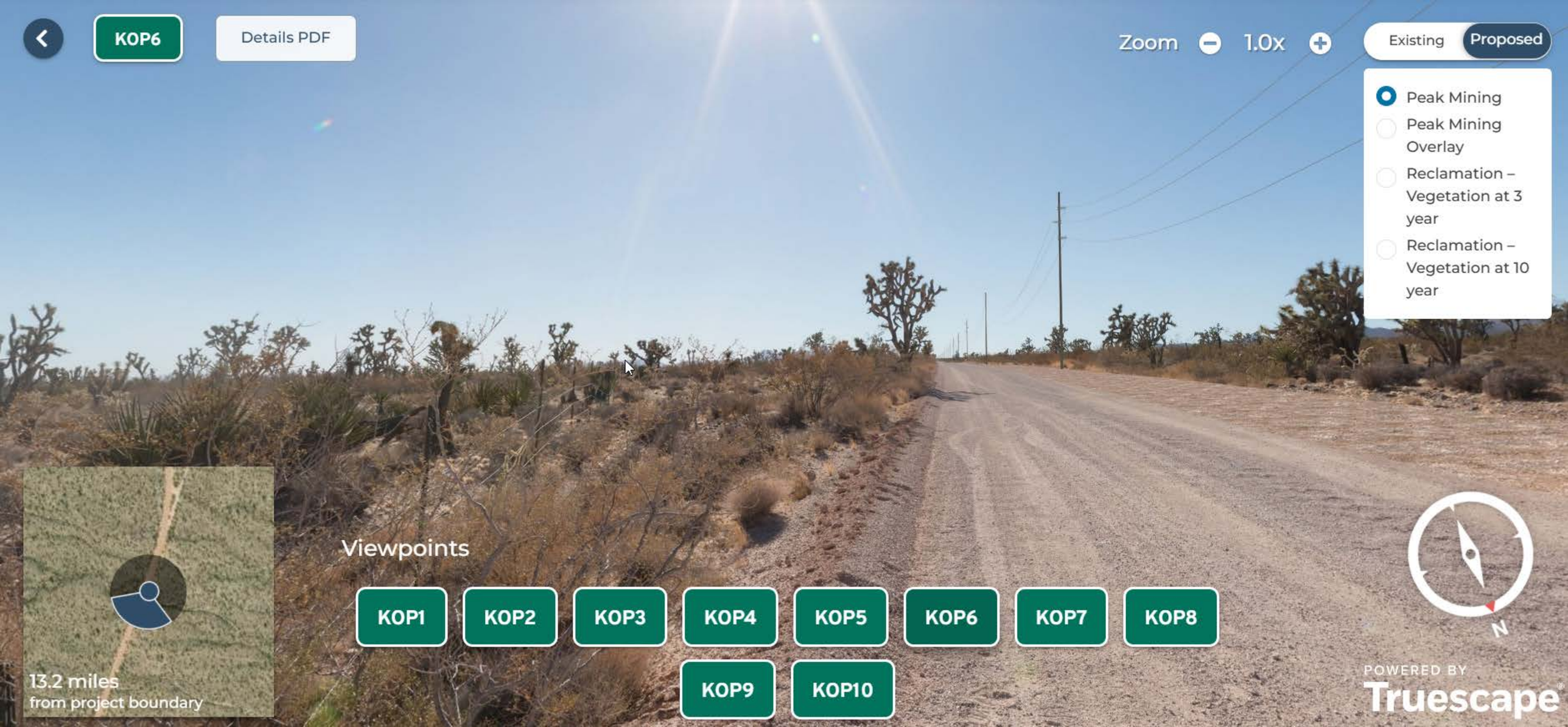

KOP5
Details PDF
Zoom
1.0x
Existing
Proposed
Castle Mountain Mine Area
Castle Peaks
Hart Peak
18.5 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

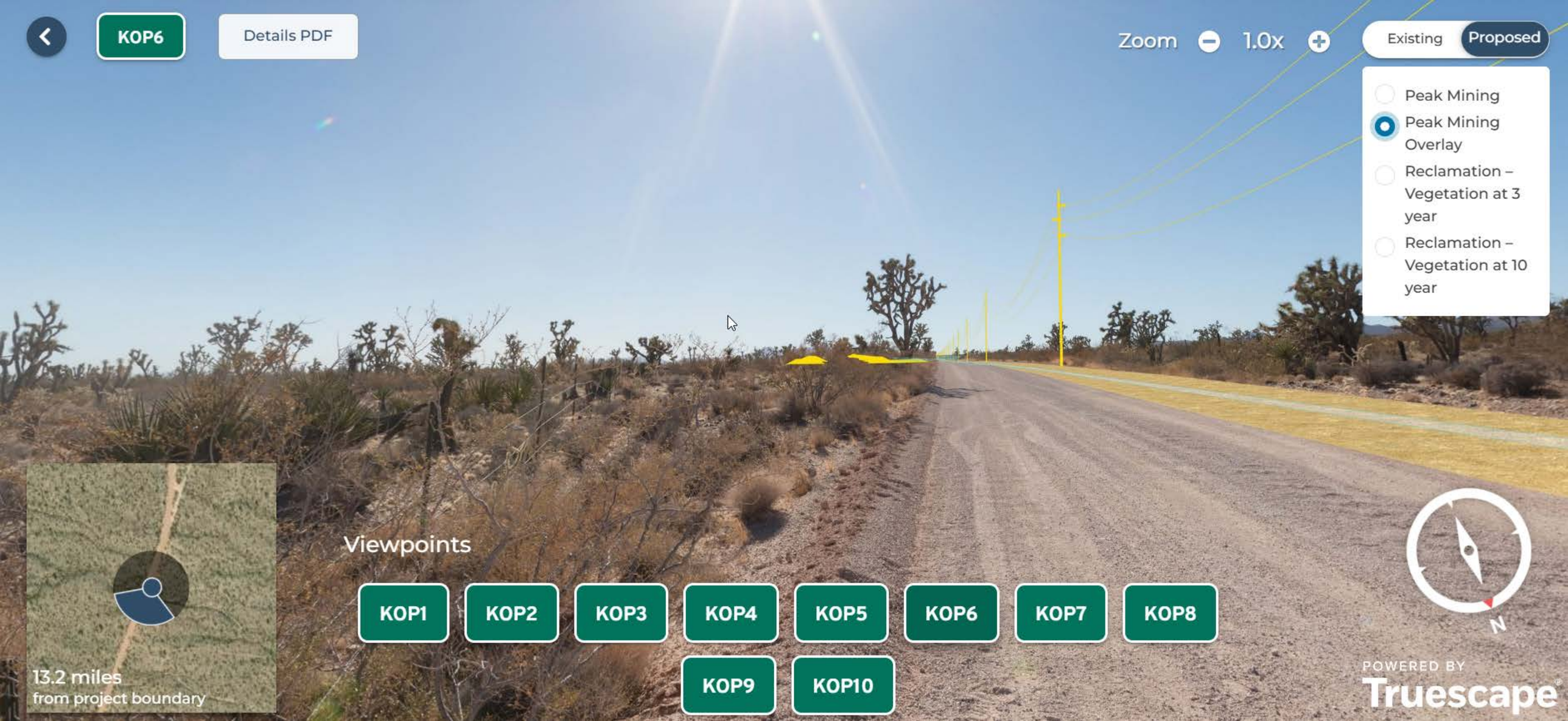

KOP5
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
Castle Mountain Mine Area
Hart Peak
Castle Peaks
18.5 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape®

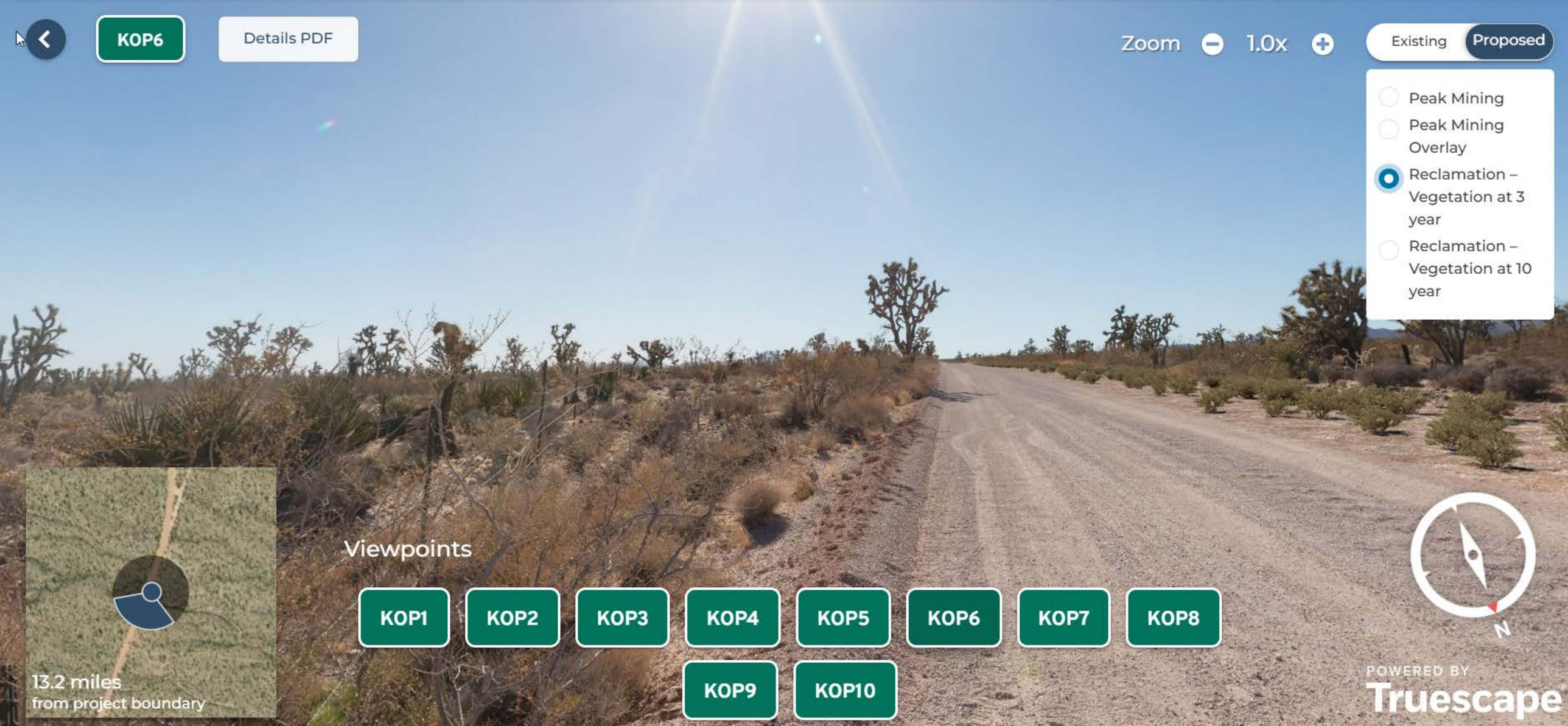

KOP5
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
Castle Mountain Mine Area
Hart Peak
Castle Peaks
18.5 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

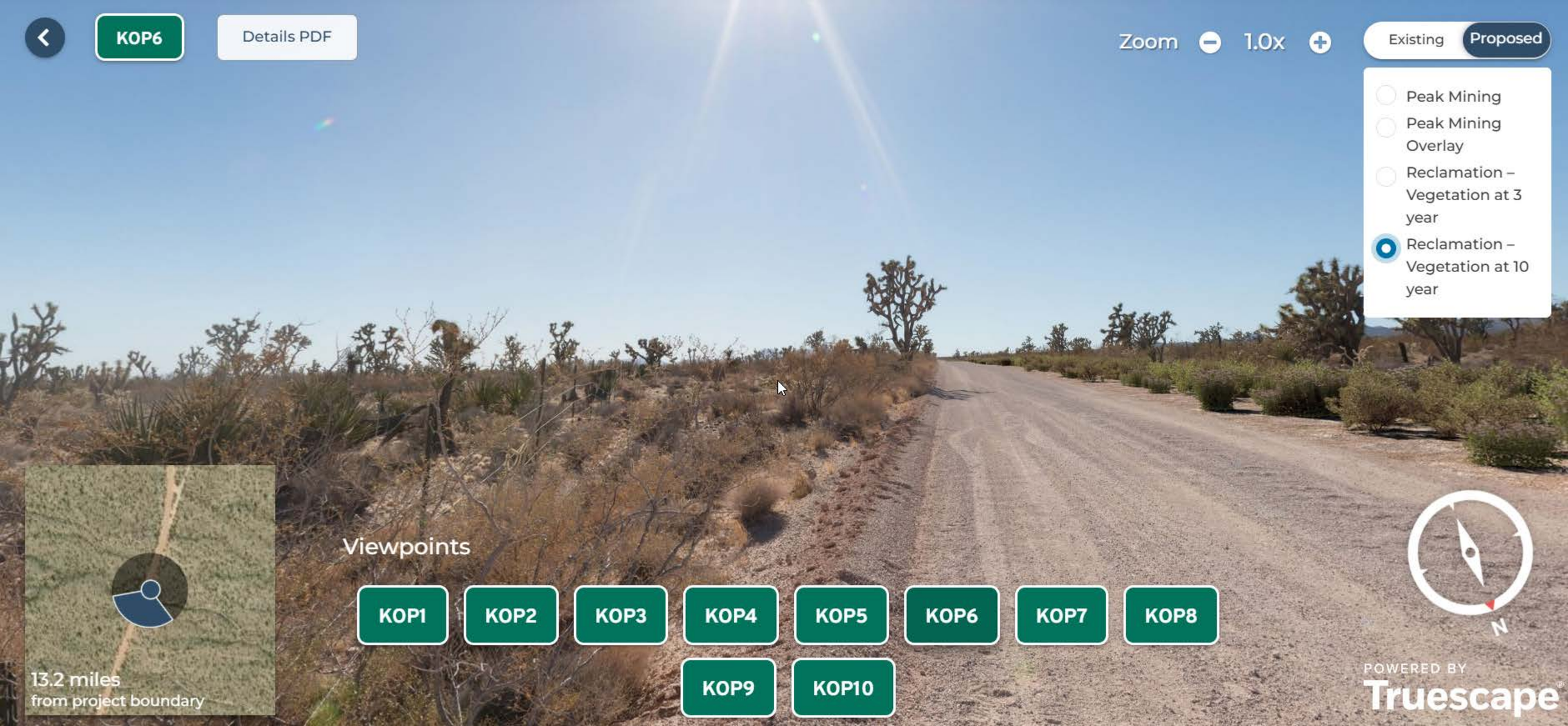

KOP5
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
Castle Mountain Mine Area
Hart Peak
Castle Peaks
18.5 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape®

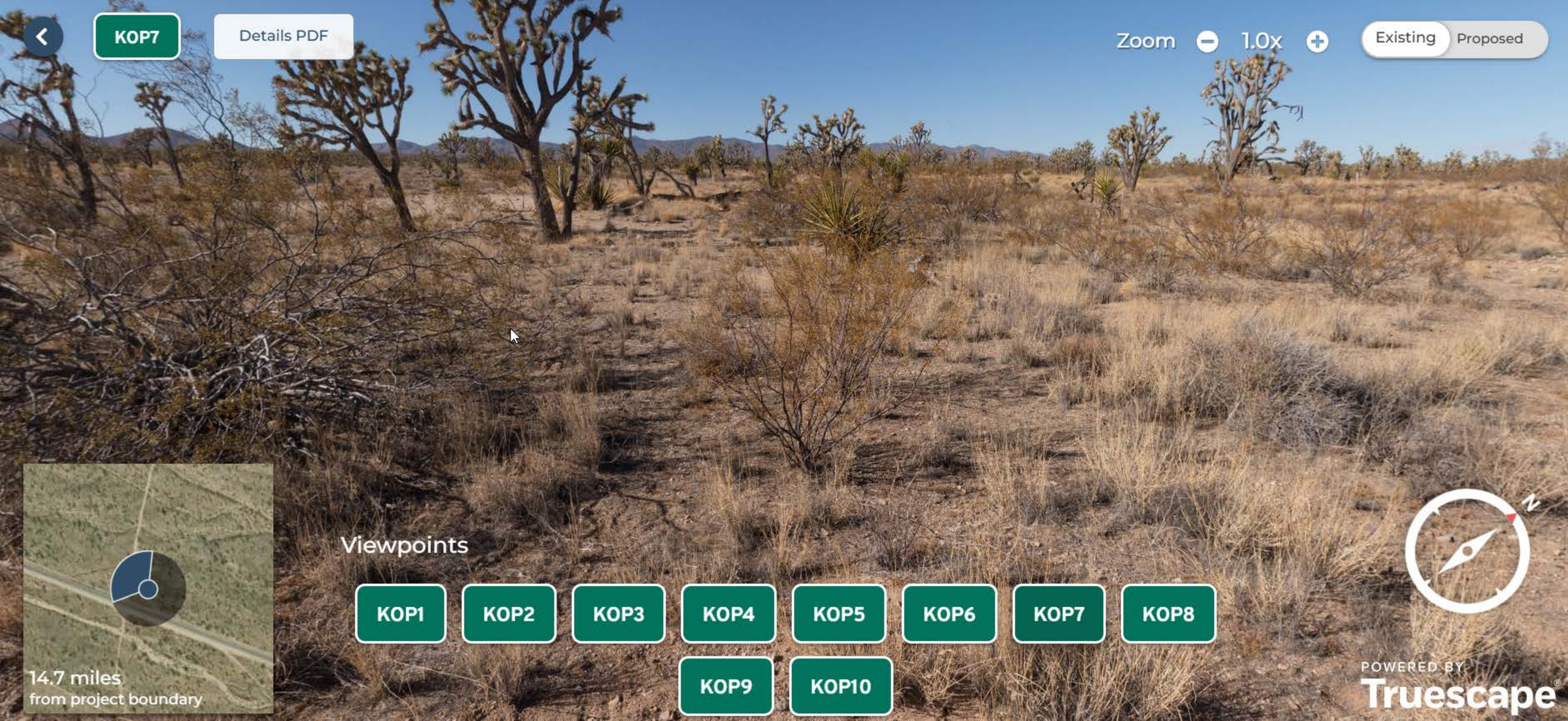

KOP6
Details PDF
Zoom
1.0x
Existing
Proposed
13.2 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

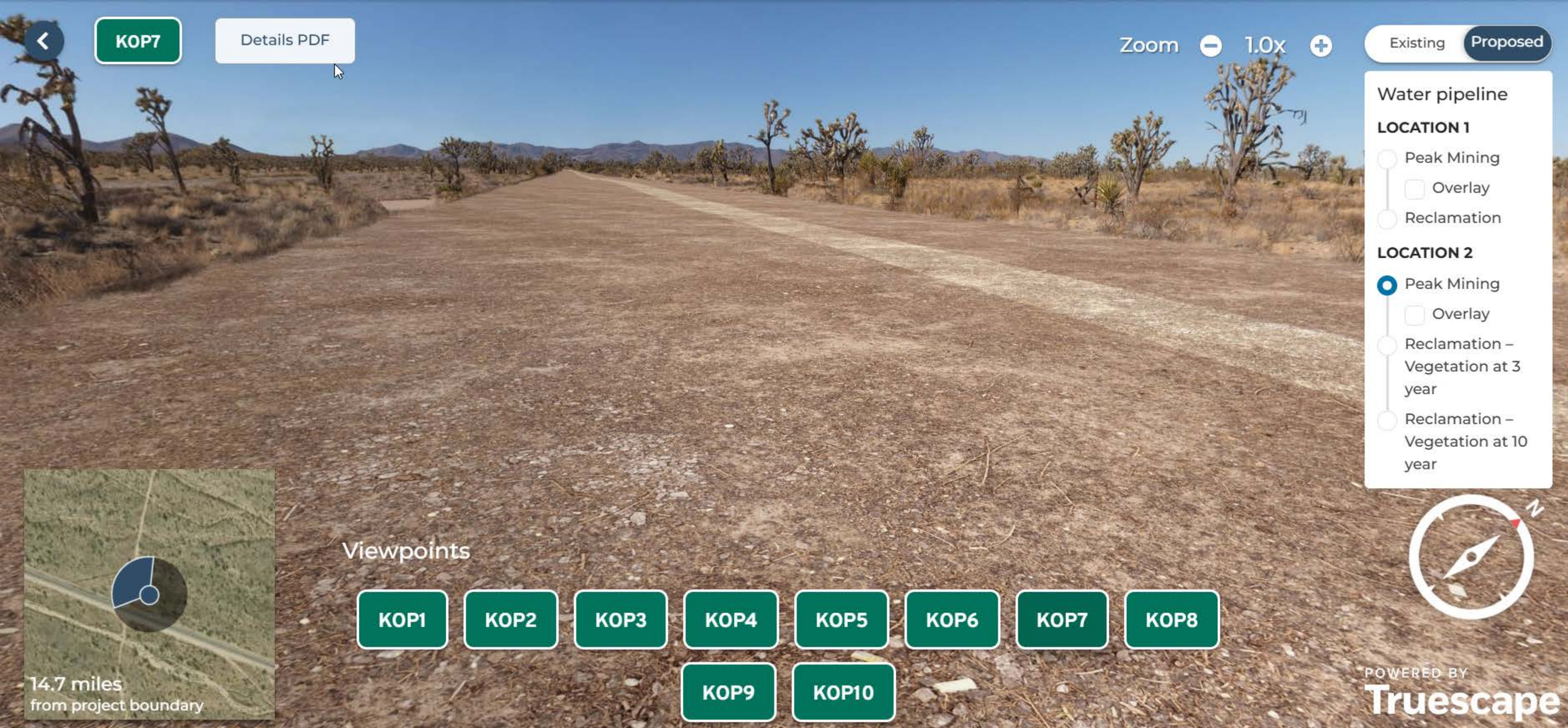

KOP6
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation – Vegetation at 3 year
Reclamation – Vegetation at 10 year
13.2 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

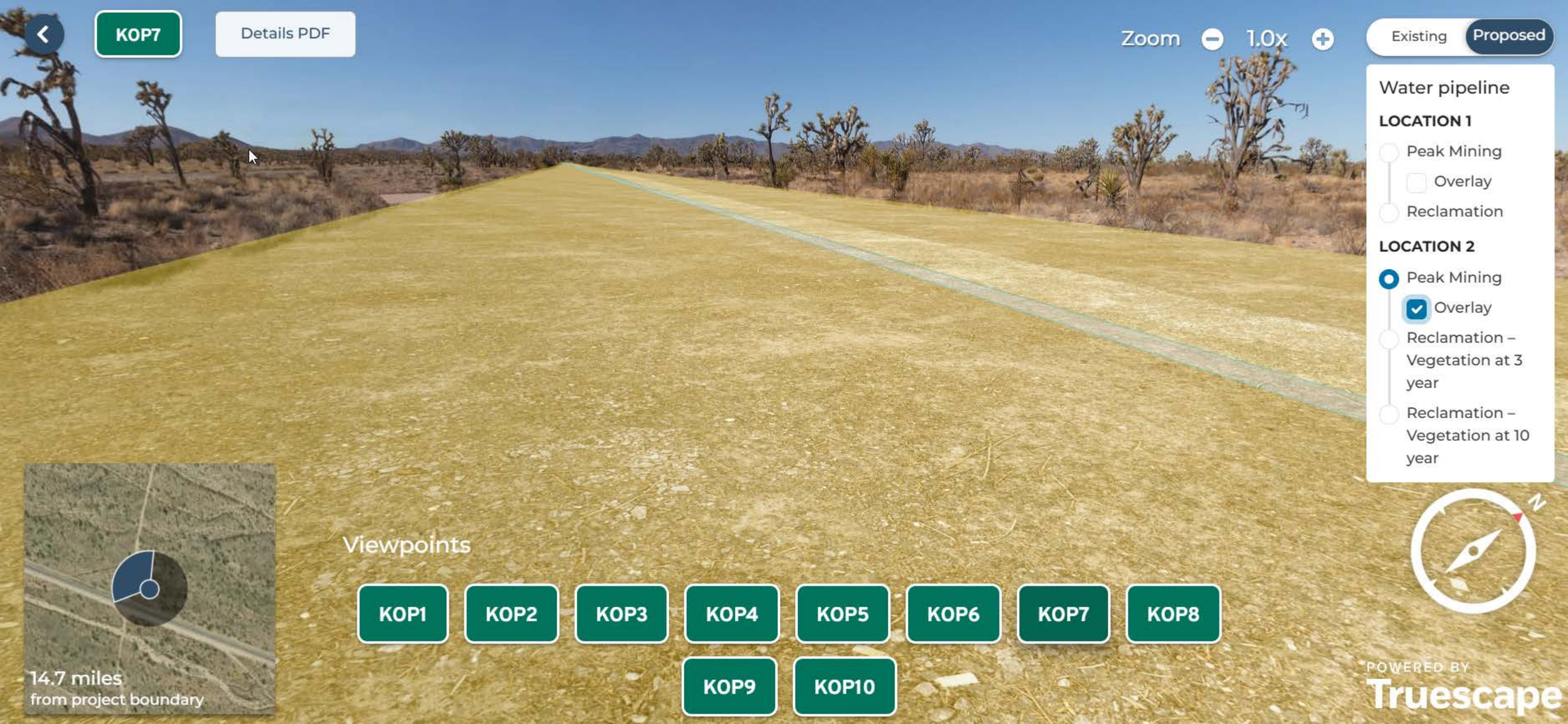

KOP6
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation – Vegetation at 3 year
Reclamation – Vegetation at 10 year
13.2 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

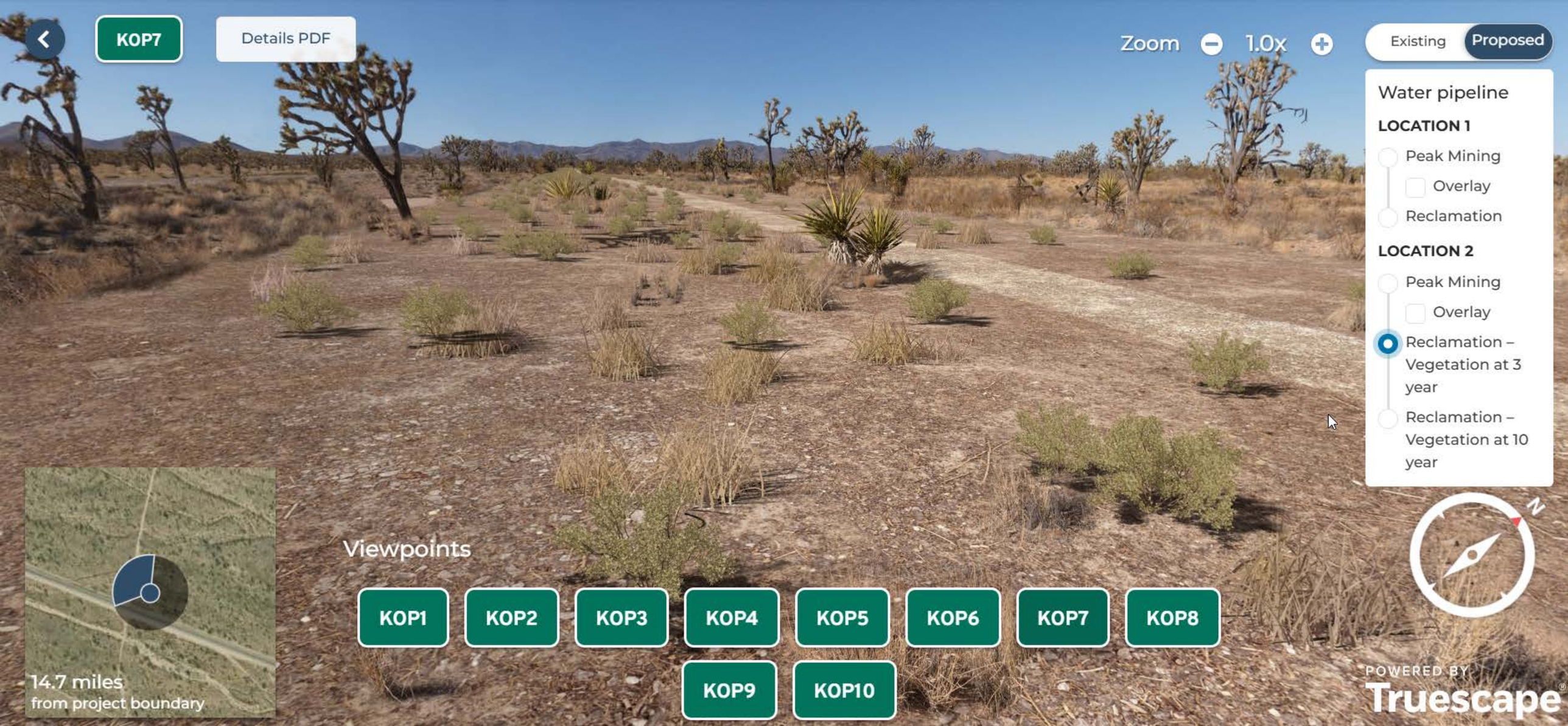

KOP6
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation – Vegetation at 3 year
Reclamation – Vegetation at 10 year
13.2 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape


KOP6
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation – Vegetation at 3 year
Reclamation – Vegetation at 10 year
13.2 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

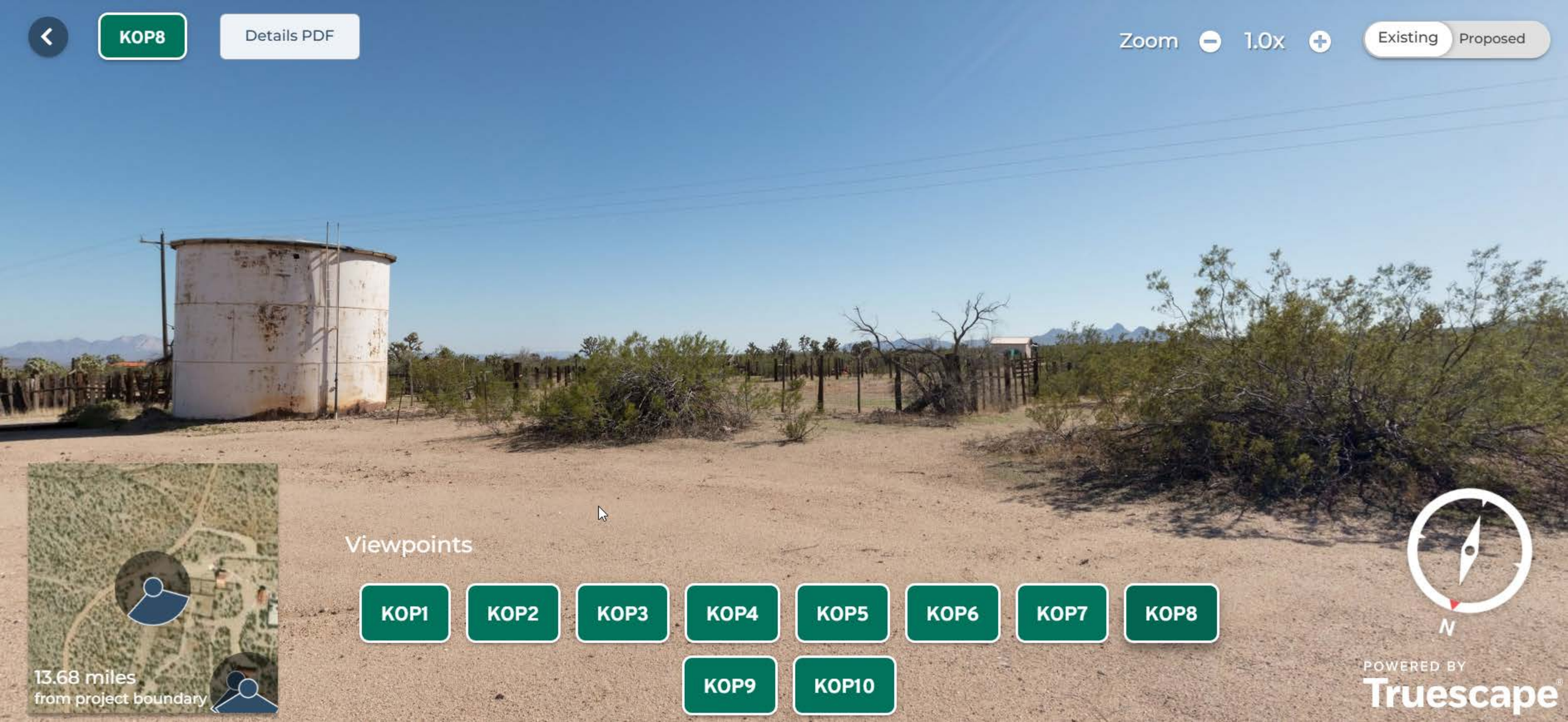

KOP7
Details PDF
Zoom
1.0x
Existing
Proposed
14.7 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

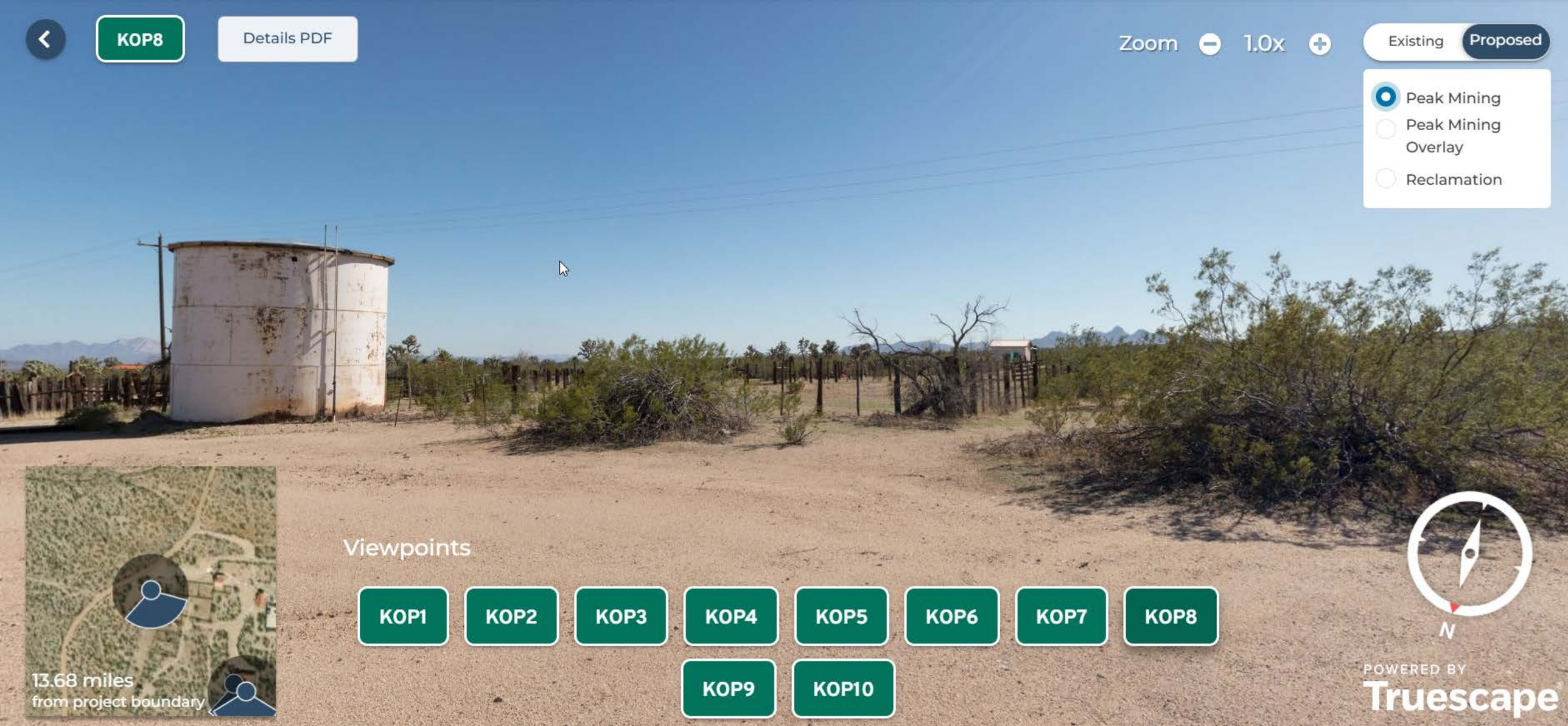

KOP7
Details PDF
Zoom
1.0x
Existing
Proposed
Water pipeline
LOCATION 1
Peak Mining
Overlay
Reclamation
LOCATION 2
Peak Mining
Overlay
Reclamation – Vegetation at 3 year
Reclamation – Vegetation at 10 year
14.7 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

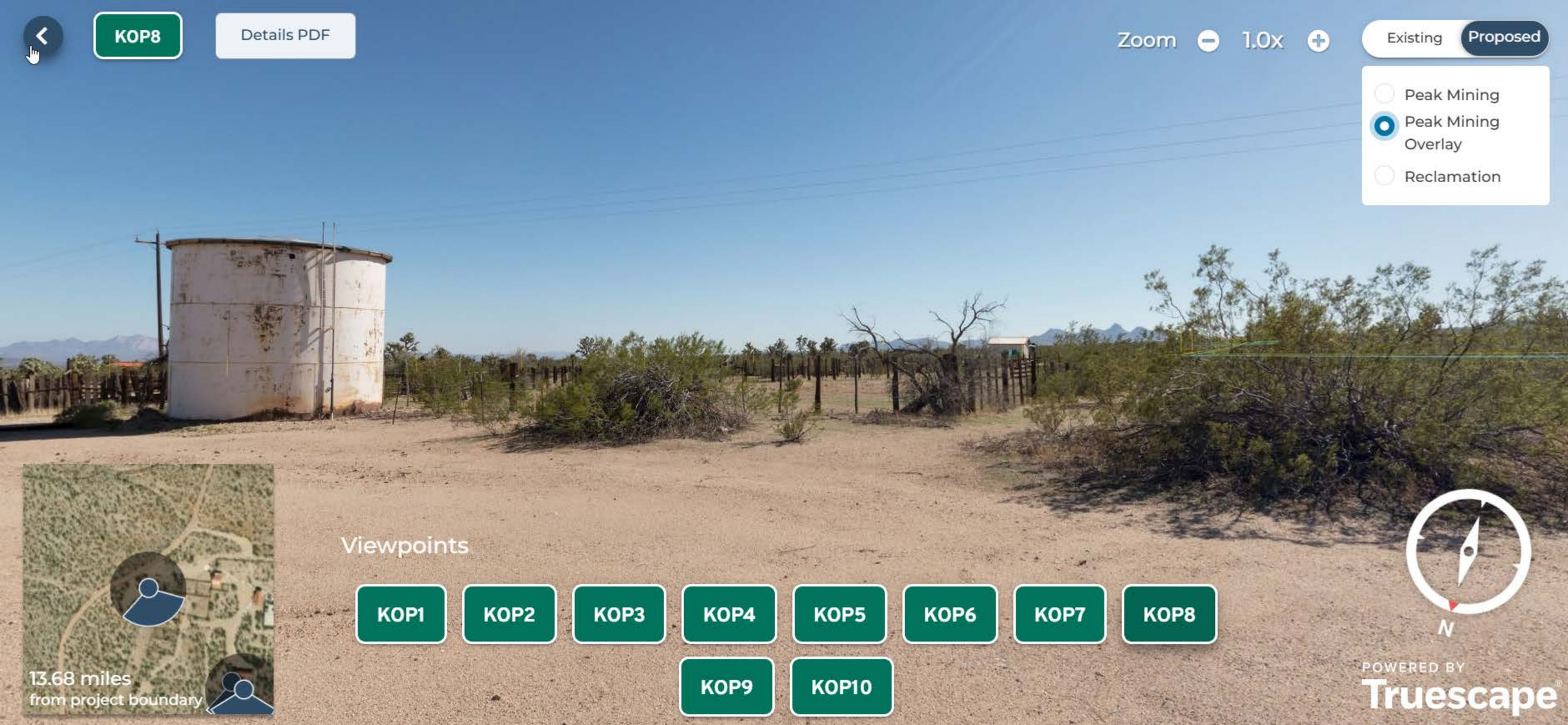

KOP7
Details PDF
Zoom
1.0x
Existing
Proposed
Water pipeline
LOCATION 1
Peak Mining
Overlay
Reclamation
LOCATION 2
Peak Mining
Overlay
Reclamation – Vegetation at 3 year
Reclamation – Vegetation at 10 year
14.7 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

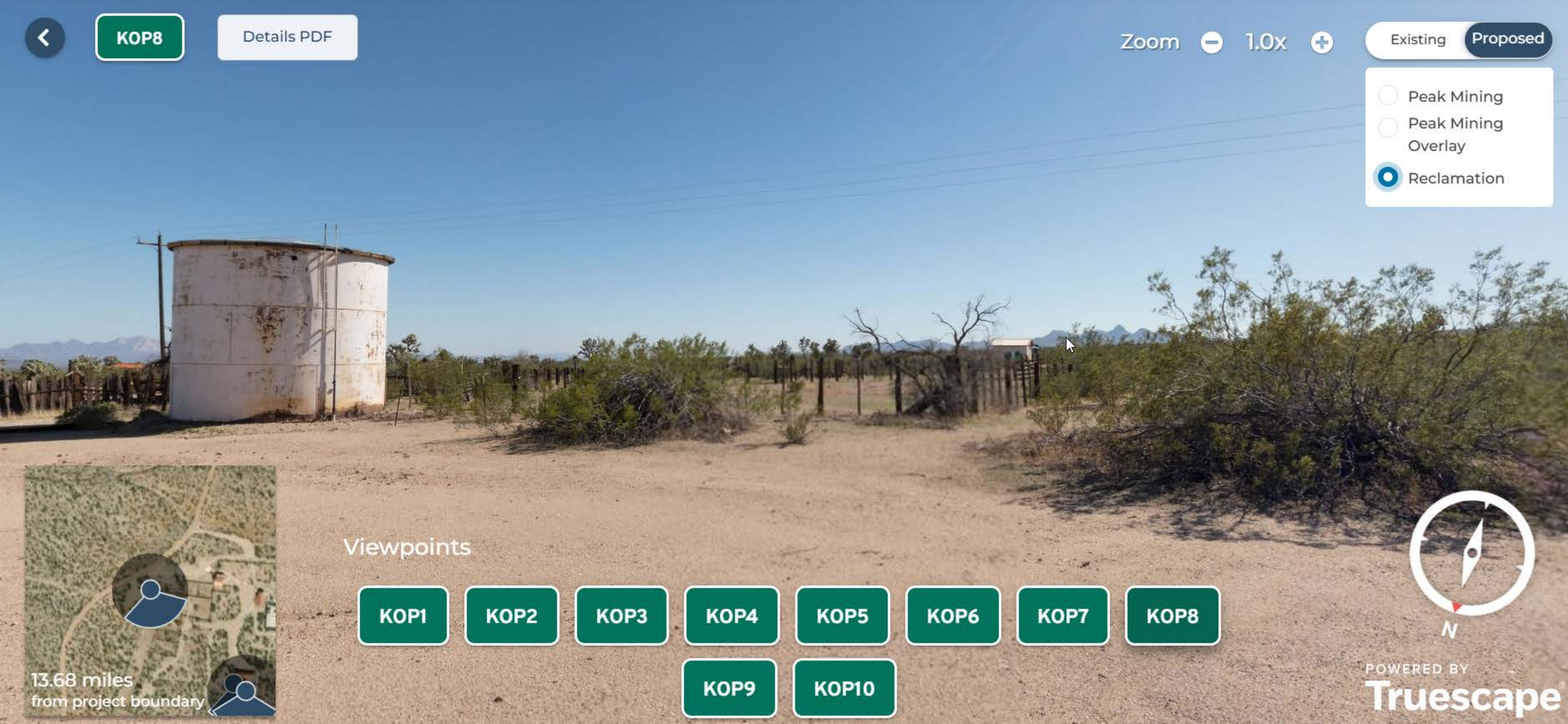

KOP7
Details PDF
Zoom
1.0x
Existing
Proposed
Water pipeline
LOCATION 1
Peak Mining
Overlay
Reclamation
LOCATION 2
Peak Mining
Overlay
Reclamation – Vegetation at 3 year
Reclamation – Vegetation at 10 year
14.7 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

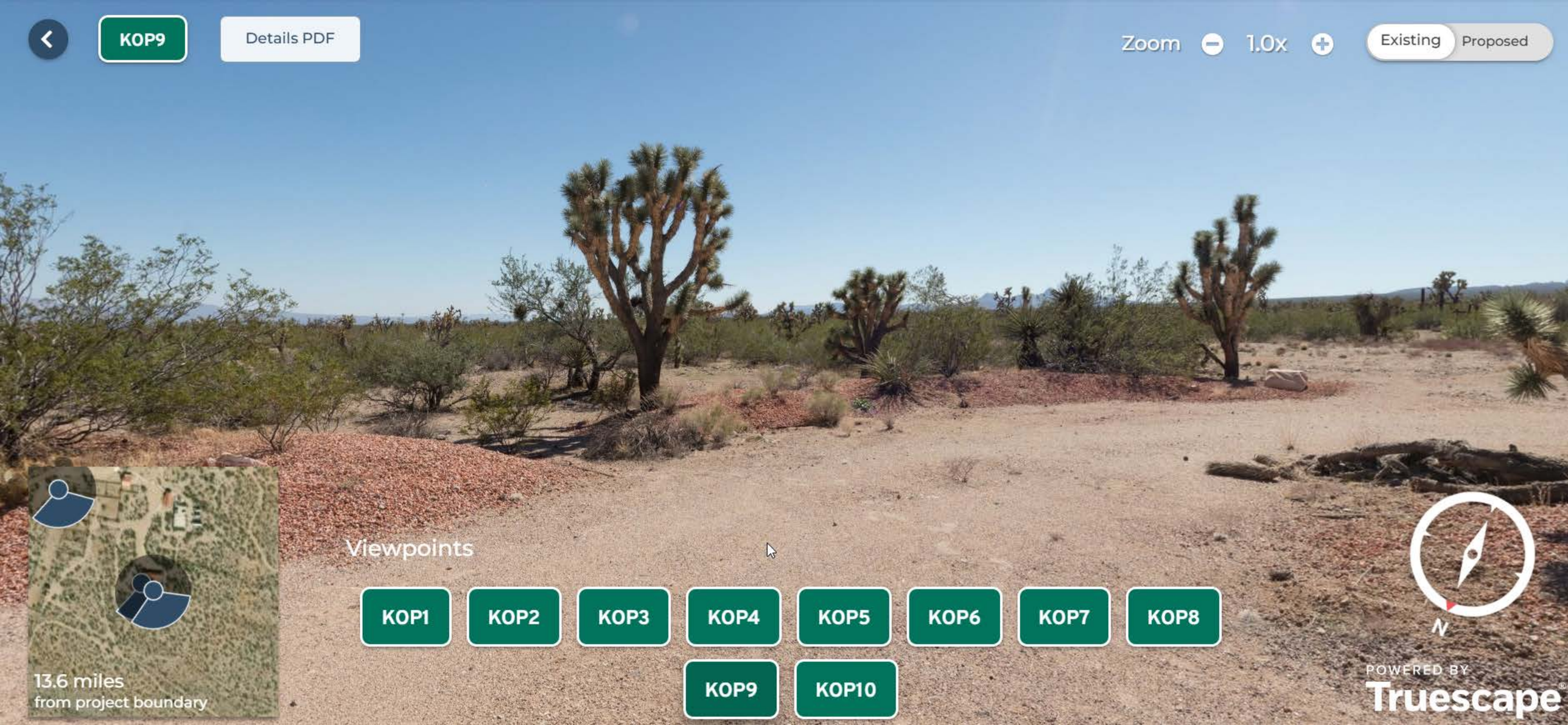

KOP7
Details PDF
Zoom
1.0x
Existing
Proposed
Water pipeline
LOCATION 1
Peak Mining
Overlay
Reclamation
LOCATION 2
Peak Mining
Overlay
Reclamation – Vegetation at 3 year
Reclamation – Vegetation at 10 year
14.7 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
POWERED BY
Truescape

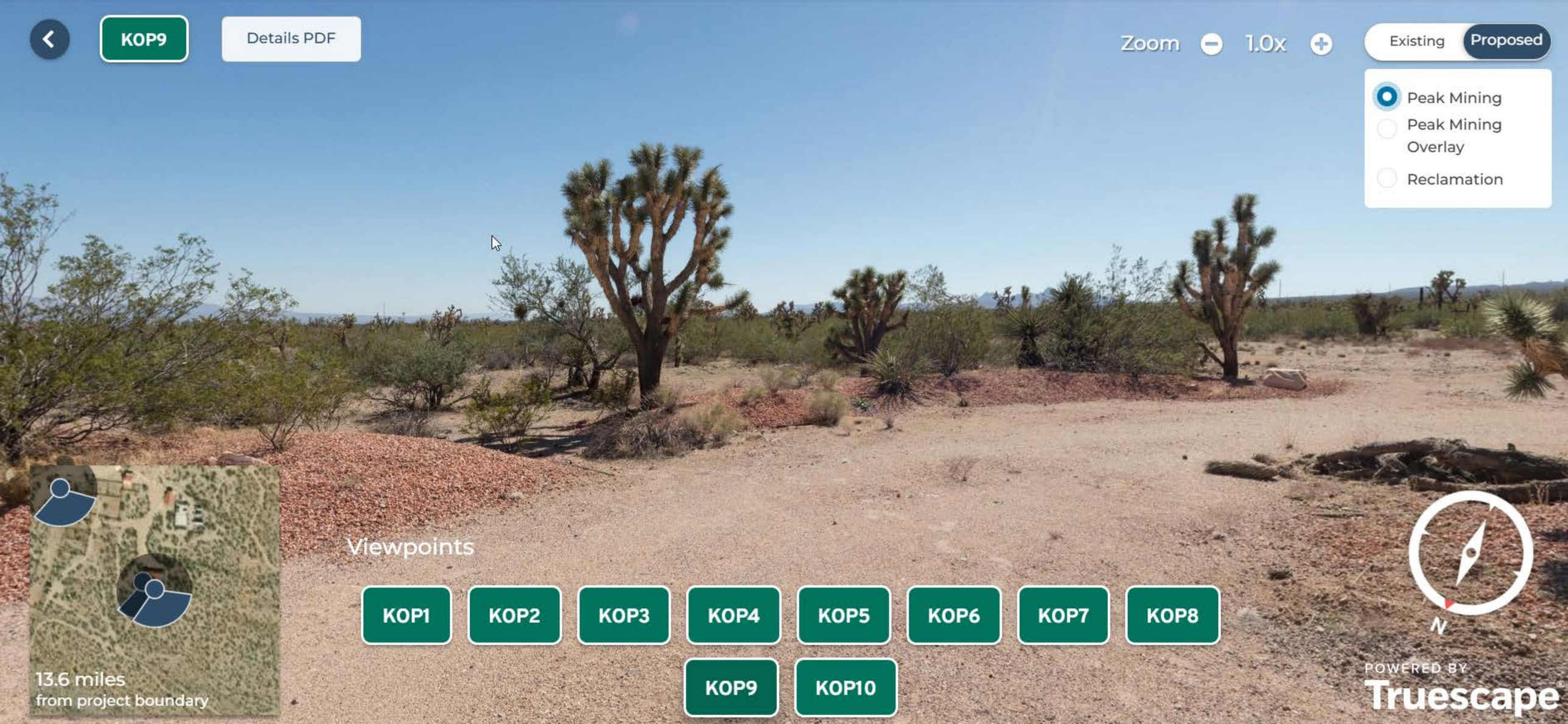

KOP8
Details PDF
Zoom
1.0x
Existing
Proposed
13.68 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

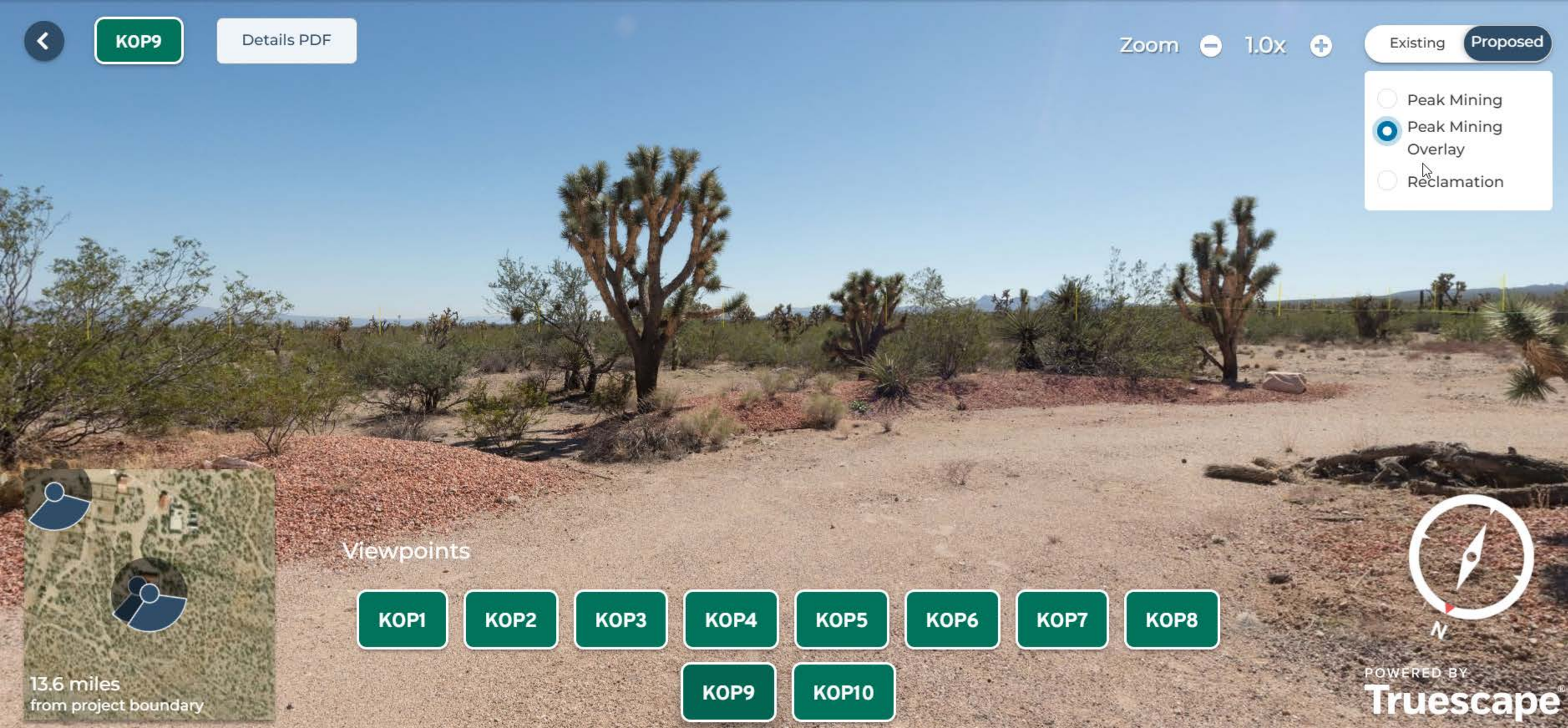

KOP8
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
13.68 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape

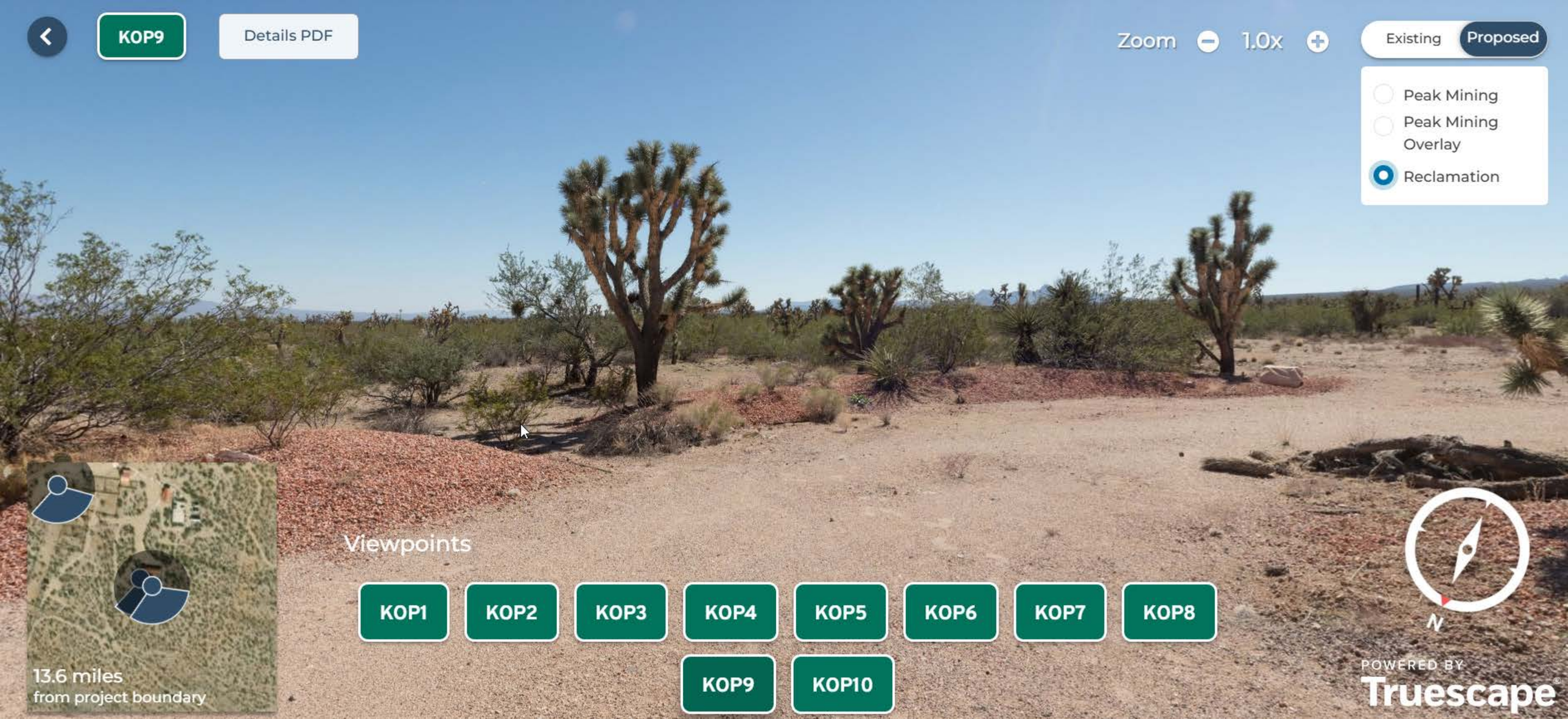

KOP8
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
13.68 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape


KOP8
Details PDF
Zoom 1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
13.68 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape


KOP9
Details PDF
Zoom
1.0x
Existing
Proposed
13.6 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape


KOP9
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
13.6 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape


KOP9
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
13.6 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape


KOP9
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
13.6 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape


KOP10
Details PDF
Zoom
1.0x
Existing
Proposed
13.6 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
N
POWERED BY
Truescape


KOP10
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
N
13.6 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
POWERED BY
Truescape


KOP10
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
N
13.6 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
POWERED BY
Truescape


KOP10
Details PDF
Zoom
1.0x
Existing
Proposed
Peak Mining
Peak Mining Overlay
Reclamation
N
13.6 miles
from project boundary
Viewpoints
KOP1
KOP2
KOP3
KOP4
KOP5
KOP6
KOP7
KOP8
KOP9
KOP10
POWERED BY
Truescape

Castle Mountain Mine Phase II Expansion

Sun and Weather

Sunny

Date: **1-13-26**

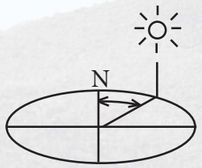
Photo Time: **9:04 am**

Visibility:

Good — Poor

Air Quality: Good

Sun Azimuth (degrees): **128.00**



Sun Angle (degrees): **11.78**

Lighting Angle on Project: **Side**

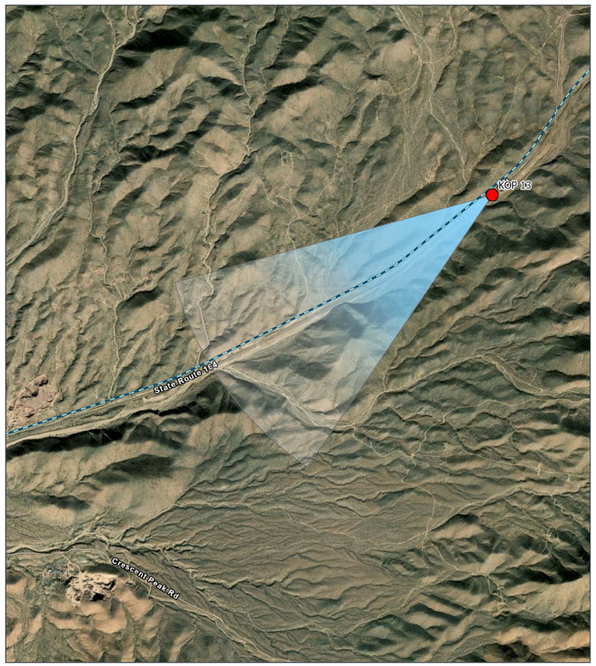
Wind: **6 mph**

Cloud Cover: **0 %**

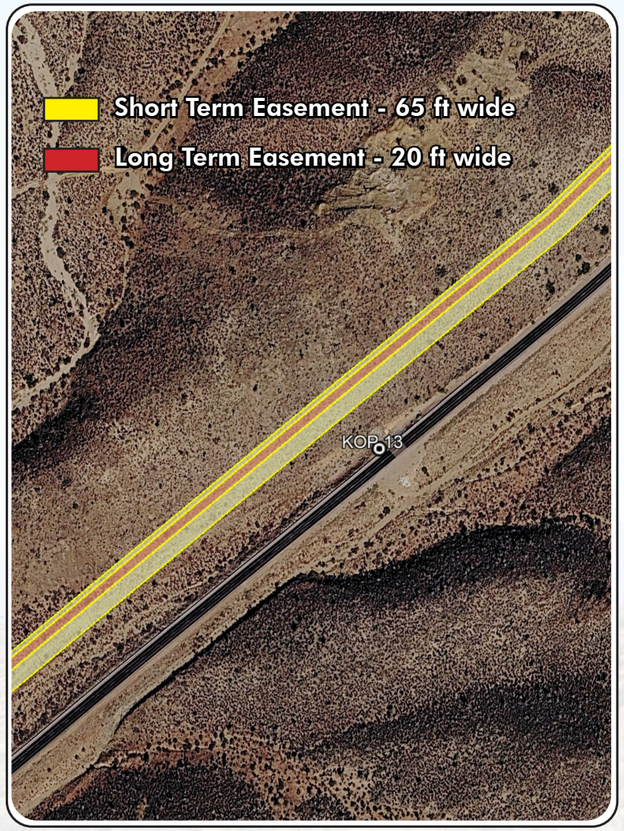
Temperature (°F): **54°F**

Simulation was prepared using information provided by client, "NPS Reroute 2026 01 12.dwg", "CMM ROW - PWL Pull Site_StrLocs. kmz", and "ROWs SHP Files_final.kmz" Locations, colors, and heights may vary based on final engineering and design.

KOP Location and Visible Elements



Structure Diagram





KOP 13 - SR 164 (McCullough Range)

Base Photographic Documentation

Latitude, Longitude (degrees):
35.50306, -115.14374

Viewpoint Elevation (feet):
4,830

Camera Height (meters):
1.8

Camera Heading (degrees):
230

Camera Make & Model:
Canon EOS 5D Mark IV

Camera Sensor Size (mm):
36 x 24 Full Frame

Lens Make & Model:
AF-P Nikkor

Lens Focal Length (mm):
50

Image Size (pixels):
6720 x 4480

Approximate Distance to Undergrounded Pipeline in Simulation:
300 feet

Viewing Instructions: Printed at 100% the resulting simulation is 16 inches wide by 10 inches high. At this size and focal length, the simulation should be viewed at arms length (24 inches). If viewed on a computer monitor, scale should be 100%.

SWCA® ENVIRONMENTAL CONSULTANTS



KOP 13: View from SR 164 (McCullough Range) looking southwest - Existing Condition



KOP 13: View from SR 164 (McCullough Range) looking southwest - Simulated Condition

Castle Mountain Mine Phase II Expansion

Sun and Weather

Sunny

Date: **1-13-26**

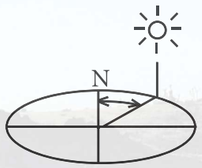
Photo Time: **8:12 am**

Visibility:

Good — Poor

Air Quality: Good

Sun Azimuth (degrees): **119.70**



Sun Angle (degrees): **3.24**

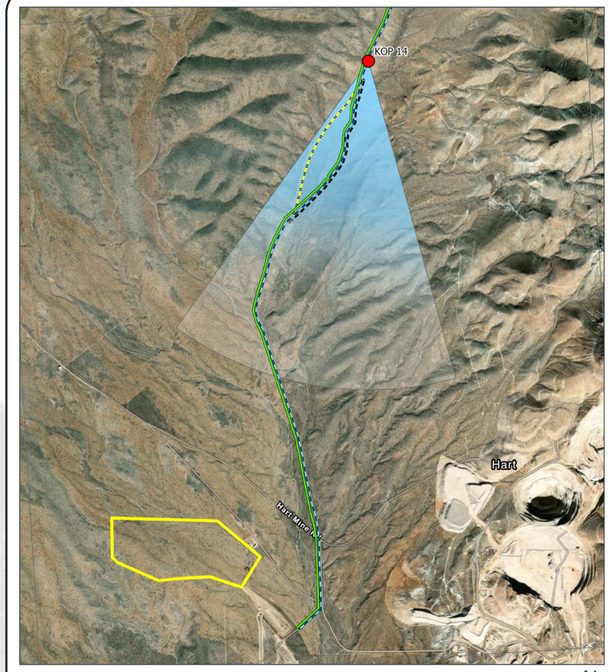
Lighting Angle on Project: **Side**

Wind: **6 mph**

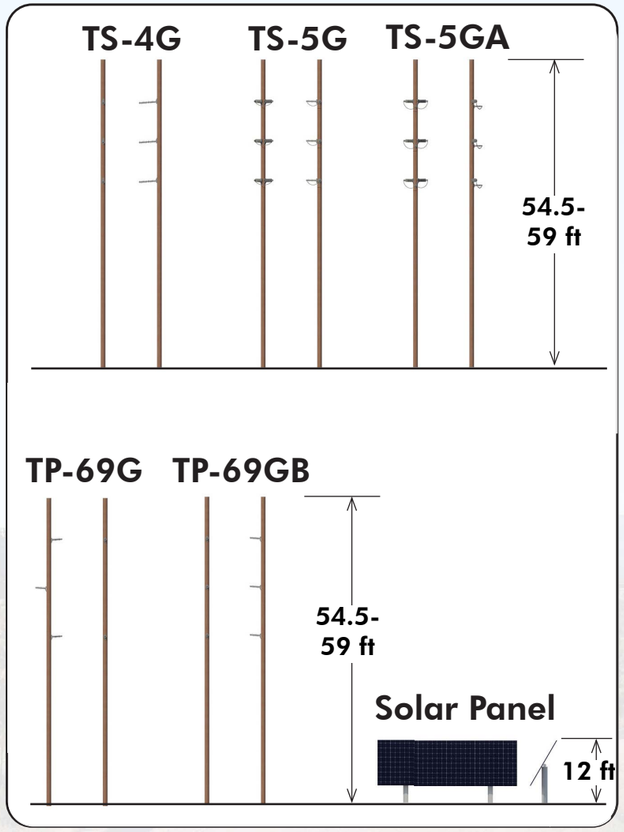
Cloud Cover: **0 %**

Temperature (°F): **48°F**

Simulation was prepared using information provided by client, "NPS Reroute 2026 01 12.dwg", "CMM ROW - PWL Pull Site_StrLocs. kmz", and "ROWs SHP Files_final.kmz" Locations, colors, and heights may vary based on final engineering and design.



KOP Location and Visible Elements



Structure Diagram



KOP 14 - Castle Mountain Mine Road (Re-Alignment Area)

Base Photographic Documentation

Latitude, Longitude (degrees):
35.31191, -115.11535

Viewpoint Elevation (feet):
4,545

Camera Height (meters):
1.8

Camera Heading (degrees):
190

Camera Make & Model:
Canon EOS 5D Mark IV

Camera Sensor Size (mm):
36 x 24 Full Frame

Lens Make & Model:
AF-P Nikkor

Lens Focal Length (mm):
50

Image Size (pixels):
6720 x 4480

Approximate Distance to Nearest Transmission Structure in Simulation:
300 feet

Viewing Instructions: Printed at 100% the resulting simulation is 16 inches wide by 10 inches high. At this size and focal length, the simulation should be viewed at arms length (24 inches). If viewed on a computer monitor, scale should be 100%.

SWCA® ENVIRONMENTAL CONSULTANTS



KOP 14: View from Castle Mountain Mine Road looking southwest - Existing Condition



KOP 14: View from Castle Mountain Mine Road looking southwest - Simulated Condition (Proposed Action)



KOP 14: View from Castle Mountain Mine Road looking southwest - Simulated Condition (Alternative E)

APPENDIX B

Key Observation Point Contrast Rating Worksheets

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 12/29/2025
District Office: California Desert
Field Office: Needles
Land Use Planning Area:

SECTION A. PROJECT INFORMATION

1. Project Name	4. KOP Location (T.R.S)	5. Location Sketch
Castle Mountain Mine Phase II Expansion	T14N, R16E, S26	
2. Key Observation Point (KOP) Name KOP 1 - Ivanpah Road (NPS)		
3. VRM Class at Project Location VRM Class III and IV	(Lat. Long) 35°15'51.57"N, 115°13'28.68"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Undulating to flat valley. Rounded trapezoidal to rugged mountains with existing mining operations visible.	Evenly patchy shrubs throughout valley. Scattered shrubs on mountains. Scattered to dense Joshua trees adjacent to KOP.	No structures are apparent in view
LINE	Gently sloping to undulating valley floor. Rounded to angular mountains. Horizontal and angular lines in mining area	Vertical Joshua trees with other vegetation indistinct to horizontal in valley; indistinct and angular in mountains.	No structures are apparent in view
COLOR	Light beige valley floor and mining scar. Mountains range from light tan to medium browns with red hues on some slopes	Olive green, sage green, bright green, brown, straw yellow.	No structures are apparent in view
TEX-TURE	Fine, smooth to undulating valley floor. Abrupt and coarse-textured mountains. Fine mining scars.	Fine, scattered and even. Foreground is more coarse from Joshua trees which become more uniform in the distance	No structures are apparent in view

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Trapezoidal expansion of mining to the south and west, partially block view of distant mountains	Geometrically cleared area associated with mining operations including tailing piles until reclamation efforts are complete	No proposed structures are apparent in view
LINE	Horizontal and angular lines in proposed mining area	Butt edge formed at base of mountain where vegetation would be removed until reclamation efforts are complete	No proposed structures are apparent in view
COLOR	Light beige soils associated with mining would be expanded compared to existing condition	Light beige soils replace olive and sage green vegetation until reclamation efforts are complete	No proposed structures are apparent in view
TEX-TURE	Coarse textured mountains would become fine texture mine tailings	Finer textured tailing piles replace vegetation until reclamation efforts are complete	No proposed structures are apparent in view

SECTION D. CONTRAST RATING __SHORT TERM ✓ LONG TERM

1. DEGREE OF CONTRAST		FEATURES: LAND/WATER BODY (1) STRONG	MODERATE	WEAK	NONE	VEGETATION (2) STRONG	MODERATE	WEAK	NONE	STRUCTURES (3) STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM		✓					✓					✓
	LINE			✓				✓					✓
	COLOR			✓				✓					✓
	TEXTURE			✓				✓					✓

2. Does project design meet visual resource management objectives? ✓ Yes ___ No (Explain on reverses side)

3. Additional mitigating measures recommended ✓ Yes ___ No (Explain on reverses side)

Evaluator's Names: SWCA Visual Resource Planners
Date: 12/29/2025

(Continued on Page 2)

Comments from item 2.

This KOP is located along Ivanpah Road in the Mojave National Preserve which was also identified as a viewpoint in the Mojave Preserve Visual Inventory Report, approximately 5 miles from the proposed mining expansion area. The viewpoint is located on a slope descending from the New York Mountains with a slightly superior views over the surrounding area. This KOP has a mostly unobstructed view of the surrounding area, with Joshua trees partially screening views. Existing mining operations associated with the Castle Mountain Mine are visible and introduce modifications to the existing landforms and vegetation of the area. Meandering roadways are visible to the east and south of the KOP.

The valley floors and surrounding mountains are populated with Joshua tree as well as low shrubs interspersed with grasses. The existing mining operations create trapezoidal forms with light colored soils associated with tailing piles. The proposed mining areas would occur adjacent to the existing mining operations and would be seen as an expansion of the existing mine. From this viewpoint, the Project would repeat many elements associated with the existing mining operations but would create larger spoil piles and expand the influence of these activities on the landscape. Based on the superior position of casual observers from this KOP and the even nature of the vegetation, proposed changes to the landforms and vegetation are expected to be visible including a butt edge formed at the base of the Castle Mountains where the area of cleared vegetation associated with mining would be juxtaposed with the vegetation which appears dense at this viewing angle. The resulting clearings and access roads would generate a weak level of contrast as they repeat those elements associated with existing roads and mining operations.

The taller spoil piles and expanded area viewed as modified by mining operations, associated with the project, would increase the influence of the activities on views and would attract attention. As such, the project would result in a weak-moderate level of visual contrast and would further attract the attention of the casual observer. Based on this level of contrast with VRM Class III (and IV) areas, the Project is expected to meet the management class from this KOP as the Project would not dominate views.

Additional Mitigating Measures (See item 3)

As described in the Project's 1998 ROD, include that site reclamation shall include modification of final overburden and heap leach pile shapes to reduce the impact of straight-line geometrics and potential contrast in form and line.

As described in the Project's 1998 ROD, rock staining solutions shall be used on the upper mine pit walls where necessary, as determined by the BLM and the County, to reduce the contrast of light-colored rock exposed by mining activities and where visible above prevailing grade. These solutions shall be specifically colored to reduce the contrast between the pit walls and the surrounding undisturbed slopes.

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 12/29/2025
District Office: California Desert
Field Office: Needles
Land Use Planning Area:

SECTION A. PROJECT INFORMATION

1. Project Name	4. KOP Location (T.R.S)	5. Location Sketch
Castle Mountain Mine Phase II Expansion	T14N, R17E, S17	
2. Key Observation Point (KOP) Name KOP 2 - Hart Mine Road (NPS)		
3. VRM Class at Project Location VRM Class III and IV	(Lat. Long) 35°17'52.75"N, 115°10'9.64"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Undulating to flat valley. Rounded trapezoidal to rugged mountains with existing mining operations partially visible.	Evenly patchy shrubs throughout valley. Scattered shrubs on mountains. Scattered to dense Joshua trees adjacent to KOP.	No structures are apparent in view
LINE	Gently sloping to undulating valley floor. Rounded to angular mountains. Angular lines in mining area	Vertical Joshua trees with other vegetation indistinct to horizontal in valley; indistinct and angular in mountains.	No structures are apparent in view
COLOR	Light beige valley floor and mining scar. Mountains range from light tan to medium browns with red hues on some slopes	Olive green, sage green, bright green, brown, straw yellow.	No structures are apparent in view
TEX-TURE	Fine, smooth to undulating valley floor. Abrupt and coarse-textured mountains. Fine mining scars.	Fine, scattered and even. Foreground is more coarse from Joshua trees which become more uniform in the distance	No structures are apparent in view

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Trapezoidal expansion of mining to the south and west, partially block distant mountains	Geometrically cleared area associated with mining operations including tailing piles until reclamation efforts are complete	No proposed structures are apparent in view
LINE	Horizontal and angular lines in proposed mining area	Butt edge formed at base of mountain where vegetation would be removed until reclamation efforts are complete	No proposed structures are apparent in view
COLOR	Light beige soils associated with mining would be expanded compared to existing condition	Light beige soils replace olive and sage green vegetation until reclamation efforts are complete	No proposed structures are apparent in view
TEX-TURE	Coarse textured mountains would become fine texture mine tailings	Finer textured tailing piles replace vegetation until reclamation efforts are complete	No proposed structures are apparent in view

SECTION D. CONTRAST RATING __SHORT TERM ✓LONG TERM

1. DEGREE OF CONTRAST		FEATURES: LAND/WATER BODY (1) STRONG	MODERATE	WEAK	NONE	VEGETATION (2) STRONG	MODERATE	WEAK	NONE	STRUCTURES (3) STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM		✓					✓					✓
	LINE			✓				✓					✓
	COLOR			✓				✓					✓
	TEXTURE			✓				✓					✓

2. Does project design meet visual resource management objectives? ✓Yes ___No (Explain on reverses side)

3. Additional mitigating measures recommended ✓Yes ___No (Explain on reverses side)

Evaluator's Names: SWCA Visual Resource Planners
Date: 12/29/2025

(Continued on Page 2)

Comments from item 2.

This KOP is located along Hart Mine Road, within the Mojave National Preserve, near the Eagle Well petroglyph site which was identified as a viewpoint in the Mojave Preserve Visual Inventory Report, approximately 2 miles from the proposed mining expansion area. The viewpoint is located on a slope descending from the New York Mountains with a level to slightly superior view of the landscape. This KOP has a partially screened view of the surrounding area, with Joshua trees partially screening views especially the area where the mountains meet the valley. Existing mining operations associated with the Castle Mountain Mine are visible and introduce modifications to the existing landforms and vegetation of the area. Due to the level viewing angle, existing roadways are generally not visible from this the KOP.

The valley floors and surrounding mountains are populated with Joshua tree as well as low shrubs interspersed with grasses. The existing mining operations create trapezoidal forms with light colored soils associated with tailing piles. The proposed mining areas would occur adjacent to the existing mining operations and would be seen as an expansion of the existing mine. Due to the screening effect associated with vegetation in the foreground, the Project would be more visible rising above the vegetation compared to the existing mining area. From this viewpoint, the Project would repeat many elements associated with the existing mining operations but would create larger spoil piles and expand the influence of these activities on the landscape. Based on the level position of casual observers from this KOP and the even nature of the vegetation, proposed changes to the landforms and vegetation are not expected to be visible in the valley but the mining areas would change landforms and vegetation visible on the Castle Mountains.

The taller spoil piles and expanded area viewed as modified by mining operations, associated with the project, would increase the influence of the activities on views and would attract attention. As such, the project would result in a weak-moderate level of visual contrast and would further attract the attention of the casual observer. Based on this level of contrast with VRM Class III (and IV) areas, the Project is expected to meet the management class from this KOP as the Project would not dominate views.

Additional Mitigating Measures (See item 3)

As described in the Project's 1998 ROD, include that site reclamation shall include modification of final overburden and heap leach pile shapes to reduce the impact of straight-line geometrics and potential contrast in form and line.

As described in the Project's 1998 ROD, rock staining solutions shall be used on the upper mine pit walls where necessary, as determined by the BLM and the County, to reduce the contrast of light-colored rock exposed by mining activities and where visible above prevailing grade. These solutions shall be specifically colored to reduce the contrast between the pit walls and the surrounding undisturbed slopes.

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 12/29/2025
District Office: California Desert
Field Office: Needles
Land Use Planning Area:

SECTION A. PROJECT INFORMATION

1. Project Name	4. KOP Location (T.R.S)	5. Location Sketch
Castle Mountain Mine Phase II Expansion	T13N, R17E, S33	
2. Key Observation Point (KOP) Name KOP 3 - Lanfair Buttes (NPS)		
3. VRM Class at Project Location VRM Class III and IV	(Lat. Long) 35°10'16.79"N, 115° 8'48.35"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Mostly flat valley. Rounded trapezoidal to rugged mountains with existing mining operations partially visible.	Evenly patchy shrubs throughout valley. Scattered shrubs on mountains. Scattered shrubs adjacent to KOP.	No structures are apparent in view
LINE	Gently sloping to undulating valley floor. Rounded to angular mountains. Angular lines in mining area	Rounded shrubs with other vegetation indistinct to horizontal in valley; indistinct and angular in mountains.	No structures are apparent in view
COLOR	Light beige valley floor and mining scar. Mountains range from light tan to medium browns with red hues on some slopes	Olive green, sage green, bright green, brown, straw yellow.	No structures are apparent in view
TEX-TURE	Fine, smooth to undulating valley floor. Abrupt and coarse-textured mountains. Fine mining scars.	Fine, scattered and even. Foreground is more coarse from woody shrubs which become more uniform in the distance	No structures are apparent in view

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Trapezoidal expansion of mining viewed to the north.	Geometrically cleared area associated with mining operations including tailing piles until reclamation efforts are complete	No proposed structures are apparent in view
LINE	Horizontal and angular lines in proposed mining area	Butt edge formed at base of mountain where vegetation would be removed until reclamation efforts are complete	No proposed structures are apparent in view
COLOR	Light beige soils associated with mining would be expanded compared to existing condition	Light beige soils replace olive and sage green vegetation until reclamation efforts are complete	No proposed structures are apparent in view
TEX-TURE	Coarse textured mountains would become fine texture mine tailings	Finer textured tailing piles replace vegetation until reclamation efforts are complete	No proposed structures are apparent in view

SECTION D. CONTRAST RATING __SHORT TERM ✓LONG TERM

1. DEGREE OF CONTRAST		FEATURES: LAND/WATER BODY (1) STRONG	MODERATE	WEAK	NONE	VEGETATION (2) STRONG	MODERATE	WEAK	NONE	STRUCTURES (3) STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM		✓					✓					✓
	LINE			✓				✓					✓
	COLOR			✓				✓					✓
	TEXTURE			✓				✓					✓

2. Does project design meet visual resource management objectives? ✓Yes ___No (Explain on reverses side)

3. Additional mitigating measures recommended ✓Yes ___No (Explain on reverses side)

Evaluator's Names: SWCA Visual Resource Planners
Date: 12/29/2025

(Continued on Page 2)

Comments from item 2.

This KOP is located near Lanfair Buttes, within the Mojave National Preserve, approximately 6 miles from the proposed mining expansion area. The viewpoint is located near the Lanfair Buttes within Lanfair Valley with level views of the surrounding area. This KOP has a partially screened view of the surrounding area, with woody shrubs partially screening views toward the Castle Mountains. Existing mining operations associated with the Castle Mountain Mine are visible and introduce modifications to the existing landforms and vegetation of the area. Due to the level viewing angle, existing roadways are generally not visible from this the KOP.

The valley floors and surrounding mountains are populated with woody shrubs and other low shrubs interspersed with grasses. The existing mining operations create trapezoidal forms with light colored soils associated with tailing piles. The proposed mining areas would occur adjacent to the existing mining operations and would be seen as an expansion of the existing mine. Due to the screening effect associated with vegetation in the foreground, views of both the existing and proposed mining areas are partially screened from view. From this viewpoint, the Project would repeat many elements associated with the existing mining operations but would create larger spoil piles and expand the influence of these activities on the landscape. Based on the level position of casual observers from this KOP and the even nature of the vegetation, proposed changes to the landforms and vegetation are not expected to be visible in the valley but the mining areas would change landforms and vegetation visible on the Castle Mountains.

The taller spoil piles and expanded area viewed as modified by mining operations, associated with the project, would increase the influence of the activities on views but would not attract attention. As such, the project would result in a weak-moderate level of visual contrast. Based on this level of contrast with VRM Class III (and IV) areas, the Project is expected to meet the management class from this KOP as the Project would not dominate views.

Additional Mitigating Measures (See item 3)

As described in the Project's 1998 ROD, include that site reclamation shall include modification of final overburden and heap leach pile shapes to reduce the impact of straight-line geometrics and potential contrast in form and line.

As described in the Project's 1998 ROD, rock staining solutions shall be used on the upper mine pit walls where necessary, as determined by the BLM and the County, to reduce the contrast of light-colored rock exposed by mining activities and where visible above prevailing grade. These solutions shall be specifically colored to reduce the contrast between the pit walls and the surrounding undisturbed slopes.

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 12/29/2025
District Office: California Desert
Field Office: Needles
Land Use Planning Area:

SECTION A. PROJECT INFORMATION

1. Project Name	4. KOP Location (T.R.S)	5. Location Sketch
Castle Mountain Mine Phase II Expansion	T14N, R17E, S14	
2. Key Observation Point (KOP) Name KOP 4 - Castle Mountain Mine Road		
3. VRM Class at Project Location VRM Class III and IV	(Lat. Long) 35°17'43.07"N, 115° 7'26.40"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Rolling hills adjacent to rounded trapezoidal to rugged mountains with existing mining mostly screened	Evenly patchy shrubs throughout valley. Scattered shrubs on mountains. Scattered shrubs and Joshua tree adjacent to KOP.	No structures are apparent in view
LINE	Undulating valley floor and foothills. Rounded to angular mountains. Angular and horizontal lines in mining area	Rounded and vertical shrubs with other vegetation indistinct to horizontal in valley; indistinct and angular in mountains.	No structures are apparent in view
COLOR	Light beige hills, road, and mining area . Mountains range from light tan to medium browns with red hues on some slopes	Olive green, sage green, bright green, brown, straw yellow.	No structures are apparent in view
TEX-TURE	Moderate, smooth to undulating valley and foothills. Abrupt and coarse-textured mountains. Fine mining scars.	Fine, scattered and even. Foreground is more coarse from Joshua tree which become more uniform in the distance	No structures are apparent in view

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Tall, trapezoidal expansion of mining adjacent to the road	Geometrically cleared utility corridor and mining area including tailing piles until reclamation efforts are complete	Vertical, transmission towers; horizontal, drooping conductors.
LINE	Strong horizontal and angular lines in proposed mining area	Butt edge formed at between the mining area and pipeline with existing landscape until reclamation efforts are complete	Straight, transmission towers; thin, horizontal, concave conductors.
COLOR	Light beige soils associated with mining would be expanded compared to existing condition	Light beige soils replace olive and sage green vegetation until reclamation efforts are complete	Brown transmission towers.
TEX-TURE	Coarse textured mountains would become fine texture mine tailings	Finer textured tailing piles replace vegetation until reclamation efforts are complete	Organized, directional, linear, repeating transmission towers.

SECTION D. CONTRAST RATING __SHORT TERM ✓ LONG TERM

1. DEGREE OF CONTRAST		FEATURES: LAND/WATER BODY (1) STRONG	MODERATE	WEAK	NONE	VEGETATION (2) STRONG	MODERATE	WEAK	NONE	STRUCTURES (3) STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM	✓					✓				✓		
	LINE		✓				✓					✓	
	COLOR		✓				✓					✓	
	TEXTURE	✓					✓					✓	

2. Does project design meet visual resource management objectives? ✓ Yes ___ No (Explain on reverses side)

3. Additional mitigating measures recommended ✓ Yes ___ No (Explain on reverses side)

Evaluator's Names: SWCA Visual Resource Planners

Date: 12/29/2025

(Continued on Page 2)

Comments from item 2.

This KOP is located on Castle Mountain Road directly adjacent to proposed mining expansion area and utilities. The viewpoint is located approximately 1 mile from existing mining area with level views of the surrounding area. This KOP has a partially screened view of the surrounding area, with Joshua tree and woody shrubs partially screening views toward the proposed mining area especially in views to the south and southwest. Existing mining operations associated with the Castle Mountain Mine are visible and introduce modifications to the existing landforms and vegetation of the area but due to topographic screening adjacent to the road, these existing activities do not attract attention. Due to the level viewing angle, existing roadways are generally not visible from this the KOP.

The valley floors and surrounding mountains are populated with woody shrubs and other low shrubs interspersed with grasses. The existing mining operations create horizontal lines with light colored soils associated with tailing piles. The proposed mining areas would occur adjacent to the existing mining operations and would be seen as an expansion of the existing mine. Due to the screening effect associated with topography and vegetation in the foreground including screening views of most of the existing mining operations, views of the proposed mining would be more noticeable and would dominate views from this location. From this viewpoint, the Project would repeat many elements associated with the existing mining operations but since views would be mostly unobstructed toward the southeast, the larger spoil piles and operations would expand the influence of these activities on the landscape. The introduction of the utilties including transmission line structures would be noticeable. The structures would repeat the patterns associated with the previously authorized transmission line which was removed in 2011.Based on the level position of casual observers from this KOP proposed changes to the landforms and vegetation are expected to be visible with the mining areas would changing landforms and vegetation visible on the Castle Mountains.

The taller spoil piles and expanded area viewed as being modified by mining operations, as well as the proposed utilieis, would increase the influence of the activities on views and would begin to dominate views. As such, the project would result in a moderate-strong level of visual contrast. Based on this level of contrast with VRM Class IV areas, the Project is expected to meet the management class from this KOP as the Project can dominate the view and be the major focus of viewer attention under this classification. For any mining operations in VRM Class III, mitigation strategies listed below would facilitate conformance with VRM Class III objectives to reduce contrast and attract attention, but not dominate landscape character.

Additional Mitigating Measures (See item 3)

As described in the Project's 1998 ROD, include that site reclamation shall include modification of final overburden and heap leach pile shapes to reduce the impact of straight-line geometrics and potential contrast in form and line.

As described in the Project's 1998 ROD, rock staining solutions shall be used on the upper mine pit walls where necessary, as determined by the BLM and the County, to reduce the contrast of light-colored rock exposed by mining activities and where visible above prevailing grade. These solutions shall be specifically colored to reduce the contrast between the pit walls and the surrounding undisturbed slopes.

Nonspecular conductors would be used to reduce visual impacts associated with potential glint and glare associated with typical conductors.

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 12/29/2025
District Office: Southern Nevada
Field Office: Las Vegas
Land Use Planning Area:

SECTION A. PROJECT INFORMATION

1. Project Name	4. KOP Location (T.R.S)	5. Location Sketch
Castle Mountain Mine Phase II Expansion	T31S, R64E, S12	
2. Key Observation Point (KOP) Name KOP 5 - Spirit Mountain		
3. VRM Class at Project Location VRM Class IV	(Lat. Long) 35°15'54.84"N, 114°47'1.87"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Rolling hills leading to flat valley; rounded, trapezoidal to rugged mountains with existing mining mostly screened	Evenly patchy shrubs throughout valley. Scattered shrubs on mountains. Scattered shrubs adjacent to KOP.	Geometric structures visible in Cal-Nev-Ari
LINE	Undulating hills, horizontal valley. Rounded to angular mountains. Angular and horizontal lines in mining area	Rounded and vertical shrubs with other vegetation indistinct to horizontal in valley; indistinct and angular in mountains.	Horizontal and vertical lines in structures
COLOR	Light beige hills, road, and mining area . Mountains range from light tan to medium browns with red hues on some slopes	Olive green, sage green, bright green, brown, straw yellow.	White and grays
TEX-TURE	Moderate, smooth to undulating valley and foothills. Abrupt and coarse-textured mountains. Fine mining scars and roads.	Fine, scattered and even. Foreground is more coarse from woody shrubs which become more uniform in the distance	Moderate to coarse geometric structures

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Rounded hill added associated with expansion of mining, visible rising above the Castle Mountains	Geometrically cleared area associated with tailing piles until reclamation efforts are complete	No proposed structures are apparent in view
LINE	Rounded ridgeline, undulating spoils pile	Butt edge formed where tailings rise above ridge, vegetation would be removed until reclamation efforts are complete	No proposed structures are apparent in view
COLOR	Light beige soils associated with mining would be expanded and more visible compared to existing condition	Light beige soils replace olive and sage green vegetation until reclamation efforts are complete	No proposed structures are apparent in view
TEX-TURE	Fine textured mining tails would be visible above coarse textured mountains	Finer textured tailing piles replace vegetation until reclamation efforts are complete	No proposed structures are apparent in view

SECTION D. CONTRAST RATING __SHORT TERM ✓LONG TERM

1. DEGREE OF CONTRAST		FEATURES: LAND/WATER BODY (1) STRONG	MODERATE	WEAK	NONE	VEGETATION (2) STRONG	MODERATE	WEAK	NONE	STRUCTURES (3) STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM			✓				✓					✓
	LINE			✓				✓					✓
	COLOR			✓				✓					✓
	TEXTURE			✓				✓					✓

2. Does project design meet visual resource management objectives? ✓Yes ___No (Explain on reverses side)

3. Additional mitigating measures recommended ✓Yes ___No (Explain on reverses side)

Evaluator's Names: SWCA Visual Resource Planners
Date: 12/31/2025

(Continued on Page 2)

Comments from item 2.

This KOP is located on gravel road on the slopes of Spirit Mountain east of Piute Valley located approximately 18 miles from the Castle Mountain Mine. Views would be from a superior angle, as compared to the landscape in general, but relative to the project, views would be inferior with the project occurring higher in the Castle Mountains. This KOP has unobstructed views across Piute Valley but views of the proposed mining area would be partially screened by terrain. Existing mining operations are mostly screened by the Castle Mountains with some access roads and earthwork visible on the some peaks but they do not attract attention from this viewpoint.

The valley floors and surrounding mountains are populated with woody shrubs and other low shrubs interspersed with grasses. The existing mining operations create subtle undulating and horizontal lines, mostly associated with existing access roads which also introduce lighter colored soils. The proposed mining areas would occur adjacent to the existing mining operations and would be seen as an expansion of the existing mine. Due to the screening effect associated with topography in the Castle Mountains, views of most of the existing mining operations would be screened, with views of the proposed mining being more noticeable from this location. From this viewpoint, the Project would repeat many elements associated with the existing mining operations but since views would include a larger spoil pile visible above the Castle Mountains ridgeline, operations would expand the influence of these activities on the landscape. Based on the elevated nature of the mining area, as viewed from this KOP, proposed changes to the landforms and vegetation are expected to be visible but would not attract attention of the casual observer.

The spoil piles and expanded area viewed as being modified by mining operations, would increase the influence of the activities on views but based on the distance, level of contrast, and scale of change visible, would not attract the attention of the casual observer. As such, the project would result in a weak level of visual contrast. Based on this level of contrast with VRM Class IV areas, the Project is expected to meet the management class from this KOP as the Project can dominate the view and be the major focus of viewer attention under this classification.

Additional Mitigating Measures (See item 3)

As described in the Project's 1998 ROD, include that site reclamation shall include modification of final overburden and heap leach pile shapes to reduce the impact of straight-line geometrics and potential contrast in form and line.

As described in the Project's 1998 ROD, rock staining solutions shall be used on the upper mine pit walls where necessary, as determined by the BLM and the County, to reduce the contrast of light-colored rock exposed by mining activities and where visible above prevailing grade. These solutions shall be specifically colored to reduce the contrast between the pit walls and the surrounding undisturbed slopes.

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 12/29/2025
District Office: Southern Nevada
Field Office: Las Vegas
Land Use Planning Area:

SECTION A. PROJECT INFORMATION

1. Project Name	4. KOP Location (T.R.S)	5. Location Sketch
Castle Mountain Mine Phase II Expansion	T28S, R62E, S28	
2. Key Observation Point (KOP) Name KOP 6 - Walking Box Ranch Road		
3. VRM Class at Project Location VRM Class II and III	(Lat. Long) 35°29'3.87"N, 115° 2'34.96"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Undulating to flat valley. Rounded trapezoidal to rugged mountains with existing mining operations screened	Evenly patchy shrubs throughout valley. Scattered shrubs on mountains. Scattered to dense Joshua trees adjacent to KOP.	Geometric structure and linear fenceline
LINE	Gently sloping to undulating valley floor. Rounded to angular mountains.	Vertical Joshua trees with other vegetation indistinct to horizontal in valley; indistinct and angular in mountains.	Horizontal and vertical lines in structure and fencing
COLOR	Light beige valley floor. Mountains range from light tan to medium browns with red hues on some slopes	Olive green, sage green, bright green, brown, straw yellow.	White, rust-red, green, gray
TEX-TURE	Fine, smooth to undulating valley floor. Abrupt and coarse-textured mountains.	Fine, scattered and even. Foreground is more coarse from Joshua trees which become more uniform in the distance	Smooth textured structure, blocky coarse form stands out in finer textured landscape

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Geometric, flat right-of-way	Geometrically cleared area associated with right-of-way until reclamation efforts are complete	Vertical, transmission towers; horizontal, drooping conductors.
LINE	Straight and horizontal graded areas.	Butt edge formed at between the right-of-way and existing landscape until reclamation efforts are complete	Straight, transmission towers; thin, horizontal, concave conductors.
COLOR	Light beige soils associated graded right-of-way and pipeline construction	Light beige soils replace olive and sage green vegetation until reclamation efforts are complete	Brown transmission towers.
TEX-TURE	Fine, linear	Finer textured soil replaces vegetation until reclamation efforts are complete	Organized, directional, linear, repeating transmission towers.

SECTION D. CONTRAST RATING __SHORT TERM ✔LONG TERM

1. DEGREE OF CONTRAST		FEATURES: LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
		STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM			✔				✔				✔	
	LINE			✔				✔				✔	
	COLOR			✔				✔				✔	
	TEXTURE			✔				✔				✔	

2. Does project design meet visual resource management objectives? ✔Yes ___No (Explain on reverses side)

3. Additional mitigating measures recommended ✔Yes ___No (Explain on reverses side)

Evaluator's Names: SWCA Visual Resource Planners
Date: 12/29/2025

(Continued on Page 2)

Comments from item 2.

This KOP is located on Walking Box Ranch Road immediately south of the Walking Box Ranch within the Avi Kwa Ame National Monument. The viewpoint is located adjacent to the proposed right-of-way which includes both a transmission line and pipeline corridor. This KOP has a partially screened view of the surrounding area, with Joshua tree and woody shrubs partially screening views of the landscape. Existing mining operations associated with the Castle Mountain Mine are not visible from this location. Due to the level viewing angle, existing roadways, except for Walking Box Ranch Road, are generally not visible from this KOP.

The valley floors and surrounding mountains are populated with wood shrubs, Joshua Trees, and other low shrubs interspersed with grasses. The existing mining operations are not visible, with the Walking Box Ranch structures and fencing being the primary landscape modifications visible from this location. Based on the proximity of the right-of-way to the Walking Box Ranch road, the introduction of the transmission line structures and clearing associated with pipeline construction would be visible to the casual viewer.

The transmission line structures would be noticeable but would not dominate views within this landscape. As motorists turn from SR 164 onto Walking Box Ranch Road, the proposed transmission line would parallel the road for approximately 8 miles in VRM Class III with the first mile in VRM Class II to the Nevada-California border and continue for an additional 5 miles in VRM Class III until near the Castle Mountain Mine where VRM Class IV lands would be crossed. KOP 14 is located in this area, please refer to that KOP worksheet for further information. Similarly, the proposed pipeline would parallel the road in VRM Class III for 8 miles to the Nevada-California border (first 1.6 miles in VRM Class II) and continue for an additional 5 miles in VRM Class III until near the Castle Mountain Mine. Based on a driving speed of 35 mph, over a total distance of 14.6 miles, this would result in the Project being in the immediate foreground for up to 25 minutes. The transmission line structures would introduce visible elements that repeat existing patterns associated with distribution line structures near Walking Box Ranch and the previously authorized transmission line which was removed in 2011. The transmission line structures would be visible to the casual viewer without dominating the view.

Following reclamation, the proposed actions would remain noticeable. The resulting visual contrast is expected to be weak. Under VRM Class II and III standards, which require projects to retain the existing character of the landscape and minimize visual contrast, the proposed project would meet management objectives from this KOP.

Additional Mitigating Measures (See item 3)

Nonspecular conductors would be used to reduce visual impacts associated with potential glint and glare associated with typical conductors.

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 12/29/2025
District Office: Southern Nevada
Field Office: Las Vegas
Land Use Planning Area:

SECTION A. PROJECT INFORMATION

1. Project Name	4. KOP Location (T.R.S)	5. Location Sketch
Castle Mountain Mine Phase II Expansion	T28S, R62E, S16	
2. Key Observation Point (KOP) Name KOP 7 - SR 164 (Wee Thump Joshua Tree WSA)		
3. VRM Class at Project Location VRM Class II	(Lat. Long) 35°30'25.19"N, 115° 3'22.92"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Undulating to flat valley. Rounded trapezoidal to rugged mountains with existing mining operations screened	Evenly patchy shrubs throughout valley. Scattered shrubs on mountains. Scattered to dense Joshua trees adjacent to KOP.	No structures are apparent in view
LINE	Gently sloping to undulating valley floor. Rounded to angular mountains.	Vertical Joshua trees with other vegetation indistinct to horizontal in valley; indistinct and angular in mountains.	No structures are apparent in view
COLOR	Light beige valley floor. Mountains range from light tan to medium browns with red hues on some slopes	Olive green, sage green, bright green, brown, straw yellow.	No structures are apparent in view
TEX-TURE	Fine, smooth to undulating valley floor. Abrupt and coarse-textured mountains.	Fine, scattered and even. Foreground is more coarse from Joshua trees which become more uniform in the distance	No structures are apparent in view

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Geometric, flat right-of-way	Geometrically cleared area associated with right-of-way until reclamation efforts are complete	No proposed structures are apparent in view
LINE	Straight and horizontal graded areas.	Butt edge formed at between the right-of-way and existing landscape until reclamation efforts are complete	No proposed structures are apparent in view
COLOR	Light beige soils associated graded right-of-way and pipeline construction	Light beige soils replace olive and sage green vegetation until reclamation efforts are complete	No proposed structures are apparent in view
TEX-TURE	Fine, linear	Finer textured soil replaces vegetation until reclamation efforts are complete	No proposed structures are apparent in view

SECTION D. CONTRAST RATING __SHORT TERM ✓ LONG TERM

1. DEGREE OF CONTRAST		FEATURES: LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
		STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM			✓				✓					✓
	LINE			✓				✓					✓
	COLOR			✓				✓					✓
	TEXTURE			✓				✓					✓

2. Does project design meet visual resource management objectives? ✓ Yes ___ No
(Explain on reverses side)

3. Additional mitigating measures recommended
___ Yes ✓ No (Explain on reverses side)

Evaluator's Names: SWCA Visual Resource Planners
Date: 12/29/2025

(Continued on Page 2)

Comments from item 2.

This KOP is located on Nevada State Route 164 adjacent to the Wee Thump Joshua Tree Wilderness Study Area within the Avi Kwa Ame National Monument. The viewpoint is located adjacent to the proposed right-of-way which includes only the pipeline corridor component in this area. This KOP has a partially screened view of the surrounding area, with Joshua tree and woody shrubs partially screening views of the landscape. Existing mining operations associated with the Castle Mountain Mine are not visible from this location. Due to the level viewing angle, existing roadways are generally not visible from this the KOP.

The valley floors and surrounding mountains are populated with woody shrubs and other low shrubs interspersed with grasses. The existing mining operations are not visible, with no structures apparent in the landscape. The introduction of the utilities including clearing associated with pipeline construction would attract the viewer's attention until reclamation efforts are successful. Based on the proximity of the right-of-way to the highway, proposed changes to the landforms and vegetation would be apparent and would initially begin to attract attention.

The proposed utilities would be noticeable and initially attract attention, but would not dominate views within this landscape. After reclamation efforts are complete, the proposed utilities would be noticeable but would not attract attention. As motorists drive from Nipton, California to the turn off toward Walking Box Ranch Road in Nevada using Nipton Road/SR 164, the proposed pipeline corridor would parallel the road for approximately 2.75 miles in VRM Class III within California (see KOP 11 for more information) and approximately 11.5 miles in VRM Class II within Nevada. Based on a driving speed of 55 mph, over a total distance of 14.25 miles, this would result in the Project being in the immediate foreground for up to 16 minutes. KOPs 11, 12, and 13 also look at conformance associated with paralleling Nipton Road/SR 164 which in other areas included rolling terrain, where right-of-way clearing may be more evident, and areas where large existing transmission lines have modified the existing setting. In this location, the project would result in a weak level of visual contrast after reclamation efforts are complete. Based on this level of contrast within VRM Class II, the Project is expected to meet the management class from this KOP and would be consistent with VRM Class II objectives based on definitions in the Las Vegas RMP through successful reclamation of the geometrically cleared right-of-way, as identified in project plans. As such, the Project would be less noticeable and would result in a weak level of visual contrast, therefore meeting VRM Class II objectives.

Additional Mitigating Measures (See item 3)

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 01/02/2026
District Office: Southern Nevada
Field Office: Las Vegas
Land Use Planning Area:

SECTION A. PROJECT INFORMATION

1. Project Name	4. KOP Location (T.R.S)	5. Location Sketch
Castle Mountain Mine Phase II Expansion	T28S, R62E, S22	
2. Key Observation Point (KOP) Name KOP 8 - Walking Box Ranch (near entrance)		
3. VRM Class at Project Location VRM Class II	(Lat. Long) 35°29'22.37"N, 115° 2'28.61"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Undulating to flat valley. Rounded trapezoidal to rugged mountains with existing mining operations screened	Evenly patchy shrubs throughout valley. Scattered shrubs on mountains. Dense Joshua trees and shrubs adjacent to KOP.	Geometric structures, vertical and linear powerline and fenceline, cylindrical tank
LINE	Gently sloping to undulating valley floor. Rounded to angular mountains.	Vertical Joshua trees with other vegetation indistinct to horizontal in valley; indistinct and angular in mountains.	Horizontal and vertical lines in structures, powerline, and fencing. Rounded tank
COLOR	Light beige valley floor. Mountains range from light tan to medium browns with red hues on some slopes	Olive green, sage green, bright green, brown, straw yellow.	White, rust-red, green, gray, brown
TEX-TURE	Fine, smooth to undulating valley floor. Abrupt and coarse-textured mountains.	Fine, scattered and even. Foreground is more coarse from Joshua trees which become more uniform in the distance	Blocky coarse form of structures and vertical powerline. Smooth tank surface

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Subtle, geometric, flat right-of-way	Geometrically cleared area associated with right-of-way until reclamation efforts are complete	Vertical proposed transmission line structures mostly screened by vegetation.
LINE	Straight and horizontal graded areas.	Butt edge formed at between the right-of-way and existing landscape until reclamation efforts are complete	Straight proposed transmission line structures mostly screened by vegetation.
COLOR	Light beige soils associated graded right-of-way and pipeline construction	Light beige soils replace olive and sage green vegetation until reclamation efforts are complete	Brown proposed transmission line structures mostly screened by vegetation.
TEX-TURE	Fine, linear	Finer textured soil replaces vegetation until reclamation efforts are complete	Repeating proposed transmission line structures mostly screened by vegetation.

SECTION D. CONTRAST RATING __SHORT TERM ✓ LONG TERM

1. DEGREE OF CONTRAST		FEATURES											
		LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
		STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM			✓				✓				✓	
	LINE			✓				✓				✓	
	COLOR			✓				✓				✓	
	TEXTURE			✓				✓				✓	

2. Does project design meet visual resource management objectives? ✓ Yes ___ No
(Explain on reverses side)

3. Additional mitigating measures recommended
✓ Yes ___ No (Explain on reverses side)

Evaluator's Names: SWCA Visual Resource Planners
Date: 01/02/2026

(Continued on Page 2)

Comments from item 2.

This KOP is located within Walking Box Ranch, near the entrance along Walking Box Ranch Road, in the Avi Kwa Ame National Monument. The viewpoint is located adjacent to the proposed right-of-way. Based on vegetation screening toward the south and southwest where the proposed transmission line is located, views would include only the pipeline corridor component in this area except for the top of a few transmission line structures in views toward the southeast. In general, this KOP has a partially screened view of the surrounding area, with Joshua tree and woody shrubs partially screening views of the landscape. Existing mining operations associated with the Castle Mountain Mine are not visible from this location. Due to the level viewing angle, existing roadways are generally not visible from this the KOP except for Walking Box Ranch Road.

The valley floors and surrounding mountains are populated with woody shrubs and other low shrubs interspersed with grasses. The existing mining operations are not visible, but structures associated with Walking Box Ranch are visible from this location including buildings, a tank, and a distribution powerline. The introduction of the utilities including clearing associated with pipeline construction would be visible, but based on the level of vegetative screening, the Project would not dominate views or readily attract attention. Where visible through or around vegetation that partially screens views, proposed changes to landforms and vegetation would be apparent, due to the proximity of the right-of-way to the viewpoint, but would not attract attention.

After reclamation efforts are complete as identified in project plans, the proposed utilities would be noticeable but would not attract attention or dominate views within this landscape. As such, the project would result in a weak level of visual contrast. Under VRM Class II standards, which require projects to retain the existing character of the landscape and minimize visual contrast, the proposed project would meet management objectives from this KOP.

Additional Mitigating Measures (See item 3)

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 01/02/2026
District Office: Southern Nevada
Field Office: Las Vegas
Land Use Planning Area:

SECTION A. PROJECT INFORMATION

1. Project Name	4. KOP Location (T.R.S)	5. Location Sketch
Castle Mountain Mine Phase II Expansion	T28S, R62E, S22	
2. Key Observation Point (KOP) Name KOP 9 - Walking Box Ranch (Big House - south)		
3. VRM Class at Project Location VRM Class II and III	(Lat. Long) 35°29'17.64"N, 115° 2'22.45"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Undulating to flat valley. Rounded trapezoidal to rugged mountains with existing mining operations screened	Evenly patchy shrubs throughout valley. Scattered shrubs on mountains. Dense Joshua trees and shrubs adjacent to KOP.	Geometric structures, vertical and linear powerline and fenceline
LINE	Gently sloping to undulating valley floor. Rounded to angular mountains.	Vertical Joshua trees with other vegetation indistinct to horizontal in valley; indistinct and angular in mountains.	Horizontal and vertical lines in structures, powerline, and fencing
COLOR	Light beige valley floor. Mountains range from light tan to medium browns with red hues on some slopes	Olive green, sage green, bright green, brown, straw yellow.	White, rust-red, green, gray, brown
TEX-TURE	Fine, smooth to undulating valley floor. Abrupt and coarse-textured mountains.	Fine, scattered and even. Foreground is more coarse from Joshua trees which become more uniform in the distance	Blocky coarse form of structures and vertical powerline

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Subtle, geometric, flat right-of-way mostly screened by vegetation	Geometrically cleared area associated with right-of-way until reclamation efforts are complete, mostly screened	Vertical proposed transmission line structures partially screened by vegetation.
LINE	Straight and horizontal graded areas mostly screened by vegetation	Butt edge formed between right-of-way and existing landscape until reclamation efforts are complete, mostly screened	Straight proposed transmission line structures partially screened by vegetation.
COLOR	Light beige soils associated graded right-of-way and pipeline construction mostly screened by vegetation	Light beige soils replace olive and sage green vegetation until reclamation efforts are complete, mostly screened	Brown proposed transmission line structures partially screened by vegetation.
TEX-TURE	Fine, linear mostly screened by vegetation	Finer textured soil replaces vegetation until reclamation efforts are complete, mostly screened	Repeating proposed transmission line structures partially screened by vegetation.

SECTION D. CONTRAST RATING __SHORT TERM ✓ LONG TERM

1. DEGREE OF CONTRAST		FEATURES: LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
		STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM			✓				✓				✓	
	LINE			✓				✓				✓	
	COLOR			✓				✓				✓	
	TEXTURE			✓				✓				✓	

2. Does project design meet visual resource management objectives? ✓ Yes ___ No
(Explain on reverses side)

3. Additional mitigating measures recommended
✓ Yes ___ No (Explain on reverses side)

Evaluator's Names: SWCA Visual Resource Planners
Date: 01/02/2026

(Continued on Page 2)

Comments from item 2.

This KOP is located within Walking Box Ranch, adjacent to the Big House, in the Avi Kwa Ame National Monument. The viewpoint is located approximately 1000 feet from the proposed right-of-way, but based on vegetation screening views of the pipeline and ground disturbance associated with construction of the pipeline and transmission line, the project would be mostly screened from view. Views would include the top of several transmission line structures toward the south and southwest similar to the existing distribution line visible to the east. In general, this KOP has a partially screened view of the surrounding area, with Joshua tree and woody shrubs partially screening views of the landscape. Existing mining operations associated with the Castle Mountain Mine are not visible from this location. Due to the level viewing angle, existing roadways are generally not visible from this the KOP except for Walking Box Ranch Road.

The valley floors and surrounding mountains are populated with woody shrubs and other low shrubs interspersed with grasses. The existing mining operations are not visible, but structures associated with Walking Box Ranch are visible from this location including multiple structures, walls and fencing, and a distribution powerline. The introduction of the utilities, including visibility of the proposed transmission line structures, would expand the influence of utility development visible from Walking Box Ranch but would repeat the patterns associated with the previously authorized transmission line which was removed in 2011. Based on the level of vegetative screening, the Project would not dominate views or readily attract attention.

Following reclamation, the proposed actions would remain noticeable. The resulting visual contrast is expected to be weak. Under VRM Class II and III standards, which require projects to retain the existing character of the landscape and minimize visual contrast, the proposed project would meet management objectives from this KOP.

Additional Mitigating Measures (See item 3)

Nonspecular conductors would be used to reduce visual impacts associated with potential glint and glare associated with typical conductors.

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 01/02/2026
District Office: Southern Nevada
Field Office: Las Vegas
Land Use Planning Area:

SECTION A. PROJECT INFORMATION

1. Project Name	4. KOP Location (T.R.S)	5. Location Sketch
Castle Mountain Mine Phase II Expansion	T28S, R62E, S22	
2. Key Observation Point (KOP) Name KOP 10 - Walking Box Ranch (Big House - southwest)		
3. VRM Class at Project Location VRM Class II and III	(Lat. Long) 35°29'17.67"N, 115° 2'23.23"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Undulating to flat valley. Rounded trapezoidal to rugged mountains with existing mining operations screened	Evenly dense shrubs throughout valley. Scattered shrubs on mountains. Dense Joshua trees and shrubs adjacent to KOP.	Geometric structures, vertical and linear powerline and fenceline
LINE	Gently sloping to undulating valley floor. Rounded to angular mountains.	Vertical Joshua trees with other vegetation indistinct to horizontal in valley; indistinct and angular in mountains.	Horizontal and vertical lines in structures, powerline, and fencing
COLOR	Light beige valley floor. Mountains range from light tan to medium browns with red hues on some slopes	Olive green, sage green, bright green, brown, straw yellow.	White, rust-red, green, gray, brown
TEX-TURE	Fine, smooth to undulating valley floor. Abrupt and coarse-textured mountains.	Fine, scattered and even. Foreground is more coarse from Joshua trees which become more uniform in the distance	Blocky coarse form of structures and vertical powerline

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Subtle, geometric, flat right-of-way mostly screened by vegetation	Geometrically cleared area associated with right-of-way until reclamation efforts are complete, mostly screened	Vertical, transmission towers; horizontal, drooping conductors.
LINE	Straight and horizontal graded areas mostly screened by vegetation	Butt edge formed between right-of-way and existing landscape until reclamation efforts are complete, mostly screened	Straight, transmission towers; thin, horizontal, concave conductors.
COLOR	Light beige soils associated graded right-of-way and pipeline construction mostly screened by vegetation	Light beige soils replace olive and sage green vegetation until reclamation efforts are complete, mostly screened	Brown transmission towers.
TEX-TURE	Fine, linear mostly screened by vegetation	Finer textured soil replaces vegetation until reclamation efforts are complete, mostly screened	Organized, directional, linear, repeating transmission towers.

SECTION D. CONTRAST RATING __SHORT TERM ✔LONG TERM

1. DEGREE OF CONTRAST		FEATURES: LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
		STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM			✔				✔				✔	
	LINE			✔				✔				✔	
	COLOR			✔				✔				✔	
	TEXTURE			✔				✔				✔	

2. Does project design meet visual resource management objectives? ✔Yes ___No (Explain on reverses side)

3. Additional mitigating measures recommended ✔Yes ___No (Explain on reverses side)

Evaluator's Names: SWCA Visual Resource Planners
Date: 01/02/2026

(Continued on Page 2)

Comments from item 2.

The KOP is located within Walking Box Ranch, adjacent to the Big House, approximately 900 feet from the proposed right-of-way. Due to existing vegetation, views of the pipeline and associated ground disturbance would be largely screened. Visible elements would include several transmission line structures to the south and southwest, exhibiting a repeating linear form as the line parallels Walking Box Ranch Road—like the existing distribution line visible to the east.

Overall, this KOP provides a partially screened view of the surrounding landscape, with Joshua trees and woody shrubs interrupting sightlines. The viewpoint is slightly elevated compared to KOP 9. Existing mining operations associated with Castle Mountain Mine are not visible. Because of the level viewing angle, most roadways are obscured except for Walking Box Ranch Road.

The valley floors and surrounding mountains feature woody shrubs, Joshua trees, and low vegetation interspersed with grasses. Structures associated with Walking Box Ranch—including multiple buildings, walls, fencing, and a distribution powerline—are visible. The transmission line structures would introduce visible elements that repeat existing patterns associated with the distribution line currently present. The structures would repeat the patterns associated with the previously authorized transmission line which was removed in 2011. The structures would be visible to the casual viewer without dominating the view.

Following reclamation, the proposed actions would remain noticeable. The resulting visual contrast is expected to be weak. Under VRM Class II and III standards, which require projects to retain the existing character of the landscape and minimize visual contrast, the proposed project would meet management objectives from this KOP.

Additional Mitigating Measures (See item 3)

Nonspecular conductors would be used to reduce visual impacts associated with potential glint and glare associated with typical conductors.

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 01/20/2026
District Office: California Desert
Field Office: Needles
Land Use Planning Area:

SECTION A. PROJECT INFORMATION

1. Project Name	4. KOP Location (T.R.S)	5. Location Sketch
Castle Mountain Mine Phase II Expansion	T16N, R16E, S33	
2. Key Observation Point (KOP) Name KOP 11 - Nipton Road		
3. VRM Class at Project Location VRM Class III	(Lat. Long) 35°28'11.83"N, 115°15'38.09"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Undulating to flat valley. Rounded to rugged mountains	Evenly patchy shrubs throughout valley. Scattered shrubs on mountains. Dense trees in Nipton town.	Geometric structures in Nipton town, cylindrical and pyramidal shapes. Flat, geometric solar facilities
LINE	Gently sloping to undulating valley floor. Rounded to angular mountains.	Desert shrubs and other vegetation indistinct to horizontal in valley; indistinct and angular in mountains. Rounded trees	Vertical, horizontal, and angular lines in structures and solar arrays
COLOR	Light beige valley floor. Mountains range from light tan to medium browns with red hues on some slopes	Olive green, sage green, bright green, brown, straw yellow.	White. tan, and gray structures. Dark blue solar arrays
TEX-TURE	Fine, smooth to undulating valley floor. Abrupt and coarse-textured mountains.	Fine, scattered and even. Trees in town create a coarser texture rising above the valley	Moderately coarse structures, trees soften texture from geometric structures. Smooth solar array surfaces

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Geometric, flat right-of-way	Geometrically cleared area associated with right-of-way until reclamation efforts are complete	No proposed structures are apparent in view
LINE	Straight and horizontal graded areas.	Butt edge formed at between the right-of-way and existing landscape until reclamation efforts are complete	No proposed structures are apparent in view
COLOR	Light beige soils associated graded right-of-way and pipeline construction	Light beige soils replace olive and sage green vegetation until reclamation efforts are complete	No proposed structures are apparent in view
TEX-TURE	Fine, linear	Finer textured soil replaces vegetation until reclamation efforts are complete	No proposed structures are apparent in view

SECTION D. CONTRAST RATING __SHORT TERM ✓LONG TERM

1. DEGREE OF CONTRAST		FEATURES: LAND/WATER BODY (1) STRONG	MODERATE	WEAK	NONE	VEGETATION (2) STRONG	MODERATE	WEAK	NONE	STRUCTURES (3) STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM			✓				✓					✓
	LINE			✓				✓					✓
	COLOR			✓				✓					✓
	TEXTURE			✓				✓					✓

2. Does project design meet visual resource management objectives? ✓Yes ___No
(Explain on reverses side)

3. Additional mitigating measures recommended
___Yes ✓No (Explain on reverses side)

Evaluator's Names: SWCA Visual Resource Planners
Date: 01/20/2026

(Continued on Page 2)

Comments from item 2.

This KOP is located on Nipton Road, 0.5 mile east of the community of Nipton. The viewpoint is located adjacent to the proposed right-of-way which includes only the pipeline corridor component in this area. This KOP has a unobstructed view of the surrounding area except in Nipton town where tall deciduous trees screen views within town. The existing mining operations associated with the Castle Mountain Mine are not visible from this location. Due to the slightly elevated viewing angle, modifications to vegetation in the valley would generally be visible from this the KOP including views of multiple solar facilities across the valley in views to the northwest.

The valley floors and surrounding mountains are populated with woody shrubs and other low shrubs interspersed with grasses. The existing mining operations are not visible, with the residences in Nipton town being the primary structures in view. The introduction of the utilities including clearing associated with pipeline construction would begin to attract the viewer's attention until reclamation efforts are successful. Based on the proximity of the right-of-way to the highway, proposed changes to the landforms and vegetation would be apparent and would initially begin to attract attention.

The proposed utility corridor would be noticeable and initially attract attention, but would not dominate views within this landscape especially once reclamation efforts are complete. As motorists drive from Nipton, California to the turn off toward Walking Box Ranch Road in Nevada using Nipton Road/SR 164, the proposed pipeline corridor would parallel the road for approximately 2.75 miles in VRM Class III within California (similar to this view) and approximately 11.5 miles in VRM Class II within Nevada (see KOPs 7, 12, and 13). Based on a driving speed of 55 mph, over a total distance of 14.25 miles, this would result in the Project being in the immediate foreground for up to 16 minutes. KOPs 7, 12, and 13 also look at conformance associated with paralleling Nipton Road/SR 164 which in other areas included rolling terrain, where right-of-way clearing may be more evident, and areas where large existing transmission lines have modified the existing setting. In this location, the project would result in a weak level of visual contrast. Based on this level of contrast within VRM Class III, the Project is expected to meet the management class from this KOP and would be consistent with VRM Class III objectives.

Additional Mitigating Measures (See item 3)

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 12/29/2025
District Office: Southern Nevada
Field Office: Las Vegas
Land Use Planning Area:

SECTION A. PROJECT INFORMATION

1. Project Name	4. KOP Location (T.R.S)	5. Location Sketch
Castle Mountain Mine Phase II Expansion	T28S, R61E, S29	
2. Key Observation Point (KOP) Name KOP 12 - SR 164 (near NV/CA border)		
3. VRM Class at Project Location VRM Class II	(Lat. Long) 35°29'10.50"N, 115°10'49.99"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Undulating hills to flat valley. Rounded to rugged mountains.	Evenly patchy shrubs throughout valley. Scattered shrubs on mountains. Dense to scattered shrubs adjacent to KOP.	Tall, vertical, geometric, transmission towers; horizontal, drooping conductors.
LINE	Rounded hills to gently sloping valley floor and angular mountains.	Desert shrubs and other vegetation indistinct to horizontal in valley; indistinct and angular in mountains.	Straight, vertical, angled lines of transmission towers; thin, horizontal, concave conductors.
COLOR	Light beige valley floor. Mountains range from light tan to medium browns with red hues on some slopes	Olive green, sage green, bright green, brown, straw yellow.	Medium to dark gray transmission towers.
TEX-TURE	Fine, smooth to undulating hills and valley floor. Abrupt and coarse-textured mountains.	Fine, scattered and even. Foreground is more coarse from desert shrubs which become more uniform in the distance	Organized, directional, linear, repeating transmission towers.

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Geometric, flat right-of-way	Geometrically cleared area associated with right-of-way until reclamation efforts are complete	No proposed structures are apparent in view
LINE	Straight and horizontal graded areas.	Butt edge formed at between the right-of-way and existing landscape until reclamation efforts are complete	No proposed structures are apparent in view
COLOR	Light beige soils associated graded right-of-way and pipeline construction	Light beige soils replace olive and sage green vegetation until reclamation efforts are complete	No proposed structures are apparent in view
TEX-TURE	Fine, linear	Finer textured soil replaces vegetation until reclamation efforts are complete	No proposed structures are apparent in view

SECTION D. CONTRAST RATING ___SHORT TERM ✓ LONG TERM

1. DEGREE OF CONTRAST		FEATURES: LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
		STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM			✓			✓						✓
	LINE			✓				✓					✓
	COLOR			✓				✓					✓
	TEXTURE			✓				✓					✓

2. Does project design meet visual resource management objectives? ✓ Yes ___ No
(Explain on reverses side)

3. Additional mitigating measures recommended
___ Yes ✓ No (Explain on reverses side)

Evaluator's Names: SWCA Visual Resource Planners
Date: 12/29/2025

(Continued on Page 2)

Comments from item 2.

This KOP is located on Nevada State Route 164 adjacent to the California-Nevada border within the Avi Kwa Ame National Monument. The viewpoint is located adjacent to the proposed right-of-way which includes only the pipeline corridor component in this area. This KOP has a partially screened view of the surrounding area, with rolling hills screening views further down the highway. Existing mining operations associated with the Castle Mountain Mine are not visible from this location. Due to the superior viewing angle, modifications to vegetation on the hills would generally be visible from this the KOP.

The rolling hills, valley floors and surrounding mountains are populated with woody shrubs and other low shrubs interspersed with grasses. The existing mining operations are not visible, but a large scale transmission line corridor crosses the highway in this area and dominates views from this portion of the highway. The introduction of the proposed utilities including clearing associated with pipeline construction would be noticeable and capture viewer's attention until reclamation efforts are successful. Based on the proximity of the right-of-way to the highway, proposed changes to the landforms and vegetation would be noticeable but due the scale of the existing transmission lines, the project would not attract attention in the landscape.

In summary, the proposed utilites would be noticeable but would not attract attention and would not dominate views within this landscape. As motorists drive from Nipton, California to the turn off toward Walking Box Ranch Road in Nevada using Nipton Road/SR 164, the proposed pipeline corridor would parallel the road for approximately 2.75 miles in VRM Class III within California (see KOP 11 for more information) and approximately 11.5 miles in VRM Class II within Nevada including the view from this location. Based on a driving speed of 55 mph, over a total distance of 14.25 miles, this would result in the Project being in the immediate foreground for up to 16 minutes. KOPs 7, 11, and 13 also look at conformance associated with paralleling Nipton Road/SR 164 which in other areas included rolling terrain, where right-of-way clearing may be more evident, and areas where large existing transmission lines have modified the existing setting such as at this location. In this location, the project would result in a weak level of visual contrast. Based on this level of contrast within VRM Class II, the Project is expected to meet the management class from this KOP and would be consistent with VRM Class II objectives based on definitions in the Las Vegas RMP after construction. Through successful reclamation of the geometrically cleared right-of-way, as identified in project plans, the Project would become less noticeable in the landscape.

Additional Mitigating Measures (See item 3)

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 01/20/2026
District Office: Southern Nevada
Field Office: Las Vegas
Land Use Planning Area:

SECTION A. PROJECT INFORMATION

1. Project Name	4. KOP Location (T.R.S)	5. Location Sketch
Castle Mountain Mine Phase II Expansion	T28S, R61E, S15	
2. Key Observation Point (KOP) Name KOP 13 - SR 164 (McCullough Range)		
3. VRM Class at Project Location VRM Class II	(Lat. Long) 35°30'10.78"N, 115° 8'37.64"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Undulating hills. Rounded to rugged mountains in the distance.	Evenly patchy shrubs throughout the hills. Scattered shrubs on mountains. Scattered Joshua trees adjacent to KOP.	No structures are apparent in view
LINE	Undulating and sloping hills. Rounded to angular mountains.	Vertical Joshua trees with other vegetation indistinct to horizontal in hills; indistinct and angular in mountains.	No structures are apparent in view
COLOR	Light beige hills. Mountains range from light tan to medium browns with red hues on some slopes	Olive green, sage green, bright green, brown, straw yellow.	No structures are apparent in view
TEX-TURE	Moderate, undulating rolling hills. Abrupt and coarse-textured mountains.	Fine, scattered and even. Foreground is more coarse from Joshua trees and desert shrubs	No structures are apparent in view

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Geometric, flat right-of-way	Geometrically cleared area associated with right-of-way until reclamation efforts are complete	No proposed structures are apparent in view
LINE	Straight and horizontal graded areas.	Butt edge formed at between the right-of-way and existing landscape until reclamation efforts are complete	No proposed structures are apparent in view
COLOR	Light beige soils associated graded right-of-way and pipeline construction	Light beige soils replace olive and sage green vegetation until reclamation efforts are complete	No proposed structures are apparent in view
TEX-TURE	Fine, linear	Finer textured soil replaces vegetation until reclamation efforts are complete	No proposed structures are apparent in view

SECTION D. CONTRAST RATING __SHORT TERM ✓ LONG TERM

1. DEGREE OF CONTRAST		FEATURES: LAND/WATER BODY (1) STRONG	MODERATE	WEAK	NONE	VEGETATION (2) STRONG	MODERATE	WEAK	NONE	STRUCTURES (3) STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM			✓				✓					✓
	LINE			✓				✓					✓
	COLOR			✓				✓					✓
	TEXTURE			✓				✓					✓

2. Does project design meet visual resource management objectives? ✓ Yes ___ No
(Explain on reverses side)

3. Additional mitigating measures recommended
___ Yes ✓ No (Explain on reverses side)

Evaluator's Names: SWCA Visual Resource Planners
Date: 01/20/2026

(Continued on Page 2)

Comments from item 2.

This KOP is located on Nevada State Route 164 in the McCullough Range within the Avi Kwa Ame National Monument. The viewpoint is located adjacent to the proposed right-of-way which includes only the pipeline corridor component in this area. This KOP has a partially screened view of the surrounding area, with rolling hills screening views further along the highway. Existing mining operations associated with the Castle Mountain Mine are not visible from this location. Due to the level viewing angle of taller hills on either side of the highway, modifications to vegetation on the hills would generally be visible from this the KOP.

The rolling hills and surrounding mountains are populated with woody shrubs and other low shrubs interspersed with grasses. The existing mining operations are not visible, with no structures apparent in the landscape. The introduction of the utilities including clearing associated with pipeline construction would attract the viewer's attention until reclamation efforts are successful. Based on the proximity of the right-of-way to the highway, proposed changes to the landforms and vegetation would be apparent and would initally begin to attract attention.

The proposed utilities would be noticeable and initially attract attention, but would not dominate views within this landscape. As motorists drive from Nipton, California to the turn off toward Walking Box Ranch Road in Nevada using Nipton Road/SR 164, the proposed pipeline corridor would parallel the road for approximately 2.75 miles in VRM Class III within California (see KOP 11 for more information) and approximately 11.5 miles in VRM Class II within Nevada. Based on a driving speed of 55 mph, over a total distance of 14.25 miles, this would result in the Project being in the immediate foreground for up to 16 minutes. KOPs 7, 11, and 12 also look at conformance associated with paralleling Nipton Road/SR 164 which in other areas included rolling terrain, where right-of-way clearing may be more evident (such as in this view), and areas where large existing transmission lines have modified the existing setting. In this location, the project would result in a weak level of visual contrast after reclamation efforts are complete. Based on this level of contrast within VRM Class II, the Project is expected to meet the management class from this KOP and would be consistent with VRM Class II objectives based on definitions in the Las Vegas RMP through successful reclamation of the geometrically cleared right-of-way, as identified in project plans. As such, the Project would be less noticeable and would result in a weak level of visual contrast, therefore meeting VRM Class II objectives.

Additional Mitigating Measures (See item 3)

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 12/29/2025
District Office: California Desert
Field Office: Needles
Land Use Planning Area:

SECTION A. PROJECT INFORMATION

1. Project Name	4. KOP Location (T.R.S)	5. Location Sketch
Castle Mountain Mine Phase II Expansion	T14N, R17E, S11	
2. Key Observation Point (KOP) Name KOP 14 - Castle Mountain Mine Road (re-alignment area)		
3. VRM Class at Project Location VRM Class III and IV	(Lat. Long) 35°18'42.63"N, 115° 6'55.47"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Rolling hills to rounded trapezoidal to rugged mountains with existing mining mostly screened. Flat road	Evenly patchy shrubs throughout valley. Scattered shrubs on mountains. Scattered shrubs and Joshua tree adjacent to KOP.	No structures are apparent in view
LINE	Undulating valley floor and foothills. Rounded to angular mountains. Curvilinear lines in road	Rounded and vertical shrubs with other vegetation indistinct to horizontal in valley; indistinct and angular in mountains.	No structures are apparent in view
COLOR	Light beige hills and road. Mountains range from light tan to medium browns with red hues on some slopes	Olive green, sage green, bright green, brown, straw yellow.	No structures are apparent in view
TEX-TURE	Moderate, smooth to undulating valley, foothills, and road. Abrupt and coarse-textured mountains.	Fine, scattered and even. Foreground is more coarse from Joshua tree which become more uniform in the distance	No structures are apparent in view

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Geometric, flat right-of-way and new roadway	Geometrically cleared area associated with right-of-way and road until reclamation efforts are complete	Vertical, transmission towers; horizontal, drooping conductors.
LINE	Straight and horizontal graded areas.	Butt edge formed between the right-of-way and existing landscape until reclamation efforts are complete	Straight, transmission towers; thin, horizontal, concave conductors.
COLOR	Light beige soils associated with road as well as graded right-of-way and pipeline construction	Light beige soils replace olive and sage green vegetation until reclamation efforts are complete	Brown transmission towers.
TEX-TURE	Fine, linear	Finer textured roadway replaces vegetation until reclamation efforts are complete	Organized, directional, linear, repeating transmission towers.

SECTION D. CONTRAST RATING __SHORT TERM ✓ LONG TERM

1. DEGREE OF CONTRAST		FEATURES: LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
		STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM		✓				✓				✓		
	LINE			✓			✓					✓	
	COLOR			✓			✓					✓	
	TEXTURE			✓			✓					✓	

2. Does project design meet visual resource management objectives? ✓ Yes ___ No (Explain on reverses side)

3. Additional mitigating measures recommended ✓ Yes ___ No (Explain on reverses side)

Evaluator's Names: SWCA Visual Resource Planners
Date: 12/29/2025

(Continued on Page 2)

Comments from item 2.

This KOP is located on Castle Mountain Road directly adjacent the proposed road re-route, to avoid NPS lands, and proposed utilities. The viewpoint is located approximately 2 miles from existing mining area, which is almost entirely screened from view at this location, with level to slightly superior views of the surrounding area. This KOP has a partially screened view of the surrounding area, with terrain mostly screening views toward the proposed mining area to the southeast. Existing mining operations associated with the Castle Mountain Mine are almost entirely screened and do not attract attention. Due to the level to slightly superior viewing angle, existing roadways are generally visible from this the KOP.

The valley floors and surrounding mountains are populated with woody shrubs and other low shrubs interspersed with grasses. The existing road creates curvilinear lines with a flat, light colored gravel surface. The proposed road re-alignment would occur adjacent to the existing road and would be seen as a re-route of the existing road, with the replaced road section to be reclaimed. Over time, the new roadway would appear similar to the existing road alignment with the former road alignment, reclaimed to mimic the adjacent landscape. The introduction of the utilities including transmission line structures would be noticeable but would not dominate views within this landscape. The structures would repeat the patterns associated with the previously authorized transmission line which was removed in 2011. Based on the level to slightly superior position of casual observers from this KOP, proposed changes to the landforms and vegetation are expected to be visible associated with the new road re-alignment and proposed utilities.

The new roadway, as well as the proposed utilities would increase the influence of the activities on views and would begin to attract attention but would not dominate views. As such, the project would result in a weak to weak/moderate level of visual contrast. Based on this level of contrast with VRM Class III and IV areas, the Project is expected to meet the management class from this KOP as the Project can attract attention but not dominate the view and be the major focus of viewer attention in VRM Class III. Following reclamation, the proposed actions would remain noticeable.

Additional Mitigating Measures (See item 3)

Nonspecular conductors would be used to reduce visual impacts associated with potential glint and glare associated with typical conductors.

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 12/29/2025
District Office: California Desert
Field Office: Needles
Land Use Planning Area:

SECTION A. PROJECT INFORMATION

1. Project Name	4. KOP Location (T.R.S)	5. Location Sketch
Castle Mountain Mine Phase II Expansion (Alternative E)	T14N, R17E, S11	
2. Key Observation Point (KOP) Name KOP 14 - Castle Mountain Mine Road (re-alignment area)		
3. VRM Class at Project Location VRM Class III and IV	(Lat. Long) 35°18'42.63"N, 115° 6'55.47"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Rolling hills to rounded trapezoidal to rugged mountains with existing mining mostly screened. Flat road	Evenly patchy shrubs throughout valley. Scattered shrubs on mountains. Scattered shrubs and Joshua tree adjacent to KOP.	No structures are apparent in view
LINE	Undulating valley floor and foothills. Rounded to angular mountains. Curvilinear lines in road	Rounded and vertical shrubs with other vegetation indistinct to horizontal in valley; indistinct and angular in mountains.	No structures are apparent in view
COLOR	Light beige hills and road. Mountains range from light tan to medium browns with red hues on some slopes	Olive green, sage green, bright green, brown, straw yellow.	No structures are apparent in view
TEX-TURE	Moderate, smooth to undulating valley, foothills, and road. Abrupt and coarse-textured mountains.	Fine, scattered and even. Foreground is more coarse from Joshua tree which become more uniform in the distance	No structures are apparent in view

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Geometric, flat right-of-way and new roadway	Geometrically cleared area associated with right-of-way and road until reclamation efforts are complete	Vertical, transmission towers; horizontal, drooping conductors. Low, geometric solar arrays
LINE	Straight and horizontal graded areas.	Butt edge formed between the right-of-way and existing landscape until reclamation efforts are complete	Straight, transmission towers; thin, horizontal, concave conductors. Horizontal solar arrays.
COLOR	Light beige soils associated with road as well as graded right-of-way and pipeline construction	Light beige soils replace olive and sage green vegetation until reclamation efforts are complete	Brown transmission towers. Dark solar arrays
TEX-TURE	Fine, linear	Finer textured roadway replaces vegetation until reclamation efforts are complete	Organized, directional, linear, repeating transmission towers. Organized solar arrays.

SECTION D. CONTRAST RATING __SHORT TERM ✓ LONG TERM

1. DEGREE OF CONTRAST		FEATURES: LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
		STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM			✓			✓				✓		
	LINE			✓			✓					✓	
	COLOR			✓			✓				✓		
	TEXTURE			✓			✓					✓	

2. Does project design meet visual resource management objectives? ✓ Yes ___ No (Explain on reverses side)

3. Additional mitigating measures recommended ✓ Yes ___ No (Explain on reverses side)

Evaluator's Names: SWCA Visual Resource Planners
Date: 12/29/2025

(Continued on Page 2)

Comments from item 2.

This KOP is located on Castle Mountain Road directly adjacent the proposed road re-route, to avoid NPS lands, and proposed utilities. The viewpoint is located approximately 2 miles from existing mining area, which is almost entirely screened from view at this location, with level to slightly superior views of the surrounding area. This KOP has a partially screened view of the surrounding area, with terrain mostly screening views toward the proposed mining area to the southeast. Existing mining operations associated with the Castle Mountain Mine are almost entirely screened and do not attract attention. Due to the level to slightly superior viewing angle, existing roadways are generally visible from this the KOP.

The valley floors and surrounding mountains are populated with woody shrubs and other low shrubs interspersed with grasses. The existing road creates curvilinear lines with a flat, light colored gravel surface. The proposed road re-alignment would occur adjacent to the existing road and would be seen as a re-route of the existing road, with the replaced road section to be reclaimed. Over time, the new roadway would appear similar to the existing road alignment with the former road alignment, reclaimed to mimic the adjacent landscape. The introduction of the utilities including transmission line structures would be noticeable but would not dominate views within this landscape. The structures would repeat the patterns associated with the previously authorized transmission line which was removed in 2011.

Under Alternative E, the introduction of the solar arrays would be noticeable but based on the distance (2 miles), partial screening by terrain, and its low form, it would not attract attention from this location. Based on the level to slightly superior position of casual observers from this KOP, proposed changes to the landforms and vegetation are expected to be visible associated with the new road re-alignment, proposed utilities and solar arrays.

The new roadway, as well as the proposed utilities and solar arrays, would increase the influence of the activities on views and would begin to attract attention but would not dominate views. As such, the project would result in a weak/moderate level of visual contrast. Based on this level of contrast with VRM Class III and IV areas, the Project is expected to meet the management class from this KOP as the Project can attract attention but not dominate the view and be the major focus of viewer attention in VRM Class III. Following reclamation, the proposed actions would remain noticeable.

Additional Mitigating Measures (See item 3)

Nonspecular conductors would be used to reduce visual impacts associated with potential glint and glare associated with typical conductors.

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 01/21/2026
District Office: California Desert
Field Office: Needles
Land Use Planning Area:

SECTION A. PROJECT INFORMATION

1. Project Name	4. KOP Location (T.R.S)	5. Location Sketch
Castle Mountain Mine Phase II Expansion	T14N, R17E, S14	
2. Key Observation Point (KOP) Name KOP 15 - Castle Mountain recreation road		
3. VRM Class at Project Location VRM Class III and IV	(Lat. Long) 35°16'54.77"N, 115° 7'28.20"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Rolling hills adjacent to rounded to rugged mountains with existing mining visible in the other direction, trapezoidal spoil piles	Evenly patchy shrubs throughout valley. Scattered shrubs on mountains. Scattered shrubs and Joshua tree adjacent to KOP.	Geometric platform, greenhouse and support structures
LINE	Undulating valley floor and foothills. Rounded to angular mountains. Angular and horizontal lines in mining area	Rounded and vertical shrubs with other vegetation indistinct to horizontal in valley; indistinct and angular in mountains.	Vertical, angular, horizontal, and curved lines in platform, greenhouse, and support structures
COLOR	Light beige hills, road, and mining area. Mountains range from light tan to medium browns with red hues on some slopes	Olive green, sage green, bright green, brown, straw yellow.	Brown wood, white greenhouse frame with translucent covering, black tanks
TEX-TURE	Moderate, smooth to undulating valley and hills. Abrupt and coarse-textured mountains. Fine mining scars and spoils.	Fine, scattered and even. Foreground is more coarse from Joshua tree which become more uniform in the distance	Moderately coarse, low structures with the taller greenhouse including a softer, rounded form

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Solar arrays interrupt the extent of the valley floor. Mountains visible above arrays.	Visible vegetation is limited to the immediate foreground where globular shrubs and grassy understory is retained.	Introduction of rectangular solar arrays with a low, angular perimeter fence.
LINE	Valley floor and mountains retain characteristics, less of landscape is visible due to the presesence of the project	Visible vegetation is limited to the immediate foreground where globular shrubs and grassy understory is retained.	Horizontal, vertical, and diagonal solar arrays. Horizontal and vertical fencing.
COLOR	Valley floor and mountains retain characteristics, less of landscape is visible due to the presesence of the project	Visible vegetation is limited to the immediate foreground where globular shrubs and grassy understory is retained.	Dark solar arrays, steel gray perimeter fence.
TEX-TURE	The valley's continuity is further interrupted by the Project.	Extent of vegetation cover is altered to minimal area around perimeter of solar arrays.	Rigid, organized solar arrays. Linear, directional perimeter fence.

SECTION D. CONTRAST RATING __SHORT TERM ✓LONG TERM

1. DEGREE OF CONTRAST		FEATURES: LAND/WATER BODY (1) STRONG	MODERATE	WEAK	NONE	VEGETATION (2) STRONG	MODERATE	WEAK	NONE	STRUCTURES (3) STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM		✓				✓				✓		
	LINE		✓				✓				✓		
	COLOR			✓				✓			✓		
	TEXTURE			✓				✓			✓		

2. Does project design meet visual resource management objectives? ✓Yes ___No (Explain on reverses side)

3. Additional mitigating measures recommended ✓Yes ___No (Explain on reverses side)

Evaluator's Names: SWCA Visual Resource Planners
Date: 01/21/2026

(Continued on Page 2)

Comments from item 2.

This KOP is located on a recreation road near Castle Mountain directly adjacent to proposed solar facility (under Alternative E). Note, if viewing the other direction, the proposed mining expansion area and utilities would be also visible. The viewpoint is located approximately 1 mile from existing mining area with level views of the surrounding area. This KOP has a mostly unobstructed view of the surrounding area, except to the southwest with terrain partially screening views. Existing mining operations associated with the Castle Mountain Mine are visible and introduce modifications to the existing landforms and vegetation of the area. Additionally, a greenhouse and other support structures near the KOP have modified the setting. Due to the level viewing angle toward rising terrain in both views to the west and east, existing roadways and other ground modifications are generally visible from this the KOP.

The valley floors and surrounding mountains are populated with woody shrubs and other low shrubs interspersed with grasses. In views to the east (see proposed activity description), the proposed solar facility would be clearly visible from this KOP and would attract viewer attention due to the Project's location directly adjacent to the roadway in context with existing landscape modifications. The scale, form, color, and texture of the Project would introduce a moderate level of visual contrast to the characteristics of the the existing landscape. Additionally, construction activities (vegetation clearing, fugitive dust emissions, the operation of equipment, etc.) would be visible and would also create visual contrast during the construction phase of the Project.

In views to the east, the existing mining operations create horizontal lines with light colored soils associated with tailing piles. The proposed mining areas would occur adjacent to the existing mining operations and would be seen as an expansion of the existing mine. Views of the proposed mining expansion would be noticeable and would attract further attention from this location. Similarly, the introduction of the utilities including transmission line structures would further attract the viewer's attention. Based on the level position of casual observers from this KOP proposed changes to the landforms and vegetation are expected to be visible with the mining areas would changing landforms and vegetation visible on the Castle Mountains.

The proposed solar facility (under Alternative E), spoil piles and expanded area viewed as being modified by mining operations, as well as the proposed utility corridor, would increase the influence of the activities on views and would attract attention and in some areas, and begin to dominate views. As such, the project would result in a moderate level of visual contrast. Based on this level of contrast with VRM Class IV areas, the Project is expected to meet the management class from this KOP as the Project can dominate the view and be the major focus of viewer attention under this classification. For any the solar facility and mining operations in VRM Class III, mitigation strategies listed below would facilitate conformance with VRM Class III objectives to reduce contrast and attract attention, but not dominate landscape character.

Additional Mitigating Measures (See item 3)

The Applicant will coordinate with the BLM to determine the applicability of the visual resource–related design features on the solar facility alternative including those from the 2024 Western Solar Plan or other applicable BLM direction.

As described in the Project's 1998 ROD, include that site reclamation shall include modification of final overburden and heap leach pile shapes to reduce the impact of straight-line geometrics and potential contrast in form and line.

As described in the Project's 1998 ROD, rock staining solutions shall be used on the upper mine pit walls where necessary, as determined by the BLM and the County, to reduce the contrast of light-colored rock exposed by mining activities and where visible above prevailing grade. These solutions shall be specifically colored to reduce the contrast between the pit walls and the surrounding undisturbed slopes.

Nonspecular conductors would be used to reduce visual impacts associated with potential glint and glare associated with typical conductors.

APPENDIX C

Non-Simulated Key Observation Point Photographs

KOP 11: Nipton Road

Photographs captured on January 13, 2026, at 9:52 a.m. – View looking west toward the Project (and Nipton) and east, respectively.





KOP 12: SR 164 (Near NV/CA Border)

Photographs captured on January 13, 2026, at 9:21 a.m. – View looking west toward the Project (and existing transmission lines) and northeast, respectively.





KOP 15: Castle Mountain Recreation Road

Photographs captured on January 12, 2026, at 2:38 p.m. – View looking northwest toward the Project's proposed solar facility under Alternative E and east toward existing mining activities, respectively.





This page intentionally left blank.

EIR APPENDIX 2

Soil Survey Summary
(NewFields 2025)

NewFields
Mining Design & Technical Services

1301 N McCarran Blvd., Suite 101
Sparks, NV 89431

T: 775.525.2575

TECHNICAL MEMORANDUM

Prepared by: **Greg Lambeth, P.G., C.E.G**

Reviewed by: **Andrew Hanson, P.E.**

Project: **Castle Mountain Mine**

Project No: **475.0468.006**

Subject: **Summary of Soil Survey Mapping along Utility Right of Way**

Date: **28 May 2025**

1. INTRODUCTION

This Technical Morandum presents and summarizes published soil survey mapping and data along proposed water pipeline and powerline utility right-of-ways (ROWs) in San Bernardino County, California, and Clark County, Nevada. Equinox Gold Corp. - Castle Mountain Venture requested that NewFields perform the subject desktop study to summarize the near surface soils along the ROWs to support submittal of the current mine plan amendment to regulators.

The following sections summarize soil mapping and data along the ROWs from the United States Department of Agriculture (USDA) Web Soil Survey website (USDA, 2025).

2. SUMMARY OF MAPPED SOILS ALONG UTILITY RIGHT OF WAYS

The USDA Web Soil Survey (WSS) provides information about the near surface soils across most of the United States to facilitiate land use planning (USDA, 2025). The objective of the WSS mapping is to separate the landscape into landforms or landform segments that have similar use and management requirements. Soil map units are developed based on interpretation of geology, landforms, relief, climate, and natural vegetation in conjunction with excavation, logging, sampling, and laboratory testing of soils at select locations. A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil. A soil map unit may be classified as an *association* or *complex.* An association is made up of two or more geographically associated soils that were grouped together and shown as one unit on the soil map due to similarities in present or anticipated land uses. A complex consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the maps.

The USDA soil units mapped within approximately 500 to 1,000 feet of the ROWs are presented on **Figure 1**. The total length of ROW intersecting each soil map unit is summarized in **Table 1**.

Table 1: Length of Right of Way Intersecting USDA Soil Map Units

USDA Soil Map Unit Number	USDA Soil Map Unit Name	Total Length of ROW Intersection (feet)	Total Length of ROW Intersection (Miles)
160	Lanip-Kidwell association	7,274	1.38
404	Lecyr very gravelly sandy loam	273	0.05
414	Helendale-Caruthers-Castaneda complex	2,680	0.51
680	Lanfair- Hoppswell association	46,017	8.72
801	Nippeno-Newera association	18,467	3.50
3420	Hartpeak-Highland association	2007	0.38
4180	Pekash-Ariz association	22,765	4.31
4220	Minehart gravelly fine sandy loam	4,950	0.94
4230	Hoppswell-Ustidur association	61,623	11.67
	TOTAL	**166,057**	**31.45**

Attachment A presents the Engineering Properties Soil Reports extracted from the USDA website for each of the soil map units intersecting the ROWs (USDA, 2025). Soil physical properties listed in the tables in **Attachment A** are measured or inferred by the USDA from direct observations in the field or laboratory. For each soil horizon, the tables list the following;

- Hydrologic group
- Soil Classifications
  - USDA texture
  - Unified Soil Classification System (USCS) (ASTM, 2005)
  - American Association of State Highway and Transportation Officials (AASHTO, 2004)
- Ranges of particle size gradation, liquid limit (LL), and plasticity index (PI).
  - Three values are provided to identify the expected Low (L), Representative Value (R), and High (H) for each tested parameter.

Depths of investigation and characterization of the typical soil profile layers for each map unit are roughly 5 feet (ranging between 59 and 64 inches). Depths of investigation are shallower where cemented horizons or bedrock was encountered.

An explanation of the characteristics in the Engineering Properties tables is included at the beginning of **Attachment A**.

2.1.1 Hydrologic Group

Soil units intersecting the ROWs range from Hydrologic Group A (soils having a high infitration rate (low runoff potential) when thoroughly wet) to Hydrologic Group D (soils having a very slow infiltration rate when thoroughly wet). Approximately half of the soil units intersecting the ROWs are classified as Hydrologic Group C (Soils having a slow infiltration rate when thoroughly wet). Group C soils consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission (USDA, 2025).

2.1.2 Soil Classifications, Particle Size Gradation, and Plasticity

The total length of the ROWs is approximately 31.45 miles. Of the nine soil map units that the ROWs intersect, four of the soil units (4230, 680, 4180, and 801) make up 28.2 miles, or nearly 90-percent of the total length of the ROWs. The soils within these four map units are mainly gravels and lesser sands with varying amounts of silt and clay. USCS material classifications range from relatively clean gravels with less than 5-percent silt or clay (USCS symbols GP and GW) to silty gravel (GM) or clayey gravel (GC) that contain more than 12-percent silt or clay. Intermediate symbols (GW-GM, GW-GC, GP-GM, and GP-GC) represent gravels with betweeen 5-percent and 12-percent silt or clay. Sandy horizons are locally present with varying amounts of silt and clay (USCS symbols SC, SP-SC, SP-SM, and SP). Particles 3 to 10 inches in diameter are logged in most layers up to a maximum of 31-percent by dry weight. Particles greater than 10 inches are also logged in many layers up to a maximum of 10-percent by dry weight. AASHTO classifications for these materials largely fall into the A-1 to A-3 categories, for granular materials with less than 35 percent passing the No. 200 sieve (silt or clay). Liquid limits for these materials range from 0 to 47, and plasticity indexes range from non-plastic (NP) to 25.

Soil map units 160, 404, 414, 3420, and 4220 make up a total of approximately 3.25 miles (approximately 10 percent) of the soils intersected along the 31.45 mile ROW length.

- Soil map units 414 and 404 are mainly sandy soils with intermittent gravelly layers, and unit 414 contains some layers of clay and silt (USCS symbols CL and ML, respectively). AASHTO classifications for these materials range from A-1 and A-2 (for granular materials with less than 35 percent passing the No. 200 sieve) to A-4 and A-6 (for silt or clay materials with more than 35 percent passing the No. 200 sieve). Particles between 3 and 10 inches are logged within unit 404 up to 17-percent by dry weight, and particles greater than 10 inches in diameter are logged at up to 4-percent by dry weight below 27 inches in depth. Trace particles between 3 and 10 inches in diameter are present in unit 414 below 23 inches in depth. Liquid limits range from 0 to 29 and plasticity indexes range from non-plastic (NP) to 12.
- Soil map unit 3420 is mainly composed of clayey and silty gravels. The Hartpeak unit, which makes up the majority of this association, contains up to 33-percent particles between 3 and

10 inches in diameter, and up to 6-percent particles greater than 10 inches in diameter. AASHTO classifications for these materials range from A-1 and A-2 (for granular materials with less than 35 percent passing the No. 200 sieve) to A-4 and A-6 (for silt or clay materials with more than 35 percent passing the No. 200 sieve). Liquid limits range from 20 to 42 and plasticity indexes range from 5 to 22.

- Soil map units 160 and 4220 are variable and mainly composed of silty and clayey gravels and sands with interbeds of clay and silt. AASHTO classifications for these materials range from A-1 and A-2 (for granular materials with less than 35 percent passing the No. 200 sieve) to locally A-4 and A-6 (for silt or clay materials with more than 35 percent passing the No. 200 sieve). Liquid limits range from 15 to 56 and plasticity indexes range from non-plastic (NP) to 32.

REFERENCES

American Association of State Highway and Transportation Officials (AASHTO), 2004, *Standard specifications for transportation materials and methods of sampling and testing*, 24th edition.

American Society for Testing and Materials (ASTM), 2005, *Standard classification of soils for engineering purposes,* ASTM Standard D2487-00.

United States Department of Agriculture (USDA), Natural Resources Conservation Service, 2025, Web Soil Survey online service, https://websoilsurvey.nrcs.usda.gov/, accessed 16 May 2025.

ATTACHMENTS

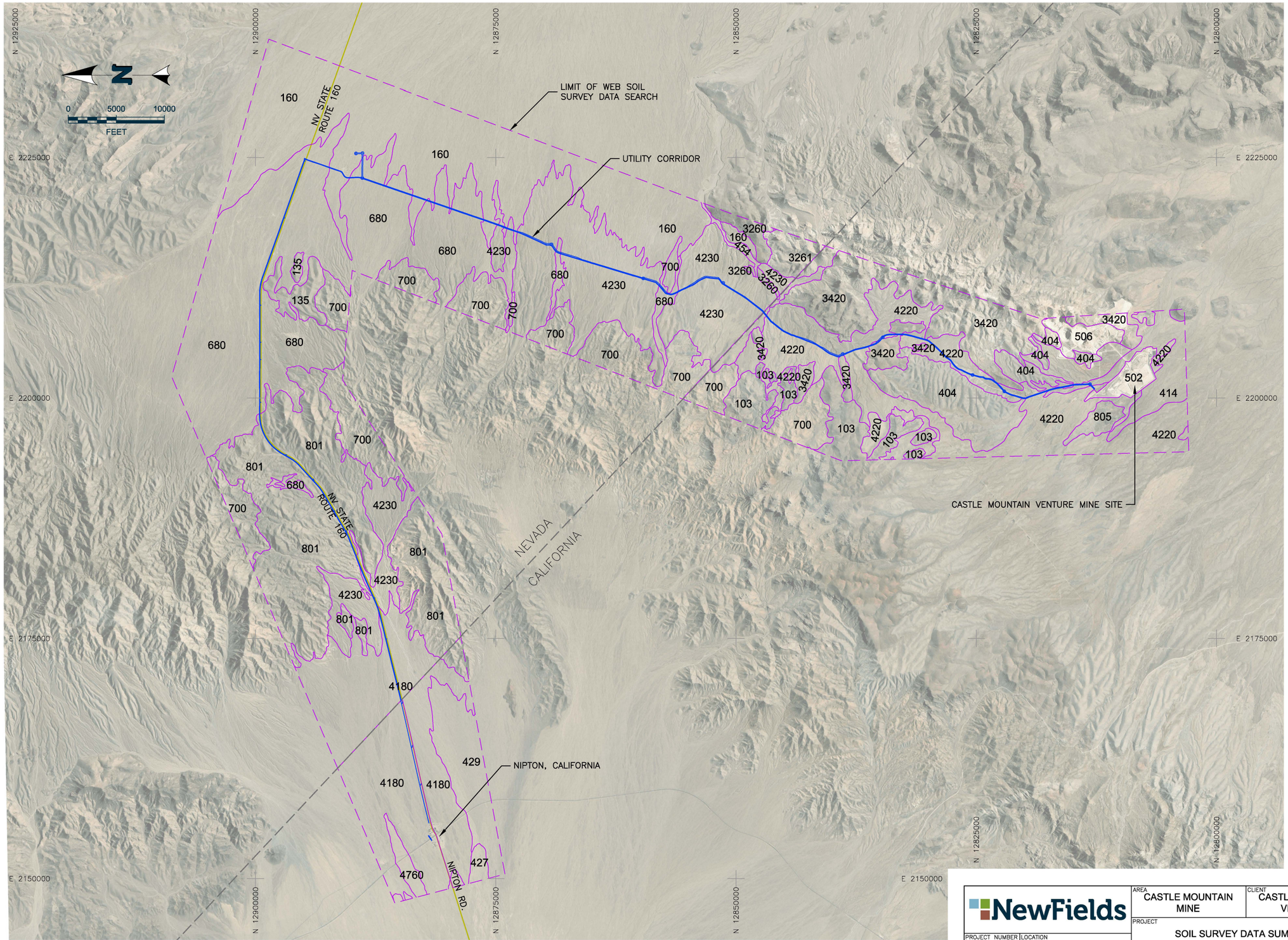
Figure 1 – Utility Corridor Soil Survey Map

Attachment A - Engineering Properties Soil Reports (USDA, 2025)

S:\Projects\0468.006 Castle Mtn Phase 2a Engineering Services\01-Doc\Utility Corridor Soil Survey\01-Memo\Utility Corridor Soils_Memo.docx

NewFields

Figure 1 – Utility Corridor Soil Survey Map



KEY:

- UTILITY CORRIDOR
- EXISTING HIGHWAY
- SOIL MAP UNIT SECTION BOUNDARY
- 20 SOIL MAP UNIT SYMBOL
- STATE BOUNDARY LINE
- LIMIT OF WEB SOIL SURVEY DATA SEARCH

USDA SOIL MAP UNIT NUMBER	TOTAL LENGTH OF MAP UNIT INTERSECTING ROW (FT)	TOTAL LENGTH OF MAP UNIT INTERSECTING ROW (MI)
160	7,274	1.38
404	273	0.05
414	2,680	0.51
680	46,017	8.72
801	18,467	3.50
3420	2,007	0.38
4180	22,765	4.31
4220	4,950	0.94
4230	61,623	11.67
TOTAL	166,057	31.45

REFERENCE:
EXISTING GROUND TOPOGRAPHY CREATED IN THE STATE PLANE UTM83 ZONE 11, INTERNATIONAL FOOT COORDINATE SYSTEM.

B:\PROJECTS\0468.006 CASTLE MTN PHASE 2A ENGINEERING SERVICES\07-DESIGN\FIGS\UTILITY CORRIDOR\0468.006-UTILITY-FIG-0001_A.DWG - Last saved by CMCCREA on 6/26/2025

NewFields

PROJECT NUMBER	475.0468.006
LOCATION	SAN BERNARDINO COUNTY, CA
DOCUMENT FILENAME	0468.006-UTILITY-FIG-0001_A.DWG
AREA	CASTLE MOUNTAIN MINE
CLIENT	CASTLE MOUNTAIN VENTURE
PROJECT	SOIL SURVEY DATA SUMMARY
FIGURE TITLE	UTILITY CORRIDOR SOIL SURVEY MAP
FIGURE NUMBER	1
REVISION	A

EQUINOX GOLD
CASTLE MOUNTAIN VENTURE

NewFields

ATTACHMENT A

Engineering Properties Soil Reports (USDA, 2025)

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Soil Physical Properties

This folder contains a collection of tabular reports that present soil physical properties. The reports (tables) include all selected map units and components for each map unit. Soil physical properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

Engineering Properties

This table gives the engineering classifications and the range of engineering properties for the layers of each soil in the survey area.

Hydrologic soil group is a group of soils having similar runoff potential under similar storm and cover conditions. The criteria for determining Hydrologic soil group is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Listing HSGs by soil map unit component and not by soil series is a new concept for the engineers. Past engineering references contained lists of HSGs by soil series. Soil series are continually being defined and redefined, and the list of soil series names changes so frequently as to make the task of maintaining a single national list virtually impossible. Therefore, the criteria is now used to calculate the HSG using the component soil properties and no such national series lists will be maintained. All such references are obsolete and their use should be discontinued. Soil properties that influence runoff potential are those that influence the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties are depth to a seasonal high water table, saturated hydraulic conductivity after prolonged wetting, and depth to a layer with a very slow water transmission rate. Changes in soil properties caused by land management or climate changes also cause the hydrologic soil group to change. The influence of ground cover is treated independently. There are four hydrologic soil groups, A, B, C, and D, and three dual groups, A/D, B/D, and C/D. In the dual groups, the first letter is for drained areas and the second letter is for undrained areas.

The four hydrologic soil groups are described in the following paragraphs:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Percentage of rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves,

numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

References:

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Engineering Properties Soil Reports
Excerpted from USDA Web Soil Survey Website (USDA, 2025)

Map unit symbol and soil name	Percent of map unit	Hydro-logic group	Depth (inches)	USDA texture	Classification		Percent Fragments		Percentage passing sieve number				Liquid Limit (L-R-H)	Plasticity Index (L-R-H)
					USCS	AASHTO	>10 inches (L-R-H)	3-10 inches (L-R-H)	4 (L-R-H)	10 (L-R-H)	40 (L-R-H)	200 (L-R-H)		
160—Lanip-Kidwell association														
Lanip	65	C	0-1	Very gravelly sandy loam	GM, SM	A-1, A-2	0-0-0	0-0-0	35-48-60	25-38-50	20-30-40	15-23-30	15-20-25	NP-3 -5
			1-15	Gravelly sandy loam, gravelly loam	SC-SM, GM, ML, SM	A-2, A-4	0-0-0	0-0-0	65-70-75	55-65-75	40-50-60	25-35-55	15-20-25	NP-3 -5
			15-39	Clay loam, sandy clay loam, gravelly sandy clay loam	CL, SC	A-6	0-0-0	0-0-0	70-90-95	60-85-90	50-58-80	40-50-65	30-35-40	10-15-20
			39-48	Gravelly sandy loam	GM, SM	A-1, A-2, A-4	0-0-0	0-0-0	65-80-85	55-70-75	40-50-60	20-30-40	15-20-25	NP-3 -5
			48-60	Very gravelly sandy loam, very gravelly loamy sand	GM, SM	A-1, A-2	0-0-0	0-0-0	40-50-60	30-40-50	15-25-35	10-20-30	15-20-25	NP-3 -5
Kidwell	20	C	0-1	Very gravelly sandy loam	GC-GM, GM	A-1, A-2	0-0-0	0-0-0	35-43-55	30-38-50	20-25-35	10-15-20	17-23-30	3-7 -12
			1-9	Sandy loam, gravelly sandy loam	GC-GM, SC-SM, SM	A-1, A-2	0-0-0	0-0-0	65-80-95	60-75-90	40-50-60	20-25-30	17-23-30	3-7 -12
			9-15	Gravelly sandy clay loam, gravelly clay loam	GC, SC	A-2, A-6	0-0-0	0-0-0	55-75-95	50-63-75	45-55-70	30-40-45	31-36-42	13-17-21
			15-31	Gravelly clay loam, gravelly sandy clay loam	GC, SC	A-2, A-6	0-0-0	0-0-0	55-75-95	50-63-75	45-55-70	30-40-45	31-36-42	13-17-21
			31-60	Gravelly sandy loam, gravelly coarse sandy loam, sandy loam	GC-GM, SC-SM, GM, SM	A-1, A-2	0-0-0	0-0-0	60-80-95	50-70-85	35-45-55	15-20-30	17-23-30	3-7 -12

NOTES:

- (L-R-H): Three values are provided to identify the expected Low (L), Representative Value (R), and High (H) for each tested parameter.
- Unified Soil Classification System (USCS) soil classifications per American Society for Testing and Materials (ASTM), 2005, *Standard Classification of Soils for Engineering Purposes, ASTM Standard D2487-00*.
- American Association of State Highway and Transportation Officials (AASHTO) soil classifications per AASHTO, 2004, *Standard Specifications for Transportation Materials and Methods of Sampling and Testing, 24th edition.*

Engineering Properties Soil Reports
Excerpted from USDA Web Soil Survey Website (USDA, 2025)

Map unit symbol and soil name	Percent of map unit	Hydro-logic group	Depth (inches)	USDA texture	Classification		Percent Fragments		Percentage passing sieve number				Liquid Limit (L-R-H)	Plasticity Index (L-R-H)
					USCS	AASHTO	>10 inches (L-R-H)	3-10 inches (L-R-H)	4 (L-R-H)	10 (L-R-H)	40 (L-R-H)	200 (L-R-H)		
404—Lecyr very gravelly sandy loam														
Lecyr	80	C	0-3	Very gravelly sandy loam	GC-GM, GC, GP-GM	A-1-b, A-2-4, A-1-a	0-0-0	0-6-8	45-55-63	27-40-53	20-31-45	10-16-27	18-20-25	3-5-9
			3-6	Gravelly sandy loam, very gravelly sandy loam	SC-SM, SC, SM	A-2-4, A-4, A-1-a	0-0-0	3-7-10	68-90-93	37-76-81	26-58-67	14-35-43	17-21-25	3-6-9
			6-11	Gravelly sandy loam, very gravelly sandy loam	SC-SM, SC, SM	A-2-4, A-4, A-1-a	0-0-0	3-7-9	62-84-90	30-69-80	22-54-68	13-35-45	17-23-25	2-7-9
			11-27	Very gravelly sandy loam	SC-SM, GW-GM	A-1-b, A-2-4, A-1-a	0-0-0	2-6-9	52-63-63	28-56-56	20-42-45	9-21- 25	0-18 -23	NP-5-7
			27-30	Cemented very gravelly sandy loam	SC-SM, SW-SM	A-1-b, A-2-4, A-1-a	0-2-4	7-12-17	57-69-72	35-54-60	25-41-49	12-20-28	0-17 -23	NP-5-7
			30-35	Very gravelly loamy sand, very gravelly sand, extremely gravelly sand, extremely gravelly loamy sand	SM, SC- SM, GW	A-1-b, A-2-4, A-1-a	0-2-4	11-13-16	39-69-72	14-53-60	10-42-52	3-15-20	0-16 -19	NP-3-4
			35-59	Extremely gravelly sand, very gravelly sand, very gravelly loamy sand, extremely gravelly loamy sand	GW, SP- SC	A-1-a, A-1-b	0-2-4	6-11-16	31-31-65	13-19-57	10-15-47	1- 2-11	0-16 -19	NP-3-4

NOTES:

- (L-R-H): Three values are provided to identify the expected Low (L), Representative Value (R), and High (H) for each tested parameter.
- Unified Soil Classification System (USCS) soil classifications per American Society for Testing and Materials (ASTM), 2005, *Standard Classification of Soils for Engineering Purposes, ASTM Standard D2487-00*.
- American Association of State Highway and Transportation Officials (AASHTO) soil classifications per AASHTO, 2004, *Standard Specifications for Transportation Materials and Methods of Sampling and Testing, 24th edition.*

Engineering Properties Soil Reports
Excerpted from USDA Web Soil Survey Website (USDA, 2025)

Map unit symbol and soil name	Percent of map unit	Hydro-logic group	Depth (inches)	USDA texture	Classification		Percent Fragments		Percentage passing sieve number				Liquid Limit (L-R-H)	Plasticity Index (L-R-H)
					USCS	AASHTO	>10 inches (L-R-H)	3-10 inches (L-R-H)	4 (L-R-H)	10 (L-R-H)	40 (L-R-H)	200 (L-R-H)		
414—Helendale- Caruthers- Castaneda complex														
Helendale	35	A	0-2	Fine sandy loam	SM, SC- SM	A-4, A-2-4	0-0-0	0-0-0	88-98-100	76-94-100	64-82-92	27-38-46	17-18-22	2-3-6
			2-14	Fine sandy loam, sandy loam	SC-SM, SC	A-2-4, A-6	0-0-0	0-0-0	88-97-97	77-92-92	63-85-92	21-33-40	19-23-29	4-7-12
			14-23	Fine sandy loam, sandy loam	SC, SC- SM	A-2-4, A-6	0-0-0	0-0-0	88-95-97	77-88-92	63-81-92	21-31-40	19-24-29	4-8-12
			23-38	Sandy loam, fine sandy loam	SC, SC- SM	A-2-6, A-6, A-2-4	0-0-0	0-1-4	88-97-97	77-92-93	64-86-93	22-33-39	21-28-29	6-11-12
			38-47	Sand, loamy sand, gravelly loamy sand, gravelly sand	SM, SP- SM	A-2-4, A-1-b	0-0-0	0-1-4	74-92-96	49-75-92	35-59-79	6-13-24	0-0 -18	NP-0-3

NOTES:

- (L-R-H): Three values are provided to identify the expected Low (L), Representative Value (R), and High (H) for each tested parameter.
- Unified Soil Classification System (USCS) soil classifications per American Society for Testing and Materials (ASTM), 2005, *Standard Classification of Soils for Engineering Purposes, ASTM Standard D2487-00*.
- American Association of State Highway and Transportation Officials (AASHTO) soil classifications per AASHTO, 2004, *Standard Specifications for Transportation Materials and Methods of Sampling and Testing, 24th edition*.

Engineering Properties Soil Reports
Excerpted from USDA Web Soil Survey Website (USDA, 2025)

Map unit symbol and soil name	Percent of map unit	Hydro-logic group	Depth (inches)	USDA texture	Classification		Percent Fragments		Percentage passing sieve number				Liquid Limit (L-R-H)	Plasticity Index (L-R-H)
					USCS	AASHTO	>10 inches (L-R-H)	3-10 inches (L-R-H)	4 (L-R-H)	10 (L-R-H)	40 (L-R-H)	200 (L-R-H)		
680—Lanfair- Hoppswell association														
Lanfair	65	A	0-2	Extremely gravelly sandy loam	GP-GC, SP-SC, GW-GC	A-1	0-8-12	0-8-12	25-40-55	10-18-25	5-10- 15	5- 8- 10	18-23-28	3-6-9
			2-9	Gravelly sandy loam, gravelly fine sandy loam	GC-GM, SC-SM	A-1, A-2, A-4	0-0-0	0-0-0	60-75-85	50-65-75	35-43-50	20-30-40	18-23-28	3-6-9
			9-15	Very gravelly sandy loam, very gravelly fine sandy loam	GC-GM, SC-SM	A-1, A-2	0-0-0	0-0-0	50-58-70	30-38-50	20-30-40	10-20-30	18-23-28	3-6-9
			15-60	Very gravelly coarse sand, very gravelly loamy coarse sand, extremely gravelly loamy coarse sand, extremely gravelly coarse sand	GP-GM, SP-SM, SW-SM, GP, SP	A-1	0-7-10	0-7-10	45-63-80	20-35-50	10-20-30	0-5-10	0-17-21	NP-2-4
Hoppswell	20	C	0-2	Extremely gravelly sandy loam	GP-GM, GW-GM, GM	A-1	0-5-8	0-8-12	20-28-35	10-18-25	10-15-20	5-10- 15	15-20-25	NP-3 -5
			2-15	Very gravelly sandy clay loam	GC, SC	A-2	0-0-0	0-0-0	45-53-65	25-38-50	15-28-40	10-20-30	30-35-40	10-15-20
			15-64	Stratified extremely gravelly coarse sand to very gravelly sandy loam	GP-GM, GM	A-1	0-0-5	0-0-5	35-40-50	20-25-35	10-15-20	5-10- 15	15-18-20	NP-3 -5

NOTES:

- (L-R-H): Three values are provided to identify the expected Low (L), Representative Value (R), and High (H) for each tested parameter.
- Unified Soil Classification System (USCS) soil classifications per American Society for Testing and Materials (ASTM), 2005, *Standard Classification of Soils for Engineering Purposes, ASTM Standard D2487-00*.
- American Association of State Highway and Transportation Officials (AASHTO) soil classifications per AASHTO, 2004, *Standard Specifications for Transportation Materials and Methods of Sampling and Testing, 24th edition.*

Engineering Properties Soil Reports
Excerpted from USDA Web Soil Survey Website (USDA, 2025)

Map unit symbol and soil name	Percent of map unit	Hydro-logic group	Depth (inches)	USDA texture	Classification		Percent Fragments		Percentage passing sieve number				Liquid Limit (L-R-H)	Plasticity Index (L-R-H)
					USCS	AASHTO	>10 inches (L-R-H)	3-10 inches (L-R-H)	4 (L-R-H)	10 (L-R-H)	40 (L-R-H)	200 (L-R-H)		
801—Nippeno-Newera association														
Nippeno	55	D	0-2	Very gravelly loam	GC-GM, GC	A-2	0-0-5	0- 8- 15	50-55-70	30-35-50	25-30-40	20-25-30	21-27-33	6-9 -13
			2-6	Very gravelly sandy clay loam	GC	A-2	0-0-0	0- 8- 15	40-48-55	30-38-45	25-33-40	15-25-35	32-41-47	13-21-25
			6-15	Gravel	GW	A-1-a	0-0-0	0-0-0	0-5-10	0-3-5	0-0-0	0-0-0	0-0-14	NP
			15-25	Bedrock	—	—	—	—	—	—	—	—	—	—
Newera	30	D	0-2	Extremely gravelly sandy loam	GP-GC, GW-GC, GP	A-2	0-0-5	0-0-5	23-32-35	8-17- 25	5-12-18	3-6-10	17-23-28	3-7 -10
			2-6	Very gravelly sandy clay loam	GC	A-2	0-0-5	0-0-5	30-45-55	20-35-50	15-30-45	10-20-30	29-38-46	12-19-25
			6-16	Bedrock	—	—	—	—	—	—	—	—	—	—

NOTES:

- (L-R-H): Three values are provided to identify the expected Low (L), Representative Value (R), and High (H) for each tested parameter.
- Unified Soil Classification System (USCS) soil classifications per American Society for Testing and Materials (ASTM), 2005, *Standard Classification of Soils for Engineering Purposes, ASTM Standard D2487-00*.
- American Association of State Highway and Transportation Officials (AASHTO) soil classifications per AASHTO, 2004, *Standard Specifications for Transportation Materials and Methods of Sampling and Testing, 24th edition.*

Engineering Properties Soil Reports
Excerpted from USDA Web Soil Survey Website (USDA, 2025)

Map unit symbol and soil name	Percent of map unit	Hydro-logic group	Depth (inches)	USDA texture	Classification		Percent Fragments		Percentage passing sieve number				Liquid Limit (L-R-H)	Plasticity Index (L-R-H)
					USCS	AASHTO	>10 inches (L-R-H)	3-10 inches (L-R-H)	4 (L-R-H)	10 (L-R-H)	40 (L-R-H)	200 (L-R-H)		
3420—Hartpeak- Highland association														
Hartpeak	50	D	0-2	Extremely cobbly loam	GC-GM, GC, GP-GC	A-2-4, A-1-a	0-3-5	28-29-33	27-38-39	10-29-36	8-25-32	6-18- 23	20-23-25	5-7 -9
			2-6	Very cobbly loam	GC-GM, SC	A-2-4, A-4, A-1-b	0-1-3	22-27-30	52-62-71	39-52-62	34-45-55	24-32-39	20-23-25	5-7 -9
			6-10	Very cobbly loam	GC	A-6, A-2-4	0-1-3	23-27-27	55-62-67	37-52-63	33-47-58	25-37-46	27-29-32	10-12-14
			10-15	Very cobbly clay loam	GC	A-2-6, A-7-6, A-6	0-1-6	25-27-28	55-62-68	40-52-64	36-48-60	29-39-49	36-39-42	19-20-22
			15-22	Very cobbly clay loam	GC	A-6, A-7-6, A-2-6	0- 1- 3	25-27-30	52-62-66	39-52-64	36-48-60	29-39-49	36-39-42	19-20-22
Highland	35	C	0-2	Extremely gravelly loam	GC-GM, GC, GP	A-2-4, A-1-a	0-0-0	0-2-7	34-39-44	6-20- 25	5-18- 22	4-13- 16	20-23-25	5-7 -9
			2-14	Very gravelly loam	GC, GC- GM	A-2-4, A-1-b	0-0-0	0-0-0	41-42-56	26-29-48	22-25-43	16-18-31	21-24-26	6-8 -9
			14-30	Very gravelly loam	GC	A-2-6, A-2-4	0-0-0	0-4-7	44-46-56	28-32-49	24-29-44	18-21-33	27-29-32	10-12-14
			30-49	Bedrock	—	—	—	—	—	—	—	—	—	—

NOTES:

- (L-R-H): Three values are provided to identify the expected Low (L), Representative Value (R), and High (H) for each tested parameter.
- Unified Soil Classification System (USCS) soil classifications per American Society for Testing and Materials (ASTM), 2005, *Standard Classification of Soils for Engineering Purposes, ASTM Standard D2487-00*.
- American Association of State Highway and Transportation Officials (AASHTO) soil classifications per AASHTO, 2004, *Standard Specifications for Transportation Materials and Methods of Sampling and Testing, 24th edition.*

Engineering Properties Soil Reports
Excerpted from USDA Web Soil Survey Website (USDA, 2025)

Map unit symbol and soil name	Percent of map unit	Hydro-logic group	Depth (inches)	USDA texture	Classification		Percent Fragments		Percentage passing sieve number				Liquid Limit (L-R-H)	Plasticity Index (L-R-H)
					USCS	AASHTO	>10 inches (L-R-H)	3-10 inches (L-R-H)	4 (L-R-H)	10 (L-R-H)	40 (L-R-H)	200 (L-R-H)		
4180—Peskah-Arizo association														
Peskah	50	B	0-1	Extremely gravelly fine sandy loam	GP-GC, GC, GP	A-1-a, A-2-4, A-2-6	0-3-5	0-5-10	18-20-33	13-16-29	11-14-28	4- 6- 13	19-24-28	4-8 -12
			1-4	Gravelly sandy loam, very gravelly fine sandy loam, gravelly fine sandy loam, very gravelly sandy loam	GC-GM, SC	A-1-a, A-2-4, A-6	0-0-3	0-0-3	50-76-82	37-70-77	26-53-65	14-32-42	19-26-29	4-10-12
			4-8	Gravelly sandy clay loam, gravelly sandy loam	SC	A-2-6, A-7-6	0-0-0	0-6-9	62-70-79	50-63-73	40-55-69	21-32-44	28-36-45	12-18-25
			8-15	Very gravelly sandy clay loam, very gravelly sandy loam	GW-GC, GC	A-2-6, A-2-7	0-0-0	0-0-3	41-53-58	29-48-53	23-42-50	12-24-32	28-36-44	12-18-25
			15-43	Stratified extremely gravelly coarse sand to very gravelly sandy loam	GP-GC, GP, GW	A-1-a, A-2-4	0-1-3	0-3-10	20-26-30	10-22-25	5-12-16	1-4-7	16-17-25	2-3-9
			43-60	Cemented material	—	—	—	—	—	—	—	—	—	—
Arizo	35	B	0-3	Very gravelly sandy loam	GC, GP, SC	A-1-a, A-2-4, A-6	0-1-5	0-3-20	30-51-77	7-40-77	5-32-67	3-20-46	0-21-29	NP-8-11
			3-9	Very gravelly sandy loam	GC, GP, SC	A-1-a, A-2-4, A-6	0-1-5	0-4-15	30-44-78	7-36-78	5-28-67	2-15- 41	0-22-29	NP-8-11
			9-38	Very gravelly loamy coarse sand	GP-GC, GP, SC	A-1-a, A-2-4	0-0-0	0-7-15	28-49-78	4-36-78	2-20-49	1-7-23	0-15-26	NP-5-9
			38-62	Extremely gravelly coarse sand	GP-GM, SC-SM, GP	A-1-a, A-2-4	0-0-0	0-8-31	27-38-78	5-30-78	4-20-56	1-5-18	0-0-22	NP-0-5

NOTES:

- (L-R-H): Three values are provided to identify the expected Low (L), Representative Value (R), and High (H) for each tested parameter.
- Unified Soil Classification System (USCS) soil classifications per American Society for Testing and Materials (ASTM), 2005, *Standard Classification of Soils for Engineering Purposes, ASTM Standard D2487-00*.
- American Association of State Highway and Transportation Officials (AASHTO) soil classifications per AASHTO, 2004, *Standard Specifications for Transportation Materials and Methods of Sampling and Testing, 24th edition.*

Engineering Properties Soil Reports
Excerpted from USDA Web Soil Survey Website (USDA, 2025)

Map unit symbol and soil name	Percent of map unit	Hydro-logic group	Depth (inches)	USDA texture	Classification		Percent Fragments		Percentage passing sieve number				Liquid Limit (L-R-H)	Plasticity Index (L-R-H)
					USCS	AASHTO	>10 inches (L-R-H)	3-10 inches (L-R-H)	4 (L-R-H)	10 (L-R-H)	40 (L-R-H)	200 (L-R-H)		
4220—Minehart gravelly fine sandy loam														
Minehart	85	C	0-3	Gravelly fine sandy loam	SC-SM, SC, SM	A-4, A-1-b	0-0-4	0-1-4	71-84-95	50-76-92	42-66-82	23-37-48	18-21-28	3-5 -10
			3-8	Sandy clay loam, gravelly loam, gravelly sandy clay loam, loam	SC, CL, SC-SM	A-4, A-6, A-2-4	0-0-4	0-4-4	78-79-95	56-57-92	44-50-84	27-36-63	23-26-39	6-8 -19
			8-13	Gravelly loam, loam, sandy clay loam, gravelly sandy clay loam	SC, CL, SC-SM	A-4, A-6, A-2-4	0-0-4	0-0-4	79-85-95	58-77-92	45-68-84	27-48-63	23-26-39	6-8 -19
			13-20	Clay, gravelly clay, clay loam, gravelly clay loam	CL, CH, SC	A-7-6, A-6	0-0-4	0-0-4	78-84-95	56-76-91	51-71-90	42-60-79	37-45-56	16-23-32
			20-39	Extremely gravelly coarse sandy loam, very gravelly coarse sandy loam, extremely gravelly sandy loam, very gravelly sandy loam	GW-GC, SC, GP	A-2-4, A-2-6, A-1-a	0-0-3	0-5-7	45-45-67	16-27-53	9-15-34	4-8-18	18-25-30	3-8-11
			39-79	Extremely gravelly sandy loam, very gravelly coarse sandy loam, very gravelly sandy loam, extremely gravelly coarse sandy loam	GW-GC, SC, GP	A-2-4, A-2-6, A-1-a	0-0-3	0-5-7	47-51-67	16-27-53	9-15-34	4-8-18	18-25-30	3-8-11

NOTES:
- (L-R-H): Three values are provided to identify the expected Low (L), Representative Value (R), and High (H) for each tested parameter.
- Unified Soil Classification System (USCS) soil classifications per American Society for Testing and Materials (ASTM), 2005, *Standard Classification of Soils for Engineering Purposes, ASTM Standard D2487-00*.
- American Association of State Highway and Transportation Officials (AASHTO) soil classifications per AASHTO, 2004, *Standard Specifications for Transportation Materials and Methods of Sampling and Testing, 24th edition.*

Engineering Properties Soil Reports
Excerpted from USDA Web Soil Survey Website (USDA, 2025)

Map unit symbol and soil name	Percent of map unit	Hydro-logic group	Depth (inches)	USDA texture	Classification		Percent Fragments		Percentage passing sieve number				Liquid Limit (L-R-H)	Plasticity Index (L-R-H)
					USCS	AASHTO	>10 inches (L-R-H)	3-10 inches (L-R-H)	4 (L-R-H)	10 (L-R-H)	40 (L-R-H)	200 (L-R-H)		
4230—Hoppswell- Ustidur association														
Hoppswell	55	C	0-4	Extremely gravelly sandy loam	GP-GC, GC, GW	A-2-4, A-1-a	0-3-5	0-5-8	18-27-35	8-17- 26	6-13- 22	3- 7- 13	19-23-26	4-7 -9
			4-18	Very gravelly sandy clay loam	GC, SC, GP-GC	A-2-6, A-2-7	0-0-0	0-0-0	46-53-65	25-37-49	20-32-48	10-18-29	30-35-41	13-17-21
			18-79	Stratified extremely gravelly coarse sand to very gravelly sandy loam	GW-GC, GP-GC, GW	A-1-a, A-2-4	0-0-3	0-0-3	35-42-51	19-27-37	14-22-31	4- 7- 12	0-19 -23	NP-6 -7
Ustidur	30	D	0-2	Extremely gravelly sandy loam	GP-GC, GW	A-2-4, A-2-6, A-1-a	0-1-3	0-5-7	15-23-31	9-17- 26	6-13- 22	3- 7- 13	20-25-30	4-8-12
			2-6	Extremely gravelly sandy loam, very gravelly sandy loam	GC	A-2-4, A-2-6, A-1-a	0-0-3	0-0-11	40-42-58	30-37-54	21-29-45	9-15-26	20-25-30	4-8-12
			6-19	Very gravelly sandy loam, extremely gravelly sandy loam	GP-GC, GC, GW	A-2-4, A-2-6, A-1-a	0-2-3	0-5-10	13-26-45	7-21-41	5-16-35	2-8-20	20-25-30	4-8-12
			19-38	Cemented material	—	—	—	—	—	—	—	—	—	—
			38-60	Extremely gravelly sandy loam, extremely gravelly loamy sand	GW-GC, GP-GC, GW	A-1-a, A-2-4	0-0-3	0-5-10	19-30-36	8-19-26	5-14-22	2-7-12	15-19-23	1-4-7

NOTES:

- (L-R-H): Three values are provided to identify the expected Low (L), Representative Value (R), and High (H) for each tested parameter.
- Unified Soil Classification System (USCS) soil classifications per American Society for Testing and Materials (ASTM), 2005, *Standard Classification of Soils for Engineering Purposes, ASTM Standard D2487-00*.
- American Association of State Highway and Transportation Officials (AASHTO) soil classifications per AASHTO, 2004, *Standard Specifications for Transportation Materials and Methods of Sampling and Testing, 24th edition.*

EIR APPENDIX 3

Air Quality Conformity Review (MDAQMD 2025)

October 8, 2025

Ron Nuckles, Field Manager
BLM Needles Field Office
1303 S. Highway 95
Needles, CA 92363

Re: Castle Mountain Mine Phase II Expansion
3809(P)
2800
LLCAD09000/NVS01000
Company#/Facility#: 2502/3896

Dear Ron Nuckles:

The Mojave Desert Air Quality Management District (District) has determined that the Castle Mountain Mine Phase II Expansion is a general federal action requiring conformity with applicable implementation plans under District Rule 2002 – *General Federal Actions Conformity*. As a result, the District is hereby accepting your invitation to become a cooperating agency on this project, to address general conformity and act as an expert agency on air quality for environmental review purposes (the District is available to review air quality elements of applicable environmental documents). The District implements Federal New Source Review (NSR), Reasonably Available Control Technology (RACT), and Reasonable Available Control Measures (RACM) through local District rules and the District permitting, inspection and compliance program. The District is the local state air agency with jurisdiction over the project by California Health & Safety Code §41200 - 41267, and is the delegated agency for many applicable elements through the California State Implementation Plan. I am the District representative, and Chris Anderson (Planning & Air Monitoring Supervisor, x1846) is my backup.

The District has reviewed the proposed project[1] for general conformity as required by District Rule 2002, including maximum future activity and emission rates, air dispersion modeling[2] evaluating maximum project fenceline concentrations for compliance with applicable ambient standards (model inputs, approach, and results). The District concurs with the emissions inventory calculation method and results. The proposed action has been analyzed under MDAQMD Rule 2002(H) and (I); the District finds that areawide and local air quality modeling of proposed emissions demonstrates that the action conforms to the applicable State

[1] Ramboll, *Castle Mountain Mine 2022 Plan Amendment Technical Support Document for Air Quality, Climate and Energy Analyses Rev.2.2*, October 2025
[2] Ramboll, *Air Dispersion Modeling and Analyses Protocol for NEPA and CEQA Review Castle Mountain Mine Proposed 2022 Mine Plan of Operations*, August 2024

Implementation Plan (SIP) and would not cause or contribute to any new violation of any air quality standard in any area, or increase the frequency or severity of any existing violation of any standard in any area. Below is a summary of the potential total emissions for the proposed project (broken down by stationary (covered by an MDAQMD permit) and fugitive (not required to be permitted by MDAQMD), the maximum potential increase from existing to proposed Phase II, and worst case (maximum from north or south operations scenario) maximum modeled impact for the project. These values are presented in Tables O-1 (criteria), O-2 (lead), 3 (criteria increase) and either 3-1, 3-2 or 3-3 (for maximum modeled impact) in the latest project TSD.

Castle Mountain Mine Phase II (worst case)					
	Proposed Project			**Phase II**	**Maximum**
	Stationary	Fugitive	Total	**Increase**	**Modeled Impact**
	(tons per year)				(µg/m3)
Carbon monoxide (CO)	*42*	*870*	912	**663**	3168
Lead (Pb)	*0.001*	*0.01*	0.011	**0.0076**	negligible
Nitrogen Oxides (NOx)	*18.9*	*552*	571	**408**	109.6
Particulate Matter (PM10)	*9.62*	*257*	267	**190**	34.4
Particulate Matter (TSP)	*~9.62*	*~257*	~267	**~190**	n/a
Particulate Matter (PM2.5)	*4.32*	*34*	38	**27**	2.6
Ozone (O3)	n/a				
Sulfur Dioxide (SO2)	*0.2868*	*1.01*	1.3	**0.82**	0.5
Volatile Organic Compounds (VOC)	*4.92*	*30*	35	**25**	n/a

If you have any questions regarding this conformity finding and letter, please contact me at (760) 245-1661, extension 6726.

Sincerely,

Alan J. De Salvio
Deputy Air Pollution Control Officer

cc: Frank Giles, BLM California State Office
Caroline Kaufman, Project Manager
Chris Anderson, MDAQMD

CMM Phase II Conformity oct25

EIR APPENDIX 4

Technical Support Document for Air Quality, Climate, and Energy Analyses (Ramboll 2025)

Prepared for:
Castle Mountain Venture (Equinox Gold Corp)

Prepared By:
Ramboll Americas Engineering Solutions, Inc

Date:

October 2025

Revision:

Rev.2.2

CASTLE MOUNTAIN MINE 2022 PLAN AMENDMENT

TECHNICAL SUPPORT DOCUMENT FOR AIR QUALITY, CLIMATE, AND ENERGY ANALYSES

RAMBOLL

CONTENTS

1.	**INTRODUCTION**	**1**
1.1	Project Description	1
2.	**EMISSIONS INVENTORY**	**2**
2.1	Operational Emissions	2
2.1.1	Proposed 2022 Mine Plan of Operations	2
2.1.2	Approved Operations	3
2.1.3	Methodology	4
2.1.4	Emission Estimates	8
2.2	Construction Emissions	9
2.2.1	Methodology	9
2.2.2	Emission Estimates	11
3.	**NEARFIELD MODELING ANALYSIS**	**11**
3.1	Modeling Methodology	11
3.1.1	Conservatisms in Analysis	11
3.2	Meteorological Data	12
3.3	Background Concentrations	12
3.4	Source Characterization and Scenarios	13
3.5	Summary of NAAQS Impact Assessment Results	13
3.6	Summary of CAAQS Impact Assessment Results (for CEQA)	14
3.7	Ozone and Secondary $PM_{2.5}$ Impact Assessment	16
4.	**AIR QUALITY RELATED VALUES (AQRV) ANALYSIS**	**18**
5.	**SENSITIVE RECEPTOR AND HEALTH RISK DISCUSSION**	**19**
6.	**CLIMATE ANALYSIS**	**23**
6.1	CEQA Significance Criteria	23
6.2	GHG Year-by-Year Inventory	24
6.3	Greenhouse Gas Impact Analysis	29
6.3.1	GHG Equivalencies	30
6.4	Climate Indicators	30
6.4.1	Observed Climate Trends	31
6.4.2	Projected Climate Trends	32
6.4.3	Downscaling	33
6.5	Combined GHG Impacts	35
6.5.1	Baseline Greenhouse Gases Emissions	35
6.5.2	Greenhouse Gases Emissions from Stationary Large Emitters	35
6.5.3	County-level Sources Other Than Stationary Sources	36
6.5.4	Total Combined GHG Emissions	37
7.	**ENERGY ANALYSIS**	**38**
7.1	Applicable Thresholds and Methodology Overview	38
7.2	Energy Used During Project Construction	39

7.3 Energy Used During Project Operation 39
7.4 Analysis of Factors Identified in CEQA Guidelines Appendix F 40
7.4.1 Appendix F.II.C.1: Energy Requirements and Energy Use Efficiencies 40
7.4.2 Appendix F.II.C.2: Local and Regional Energy Supplies 41
7.4.3 Appendix F.II.C.3: Peak and Base Period Demands 44
7.4.4 Appendix F.II.C.4: Existing Energy Standards 45
7.4.5 Appendix F.II.C.5: Energy Resources 45
7.4.6 Appendix F.II.C.6: Transportation Energy Use 45
7.4.7 Summary of Energy Impact Analysis Based on Appendix F Guidelines 46
7.5 Consistency with Energy Plans 46

TABLES (ATTACHED)

Operational Emissions Inventory, Summary Tables

Table 1: 2022 Plan, Proposed Air Contaminant Total Emissions – Including 1998 Plan Approved Emissions
Table 2: 1998 Plan, Approved Air Contaminant Emissions
Table 3: 2022 Plan, Proposed Air Contaminant Emissions – Excluding 1998 Plan Approved Emissions
Table 4: Comparison of 1997 EIR/EIS Approved Emissions and 2022 Plan Total Emissions

Operational Emissions Inventory: Proposed 2022 Mine Plan of Operations, Detailed Tables

Table O-1: Proposed 2022 Mine Plan of Operations: Criteria Air Pollutant and Greenhouse Gas Emissions Summary
Table O-2: Proposed 2022 Mine Plan of Operations: Toxic Air Contaminant and Hazardous Air Pollutant Emissions Summary, On-Site Sources
Table O-3: Proposed 2022 Mine Plan of Operations: Material Transfer Emissions, Criteria Air Pollutants
Table O-4: Proposed 2022 Mine Plan of Operations: Refinery Mercury Emissions
Table O-5a: Proposed 2022 Mine Plan of Operations: Acid Tank Evaporative Emissions
Table O-5b: Proposed 2022 Mine Plan of Operations: Heap Leach and Process Tank HCN Emissions
Table O-6: Proposed 2022 Mine Plan of Operations: Crushing Emissions
Table O-7: Proposed 2022 Mine Plan of Operations: Screening Emissions
Table O-8: Proposed 2022 Mine Plan of Operations: On-site Mobile Fugitive Dust Emissions, Unpaved Road Travel
Table O-9: Proposed 2022 Mine Plan of Operations: On-site Mobile Fugitive Dust Emissions, Dozing/Scraping/Grading and Similar Activity
Table O-10: Proposed 2022 Mine Plan of Operations: On-site Mobile Vehicles, Exhaust Emission Factors
Table O-11: Proposed 2022 Mine Plan of Operations: On-site Mobile Vehicles, CAP Exhaust Emissions
Table O-12: Proposed 2022 Mine Plan of Operations: On-site Mobile Vehicles, GHG Exhaust Emissions
Table O-13a: Proposed 2022 Mine Plan of Operations: Off-site On-Road Mobile Vehicles, Trip Rates
Table O-13b: Proposed 2022 Mine Plan of Operations: On-site On-Road Mobile Vehicles, Trip Rates

Table O-14a: Proposed 2022 Mine Plan of Operations: Off-site On-Road Mobile Vehicles, Fleet Mix Distribution

Table O-14b: Proposed 2022 Mine Plan of Operations: On-site On-Road Mobile Vehicles, Fleet Mix Distribution

Table O-15a: Proposed 2022 Mine Plan of Operations: Off-site On-Road Mobile Vehicles, Exhaust and Brake Wear/Tire Wear Emission Factors

Table O-15b: Proposed 2022 Mine Plan of Operations: On-site On-Road Mobile Vehicles, Exhaust and Brake Wear/Tire Wear Emission Factors

Table O-16a: Proposed 2022 Mine Plan of Operations: Off-site On-Road Mobile Vehicles, Exhaust and Brake Wear/Tire Wear Emissions

Table O-16b: Proposed 2022 Mine Plan of Operations: On-site On-Road Mobile Vehicles, Exhaust and Brake Wear/Tire Wear Emissions

Table O-17a: Proposed 2022 Mine Plan of Operations: Off-site On-Road Mobile Vehicles, Fugitive Dust Emissions - Paved Roads

Table O-17b: Proposed 2022 Mine Plan of Operations: Off-site On-Road Mobile Vehicles, Fugitive Dust Emissions - Unpaved Roads

Table O-18: Proposed 2022 Mine Plan of Operations: Watering Assumptions for Disturbed Operational Areas

Table O-19: Proposed 2022 Mine Plan of Operations: Disturbed Operational Area Emissions, Wind Erosion

Table O-20: Proposed 2022 Mine Plan of Operations: Stockpile Wind Erosion Emissions

Table O-21: Proposed 2022 Mine Plan of Operations: Fugitive Blast Hole Drilling Emissions

Table O-22: Proposed 2022 Mine Plan of Operations: Fugitive Dust Entrainment from Blasting Emissions

Table O-23: Proposed 2022 Mine Plan of Operations: Emissions from Blasting Explosives

Table O-24a: Proposed 2022 Mine Plan of Operations: Toxic Air Contaminant and Hazardous Air Pollutant Emissions (On-Site Dust Emissions from Fugitive and Stationary Points)

Table O-24b: Proposed 2022 Mine Plan of Operations: Toxic Air Contaminant and Hazardous Air Pollutant Emissions (On-Site Mobile Exhaust)

Table O-25: Proposed 2022 Mine Plan of Operations: Diesel Generators, Criteria Air Pollutants and Greenhouse Gases

Table O-26: Proposed 2022 Mine Plan of Operations: Diesel Generators, Toxic Air Contaminants and Hazardous Air Pollutants

Table O-27: Proposed 2022 Mine Plan of Operations: Gasoline Dispensing Facility Emissions

Table O-28a: Proposed 2022 Mine Plan of Operations: Storage Tank Emissions

Table O-28b: Proposed 2022 Mine Plan of Operations: GHG Emissions from LNG Storage

Table O-29: Proposed 2022 Mine Plan of Operations: GHG Emissions from Electricity Usage

Table O-30: Proposed 2022 Mine Plan of Operations: GHG Emissions from Solid Waste Generation

Table O-31: Proposed 2022 Mine Plan of Operations: GHG Emissions from Wastewater Treatment

Table O-32: Proposed 2022 Mine Plan of Operations: On-site Power Generation Emissions from NG Turbines, Criteria Air Pollutants and Greenhouse Gases

Table O-33: Proposed 2022 Mine Plan of Operations: On-site Power Generation Emissions from NG Turbines, Toxic Air Contaminants and Hazardous Air Pollutants

Operational Emissions Inventory: Approved Operations, Detailed Tables

Table OA-1: Approved Operations: Criteria Air Pollutant and Greenhouse Gas Emissions Summary
Table OA-2: Approved Operations: Toxic Air Contaminant and Hazardous Air Pollutant Emissions Summary, On-Site Sources
Table OA-3: Approved Operations: Material Transfer Emissions, Criteria Air Pollutants
Table OA-4: Approved Operations: Refinery Mercury Emissions
Table OA-5a: Approved Operations: Acid Tank Evaporative Emissions
Table OA-5b: Approved Operations: Heap Leach and Process Tank HCN Emissions
Table OA-6: Approved Operations: Crushing Emissions
Table OA-7: Approved Operations: Screening Emissions
Table OA-8: Approved Operations: On-site Mobile Fugitive Dust Emissions, Unpaved Road Travel
Table OA-9: Approved Operations: On-site Mobile Fugitive Dust Emissions, Dozing/Scraping/Grading and Similar Activity
Table OA-10: Approved Operations: On-site Mobile Vehicles, Exhaust Emission Factors
Table OA-11: Approved Operations: On-site Mobile Vehicles, CAP Exhaust Emissions
Table OA-12: Approved Operations: On-site Mobile Vehicles, GHG Exhaust Emissions
Table OA-13a: Approved Operations: Off-site On-Road Mobile Vehicles, Trip Rates
Table OA-13b: Approved Operations: On-site On-Road Mobile Vehicles, Trip Rates
Table OA-14a: Approved Operations: Off-site On-Road Mobile Vehicles, Fleet Mix Distribution
Table OA-14b: Approved Operations: On-site On-Road Mobile Vehicles, Fleet Mix Distribution
Table OA-15a: Approved Operations: Off-site On-Road Mobile Vehicles, Exhaust and Brake Wear/Tire Wear Emission Factors
Table OA-15b: Approved Operations: On-site On-Road Mobile Vehicles, Exhaust and Brake Wear/Tire Wear Emission Factors
Table OA-16a: Approved Operations: Off-site On-Road Mobile Vehicles, Exhaust and Brake Wear/Tire Wear Emissions
Table OA-16b: Approved Operations: On-site On-Road Mobile Vehicles, Exhaust and Brake Wear/Tire Wear Emissions
Table OA-17a: Approved Operations: Off-site On-Road Mobile Vehicles, Fugitive Dust Emissions - Paved Roads
Table OA-17b: Approved Operations: Off-site On-Road Mobile Vehicles, Fugitive Dust Emissions - Unpaved Roads
Table OA-18: Approved Operations: Watering Assumptions for Disturbed Operational Areas
Table OA-19: Approved Operations: Disturbed Operational Area Emissions, Wind Erosion
Table OA-20: Approved Operations: Stockpile Wind Erosion Emissions
Table OA-21: Approved Operations: Fugitive Blast Hole Drilling Emissions
Table OA-22: Approved Operations: Fugitive Dust Entrainment from Blasting Emissions
Table OA-23: Approved Operations: Emissions from Blasting Explosives
Table OA-24a: Approved Operations: Toxic Air Contaminant and Hazardous Air Pollutant Emissions (On-Site Dust Emissions from Fugitive and Stationary Points)

Table O-24b: Approved Operations: Toxic Air Contaminant and Hazardous Air Pollutant Emissions (On-Site Mobile Exhaust)
Table OA-25: Approved Operations: Diesel Generators, Criteria Air Pollutants and Greenhouse Gases
Table OA-26: Approved Operations: Diesel Generators, Toxic Air Contaminants and Hazardous Air Pollutants
Table OA-27: Approved Operations: Gasoline Dispensing Facility Emissions
Table OA-28: Approved Operations: Storage Tank Emissions
Table OA-29: Approved Operations: GHG Emissions from Electricity Usage
Table OA-30: Approved Operations: GHG Emissions from Solid Waste Generation
Table OA-31: Approved Operations: GHG Emissions from Wastewater Treatment
Table OA-32: Approved Operations: On-site Power Generation Emissions from Diesel Generators, Criteria Air Pollutants and Greenhouse Gases
Table OA-33: Approved Operations: On-site Power Generation Emissions from Diesel Generators, Toxic Air Contaminants and Hazardous Air Pollutants

Construction Emissions Inventory, Summary Tables

Table C-1: Construction Emissions Summary, CAP Emissions
Table C-2: Construction Emissions Summary, GHG Emissions

Construction Emissions Inventory, Detailed Tables

Table C-3: Fugitive Dust Emissions from Bulldozing, Scraping and Grading Activity, Offroad Construction Equipment
Table C-4: Fugitive Dust Emissions from Offroad Trucks, Unpaved Roads
Table C-5: Offroad Equipment, Exhaust CAP Emissions
Table C-6: Offroad Equipment, Exhaust GHG Emissions
Table C-7: Watering Assumptions for Disturbed Construction Areas, Construction Vehicles
Table C-8: Construction Mobile Vehicle Fleet Mix, On-road Vehicles
Table C-9: On-road Mobile Vehicles, Exhaust Emission Factors
Table C-10: On-road Mobile Vehicles, Trip Rates
Table C-11: On-road Mobile Vehicles, Exhaust CAP Emissions
Table C-12: On-road Mobile Vehicles, Exhaust GHG Emissions
Table C-13: Fugitive Dust Emissions from On-road Mobile Vehicles, Paved Roads
Table C-14: Fugitive Dust Emissions from On-road Mobile Vehicles, Unpaved Roads
Table C-15: Disturbed Construction Area Emissions, Wind Erosion

Climate Analysis, GHG Inventory Tables

Table GHG-1: Greenhouse Gas Emissions Summary by Species
Table GHG-2: Construction GHG Emissions, On-Site Mobile Equipment Exhaust Emissions
Table GHG-3: Construction GHG Emissions, Off-Site Mobile Vehicle Trip Rates
Table GHG-4: Construction GHG Emissions, Off-Site Mobile Vehicle Exhaust Emission Factors

Table GHG-5: Construction GHG Emissions, Off-Site Mobile Vehicles Exhaust Emissions

Table GHG-6: 2022 Mine Plan of Operations: Operational GHG Emissions, On-site Mobile Vehicle Annual Fuel Usage

Table GHG-7a: 2022 Mine Plan of Operations: Operational GHG Emissions, On-site Mobile Vehicle Exhaust CO_2 Emissions

Table GHG-7b: 2022 Mine Plan of Operations: Operational GHG Emissions, On-site Mobile Vehicle Exhaust CH_4 Emissions

Table GHG-7c: 2022 Mine Plan of Operations: Operational GHG Emissions, On-site Mobile Vehicle Exhaust N_2O Emissions

Table GHG-8a: 2022 Mine Plan of Operations: Operational GHG Emissions, Off-site On-Road Mobile Vehicles, Trip Rates

Table GHG-8b: 2022 Mine Plan of Operations: Operational GHG Emissions, On-site On-Road Mobile Vehicles, Trip Rates

Table GHG-9a: 2022 Mine Plan of Operations: Operational GHG Emissions, Off-site On-Road Mobile Vehicles, Exhaust Emission Factors

Table GHG-9b: 2022 Mine Plan of Operations: Operational GHG Emissions, On-site On-Road Mobile Vehicles, Exhaust Emission Factors

Table GHG-10a: 2022 Mine Plan of Operations: Operational GHG Emissions, Off-Site On-Road Mobile Vehicles, Exhaust Emissions

Table GHG-10b: 2022 Mine Plan of Operations: Operational GHG Emissions, On-Site On-Road Mobile Vehicles, Exhaust Emissions

Table GHG-11: 2022 Mine Plan of Operations: Operational GHG Emissions, Blasting Explosives Emissions

Table GHG-12: 2022 Mine Plan of Operations: Operational GHG Emissions, Diesel Generator Emissions

Table GHG-13: 2022 Mine Plan of Operations: Operational GHG Emissions, Electricity Usage Emissions

Table GHG-14: 2022 Mine Plan of Operations: Operational GHG Emissions, Solid Waste Generation Emissions

Table GHG-15: 2022 Mine Plan of Operations: Operational GHG Emissions, Wastewater Treatment Emissions

Table GHG-16: 2022 Mine Plan of Operations: Operational GHG Emissions, On-site Power Generation Emissions from NGTurbines

Table GHG-17: 2022 Mine Plan of Operations: Operational GHG Emissions, LNG Storage Emissions

Energy Analysis, Summary and Detailed Tables

Table E-1: Summary of Construction Energy Consumption

Table E-2: Estimated Energy Consumption by Off-Road Construction Equipment

Table E-3: Estimated Energy Consumption by On-Road Construction Vehicles

Table E-4: 2022 Mine Plan of Operations: Summary of Operational Energy Consumption

Table E-5: 2022 Mine Plan of Operations: Estimated Energy Consumption by Off-Road Operational Equipment

Table E-6: 2022 Mine Plan of Operations: Estimated Energy Consumption by Off-site On-Road Operational Vehicles

Table E-7: 2022 Mine Plan of Operations: Estimated Energy Consumption by On-site On-Road Operational Vehicles

FIGURES

Figure 1: Nearest Receptors

ATTACHMENTS

Attachment A: Modeling Report

ACRONYMS AND ABBREVIATIONS

AB:	Assembly Bill
API:	American Petroleum Institute
AQRV:	Air Quality Related Value
ATCM:	Air Toxics Control Measure
BAAQMD:	Bay Area Air Quality Management District
BAPC:	Bureau of Air Pollution Control
BLM:	Bureau of Land Management
°C:	Degrees Celsius
CAA:	Clean Air Act
CAAQS:	California Ambient Air Quality Standards
CalARP:	California Accidental Release Prevention
CAP:	Criteria air pollutant
CAPCOA:	California Air Pollution Control Officers Association
CARB:	California Air Resources Board
CEC:	California Energy Commission
CEI:	Comprehensive Emissions Inventory
CEIP:	Comprehensive Emissions Inventory Plan
CEIR:	Comprehensive Emissions Inventory Report
CEQ:	Council on Environmental Quality
CEQA:	California Environmental Quality Act
CH_4:	Methane
CI:	Compression ignition
CMM:	Castle Mountain Mine
CMV:	Castle Mountain Venture
CNG:	Compressed natural gas
CO:	Carbon monoxide
CO_2:	Carbon dioxide
CO_2e:	Carbon dioxide equivalent
CTR:	Criteria Pollutant and Toxics Emissions Reporting
DPM:	Diesel particulate matter
DOI:	Department of Interior

EI:	Emissions inventory
EICG:	Emissions Inventory Criteria and Guidelines
EO:	Executive Order
EPCRA:	Emergency Planning and Community Right-to-Know Act
°F:	Degrees Fahrenheit
FLAG:	Federal Land Managers' Air Quality Related Values Work Group
FLIGHT:	Facility Level Information on Greenhouse Gases
GCM:	Global Climate Model
GHG:	Greenhouse gas
GHGRP:	Greenhouse Gas Emissions Reduction Plan
GWPs:	Global Warming Potentials
HAP:	Hazardous Air Pollutant
HC:	Hydrocarbon
IPCC:	Intergovernmental Panel on Climate Change
IRP:	Integrated Resource Plan
ISO:	Independent System Operation
km:	Kilometer
kW:	Kilowatt
lb	Pound
LCFS:	Low Carbon Fuel Standard
LNG:	Liquified natural gas
MDAQMD:	Mojave Desert Air Quality Management District
MERPs:	Modeled Emission Rates for Precursors
MMBTU:	Million British Thermal Units
MMT:	Million metric tons
MT:	Metric tons
MW:	Megawatt
MWh:	Megawatt hour
NAAQS:	National Ambient Air Quality Standards
NG:	Natural gas
NEI:	National Emissions Inventory
NEPA:	National Environmental Policy Act
NDEP:	Nevada Division of Environmental Protection

NMHC:	Nonmethane hydrocarbon
N_2O:	Nitrous oxide
NO_2:	Nitrogen dioxide
NO_x:	Nitrogen oxides
NV Energy:	Nevada Energy
OEHHA:	Office of Environmental Health Hazard Assessment
OPR:	Office of Planning and Research
$PM_{2.5}$:	Particulate Matter Less Than or Equal to 2.5 Microns in Diameter
PM_{10}:	Particulate Matter Less Than or Equal to 10 Microns in Diameter
ppb:	Parts per billion
Q:	Annualized emissions in tons per year
RCP:	Representative Concentration Pathway
RMP:	Risk Management Plan
RNG:	Renewable natural gas
SAF:	State Alternative Fuels
SB:	Senate Bill
SBC:	San Bernardino County
SCAQMD:	South Coast Air Quality Management District
SCE:	Southern California Edison
SIL:	Significant Impact Level
SO_2:	Sulfur dioxide
TAC:	Toxic air contaminant
TMT:	Thousand metric tons
T-NSR:	Toxic New Source Review
tpy:	Tons per year
TRI:	Toxic Release Inventory
U.S.:	United States
USEPA:	United States Environmental Protection Agency
USGCRP:	United States Global Change Research Program
USGS:	United States Geological Survey
VMT:	Vehicle miles traveled
VOC:	Volatile organic compound
$\mu g/m^3$:	Microgram per cubic meter

1. INTRODUCTION

To support the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) environmental review, Ramboll, on behalf of Castle Mountain Mine (CMM), has performed select air quality, climate, and energy technical assessments, as detailed in this document.

1.1 Project Description

The Castle Mountain Mine is an open pit gold mine located in the Mojave Desert of eastern San Bernardino County, California. The elevation at CMM ranges from 4,100 to 5,100 feet above mean sea level. The proposed 2022 Mine Plan of Operations ("2022 Plan" or "Project") is an amendment proposing changes to the authorized plan currently in effect at CMM.[1] The 2022 Plan proposes a continuation of mining at gold mineral ore zones including extensions of approved pit boundaries and increased mining rates. The 2022 Plan does not propose to increase the current site boundary of 3,910 acres.

The United States Bureau of Land Management (BLM) and San Bernardino County (SBC) are serving as the lead agencies in the review of the Mining Extension and Amendment to the Mine Plan of Operation and Reclamation Plan prepared for CMM, operated by Equinox Gold through their wholly owned subsidiary, Castle Mountain Venture (CMV).

[1] This 2022 Plan amendment is a continuation of the original approved 1990 Plan and the 1998 Plan approved as Ver 2.0 of the 1990 Plan and includes other minor plan modifications made since the original 1990 Plan, including the 2018 Plan Update, approved as Ver 2.1. This 2022 Plan amendment will be referenced as Ver 2.2.

2. EMISSIONS INVENTORY

An emissions inventory (EI) was prepared for the proposed 2022 Mine Plan of Operations, including the subset of emissions associated with currently approved operations. The scope of emissions evaluated includes direct and indirect emission sources including on-site stationary sources, on-site mobile sources, on-site fugitive dust sources, on-site blasting sources, off-site mobile exhaust, off-site fugitive dust, and indirect greenhouse gas (GHG) emissions from electricity usage, solid waste generation, and wastewater generation.

Emissions during a maximum operational year as well as during construction were quantified, as discussed in further detail below.

2.1 Operational Emissions

Criteria air pollutant (CAP), toxic air contaminant (TAC),[2] and GHG emissions were quantified for a peak year of mine operation.

2.1.1 Proposed 2022 Mine Plan of Operations

Activity and design information for the proposed 2022 Mine Plan of Operations, including the portion of activity that is currently approved, was provided by CMV and design engineering teams. Process flow diagrams were utilized to identify material streams; material transfer points; scrubber, baghouse, and bin vent controls; and process and storage tank operations. Detailed mining schedules, hauling routes, and equipment selection were utilized to derive annual and daily activity data from various mining operations including off-road equipment, hauling, blasting, and area disturbance. Activity data for supporting operations such as delivery vehicles and employee transportation were provided by CMV and design engineering teams and utilize conservative assumptions of trip origins.

To conservatively capture variations in year-to-year operations and to present a potential peak year of operation, maximum annual activity data was selected from each activity type, regardless of overlapping year. For example, maximum hauling operations utilized in the inventory and maximum equipment counts utilized in the inventory are projected to occur in different years but are conservatively used together in this inventory development.

Maximum annual operations evaluated account for up to 19.2 million tons of ore processed and up to 60.6 million tons of overburden material mined, which include the portions of ore and overburden processing that are currently approved (6.25 million tons annually and 16.3 million tons annually, respectively). Power demands assume up to a 20 megawatt (MW) on-site load[3] plus a 1,314 kilowatt (kW) off-site pump station in Nipton, California. The on-site load is assumed to be met with 10 MW of energy generated on-site using natural gas (NG) turbines[4] and 10 MW of grid power provided by Nevada Energy (NV Energy). In addition, 1,314 kW of grid power provided by Southern California Edison (SCE) would be utilized for an off-site water pump station. The inventory developed accounts

[2] TACs are currently presented for on-site emission sources only. TAC emissions include hazardous air pollutant (HAP) emissions.

[3] Hourly/start-up electricity loads for on-site facilities may potentially be up to 25 MW, but 20 MW is anticipated on an annual/regular basis.

[4] The current proposed turbine configuration would consist of microturbines, packaged into 1 MW units, which each consist of five 200 kW engine bays. Throughout this document and supporting tables these units are simply referred to as "turbines".

for the following commitments to clean technology and control options: on-site diesel off-road units, including emergency generators, are assumed to meet Tier 4 Final emission standards, consistent with equipment currently operating at the site, and will use 100% renewable diesel fuel (when available from suppliers), consistent with regulatory requirements under the California Air Resources Board (CARB) In-Use Off-Road Diesel-Fueled Fleets Regulation and CMV commitments; haul roads are controlled with watering, graveling surface, treatment with chemical stabilizers, and speed control; watering is used for fugitive dust control from disturbed areas; and watering, bin vent, or baghouse controls are used for several stationary sources of particulate matter.

As the site does not have access to a direct natural gas pipeline, the proposed NG turbines would operate from supply delivered in liquefied natural gas (LNG) form. An estimated three fuel delivery trips would be made per day to onsite LNG storage tanks. Potential fugitive emissions due to LNG supply, transfer, and storage are expected to be minimal based on planned system design and operation, as further described below. A vapor balance line or a direct vapor feed line to the turbines will be utilized during fuel transfers from truck to onsite storage tanks to minimize emissions of any displaced vapor. Fuel transfer operations will be completed via pressure differential offloads and thus will not require the use of an additional pump. The storage system will be designed to hold the fuel to minimize or eliminate boil-off conditions. This will be managed by balancing fuel storage with the rate of use by the turbines, such that the fuel in the tanks will be kept fresh to eliminate any pressure discharges. Additional features of tank design and operation, including double-walled and heavily insulated tanks, no systematic venting, and the use of welded versus flanged piping connections when possible, will further reduce the potential for GHG emissions (in the form of methane) from LNG storage tanks.[5] While potential fugitive emissions from components such as valves, pump seals, and connectors are highly dependent on the presence and detection of leaks during operation and are expected to be minimal with proper system maintenance, a conservative estimate of potential emissions has been presented in the inventory developed here. The proposed maintenance program would include checks during fuel offload periods (occurring three times per day), as well as routine monthly or quarterly system inspections of the storage tanks and turbines. The proposed vaporization system is an ambient air vaporizer which utilizes the heat from ambient air to vaporize the LNG and thus does not require a supplemental fuel or combustion source to operate. Any power required to operate the regassification system will be from line power or a solar/battery system.

Emissions presented in this report are intended to be conservative but are subject to further refinement based on further engineering design and analysis.

2.1.2 Approved Operations

The emissions inventory developed for approved operations reflects potential activity and emissions associated with mining and processing of materials as authorized in the 1998 Plan and recent revisions (1998 Plan Ver 2.0 and Ver 2.1). Ore processing is currently authorized and permitted for up to 6.25 million tons annually, and overburden mining is currently authorized for up to 16.3 million tons annually. As approved operations consist of the same scope of on-site operations (mining, crushing, and refining), an approved inventory was developed based on scaled operations relative to the proposed 2022 Mine Plan of Operations. Specifically, the following types of activities and emissions were assumed to scale with the ratio of ore processed: ore crushing, screening, and processing, refining (including supporting combustion equipment), reagent usage, electrical demand, and on-site

[5] 2025. American Petroleum Institute (API). Liquefied Natural Gas (LNG) Operations. Consistent Methodology for Estimating Greenhouse Gas Emissions. Version 1.0.

power generation[6]; the following types of activities and emissions were assumed to scale with the ratio of overburden mined: overburden material transfer; and the following types of activities and emissions were assumed to scale with the ratio of ore and overburden material: blasting, hauling, off-road equipment, fuel usage, employee and vendor travel, and resulting employee waste and wastewater generation. The following activities and emissions were assumed to stay consistent on a maximum daily and annual basis: disturbance of operational areas and emergency generators (including the associated fuel storage tank).

Following the above methodology, emission estimates for approved operations take into account the commitments to clean technology and control options as outlined above for the proposed 2022 Mine Plan of Operations and reflect updated emission factors and methodologies, as compared to those utilized in prior environmental review documentation, specifically Appendix F of the 1997 Castle Mountain Mine Expansion Project Draft EIS/EIR, March 1997.

2.1.3 Methodology

The operational EI utilized the latest engineering and mining design for the proposed 2022 Mine Plan of Operations to extract potential activity data, evaluated on both a maximum annual and maximum daily basis. Emission factors and methodology were then selected for each activity utilizing applicable local, state, and federal guidance as appropriate. Selected emission methodologies and emission factors used to prepare this operational EI are listed below and are detailed in supporting tables.

- American Petroleum Institute (API). 2015. Liquefied Natural Gas (LNG) Operations: Consistent Methodology for Estimating Greenhouse Gas Emissions. May. Available online at: https://www.api.org/-/media/Files/EHS/climate-change/api-lng-ghg-emissions-guidelines-05-2015.pdf.
- Bay Area Air Quality Management District (BAAQMD). 2004. CARB Emission Factors for CI Diesel Engines – Percent HC in Relation to NMHC + NO_x.
- BLM. 1997. Castle Mountain Mine Expansion Project Final Environmental Impact Statement/Environmental Impact Report. October.
- California Air Pollution Control Officers Association (CAPCOA). User Guide for CalEEMod Version 2022.1. Available online at: https://www.caleemod.com/user-guide
- CARB. CARB and United States Environmental Protection Agency (USEPA) Off-Road Compression-Ignition (Diesel) Engine Standards. Available online at: https://ww2.arb.ca.gov/sites/default/files/2020-03/Tier_Color_Chart_Off_Road_Diesel_Stds_R.pdf
- CARB. Off-Road Diesel New Engine Emissions Standards. Available online at: https://ww3.arb.ca.gov/msei/ordiesel/ordieselstandards.xlsx
- CARB Engine Certification data.
- CARB. Particulate Matter chemical speciation profiles for source categories. Available at: https://ww2.arb.ca.gov/sites/default/files/2025-05/pmchemprofile29apr25.xlsx

[6] Under approved operations, and consistent with operations currently employed at the mine, on-site power generation is assumed to be provided by diesel generators. As discussed above, the proposed Project would utilize NG turbines for on-site power generation, supplementing available grid supply.

- CARB. VOC chemical speciation profiles for source categories. Available at: https://ww2.arb.ca.gov/sites/default/files/2024-10/orgprofile20sep24.xlsx
- CARB. 1996. CATEF emission factors. Available online at: https://ww3.arb.ca.gov/ei/catef/catef.csv
- CARB. 2017. 2017 Off-road Diesel Emission Factors. Available online at: https://ww2.arb.ca.gov/sites/default/files/classic/msei/ordiesel/ordas_ef_fcf_2017.xlsx
- CARB. 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf
- CARB. 2021a. EMFAC2021. Available online at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250
- CARB. 2021b. Miscellaneous Process Methodology 7.9, Entrained Road Travel, Paved Road Dust. March. Available online at: https://ww3.arb.ca.gov/ei/areasrc/fullpdf/2021_paved_roads_7_9.pdf
- CARB. 2022a. In-Use Off-Road Diesel-Fueled Fleets regulation. Available online at: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/off-roaddiesel/appa-1.pdf
- CARB. 2022b. Gasoline Service Station Industrywide Risk Assessment Technical Guidance. February. Available online at: https://www.mdaqmd.ca.gov/home/showpublisheddocument/9310/637850250462300000
- City of Los Angeles. 2006. L.A. CEQA Thresholds Guide: Your Resource for Preparing CEQA Analyses in Los Angeles. Available online at: Available online at: https://planning.lacity.org/eir/CrossroadsHwd/deir/files/references/A07.pdf
- Code of Federal Regulations. Title 40 Chapter I Subchapter C Part 98. Available at: Available online at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1
- Code of Federal Regulations. Title 40 Chapter I Subchapter C Part 63. Available at: Available online at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-63/subpart-EEEEEEE
- Dregger. 2005. The Wind Investigator: How to Approximate Wind Velocities at Roof Level. October.
- Edison International. 2021 Sustainability Report. Available online at: https://www.edison.com/_gallery/get_file/?file_id=634a11c88ed7df0e03e0e410&file_ext=.pdf&page_id=
- Edison International. 2022 Sustainability Report. Available online at: https://www.edison.com/_gallery/get_file/?file_id=6477e962b3aed34e0382ae64&file_ext=.pdf&page_id=
- Edison International. 2023 Sustainability Report. Available online at: https://www.edison.com/_gallery/get_file/?file_id=6657b3b63d6332eaafbcc867&file_ext=.pdf&page_id=
- Fouad and Calvert. 2002. Wind Load Provisions in the 2001 Supports Specification. November.
- The Mining Association of Canada. 2014. Toward Sustainable Mining: Energy and GHG Emissions Management Reference Guide. June. Available online at: https://mining.ca/wp-

content/uploads/dlm_uploads/2021/06/EnergyandGreenhouseGasEmissionsManagementReferenceGuide2014.pdf.

- Mojave Desert Air Quality Management District (MDAQMD). 2005. Default Emission Factors for Desert Soils.
- MDAQMD. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768.
- MDAQMD. 2015. Default Emission Factors for Internal Combustion Engines. Available online at: http://mdaqmd.ca.gov/home/showdocument?id=722
- Nevada Division of Environmental Protection (NDEP) Bureau of Air Pollution Control (BAPC). 2017. Guidance on Emission Factors for the Mining Industry. May. Available online at: https://ndep.nv.gov/uploads/air-permitting-docs/ndep-mining-emissions-guidance.pdf.
- NV Energy. 2021 NV Energy Sustainability Report. Available online at: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/cleanenergy/sustainability/2021-sustainability-nvenergy.pdf
- NV Energy. 2022 NV Energy Sustainability Report. Available online at: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/cleanenergy/sustainability/2022-sustainability-nvenergy.pdf
- NV Energy. 2023 NV Energy Sustainability Report. Available online at: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/cleanenergy/sustainability/2023-sustainability-nvenergy.pdf
- Nevada Governor's Office of Energy. 2023. 2022 Status of Energy Report. January. Available online at: https://energy.nv.gov/uploadedFiles/energynvgov/content/Media/2022_status_of_energy_final.pdf.
- Nevada Governor's Office of Energy. 2024. 2024 Status of Energy Report. January. Available online at: https://energy.nv.gov/uploadedFiles/energynvgov/content/Home/Features/2024%20Status%20of%20Energy%20Report_Final.pdf
- Perry, Robert H et al. 1997. Perry's Chemical Engineers' Handbook. 7th Edition. Table 2-10. Partial Pressures of HCl over Aqueous Solutions of HCl.
- San Bernardino Air Pollution Control District. 1991. Final New Source Review. Viceroy Gold Corporation: Castle Mountain Project. March.
- South Coast Air Quality Management District (SCAQMD) Combustion Default Emission Factors. December 2024. Available online at: https://www.aqmd.gov/docs/default-source/planning/annual-emission-reporting/combustion-default-emission-factors-2024.pdf?sfvrsn=9c358361_9
- State of Nevada Public Utilities Commission. Renewable Portfolio Standard. Available online at: https://puc.nv.gov/Renewable_Energy/Portfolio_Standard/
- USEPA. Method 19: Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates. Available online at: https://www.epa.gov/sites/production/files/2017-08/documents/method_19.pdf

- USEPA. 1980. Compilation of Air Pollutant Emission Factors (AP-42), Section 13.3, Explosives Detonation. February. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s03.pdf.
- USEPA. 1998. AP-42, Section 11.9. Western Coal Mining. October. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s09.pdf.
- USEPA. 2004. AP-42, Section 11.19.2. Crushed Stone and Pulverized Mineral Processing. August. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s1902.pdf.
- USEPA. 2006a. AP-42, Section 13.2.2, Unpaved Roads. November. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0202.pdf.
- USEPA. 2006b. AP-42, Section 13.2.4, Aggregate Handling and Storage Piles. November. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/13.2.4_aggregate_handling_and_storage_piles.pdf.
- USEPA. 2006c. AP-42, Section 13.2.5, Industrial Wind Erosion. November. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0205.pdf.
- USEPA. 2009. Quality Assurance Project Plan, Comprehensive Air Emissions Testing for Hydrogen Cyanide at Three Nevada Gold Mines Sites Using the USEPA Surface Isolation Flux Chamber Technology, Revision 2 (November 18, 2009). EPA-HQ-OAR-2010-0239-0163_attachment 5.
- USEPA. 2009. Risk Management Program for Offsite Consequence Analysis. Appendix D: D-1. Available online at: https://www.epa.gov/sites/production/files/2017-05/documents/oca-apds.pdf.
- USEPA. 2010. Conversion Factors for Hydrocarbon Emission Components, NR-002d. EPA-420-R-10-015. July. Available online at: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10081RP.pdf.
- USEPA. 2010. Evaluation of Air Emissions of Hydrogen Cyanide from Fugitive Sources at Nevada Gold Mines Using the USEPA Surface Insolation Flux Chamber Technology: Cortez, Gold Quarry & Round Mountain Mines. April 2010. Prepared by Dr. C.E. Schmidt and Tom Card. EPA-HQ-OAR-2010-0239-0163.
- USEPA. 2010. HCN Flux Box Results. EPA-HQ-OAR-2010-0239-0403.
- USEPA. 2011a. AP-42, Section 13.2.1, Paved Roads. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/13.2.1_paved_roads.pdf.
- USEPA. 2011b. NESHAP for Gold Mine Ore Processing and Production (40 CFR Part 63 Subpart EEEEEEE). Available online at: https://www.govinfo.gov/content/pkg/FR-2011-02-17/pdf/2011-2608.pdf#page=2. February.
- USEPA. 2012. AP-42, Section 11.12, Concrete Batching. January. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s12.pdf.
- USEPA. 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and.
- USEPA. 2024. AP-42. Section 7.1, Organic Liquid Storage Tanks. October. Available online at: https://www.epa.gov/system/files/documents/2024-10/c7s1_2024_clean.pdf.

- USEPA. 2021. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019. Available at: https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-annexes.pdf.
- Site specific testing of material compositions.

Emission factors for on-road mobile units conservatively utilize the year 2027, while mining operations may commence after this year and will continue into future years when corresponding emission factors will continue to decrease due to improved technology and vehicle regulation. Similarly, greenhouse gas emission factors for electricity use conservatively utilize projected emission factors for year 2027, while grid mixes are expected to continue to incorporate additional renewable sources in future years, For example, NV Energy's 2021 Integrated Resource Plan, which is discussed further in **Section 7.4,** outlines a path to achieve or exceed 50% renewable energy by 2030 and targets the State's goal of net-zero carbon dioxide (CO_2) emissions by 2050.

CO_2 emissions from renewable diesel use have conservatively been quantified and categorized as biogenic emissions. Per BAAQMD guidance[7], "biogenic CO_2 emissions should not be included in the quantification of GHG emissions for a project". Similarly, as noted by CARB in their GHG emissions trend report from 2000 to 2021: "Biogenic CO_2 is tracked separately from the rest of the emissions in the Assembly Bill (AB) 32 GHG Inventory and is not included in the total emissions when comparing to California's GHG reduction goals."[8] Specific to renewable diesel, the Metropolitan Water District of Southern California's Climate Action Plan notes that "[b]ecause the CO_2 emissions associated with renewable diesel fuels are biogenic, those emissions do not contribute to climate change."[9] Nonetheless**,** biogenic emissions are conservatively quantified here. Further, GHG emissions estimated from the use of renewable diesel fuel in offroad equipment conservatively use CO_2 emission factors consistent with conventional diesel fuel. Some studies have shown reductions in direct CO_2 emissions with the use of renewable diesel, though such potential reductions are conservatively not accounted for here.[10]

2.1.4 Emission Estimates

Emission estimates for maximum daily and annual operations for the proposed 2022 Mine Plan of Operations, including emissions from approved activity, are summarized in **Table 1**. Emission estimates for maximum daily and annual operations for approved operations as authorized in the 1998 Plan, and recent revisions (1998 Plan Ver 2.0 and Ver 2.1), are shown in **Table 2**. The estimated emissions increase as a result of the proposed 2022 Mine Plan of Operations (i.e. the change between

[7] BAAQMD. 2017. California Environmental Quality Act Air Quality Guidelines. May. Available at: https://www.baaqmd.gov/~/media/files/planning-and-research/ceqa/ceqa_guidelines_may2017-pdf.pdf?la=en&rev=0d2d971e661d41f28a56953f1776bdde. Accessed August 2025.

[8] CARB. 2023. California Greenhouse Gas Emissions from 2000 to 2021: Trends of Emissions and Other Indicators. December. Available online at: https://ww2.arb.ca.gov/sites/default/files/2023-12/2000_2021_ghg_inventory_trends.pdf. Accessed August 2025.

[9] Metropolitan Water District of Southern California. 2022. Climate Action Plan. May. Available online at: https://www.mwdh2o.com/media/12469/final-cap.pdf. Accessed August 2025.

[10] California Environmental Protection Agency. 2015. Staff Report, Multimedia Evaluation of Renewable Diesel. May. Available online at: https://ww2.arb.ca.gov/sites/default/files/2018-08/Renewable_Diesel_Multimedia_Evaluation_5-21-15.pdf. Accessed August 2025.

the proposed 2022 Mine Plan of Operations and approved operations, when utilizing the same emission factors and methodologies) are summarized in **Table 3**.

The difference in emissions estimated under the proposed 2022 Mine Plan of Operations, including emissions from approved activity, and those estimated in the 1997 EIR/EIS are shown in **Table 4**. Emission factors and methodologies utilized at the time of the 1997 EIR/EIS may reflect older guidance, less advanced technologies, fewer control technology commitments, and other differences. As such, **Table 3** represents a more direct comparison of potential emission differences as a result of proposed changes to mining activity under the 2022 Mine Plan of Operations.

Detailed emission tables supporting the proposed 2022 Mine Plan of Operations, including approved activity, are included as **Tables O-1 through O-33**. Detailed emission tables supporting approved operations are included as **Tables OA-1 through OA-33**.

2.2 Construction Emissions

CAP and GHG emissions were quantified for the two years of mine construction. Construction is expected to occur over an 18-month period and was conservatively assumed to start as early as 2026. Construction may commence after this time and thus the emission estimates presented here are conservative.

2.2.1 Methodology

The construction EI prepared utilizes anticipated construction activity, including worker and vendor travel to and from the site, off-road equipment use, and fugitive dust disturbance details. Emission factors and methodologies were selected for each activity utilizing applicable local, state, and federal guidance as appropriate. The selected emission methodologies and emission factors used to prepare the construction EI are listed below and are detailed in supporting tables.

- BAAQMD. 2004. CARB Emission Factors for CI Diesel Engines - Percent HC in Relation to NMHC + NO_x.
- BLM. 1997. Castle Mountain Mine Expansion Project Final Environmental Impact Statement/Environmental Impact Report. October.
- CAPCOA. User Guide for CalEEMod Version 2022.1. Available online at: https://www.caleemod.com/user-guide
- CARB. CARB and USEPA Off-Road Compression-Ignition (Diesel) Engine Standards. Available online at: https://ww2.arb.ca.gov/sites/default/files/2020-03/Tier_Color_Chart_Off_Road_Diesel_Stds_R.pdf
- CARB. Off-Road Diesel New Engine Emissions Standards. Available online at: https://ww3.arb.ca.gov/msei/ordiesel/ordieselstandards.xlsx
- CARB. 2017. 2017 Off-road Diesel Emission Factors. Available online at: https://ww2.arb.ca.gov/sites/default/files/classic/msei/ordiesel/ordas_ef_fcf_2017.xlsx
- CARB. 2021a. EMFAC2021. Available online at: https://arb.ca.gov/emfac/emissions-inventory
- CARB. 2021b. Miscellaneous Process Methodology 7.9, Entrained Road Travel, Paved Road Dust. March. Available online at: https://ww3.arb.ca.gov/ei/areasrc/fullpdf/2021_paved_roads_7_9.pdf

- CARB. 2022a. In-Use Off-Road Diesel-Fueled Fleets regulation. Available online at: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/off-roaddiesel/appa-1.pdf
- CARB. 2022b. Renewable Diesel Joint Statement. Available online at: https://ww2.arb.ca.gov/our-work/programs/alternative-diesel-fuels/biodiesel-renewable-diesel
- Code of Federal Regulations. Title 40 Chapter I Subchapter C Part 98. Available at: Available online at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1
- Dregger. 2005. The Wind Investigator: How to Approximate Wind Velocities at Roof Level. October.
- Fouad and Calvert. 2002. Wind Load Provisions in the 2001 Supports Specification. November.
- Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007. Available at: https://www.ipcc.ch/assessment-report/ar4/
- MDAQMD. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768.
- USEPA. 1996. AP-42 Chapter 3.4 Large Stationary Diesel and Stationary Dual-fuel Engines. Available at: https://www.epa.gov/sites/default/files/2020-10/documents/c03s04.pdf
- USEPA. 2006a. AP-42, Section 13.2.2, Unpaved Roads. November. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0202.pdf.
- USEPA. 2006c. AP-42, Section 13.2.5, Industrial Wind Erosion. November. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0205.pdf.
- USEPA. 2010. Conversion Factors for Hydrocarbon Emission Components, NR-002d. EPA-420-R-10-015. July. Available online at: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10081RP.pdf
- USEPA. 2011a. AP-42, Section 13.2.1, Paved Roads. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/13.2.1_paved_roads.pdf.
- USEPA. 2021. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019. Available at: https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-annexes.pdf

Emission factors for on-road mobile units conservatively utilize the years 2026 and 2027 even though construction may commence after these years when corresponding emission factors will continue to decrease due to improved technology and vehicle regulation.

Due to uncertainty in contractor selection during construction, the emissions inventory conservatively assumes Tier 3 emission standards for all off-road equipment. Due to state and federal regulations, fleet turnover, and continuing improvement in emissions control technology, it is expected that many, if not all, off-road units will meet emission standards higher than this (Tier 4 Interim or Tier 4 Final). Thus, emissions presented here are conservative.

Construction off-road equipment, similar to operational off-road equipment, will use 100% renewable diesel fuel (when available from suppliers), consistent with regulatory requirements under the CARB In-Use Off-Road Diesel-Fueled Fleets Regulation and CMV commitments. Roads utilized during construction will also similarly be controlled with watering, graveling surface, treatment with chemical stabilizers, and speed control for fugitive dust control from disturbed areas.

2.2.2 Emission Estimates

Emission estimates for maximum daily and annual construction activity are summarized in **Table C-1 and Table C-2**. Detailed emission tables which document activity data, emission factors, and emissions methodologies are included as **Tables C-3 through C-15**.

3. NEARFIELD MODELING ANALYSIS

3.1 Modeling Methodology

The air dispersion modeling utilized the models, inputs, and methodology fully described and documented in the modeling protocol (see **Attachment A**). This includes the model versions and guidance available at the time of the analyses, which include AERMOD version 24142, its associated processors, USEPA's Guideline on Air Quality Models 40 CFR 51, Appendix W (USEPA 2024), and other applicable USEPA guidance described in the modeling protocol and modeling report.

3.1.1 Conservatisms in Analysis

The modeling analysis was designed to be both comprehensive and conservative to ensure compliance with the applicable air quality standards will be maintained over a broad range of operating scenarios.

First, the modeled emission scenario is conservatively based on the maximum annual activity data from each activity type, regardless of the year. For example:

- Maximum hauling operations and maximum equipment counts for the inventory are projected to occur in different years but were conservatively modeled together in the inventory development.
- Maximum annual operations will be evaluated to account for up to 19.2 million tons of ore processed and up to 60.6 million tons of overburden material mined, which include the portions of ore and overburden processing that are currently approved (6.25 million tons annually and 16.3 million tons annually, respectively).

During the year with peak activity, the mining activity will be primarily located at the South Extension Pit along the South Extension Phase I haul route and at the northern pit complex along the East Ridge haul route, with a small amount of additional activity along with Jumbo Oro Belle haul route. The peak year of haul truck travel will occur along the East Ridge, South Extension Phase I, and South Extension Phase II haul routes. During these years, the overburden will be hauled from the mining locations and used as backfill at the northern pit complex.

In addition to modeling the maximum emissions scenario with mining, hauling, and overburden activity occurring at the above specified locations, in order to address the spatial movement of these activities over the life of the mine, two additional scenarios were analyzed. These additional scenarios retained the same level of emissions as the maximum emissions scenario but spatially allocated emissions from these activities to the northern portion of the development area (North Operations Scenario) and the southern portion of the development area (South Operations Scenario). This approach ensures that as the mining activity moves, and the emission source's proximity to off-site ambient air changes, compliance with the applicable air quality standards will be maintained.

This modeling approach conservatively assumes that when mining activity is occurring at different locations throughout the development area, the emissions from that activity are based on overall

Project maximums. In reality, as the mining activity moves, the level of activity will vary and will be less than or equal to the modeled emissions for that activity location.

Other conservatisms in the analysis include the assumption that the majority of emission activities will occur for every hour of the year (8760 hours per year). This ensures that the Project emissions are being evaluated over the full range of meteorological conditions at the site. The most significant exception to this continuous operating schedule is the blasting schedule, which is expected to occur once per day for up to 312 days per year. Since the exact hour the blasting will occur is unknown, blasting was modeled to occur between 6 am and 6 pm each day. The analysis conservatively assumed that the blasting emissions for each hour were based on the maximum, hourly blasting emissions. Additionally, for any emission sources of PM_{10} that occur within pits or areas where the land itself will act as a wind screen, the effective control efficiency that was applied during inventory development (see **Section 2** above) was removed for modeling purposes.

USEPA has documented the challenges and overly conservative nature of assuming that intermittent sources (such as blasting) occur continuously during their potential operating schedule. AERMOD is unable to properly model a truly intermittent source; therefore, the conservative approach is to assume it operates continuously within the time period specified in the model. This approach, as reported by AERMOD, results in impacts that are based on the maximum hourly emissions and the worst-case meteorological conditions. For probabilistic standards, such as the 1-hour nitrogen dioxide (NO_2) National Ambient Air Quality Standards (NAAQS) and 1-hour sulfur dioxide (SO_2) NAAQS, this significantly overstates the likelihood of this worst-case pairing occurring in reality. The 1-hour NO_2 NAAQS is based on a multiyear average of the 98th percentile of the maximum daily impacts (by receptor), thus for a given year this worst-pairing would have to happen on seven unique days (with impacts at the same receptor).

This conservative approach was used for the 1-hour NO_2 blasting emissions, assuming maximum hourly emissions between 6 am and 6 pm for every day of a year. As a result, the reported 1-hour NO_2 impacts are based on the assumption that the maximum hourly emissions will always occur during worst-case meteorology. Since this will not consistently happen in reality, the 1-hour NO_2 impacts should be considered as conservative. It is noted that this conservatism is also applicable to the 1-hour SO_2 NAAQS model.

Other calculation-specific conservatisms are noted in **Sections 3.8 and 4.1**.

3.2 Meteorological Data

The meteorological data is based on data from CMM's on-site 10-meter tower. The use of on-site meteorological data is preferred by USEPA and increases the veracity of the analysis. Additional details about the data and processing steps are provided in the modeling protocol (see **Attachment A**).

3.3 Background Concentrations

Ambient background concentrations are added to the modeled impacts from the Project sources in order to compare the cumulative impacts to the applicable NAAQS and California Ambient Air Quality Standards (CAAQS). The background concentrations are summarized in Table 5 and Tables 6a/6b of the modeling protocol (see **Attachment A**). The background values were conservatively assumed to be constant at the design value, except for PM_{10} which were varied monthly to account for monthly/seasonal changes in wind speed.

3.4 Source Characterization and Scenarios

As discussed in detail in the modeling protocol and modeling report (see **Attachment A**), three modeling scenarios were analyzed:

- The "Maximum Emissions Scenario" with mining, hauling, and overburden activity occurring at the true locations associated with those maximum activities.
- A hypothetical North Operations Scenario conserving the maximum emissions but spatially shifting mining, hauling, and overburden activity to the northern pit complex and Northern Overburden Pile.
- A hypothetical South Operations Scenario conserving the maximum emissions but spatially shifting mining, hauling, and overburden activity to the Southern Extension Pit and the South Overburden Pile.

While the second and third configurations are not reflective of specific mining years, they are intended to conservatively evaluate potential operations across multiple mining years where activity may occur in the northern or southern portions of the site.

Source characterization for the emissions was based on spatial size and location of the emissions, type of activity, and available guidance. Modeled source parameters are documented in the modeling protocol (see **Attachment A**).

3.5 Summary of NAAQS Impact Assessment Results

The modeling results for comparison to the NAAQS are summarized below for each of the three scenarios: Maximum Emissions Scenario (Table 3-1), North Operations Scenario (Table 3-2), and South Operations Scenario (Table 3-3). All modeled scenarios are in compliance with the applicable NAAQS. The impacts of the three modeled scenarios differ slightly based on the different spatial locations of the emission sources between the scenarios (e.g., location of blasting, haul roads, overburden piles, etc.). For each scenario, the highest impacts compared to the applicable standard were for 1-hour NO_2 concentrations. As detailed in Section 3.1.1, these results represent a scenario with maximum hourly blasting emissions always occurring with worst-case meteorology and should be considered conservative. All other results are less than 75% of the applicable NAAQS.

Table 3-1. Maximum Emissions Scenario NAAQS Results

Pollutant	Averaging Time	Rank	Impact (µg/m³)	Background (µg/m³)	Total Concentration (µg/m³)	NAAQS (µg/m³)	Percent of Standard
SO_2	1-hr	99th Percentile	0.4	11	11.4	196	6%
NO_2	1-hr	98th Percentile	101.6	64.9	166.5	188	89%
	Annual	Maximum	5.9	6.8	12.7	100	13%
CO	1-hr	H2H	3,164	2,406	5,570	40,000	14%
	8-hr	H2H	487	1,948	2,435	10,000	24%
PM_{10}	24-hr	H2H	28.7	(included)	28.7	150	19%
$PM_{2.5}$	24-hr	98th Percentile	1.5[a]	16.6	18.1	35	52%

	Annual	Maximum	0.46[a]	4.8	5.3	9	58%

[a] Includes primary and secondary contributions.

Table 3-2. Maximum Emissions Scenario – Assumed North Operations NAAQS Results

Pollutant	Averaging Time	Rank	Impact (µg/m³)	Background (µg/m³)	Total Concentration (µg/m³)	NAAQS (µg/m³)	Percent of Standard
SO_2	1-hr	99th Percentile	0.4	11	11.4	196	6%
NO_2	1-hr	98th Percentile	109.6	64.9	174.5	188	93%
	Annual	Maximum	8.0	6.8	14.8	100	15%
CO	1-hr	H2H	3,076	2,406	5,482	40,000	14%
	8-hr	H2H	491	1,948	2,439	10,000	24%
PM_{10}	24-hr	H2H	34.4	(included)	34.4	150	23%
$PM_{2.5}$	24-hr	98th Percentile	2.6[a]	16.6	19.2	35	55%
	Annual	Maximum	0.76[a]	4.8	5.6	9	62%

[a] Includes primary and secondary contributions.

Table 3-3. Maximum Emissions Scenario – Assumed South Operations NAAQS Results

Pollutant	Averaging Time	Rank	Impact (µg/m³)	Background (µg/m³)	Total Concentration (µg/m³)	NAAQS (µg/m³)	Percent of Standard
SO_2	1-hr	99th Percentile	0.5	11	11.5	196	6%
NO_2	1-hr	98th Percentile	103.8	64.9	168.7	188	90%
	Annual	Maximum	7.5	6.8	14.3	100	14%
CO	1-hr	H2H	3,168	2,406	5,574	40,000	14%
	8-hr	H2H	493	1,948	2,441	10,000	24%
PM_{10}	24-hr	H2H	29.8	(included)	29.8	150	20%
$PM_{2.5}$	24-hr	98th Percentile	1.6[a]	16.6	18.2	35	52%
	Annual	Maximum	0.58[a]	4.8	5.4	9	60%

[a] Includes primary and secondary contributions.

3.6 Summary of CAAQS Impact Assessment Results (for CEQA)

The modeling results for comparison to the CAAQS are summarized below for each of the three scenarios: Maximum Emissions Scenario (**Table 3-4**), North Operations Scenario (**Table 3-5**), and South Operations Scenario (**Table 3-6**). All modeled scenarios are in compliance with the applicable CAAQS. The impacts of the three modeled scenarios differ slightly based on the different spatial

locations of the emission sources between the scenarios (e.g., location of blasting, haul roads, overburden piles, etc.). For each scenario, all results are less than 75% of the applicable CAAQS.

Table 3-4. Maximum Emissions Scenario CAAQS results

Pollutant	Averaging Time	Rank	Impact (µg/m³)	Background (µg/m³)	Total Concentration (µg/m³)	CAAQS (µg/m³)	Percent of Standard
SO_2	1-hr	Maximum	0.9	19.3	20.2	655	3%
	24-hr	Maximum	0.1	19.3	19.4	105	18%
NO_2	1-hr	Maximum	164.1	82	246.1	339	73%
	Annual	Maximum	5.9	6.8	12.7	57	22%
CO	1-hr	Maximum	9,011	2,635	11,646	23,000	51%
	8-hr	Maximum	1,145	1,948	3,093	10,000	31%
PM_{10}	24-hr	Maximum	29.7	(included)	29.7	50	59%
	Annual	Maximum	3.5	6.3	9.8	20	49%
$PM_{2.5}$	Annual	Maximum	0.46[a]	5.1	5.6	12	46%

[a] Includes primary and secondary contributions.

Table 3-5. Maximum Emissions Scenario – Assumed North Operations CAAQS Results

Pollutant	Averaging Time	Rank	Impact (µg/m³)	Background (µg/m³)	Total Concentration (µg/m³)	CAAQS (µg/m³)	Percent of Standard
SO_2	1-hr	Maximum	0.8	19.3	20.1	655	3%
	24-hr	Maximum	0.1	19.3	19.4	105	18%
NO_2	1-hr	Maximum	142.2	82	224.2	339	66%
	Annual	Maximum	8.0	6.8	14.8	57	26%
CO	1-hr	Maximum	6,231	2,635	8,866	23,000	39%
	8-hr	Maximum	784	1,948	2,732	10,000	27%
PM_{10}	24-hr	Maximum	34.9	(included)	34.9	50	70%
	Annual	Maximum	5.3	6.3	11.6	20.0	58%
$PM_{2.5}$	Annual	Maximum	0.76[a]	5.1	5.9	12	49%

[a] Includes primary and secondary contributions.

Table 3-6. Maximum Emissions Scenario – Assumed South Operations CAAQS Results

Pollutant	Averaging Time	Rank	Impact (µg/m³)	Background (µg/m³)	Total Concentration (µg/m³)	CAAQS (µg/m³)	Percent of Standard
SO_2	1-hr	Maximum	1.2	19.3	20.5	655	3%
	24-hr	Maximum	0.1	19.3	19.4	105	18%
NO_2	1-hr	Maximum	167.4	82	249.4	339	74%
	Annual	Maximum	7.5	6.8	14.3	57	25%
CO	1-hr	Maximum	9,042	2,635	11,677	23,000	51%
	8-hr	Maximum	1,143	1,948	3,091	10,000	31%
PM_{10}	24-hr	Maximum	33.0	(included)	33.0	50	66%
	Annual	Maximum	4.4	6.3	10.7	20	54%
$PM_{2.5}$	Annual	Maximum	0.58[a]	5.1	5.7	12	47%

[a] Includes primary and secondary contributions.

3.7 Ozone and Secondary $PM_{2.5}$ Impact Assessment

The secondary formation of particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$) from Project emissions of SO_2 and nitrogen oxides (NO_x) emissions were estimated using the USEPA Modeled Emission Rates for Precursors (MERPs) guidance. The secondary $PM_{2.5}$ impacts are added to the primary $PM_{2.5}$ impacts generated from AERMOD. The total $PM_{2.5}$ concentrations, primary plus secondary, are compared to the applicable $PM_{2.5}$ air quality standards. Secondary ozone formation from on-site Project emissions of NO_x and volatile organic compounds (VOC) emissions were estimated using the same approach based on the MERPs guidance.

Using the USEPA MERPs Qlik tool,[11] the hypothetical source closest to CMM is in Las Vegas, Nevada, which is approximately 129 kilometers (km) (or 80 miles) away from CMM. The total Project emissions and data extracted from the USEPA MERPs database for the 10-meter stack for this source are provided in **Table 3-7** below. Use of the 10-meter stack is representative of the majority of Project emissions, which are fugitive or low-level releases. The development of Project emissions is documented in the modeling protocol (see **Attachment A**).

As summarized in **Table 3-7** below, the estimated impacts for the Project are below the ozone Significant Impact Level (SIL) value of 1.0 parts per billion (ppb). The secondary 24-hour and annual $PM_{2.5}$ impacts are added to the primary $PM_{2.5}$ AERMOD impacts, as summarized in **Sections 3.5 and 3.6**.

It is noted that the USEPA-estimated secondary impacts from the MERPs database represent the maximum impacts anywhere within 50 km (31 miles) of the hypothetical source. This maximum impact is added to design value impacts of primary $PM_{2.5}$ from AERMOD, which occur at the site boundary. The addition of the secondary and primary $PM_{2.5}$ impacts, even though they are not spatially paired, provides a conservative estimate of the total $PM_{2.5}$ impacts from the Project.

[11] https://www.epa.gov/scram/merps-view-qlik. Accessed August 2025.

Table 3-7. USEPA MERP Modeling Results for a Hypothetical Source in Las Vegas, NV

State	County	Metric	Precursor	MERP Emissions (tpy)	On-site Project Emissions (tpy)	MERP Impact	Estimated Project Impact by Precursor	Combined, Estimated Project Impact
Nevada	Clark Co	8-hr Ozone	NO_x	1000	569	0.636 ppb	0.362 ppb	0.373 ppb
Nevada	Clark Co	8-hr Ozone	VOC	500	35	0.160 ppb	0.011 ppb	
Nevada	Clark Co	Annual $PM_{2.5}$	NO_x	1000	569	0.009 µg/m^3	0.005 µg/m^3	0.005 µg/m^3
Nevada	Clark Co	Annual $PM_{2.5}$	SO_2	1000	1.3	0.012 µg/m^3	0.000 µg/m^3	
Nevada	Clark Co	Daily $PM_{2.5}$	NO_x	1000	569	0.085 µg/m^3	0.048 µg/m^3	0.048 µg/m^3
Nevada	Clark Co	Daily $PM_{2.5}$	SO_2	1000	1.3	0.086 µg/m^3	0.000 µg/m^3	

4. AIR QUALITY RELATED VALUES (AQRV) ANALYSIS

Following the Federal Land Managers' Air Quality Related Values Work Group (FLAG) guidance for Class I areas, an assessment of Project impacts on the air quality related values (AQRVs) of regional haze and acid deposition at Class I areas beyond 50 km (31 miles) is made using the Q/D screening approach. For Q/D, Q is the onsite annualized, maximum daily Project emissions of visibility-impairing pollutants (i.e., PM_{10}, SO_2, and NO_x for this Project), in tons per year (tpy), divided by the distance between the Project and the Class I area, D in kilometers (km). The estimated onsite maximum daily emissions and conservatively converted annual emissions for each of the Project emission categories are provided in the modeling report (see **Attachment A**). The closest Class I areas to the Project are Grand Canyon National Park and Joshua Tree National Park. The Q/D calculations using the maximum daily Project emissions for the emitted visibility-impairing pollutants (PM_{10}, SO_2, and NO_x) at each of these Class I areas are provided in **Table 4-1**.

The Q/D values for both Class I areas are less than 10, therefore Project emissions will not have an adverse impact on AQRVs at these national parks. It is noted that the value of Q includes fugitive PM_{10} emissions, which are unlikely to travel to the Class I areas due to gravitational settling, wet and dry deposition, and the low-level nature of the emissions. Therefore, this Q/D calculation should be considered a conservative estimate of the Q/D value.

Table 4-1. Q/D Calculations for the Nearest Class I Areas

Onsite Annualized Maximum Daily Emissions (tpy)	Distance to Grand Canyon, D (km)	Distance to Joshua Tree, D (km)
NO_x = 678	128	131
SO_2 = 1.5		
PM_{10} = 344		
Q = 1,023	Q/D = 8.0	Q/D = 7.8

5. SENSITIVE RECEPTOR AND HEALTH RISK DISCUSSION

Per the Mojave Desert Air Quality Management District California Environmental Quality Act and Federal Conformity Guidelines,[12] a project may be considered significant if it exposes sensitive receptors to pollutant concentrations which result in a cancer risk greater than or equal to 10 in a million and/or a Hazard Index greater than or equal to 1. The guidelines define existing or planned residences, schools, daycare centers, playgrounds, and medical facilities as a sensitive receptor land use. For an industrial project such as this Project, health risks must be evaluated for significance if a sensitive receptor land use is within 1,000 feet of the project boundary.

The nearest resident, school, daycare center, playground, and medical facility to the Project site are provided in **Figure 1**. As the nearest sensitive receptor land use to the Project site is a residential site more than 28,000 feet (5.3 miles) away from the Project boundary, further evaluation of potential health risks was not completed.

The operational emissions inventory presented in Section 2.1 evaluates and quantifies potential onsite hazardous air pollutant (HAP) and TAC emissions from the proposed 2022 Mine Plan of Operations. As CMM is located within the MDAQMD, the facility is and will continue to be subject to several local, state, and federal regulations that limit emissions of hazardous air pollutants and require the ongoing evaluation of the potential health risk from site operations. An overview of these regulations and programs and their applicability to the CMM Facility and proposed Project is discussed below.

CARB Assembly Bill (AB) 2588 Air Toxics "Hot Spots" Program

The Air Toxics "Hot Spots" Information and Assessment Act (AB 2588) was enacted in 1987 and requires stationary sources in California to report the types and quantities of certain substances routinely released into the air.[13] Emissions data is then utilized to identify facilities with potential localized health risk impacts and should impacts be above acceptable levels, risk reduction measures are identified and put in place to reduce such risk.

The AB 2588 Air Toxics "Hot Spots" Emissions Inventory Criteria and Guidelines Regulation (EICG Regulation), with the latest updates adopted in 2022, provides direction and criteria to be followed by facilities when compiling and submitting emissions data under the AB 2588 program.

The AB 2588 program is managed through the local air district, MDAQMD. See further details on routine emissions inventory submittal requirements under the MDAQMD's Comprehensive Emissions Inventory Plan (CEIP) and Comprehensive Emissions Inventory Report (CEIR) program below.

CARB Criteria Pollutant and Toxics Emissions Reporting (CTR)

In 2020, to help meet the mandates of AB 617, CARB developed the Regulation for the Reporting of Criteria Air Pollutants and Toxic Air Contaminants (CTR Regulation) to implement uniform statewide

[12] MDAQMD. 2020. Mojave Desert Air Quality Management District California Environmental Quality Act and Federal Conformity Guidelines. https://www.mdaqmd.ca.gov/home/showpublisheddocument/8510/638126583450270000. Accessed August 2025.

[13] CARB. AB 2588 Air Toxics "Hot Spots". https://ww2.arb.ca.gov/our-work/programs/ab-2588-air-toxics-hot-spots. Accessed August 2025.

annual reporting of criteria air pollutant and toxic air contaminant emissions from applicable facilities.[14] The goal of this regulation is to improve emissions data completeness and quality to aid in meeting the community protection and public right to know mandates of AB 617, among other uses of the public, regulators, and scientists.

MDAQMD Comprehensive Emissions Inventory Plan and Comprehensive Emissions Inventory Report (CEIP/CEIR)

MDAQMD requires certain facilities to periodically prepare and submit CEIPs and CEIRs. Submitted reports are to include the releases of all substances including criteria pollutants, their precursors, and state and federal toxic substances emitted into the ambient air from all permitted sources and permitted source fugitive emissions. MDAQMD developed the Comprehensive Emissions Inventory Guidelines[15] (CEI Guidance) to establish a uniform method for preparing and submitting emissions data that satisfies Federal, State, and District requirements for criteria and toxics air emission inventories from stationary sources. The program, its applicability, and reporting requirements are updated annually to ensure consistency with other state and federal reporting programs and requirements. For example, the 2024 CEI Guidance was updated to reference the latest 2022 CTR and AB 2588 EICG amendments.

CMM prepared CEIPs and CEIRs during historical site operations in the 1990s and early 2000s and for the 2021 and 2024 data years following the restart of mining operations in 2020. Beginning in 2024, CMM's current reporting schedule requires annual submittals.

Consistent with the goal of the AB 2588 program discussed above, these submittals are utilized to develop prioritization scores for facilities to assess the potential health risk impact to offsite receptors. As available via CARB's Facility Search Engine[16], prioritization scores associated with emissions from 2021 operations at the Facility were compared to MDAQMD prioritization thresholds for cancer, chronic, and acute impacts. As shown in **Table 5-1**, the prioritization scores for the Facility based on 2021 emissions are all below the MDAQMD high prioritization thresholds. Prioritization scores based on 2024 emissions are not yet available via CARB's Facility Search Engine, and 2021 is therefore the most recent year with data available for the Facility.

Table 5-1. AB2588 Air Toxics Hot Spots Program Prioritization Score Evaluation (2021 Emissions)

Facility Prioritization	Above High Threshold?	District Prioritization Threshold	
		High	Low
Cancer Prioritization	No	10	1
Chronic Prioritization	No	10	1
Acute Prioritization	No	10	1

[14] CARB. Criteria Pollutant and Toxics Emissions Reporting (CTR). https://ww2.arb.ca.gov/our-work/programs/criteria-and-toxics-reporting. Accessed August 2025.

[15] MDAQMD. Comprehensive Emissions Inventory Guidelines. 2024. https://www.mdaqmd.ca.gov/home/showpublisheddocument/10481/638681409975970000. Accessed August 2025.

[16] AB2588 prioritization score results obtained from https://ww2.arb.ca.gov/applications/facility-search-engine, with the search term "Castle Mountain" in the Facility Name field. Accessed August 2025.

MDAQMD Rule 1320

MDAQMD Rule 1320[17] requires State Toxic New Source Review (State T-NSR) for any new or modified emission units that have the potential to emit a TAC or are subject to an Airborne Toxic Control Measure (ATCM). In addition, MDAQMD Rule 1320 requires Federal Toxic New Source Review (Federal T-NSR) for any new or reconstructed facility or new or modified emissions units which have the potential to emit 10 tpy or more of any single HAP or 25 tpy of any combination of HAPs.

The first step in State T-NSR is the calculation of prioritization scores for carcinogenic effects, non-carcinogenic acute effects, and non-carcinogenic chronic effects for each new or modified emission unit using the most recently approved version of the CAPCOA *Facility Prioritization Guidelines*[18] along with the most recently approved Office of Environmental Health Hazard Assessment (OEHHA) unit risk factors for cancer potency factors and reference exposure levels for non-cancer acute and chronic factors.

While Federal T-NSR review has not been required for CMM operations to date, as HAP emissions from the CMM Facility do not exceed the specified thresholds, State T-NSR review has been completed for all new and modified emission units. To date, CMM's prioritization score has been below 10 which is the threshold for a High Priority Facility. Only above this threshold is a health risk assessment required. As the 2022 Mine Plan of Operations proposes to utilize grid power for half of the onsite power needs of stationary equipment, this will eliminate the majority of diesel generators currently operating at the site and will reduce potential health risks from corresponding diesel particulate matter (DPM) emissions from stationary sources.

It is also relevant to note that with the CAPCOA Facility Prioritization Guidelines, receptor proximity adjustments are only provided for distances up to 2 km (1.2 miles). As discussed above, CMM's nearest sensitive receptor is over 5 miles from the Project site; therefore, the resulting health risks and prioritization scores would be even lower than those quantified to date.

USEPA NESHAP Subpart EEEEEEE

NESHAP Subpart EEEEEEE (Gold Mine Ore Processing and Production)[19], which was developed in 2011, establishes mercury emission limits for the following processes at gold production facilities for existing and new sources: ore-pretreatment processes, carbon processes with and without mercury retorts, and non-carbon concentrate processes. This regulation includes annual compliance testing, ongoing monitoring, reporting, and recordkeeping requirements which would be applicable to proposed operations under the 2022 Mine Plan of Operations.

[17] MDAQMD. Rule 1320 New Source Review for Toxic Air Contaminants. Last amended: 2021. https://www.mdaqmd.ca.gov/home/showpublisheddocument/8802/637562297984770000. Accessed August 2025.

[18] CAPCOA. 2016. Air Toxics "Hot Spots" Program: Facility Prioritization Guidelines. August. Available online at: https://ww2.arb.ca.gov/sites/default/files/classic/ab2588/CAPCOA%20Prioritization%20Guidelines%20-%20August%202016%20FINAL.pdf. Accessed August 2025.

[19] USEPA. NESHAP Subpart EEEEEEE. 2011. https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-63/subpart-EEEEEEE. Accessed August 2025.

USEPA Toxic Release Inventory (TRI) Program

Under Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA), the Toxics Release Inventory (TRI) program[20] tracks the waste management of certain toxic chemicals that may pose a threat to human health and the environment. Applicable facilities that manufacture, process, or otherwise use covered chemicals above threshold quantities established by the regulation are required to report corresponding releases, including releases to air, waste, and water mediums. The information collected under the TRI program is intended to inform the public and surrounding communities about the release of toxic chemicals from covered facilities and aids in regulatory, guidance, and standard development. CMM has reported under this program during historical site operations in the 1990s and early 2000s and annually since 2020 when mining operations were resumed.

USEPA Risk Management Program and California Accidental Release Prevention (CalARP) Program

The USEPA is required by the Clean Air Act (CAA) Amendments of 1990[21] to publish regulations and guidance for chemical accident prevention at facilities using select hazardous substances. The Risk Management Plan Program Rule (i.e., the "Federal RMP") was written to implement Section 112(r) of these amendments. The rule built upon existing industry codes and standards, requires organizations of all sizes that use certain flammable and toxic substances to develop a Risk Management Program and submit a summary of the facility's risk management program, known as a Risk Management Plan (RMP). The requirements of these plans are detailed and codified in 40 CFR Part 68, and include hazard assessments, prevention programs, and emergency response programs and procedures.

The CalARP[22] Program is a merging of the federal and state programs for the prevention of accidental releases of regulated toxic and flammable substances. The goal is to eliminate the need for two separate and distinct chemical risk management programs. The CalARP Program has additional requirements specific to the State of California, in accordance with the California Health and Safety Code.[23] Similar to the Federal program, CalARP was implemented to prevent and minimize the accidental release of substances that can cause serious harm to the public and environment. Facilities that handle, manufacture, use, or store regulated substances above threshold quantities are required to prepare, submit, and routinely update an RMP, including an offsite consequence analysis.

The CMM Facility prepared and submitted an RMP under the CalARP program for sodium cyanide upon resuming mining operations in 2020. The RMP for the CMM Facility was last updated in 2024.

[20] USEPA. Toxic Release Inventory Program. https://www.epa.gov/toxics-release-inventory-tri-program. Codified under 40 CFR Part 372. Accessed August 2025.

[21] Clean Air Act §112(r)(1).

[22] CalEPA. California Accidental Release Prevention Program. https://calepa.ca.gov/california-accidental-release-prevention/. Accessed August 2025.

[23] California Health and Safety Code, Chapter 6.95, Article 2, Sections 25531-25543.3

6. CLIMATE ANALYSIS

6.1 CEQA Significance Criteria

Section 15064.4 of California's CEQA guidelines[24] provides direction to lead agencies for determining the significance of a project's GHG emissions. According to the guidelines, a lead agency should consider the following factors when evaluating whether a project has a significant impact for GHG emissions:

- The extent to which the project may increase or reduce GHG emissions as compared to the existing environmental setting.
- Whether the project emissions exceed a threshold of significance that the lead agency determines applies to the project.
- The extent to which the project complies with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of GHG emissions. Such requirements must be adopted by the relevant public agency through a public review process and must reduce or mitigate the project's incremental contribution of GHG emissions.

In practice, the Environmental Checklist Form found in Appendix G of the CEQA guidelines[25] is often used as a basis for a lead agency's significance determinations. The Environmental Checklist Form recommends evaluating whether a project would:

1. Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment; or
2. Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of GHGs.

The Project's expected GHG emissions are provided in **Section 6.2**. The MDAQMD CEQA and Federal Conformity Guidelines[26] use a mass emissions threshold to determine if a project is significant for GHG emissions. A project is significant under the MDAQMD CEQA Guidelines if the total direct and indirect CO_2 emissions exceed 100,000 tpy or 548,000 pounds per day (lb/day).

In 2011, San Bernardino County released its first Greenhouse Gas Reduction Plan (GHGRP) to implement strategies to reduce GHG emissions. The 2011 plan targeted a 15% reduction of GHG emissions from 2007 levels to a 2020 target date. Following the 2011 GHGRP, the state published additional climate regulation, including Senate Bill 32 in 2016, which targets reducing emissions by 40% from 1990 levels to a 2030 target date. In 2021, San Bernardino County released an update to its GHGRP[27] to continue to ensure conformity with the state's climate regulations, including Senate Bill

[24] California Office of Administrative Law. 2018. California Code of Regulations, 14 CCR 15064.4. https://govt.westlaw.com/calregs/Document/I87CE0CC45B4D11EC976B000D3A7C4BC3. Accessed August 2025.

[25] California Office of Administrative Law. 2018. California Code of Regulations, 14 CA ADC Div. 6 Ch. 3 App. G. https://govt.westlaw.com/calregs/Document/I8EA91DA75B4D11EC976B000D3A7C4BC3. Accessed August 2025.

[26] MDAQMD. 2020. Mojave Desert Air Quality Management District California Environmental Quality Act and Federal Conformity Guidelines. https://www.mdaqmd.ca.gov/home/showpublisheddocument/8510/638126583450270000. Accessed August 2025.

[27] San Bernardino County. 2021. County of San Bernardino Greenhouse Gas Reduction Plan Update. https://lus.sbcounty.gov/wp-content/uploads/sites/48/GreenhouseGas/GHG_2021/GHG-Reduction-Plan-Update-Greenhouse-Gas-Reduction-Plan-Update-Adopted-9-21-2021.pdf. Accessed August 2025.

32. The 2021 GHGRP update includes plans and strategies to continue reducing GHG emissions to reach the 2030 target and predicts the outlined reductions will put the county on the trajectory to reach carbon neutrality by 2045.

In 2022, the state released AB 1279, creating a new target to reduce GHG emissions by at least 85% from 1990 levels to a 2045 target date and achieve carbon neutrality. CARB then approved the third update to California's scoping plan,[28] which lays out strategies by sector to achieve the state's target of achieving carbon neutrality by 2045. Appendix D of the third scoping plan discusses the role local governments have in adopting land use and climate action plans to support the state's GHG goals.[29] Local strategies that are prioritized in Appendix D of the third scoping plan include electrifying transportation, reducing vehicle miles traveled, and decarbonizing buildings. Although AB 1279 and the third update to the scoping plan were released after San Bernardino County released its 2021 GHGRP update, the GHGRP update includes forecasts and strategies for greenhouse gas reductions continuing through 2045. Notably, the plan considers Executive Order (EO) B-55-18 in its reduction estimates and projections, which established a target to achieve statewide carbon neutrality by 2045 and was later codified by AB 1279.

The 2021 GHGRP update focuses on reducing GHG emissions in several primary source categories: building energy consumption, renewable energy, mobile traffic, off-road equipment, solid waste generation, and water consumption. Notably, neither the 2011 GHGRP nor the 2021 update contains specific measures or requirements for mining projects to reduce GHG emissions.

Appendix A of the 2021 GHGRP update provides a development review process for CEQA projects that can be used to evaluate GHG significance. Projects that emit less than 3,000 metric tons (MT) of carbon dioxide equivalent (CO_2e) per year are considered less than significant with the application of GHG performance standards. Projects emitting more than 3,000 MT of CO_2e per year can either use the screening tables provided as Attachment 2 to Appendix A of the 2021 GHGRP update or quantify emissions to demonstrate that emissions by 2030 will be reduced by 40% below 1990 levels of emissions. To demonstrate a project is less than significant using the screening tables, point values are assigned for emission reduction measures, and the sum of a project's reduction measures point value must equal at least 100. The screening tables for commercial or industrial projects include measures relating to building envelope improvements, indoor space efficiencies, commercial building efficiencies, clean energy for buildings, efficient water usage for irrigation or landscaping, mixed-use development measures, bicycle route inclusion, and landfill waste reduction. Because the measures are heavily focused on new building developments, the use of these tables may not be appropriate for a mining project, and Project-specific quantification and evaluation of emissions should be performed.

6.2 GHG Year-by-Year Inventory

Annual emissions of GHGs are estimated for Project combustion sources including on-site and off-site mobile vehicles and equipment, (i.e., worker commute vehicles, non-road equipment and haul trucks, fuel delivery trucks, reagent and non-reagent delivery trucks, and product delivery and blasting contractor trucks), diesel generators, NG turbines, LNG storage, electricity usage, solid waste, and

[28] CARB. 2022. 2022 Scoping Plan for Achieving Carbon Neutrality. https://ww2.arb.ca.gov/sites/default/files/2022-12/2022-sp.pdf. Accessed August 2025.

[29] CARB. 2022. 2022 Scoping Plan for Achieving Carbon Neutrality, Appendix D. https://ww2.arb.ca.gov/sites/default/files/2022-11/2022-sp-appendix-d-local-actions.pdf. Accessed August 2025.

wastewater. Annual GHG emissions from construction and operational years are summarized in **Table GHG-1**.

GHG emissions from construction were developed following the methodologies presented in Section 2 above. Project specific data such as equipment quantities, types, sizes, and worker and vendor travel to and from the site were utilized with fuel specific emission factors sourced from USEPA and CARB. Construction GHG emission estimates, including detailed methodologies and inputs, are presented in **Tables GHG-2 through GHG-5**.

GHG emissions from Project operation were developed consistent with the methodologies presented in Section 2 above, but select sources take into account annual variations expected during the mine life. Emissions from on-site mobile equipment were estimated based on Project-specific estimates of annual fuel use, which varies over the life of the mine, and emission factors sourced from USEPA. Emissions from off-site mobile vehicles utilize the same annual trip rates and distances as the maximum operational year and conservatively apply these rates across all years. Emission factors for on-road mobile vehicles are sourced from CARB's EMFAC model. GHG emissions from blasting operations (explosive use) also conservatively utilize explosive quantities from the maximum expected operational year and apply those quantities to all years of mining operation. Blasting GHG emission factors are sourced from the Mining Association of Canada and USEPA's Compilation of Air Pollutant Emission Factors (AP-42). GHG emissions from stationary combustion sources including NG turbines and diesel generators utilize activity rates consistent with the maximum expected operation year, conservatively applied to all years of the mine life, and emission factors sourced from USEPA. GHG emissions from LNG storage tanks utilize methodologies and emission factors consistent with ARB and USEPA guidance. Electricity loads for all years are conservatively assumed to be equivalent to the maximum operational year, but emission factors were derived for two operational periods: 2027-2029 and 2030+ to account for renewable energy goals of NV Energy and SCE. GHG emissions from solid waste and wastewater are consistent with estimates presented for the maximum operational year and are conservatively assumed to be constant over all operational years. For solid waste, waste generation rates were based on industrial standards and the number of employees, with emission factors and treatment types sourced from CalEEMod. Wastewater emissions were estimated using projected potable water usage rates emission factors from CalEEMod, considering on-site septic system treatment. GHG emission estimates for Project operations, with detailed methodologies and inputs, are presented in **Tables GHG-6 through GHG-16**.

On-site diesel off-road units will use renewable diesel fuel (when available from suppliers), consistent with regulatory requirements under the CARB In-Use Off-Road Diesel-Fueled Fleets Regulation and CMV commitments. CO_2 emissions from renewable diesel use have been accounted for in the inventories as biogenic emissions. Similarly, LNG delivery trucks will be fueled by renewable compressed natural gas (CNG), and associated CO_2 emissions are accounted for as biogenic. Per BAAQMD guidance[30], "biogenic CO_2 emissions should not be included in the quantification of GHG emissions for a project". Similarly, as noted by CARB in their GHG emissions trend report from 2000 to 2021: "Biogenic CO_2 is tracked separately from the rest of the emissions in the AB 32 GHG Inventory and is not included in the total emissions when comparing to California's GHG reduction

[30] BAAQMD. 2017. California Environmental Quality Act Air Quality Guidelines. May. Available at: https://www.baaqmd.gov/~/media/files/planning-and-research/ceqa/ceqa_guidelines_may2017-pdf.pdf?la=en&rev=0d2d971e661d41f28a56953f1776bdde. Accessed August 2025.

goals."[31] Specific to renewable diesel, the Metropolitan Water District of Southern California's Climate Action Plan notes that "[b]ecause the CO_2 emissions associated with renewable diesel fuels are biogenic, those emissions do not contribute to climate change."[32] Nonetheless, biogenic emissions are conservatively quantified and evaluated here.

For purposes of this analysis, Project construction is assumed to begin as early as year 2026 and is expected to occur over a period of 18 months. Project operations are assumed to occur as early as year 2027, with the first year of operation conservatively assumed to overlap with a portion of construction. Actual construction and operational periods may be later than those presented here and overlap of the construction and operational phases may not occur.

GHG emissions presented and evaluated in this analysis also include mining activity that is currently approved and thus represent a conservative evaluation of the Project's potential climate impacts.

Emissions of CO_2, methane (CH_4), and nitrous oxide (N_2O) are used to calculate total CO_2e emissions using the 100-year and 20-year global warming potentials (GWPs) from the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6)[33]. The IPCC AR6 GWPs are provided in **Table 6-1**. The IPCC AR6 presents different GWPs for fossil and non-fossil methane emissions since methane emitted from fossil fuel sources has a slightly greater potential for warming. The emissions inventory calculates CO_2e from biogenic emissions using the non-fossil origin GWPs for CO_2 and CO_2e from other emission sources using the fossil origin GWPs.

Table 6-1. Global Warming Potentials Adapted from Sixth Assessment Report of the Intergovernmental Panel on Climate Change[33]

Time Horizon	CO_2	CH_4	N_2O
Fossil Origin			
100 Year	1	29.8	273
20 Year	1	82.5	273
Non-Fossil Origin			
100 Year	1	27.2	273
20 Year	1	80.8	273

Annual GHG emissions from biogenic sources are presented for the Project life in **Table 6-2**. Biogenic emissions primarily result from three sources: exhaust from on-site mobile equipment powered by biogenic fuels (e.g., drills, loaders, haul trucks, dozers, and excavators), exhaust from LNG fuel delivery trucks fueled by RNG, and emissions from organic solid waste generated from the site.

[31] CARB. 2023. California Greenhouse Gas Emissions from 2000 to 2021: Trends of Emissions and Other Indicators. December. Available online at: https://ww2.arb.ca.gov/sites/default/files/2023-12/2000_2021_ghg_inventory_trends.pdf. Accessed August 2025.

[32] Metropolitan Water District of Southern California. 2022. Climate Action Plan. May. Available online at: https://www.mwdh2o.com/media/12469/final-cap.pdf. Accessed August 2025.

[33] IPCC. 2021. Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Available online at: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_FullReport.pdf. Accessed August 2025.

Methane and nitrous oxide emissions from these sources were conservatively grouped with non-biogenic emissions consistent with statewide reporting formats[34].

Table 6-2. Annual and Project Lifetime GHG emissions from Biogenic Sources (metric tons)

Year	CO_2	CH_4	N_2O	CO_2e[1] (100-year GWP)	CO_2e[1] (20-year GWP)
2025	-	-	-	-	-
2026	7,526	-	-	7,526	7,526
2027	7,146	-	-	7,146	7,146
2028	19,309	-	-	19,309	19,309
2029	55,971	-	-	55,971	55,971
2030	60,415	-	-	60,415	60,415
2031	64,479	-	-	64,479	64,479
2032	68,191	-	-	68,191	68,191
2033	65,151	-	-	65,151	65,151
2034	69,671	-	-	69,671	69,671
2035	72,388	-	-	72,388	72,388
2036	69,069	-	-	69,069	69,069
2037	64,822	-	-	64,822	64,822
2038	71,262	-	-	71,262	71,262
2039	73,354	-	-	73,354	73,3524
2040	80,002	-	-	80,002	80,002
2041	82,533	-	-	82,533	82,533
2042	79,351	-	-	79,351	79,351
2043	74,005	-	-	74,005	74,005
2044	38,152	-	-	38,152	38,152
2045	6,962	-	-	6,962	6,962
Lifetime	**1,129,759**	**-**	**-**	**1,129,759**	**1,129,759**
Annual Average	**56,488**	**-**	**-**	**56,488**	**56,488**

[1] CO_2e from biogenic sources are calculated using non-fossil origin GWPs from IPCC AR6.

Annual GHG emissions from non-biogenic sources result from exhaust from on- and off-site on-road mobile equipment, diesel generators,[35] on-site power generation via NG turbines, blasting and blast hole drilling, electricity usage, solid waste, and wastewater and are presented for the Project life in **Table 6-3**.

[34] CARB. 2023. California Greenhouse Gas Emissions from 2000 to 2021: Trends of Emissions and Other Indicators. December. Available online at: https://ww2.arb.ca.gov/sites/default/files/2023-12/2000_2021_ghg_inventory_trends.pdf. Accessed August 2025.

[35] Diesel generators will likely utilize renewable diesel but have conservatively been assumed to use conventional diesel (non-biogenic) in this analysis.

Table 6-3. Annual and Project Lifetime GHG emissions from Non-biogenic Sources (metric tons)

Year	CO_2 (Metric Tons)	CH_4 (Metric tons)	N_2O (Metric tons)	CO_2e 100-year [1] (Metric tons)	CO_2e 20-year [1] (Metric tons)
2025	-	-	-	-	-
2026	2,647	0.73	0.85	2,900	2,939
2027	84,921	317	1.4	94,771	111,498
2028	83,618	319	2.4	93,757	110,542
2029	83,618	322	5.5	94,710	111,674
2030	79,593	322	5.8	90,780	107,749
2031	79,593	322	6.2	90,886	107,874
2032	79,593	323	6.5	90,982	107,989
2033	79,593	322	6.2	90,903	107,895
2034	79,593	323	6.6	91,021	108,035
2035	79,593	323	6.9	91,091	108,119
2036	79,593	323	6.6	91,005	108,016
2037	79,593	322	6.2	90,895	107,885
2038	79,593	323	6.8	91,062	108,084
2039	79,593	323	6.9	91,117	108,148
2040	79,593	324	7.5	91,290	108,354
2041	79,593	324	7.7	91,355	108,432
2042	79,593	324	7.4	91,273	108,334
2043	79,593	323	7.0	91,134	108,169
2044	79,593	320	3.9	90,201	107,062
2045	79,593	317	1.3	89,389	106,099
Lifetime	**1,528,288**	**6117**	**110**	**1,740,522**	**2,062,896**
Annual Average	**76,414**	**306**	**5.5**	**87,026**	**103,145**

[1] CO_2e from non-biogenic sources are calculated using fossil origin 100-year and 20-year GWPs from IPCC AR6

Total annual GHG emissions from biogenic and non-biogenic sources for the Project life are shown in **Table 6-4**. The maximum total annual GHG emissions occur in 2041.

Table 6-4. Annual and Project Lifetime GHG Emissions from Biogenic and Non-biogenic Sources (metric tons)

Year	CO_2 (Metric Tons)	CH_4 (Metric tons)	N_2O (Metric tons)	CO_2e 100-year (Metric tons)	CO_2e 20-year (Metric tons)
2025	-	-	-	-	-
2026	10,172	0.73	0.85	10,426	10,465
2027	92,067	317	1.4	101,917	118,644
2028	102,928	319	2.4	113,066	129,851
2029	139,590	322	5.5	150,682	167,645
2030	140,008	322	5.8	151,195	168,164
2031	144,071	322	6.2	155,364	172,353
2032	147,783	323	6.5	159,173	176,180
2033	144,744	322	6.2	156,054	173,046
2034	149,264	323	6.6	160,692	177,706
2035	151,981	323	6.9	163,479	180,507

Year	CO_2 (Metric Tons)	CH_4 (Metric tons)	N_2O (Metric tons)	CO_2e 100-year (Metric tons)	CO_2e 20-year (Metric tons)
2036	148,662	323	6.6	160,074	177,085
2037	144,415	322	6.2	155,717	172,707
2038	150,854	323	6.8	162,324	179,346
2039	152,947	323	6.9	164,471	181,503
2040	159,595	324	7.5	171,292	188,356
2041	162,126	324	7.7	173,889	190,965
2042	158,944	324	7.4	170,624	187,685
2043	153,598	323	7.0	165,139	182,174
2044	117,744	320	3.9	128,352	145,213
2045	86,554	317	1.3	96,351	113,061
Lifetime	**2,658,048**	**6,117**	**110**	**2,870,282**	**3,192,655**
Annual Average	**132,902**	**306**	**5.5**	**143,514**	**159,633**

6.3 Greenhouse Gas Impact Analysis

On February 25, 2025, the Council on Environmental Quality (CEQ) published an interim final rule[36] to remove its regulations implementing NEPA. On May 28, 2025, CEQ rescinded its 2023 interim guidance on considering greenhouse gas emissions under NEPA. CEQ Memorandum[37] on Implementation of the National Environmental Policy Act (02/19/25) notes that "Federal agencies should analyze the reasonably foreseeable effects of the proposed action consistent with section 102 of NEPA, which does not employ the term "cumulative effects;" NEPA instead requires consideration of "reasonably foreseeable" effects, regardless of whether or not those effects might be characterized as "cumulative."" On July 3, 2025[38], the Department of Interior (DOI) published updated NEPA implementing regulations. The GHG analysis presented here follows these updated guidance, regulations, and NEPA statutory requirements when relevant to GHGs.

The annual average GHG emissions for biogenic and non-biogenic sources are summarized in **Table 6-5**. On-site mobile equipment (biogenic) is the largest contributor to the total GHG emissions, accounting for approximately 39% of the total 100-year CO_2e emissions throughout the Project lifetime. The second largest contributor is on-site power generation, contributing 33% of the total 100-year CO_2e emissions throughout the Project lifetime. The third largest contributor is electricity usage, which makes up roughly 17% of the total GHG emissions throughout the Project lifetime. The annual average GHG emissions for biogenic and non-biogenic sources, as well as the total GHG emissions across the life of the Project, are shown in **Table 6-5**.

[36] https://www.federalregister.gov/documents/2025/02/25/2025-03014/removal-of-national-environmental-policy-act-implementing-regulations

[37] https://ceq.doe.gov/docs/ceq-regulations-and-guidance/CEQ-Memo-Implementation-of-NEPA-02.19.2025.pdf

[38] https://www.federalregister.gov/documents/2025/07/03/2025-12433/national-environmental-policy-act-implementing-regulations

Table 6-5. Annual Average GHG Emissions from Biogenic and Non-biogenic Sources and Total Annual and Lifetime Total GHG Emissions (metric tons)

Category	CO_2 (Metric Tons)	CH_4 (Metric tons)	N_2O (Metric tons)	CO_2e 100-year (Metric tons)	CO_2e 20-year (Metric tons)
Biogenic	56,488	-	-	56,488	56,488
Non-biogenic	76,414	306	5.5	87,026	103,145
Total	132,902	306	5.5	143,514	159,633
Lifetime Total	2,658,048	6,117	110	2,870,282	3,192,655

Note: Numbers may not add exactly due to rounding.

6.3.1 GHG Equivalencies

Following the 2023 CEQ NEPA GHG guidance, the USEPA GHG emissions equivalencies calculator[39] was used to convert the total annual average CO_2, CH_4, and N_2O emissions from the Project into equivalent GHG emissions/reductions from other more readily understandable sources. **Table 6-6** shows the number of coal-fired power plants, gasoline-powered passenger vehicles, and other more commonly understandable emissions sources that would result in the equivalent amount of annual GHG emissions produced or avoided from the average annual GHG emissions from the Project.

Table 6-6. Comparison of the Annual Average Greenhouse Gas Emissions to Equivalent Annual GHG Emissions Produced, Avoided, or Sequestered from other Common Activities

Source Type	Average Annual Project Related GHG Emissions* (metric tons of 100-year CO_2e)	Number of Gasoline Powered Passenger Vehicles (annual emissions produced)	Number of Homes' Electricity Use (annual emissions produced)	Number of railcars' worth of coal burned (annual emissions produced)	Gallons of gasoline consumed (annual emissions produced)	Number of Wind Turbines (annual emissions avoided)	Acres of US forests (annual emissions sequestered)
Biogenic	56,488	13,176	7,586	313	6,356,251	17	56,661
Non-biogenic	87,026	20,299	11,687	482	9,792,506	26	87,292
Total	143,514	33,475	19,273	795	16,148,757	43	143,953

Note: Numbers may not add exactly due to rounding.

6.4 Climate Indicators

This climate trend analysis evaluates observed and projected trends in relevant climate indicators to help inform the affected environment of the Project and potential impacts to and from climate change. The potential impacts of the Project on climate change are global due to the long-lived nature of the GHGs emitted, which would remain in the Earth's atmosphere and contribute to long-term climate change. Since the project is located in San Bernardino County in Southern California near the southern

[39] USEPA. 2025. Greenhouse Gas Equivalencies Calculator. Available online at: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator. Accessed August 2025.

border of Nevada, this analysis focuses on observed and projected climate trends for the county, the state of California, and the southwestern United States.

6.4.1 Observed Climate Trends

California's climate is marked by diversity, from dry desert regions in the southeast to cold and precipitous regions in the north. The Project is in the Inland Deserts region of California, characterized by a desert climate that houses some of the hottest and most arid conditions in the United States and is historically marked by periods of drought and intermittent intense precipitation[40,41]. The Project is near the southern border of Nevada, the driest state in the United States, where in the past 10 years the average annual precipitation has decreased by 2.2% and average annual temperatures have increased by 5.7% when compared to the beginning of the 20th century[42].

Precipitation is highly variable both spatially and temporally in California, with the southeastern region experiencing annual precipitation rates of less than 3 inches per year.[41] Since the start of 20th century, temperatures have increased almost 3 degrees Fahrenheit (°F) in California and average annual temperatures from 1991 to 2020 demonstrate that this period was substantially warmer than previous 30-year periods.[40]

The IPCC Sixth Assessment Report (AR6) asserts that human activities are responsible for atmospheric warming and have affected global systems in the oceans, atmosphere, and on land[43]. Surface temperatures were 1.09 degrees Celsius (°C) higher from 2011 to 2020 than they were from 1850 to 1900.[43] Additionally, the United States has been warming approximately 60% faster than the rest of the planet since 1970, altering both the frequency and intensity of extreme weather events throughout the country[44]. California experienced an increasing number of very warm nights (minimum temperature at or above 75°F) since the 1990s and a decreasing number of cold nights (minimum temperature of 20°F or lower) since 1995. [41]

IPCC[33] stated with medium confidence that the average precipitation over land has increased globally since 1950 and that human influence has contributed to this increasing pattern since the mid-20th century. Since 1901, annual average precipitation has increased by 4% across the United States but a

[40] United States Global Change Research Program (USGCRP), 2023: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA.

[41] Frankson, R., L.E. Stevens, K.E. Kunkel, S.M. Champion, D.R. Easterling, W. Sweet, and M. Anderson, 2022: California State Climate Summary 2022. NOAA Technical Report NESDIS 150-CA. NOAA/NESDIS, Silver Spring, MD, 6 pp.

[42] BLM. 2024. 2023 BLM Specialist Report on Annual Greenhouse Gas Emissions and Climate Trends. Available online at: https://www.blm.gov/sites/default/files/docs/2025-04/BLM-2023-Base-GHG-Report.pdf. Accessed August 2025.

[43] IPCC. 2023. Climate Change Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee, and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 35–115, doi: 10.59327/IPCC/AR6-9789291691647. Available online at: https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_LongerReport.pdf. Accessed August 2025.

[44] Marvel, K., W. Su, R. Delgado, S. Aarons, A. Chatterjee, M.E. Garcia, Z. Hausfather, K. Hayhoe, D.A. Hence, E.B. Jewett, A. Robel, D. Singh, A. Tripati, and R.S. Vose. 2023. Ch. 2. Climate trends. In: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Available online at: https://toolkit.climate.gov/sites/default/files/2025-07/NCA5_Ch2_Climate-Trends.pdf. Accessed August 2025.

decreasing pattern was observed in the Southwest United States.[45] Approximately half of California's precipitation consists of winter precipitation, which has been highly variable in the past 100 years, with snowpack levels approximately 10% lower from 2000 to 2020 than snowpack from 1980 to 2020.[41,42] Intense droughts often overlap with periods of low snowpack since California's hydrologic system is dependent on snowpack as a water source.[41]

The frequency and intensity of extreme events (such as heatwaves, flooding, drought, and wildfires) have increased globally since the 1950s likely due to human influence.[33] California's primary climate hazards consist of flooding, drought, and wildfires. Atmospheric rivers are a naturally occurring phenomenon in California, characterized by periods of intense precipitation caused by moist air traveling from the tropics to the West Coast.[41] Extreme weather events such as these have the potential to increase with climate change; the winter of 2016-2017 was the wettest in California's recorded history.[40,41] Increases in temperature can additionally worsen drought conditions, as seen in 2014 and 2015 when one of the most intense droughts in the state occurred, caused by high temperatures in tandem with substandard precipitation.[41] Lack of precipitation and wind activity can exacerbate wildfire occurrences during California summers, which in combination with heavy rain after the fact, could contribute to mudslides and flooding due to the denudation of vegetation. [41] Year 2020 was notable for some of the most devastating wildfire activity in the state, with historical records in the number of acres burned, the largest single fire, and the largest fire complex.[41] Furthermore, seven of the largest wildfires in California have occurred in the last six years.[40]

6.4.2 Projected Climate Trends

IPCC[33] projected with high confidence that global surface temperatures will continue to increase until at least the mid-21st century even under scenarios in which global GHG emissions rapidly decrease. Temperature increases are projected across both high and low emissions scenarios, but the lower pathways projections show increases only slightly higher than historical temperature records.[42] Any degree of warming would increase the severity of heat waves in the state. Further, the southern deserts of Nevada near the Project location are projected to have extreme high temperatures substantially increase.[42]

Climate modeling suggests there will be an increase in the frequency of intense rainfall events in California, particularly through atmospheric rivers.[42] The highest climate scenario (RCP8.5) projects increases in both frequency and severity of atmospheric rivers; however, overall precipitation is expected to decrease between 5% to 10% in southern California and southern Nevada by the middle of the 21st century compared to precipitation in the late 20th century under a high emissions pathway.[42,46]

Drought intensity will likely increase due to the rise in overall temperatures and decreases in precipitation which would increase the rate of soil moisture loss and reduce stream flow. In turn,

[45] Gonzalez, P., G.M. Garfin, D.D. Breshears, K.M. Brooks, H.E. Brown, E.H. Elias, A. Gunasekara, N. Huntly, J.K. Maldonado, N.J. Mantua, H.G. Margolis, S. McAfee, B.R. Middleton, and B.H. Udall, 2018: Southwest. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 1101–1184. doi: 10.7930/NCA4.2018.CH25. Available online at: https://repository.library.noaa.gov/view/noaa/19487. Accessed August 2025.

[46] Runkle, J., K.E. Kunkel, S.M. Champion, D.R. Easterling, and S.A. McAfee, 2022: Nevada State Climate Summary 2022. NOAA Technical Report NESDIS 150-NV. NOAA/NESDIS, Silver Spring, MD, 5 pp. Available online at: https://statesummaries.ncics.org/downloads/Nevada-StateClimateSummary2022.pdf. Accessed August 2025.

wildfires are also expected to become more intense and frequent due to temperature increases and precipitation decreases.[42] The southwestern United States is expected to continue to experience high-intensity wildfires in the near future, which will continue to disrupt and damage ecosystems.[42]

According to the United States Geological Survey (USGS) National Climate Change Viewer (2024), the annual average temperature in San Bernardino County from 2025 to 2049 is projected to be 1.12 °C to 2.71 °C higher than 1981 to 2010 under a high GHG emissions scenario (SSP5-8.5) and 0.81°C to 2.27 °C higher under an intermediate GHG emissions scenario (SSP2-4.5).[47] Most climate model projections do not indicate significant precipitation differences in San Bernardino County for the 2025 to 2049 time period under both scenarios compared to 1981 to 2010.

6.4.3 Downscaling

Potential future changes in the Project area due to climate change were evaluated using historical operational and weather data for California and high-resolution ("downscaled") global climate model projections through the Cal-Adapt[48] database. The Cal-Adapt climate tools provide the latest data and climate scenarios available for the state of California. Using data from the Coupled Model Intercomparison Project Phase 5 (CMIP5) and the Localized Constructed Analogs (LOCA) statistical downscaling approach, it is possible to use past climate history to improve the resolution of global climate models to assess localized impacts. Summary statistics are calculated for each time horizon using values from four global climate models (GCMs): CanESM2, CNRM-CM5, HadGEM2-ES, and MIROC5. This downscaling process was performed under two GHG emissions scenarios called Representative Concentration Pathways (RCPs), which were developed for use in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.[49]

The two RCPs analyzed are an intermediate scenario (RCP 4.5) and a higher-emissions scenario (RCP 8.5). The time horizons assessed were a mid-century time horizon (2035 to 2064) and an end-century time horizon (2070 to 2099). Baseline conditions, defined as the observed 1975 to 2004 average, were used to assess historical climate conditions. The primary climate variables assessed were annual average maximum temperature, annual average minimum temperature, and annual average precipitation.

Table 6-8 presents the 30-year averages under both RCP 4.5 and RCP 8.5 for both time horizons. **Table 6-9** presents the absolute change and percent change from baseline observation averages under both RCP 4.5 and RCP 8.5 for both time horizons. All parameters show increases over time. Average minimum temperature is projected to increase by 8.2% to 11.2% relative to baseline under RCP 4.5, and by 10.6% to 19.2% compared to baseline under RCP 8.5. The projected increases in the annual average maximum temperature are approximately 5.6% to 7.8% under RCP 4.5 and 7.3% to 12.4% under RCP 8.5, relative to the baseline period. Precipitation is projected to increase by 7.2% to 9.6% under RCP 4.5 and by 3.6% to 19.3% under RCP 8.5.

[47] United States Geological Survey (USGS). 2024. National Climate Change Viewer. Available online at: https://apps.usgs.gov/nccv/maca2/maca2_counties.html. Accessed August 2025.

[48] https://cal-adapt.org/tools/local-climate-change-snapshot/. Accessed August 2025.

[49] IPCC. 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. Available online at: https://www.ipcc.ch/site/assets/uploads/2018/05/SYR_AR5_FINAL_full_wcover.pdf. Accessed August 2025.

Annual average maximum temperatures are modeled to increase by 4.1 to 5.3 °F by mid-century and by 5.7 to 9.0 °F by the end of the century, depending on the RCP scenarios. Annual average minimum temperatures are modeled to increase by 4.0 to 5.2°F by mid-century and by 5.5 to 9.4 °F by the end of the century. Precipitation is variable, with projected increases of 0.3 to 0.6 inches by mid-century, and 0.8 to 1.6 inches by the end of the century, depending on the RCP scenario. Note that the modeled precipitation increase throughout the century under RCP 4.5 has a narrower range (0.6 to 0.8 inches) than under RCP 8.5 (0.3 to 1.6 inches).

Table 6-8. Average Baseline Values and Projected Change in Climate Indicators Under RCP 4.5 and RCP 8.5.

Parameter	Description	Units	Baseline (1975–2004) Average	Projected 30-yr Average under RCP 4.5 30-yr Average (Range)		Projected 30-yr Average under RCP 8.5 30-yr Average (Range)	
				2035–2064	2070–2099	2035–2064	2070–2099
Annual Average Maximum Temperature	Average of the hottest (maximum) temperatures for every day in a year	°F	72.7	76.8 (73.1–80.2)	78.4 (75.5–81.9)	78.0 (74.4–83.3)	81.7 (76.3–86.4)
Annual Average Minimum Temperature	Average of the coldest (minimum) temperatures for every day in a year	°F	48.9	52.9 (50.4–56.5)	54.4 (51.7–56.7)	54.1 (51.0–58.4)	58.3 (53.9–63.2)
Annual Average Precipitation	Total precipitation in the form of rain or snow over the course of a year	inches	8.3	8.9 (2.4–18.0)	9.1 (3.0–21.7)	8.6 (2.6–19.9)	9.9 (3.0–27.4)

Table 6-9. Annual Baseline Values with Absolute and Percent Change in Climate Indicators Under RCP 4.5 and RCP 8.5.

Parameter	Description	Units	Baseline (1975–2004) Average	Change from Baseline under RCP 4.5 Absolute (% change)		Change from Baseline under RCP 8.5 Absolute (% change)	
				2035–2064	2070–2099	2035–2064	2070–2099
Annual Average Maximum Temperature	Average of the hottest (maximum) temperatures for every day in a year	°F	72.7	4.1 (5.64)	5.7 (7.84)	5.3 (7.29)	9 (12.38)
Annual Average Minimum Temperature	Average of the coldest (minimum) temperatures for every day in a year	°F	48.9	4 (8.18)	5.5 (11.25)	5.2 (10.63)	9.4 (19.22)
Annual Average Precipitation	Total precipitation in the form of rain or snow over the course of a year	inches	8.3	0.6 (7.23)	0.8 (9.64)	0.3 (3.61)	1.6 (19.28)

6.5 Combined GHG Impacts

Project-related greenhouse gases emissions are discussed in **Section 6.2**. Annual average emissions of biogenic GHGs from the Project (based on 100-year GWP values) are approximately 56,488 metric tons of CO_2e, and annual average emissions of non-biogenic GHGs from the Project are approximately 87,026 metric tons of CO_2e, for a total annual average of 143,514 metric tons of CO_2e. Other GHG emissions considered in the combined effects analysis and presented in the following sections include county-level emissions from large GHG emitters, wildfire and prescribed burning, locomotive use, nonroad equipment, and on-road use.

6.5.1 Baseline Greenhouse Gases Emissions

The total gross GHG emissions for the United States in 2022 were 6,343.2 million metric tons (MMT) CO_2e, which has decreased by 3% compared to 1990.[50] The total net GHG emissions for the United States (including GHG sinks) in 2022 were 5,489 MMT CO_2e, which was 16.7% lower than 2005.[50]

In 2021 (the most recent year state-level data is available), the total gross and net GHG emissions for the state of California were 393.4 MMT and 376.4 MMT of CO_2e, respectively.[51] The energy sector contributed most of the state's GHG emissions with emissions of 323.1 MMT of CO_2e in 2021.[51] Within the energy sector, fossil fuel combustion was the top contributor, representing over 95% of the GHG emissions in California's energy sector.[51]

6.5.2 Greenhouse Gases Emissions from Stationary Large Emitters

USEPA's Greenhouse Gas Reporting Program requires all large emitters (facilities with annual GHG emissions of more than 25,000 MT of CO_2e) to report their annual GHG emissions. The emissions reported are collated by USEPA and are available to the public at the Facility Level Information on Greenhouse Gases (FLIGHT) Tool.[52] GHG emissions from large emitters in San Bernardino County in 2023 (most recent year available) are shown in **Table 6-10**. GHG emissions reported under the USEPA GHG Reporting Program are generally limited to stationary sources from defined source categories and do not include emissions from mobile or portable equipment, nor do they include indirect emissions from sources such as electricity use.[53,54]

The Cemex Construction Materials Pacific LLC, a cement production facility, had the highest reported GHG emissions in San Bernardino County in 2023. High Desert Power Project, a power plant, had the second highest emissions, followed by Searles Valley Minerals, a materials mining and production facility.

---

[50] USEPA. 2024a. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022. U.S. Environmental Protection Agency, EPA 530-R24-004. Available online at: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2002. Accessed August 2025.

[51] USEPA. 2023. Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2021. U.S. Environmental Protection Agency, EPA 430-R-23-002. Available online at: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2021. Accessed August 2025.

[52] USEPA. 2024c. Facility Level Information on Greenhouse Gases Tool (FLIGHT): 2022 Greenhouse Gas Emissions from Large Facilities. Available online at: https://ghgdata.epa.gov/ghgp/main.do. Accessed August 2025.

[53] https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98/subpart-C/section-98.30. Accessed August 2025.

[54] https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98/subpart-A. Accessed August 2025.

Table 6-10. Greenhouse Gases Emissions (in metric tons of CO_2e) in 2023 from Large Emitters in San Bernardino County, CA

Facility Name	2023 GHG Emissions (metric tons CO_2e)
CEMEX Construction Materials Pacific LLC	1,816,908
High Desert Power Project	1,585,414
Searles Valley Minerals	1,429,568
CalPortland Company Oro Grande Plant	1,424,150
Mitsubishi Cement Corp Cushenbury Cement Plant	1,178,982
Mountainview Generating Station	1,056,295
New-Indy Ontario, LLC	207,410
CALIFORNIA STEEL INDUSTRIES INC	164,102
Mid-Valley Sanitary Landfill	77,547
LINDE ONTARIO CA	70,757
PG&E HINKLEY COMPRESSOR STATION	59,972
MP Mine Operations LLC	58,720
Ivanpah Solar Electric Generating Facility	56,418
Victorville Sanitary Landfill	50,926
Loma Linda University	49,210
Landers Sanitary Landfill	47,543
PG&E TOPOCK COMPRESSOR STATION	46,870
BARSTOW SANITARY LANDFILL	46,101
US Marine Corps MCAGCC Twentynine Palms Environmental Affairs	38,143
VISTA METALS CORPORATION	32,234
COLTON SANITARY LANDFILL	26,776
Schlosser Forge Company	22,860
MILLIKEN SANITARY LANDFILL	21,894
SAN TIMOTEO SOLID WASTE DISPOSAL SITE(REDLANDS)	21,366
California Street Landfill	6,454
Agua Mansa Power	6,120
LUZ SOLAR PARTNERS VIII & IX LTD.	161
Total	**9,602,901**

Source: USEPA FLIGHT Tool[52]

6.5.3 County-level Sources Other Than Stationary Sources

California is especially prone to wildfires due to its dry summers and high temperatures. Wildfires in the state lead to large emissions of GHGs. Estimated emissions from wildfires and prescribed burning are available from the USEPA's 2020 National Emissions Inventory (NEI).[55] The current version of the NEI provides estimated county-level GHG emissions from wildfires and prescribed burning in 2020. The NEI also provides other anthropogenic GHG emissions from sources such as from locomotives, non-road equipment and on-road sources (other stationary source emissions from large emitters were

[55] USEPA. 2024d. 2020 National Emissions Inventory (NEI) Data. Available online at: https://awsedap.epa.gov/public/single/?appid=20230c40-026d-494e-903f-3f112761a208&sheet=5d3fdda7-14bc-4284-a9bb-cfd856b9348d&opt=ctxmenu,currsel. Accessed August 2025.

reported above in **Table 6-10**). The sum of GHG emissions from wildfires, prescribed burning, and other anthropogenic emissions in San Bernardino County is also shown in **Table 6-11**.

Table 6-11. Greenhouse Gases Emissions (in metric tons) from Wildfires, Prescribed Burning, and Other Anthropogenic Sources in San Bernardino County.

	CO_2	CH_4	N_2O	CO_2e (100-yr GWP)	CO_2e (20-yr GWP)
Wildfires	869,975	3,058	-	953,157	1,117,073
Prescribed Burns	15,051	54	-	16,506	19,373
Other Anthropogenic	13,282,608	402	198	13,347,679	13,369,235
Total	**14,167,634**	**3,514**	**198**	**14,317,342**	**14,505,681**

Source: 2020 USEPA National Emissions Inventory[55]

Note: The emissions for wildfires and prescribed burns include emissions from both flaming and smoldering.

6.5.4 Total Combined GHG Emissions

Total GHG emissions from San Bernardino County are approximately 24.06 MMT of CO_2e annually, which include 143.5 thousand metric tons (TMT) of Project related CO_2e emissions (including biogenic and non-biogenic emissions), 9.6 MMT of CO_2e from large emitters within San Bernardino County, 969.7 TMT of CO_2e from wildfire and prescribed forest burning, and 13.3 MMT of CO_2e from other anthropogenic emissions (**Table 6-12**). Projected annual GHG emissions from the Project account for a small portion (roughly 0.6%) of the total GHG emissions from the San Bernardino County area. The total emissions from this county account for approximately 6.29% of the total net GHG emissions in the state of California in 2022, and approximately 0.39% of the total net GHG emissions for the entire United States.[50] The county total emissions of 24.06 MMT of CO_2e account for approximately 0.8% of the 2030 target of total net GHG emissions for the United States of 3,162 to 3,293 MMT of CO_2e.

Table 6-12. Greenhouse Gases Emissions (in metric tons of CO_2e) from Project and San Bernardino County.

Emissions Source Type	GHG Emissions (100-year GWP)
Project Average Annual Biogenic	56,488
Project Average Annual Non-biogenic	87,026
Wildfires and prescribed burns	969,663
Stationary Large Emitters	9,602,901
Other Anthropogenic	13,347,679
Total	**24,063,757**

7. ENERGY ANALYSIS

The methodology and results for the Project's energy analysis are summarized in this technical report. **Section 7.1** presents the applicable CEQA thresholds of significance on the topic of energy and provides an overview of the approach. **Sections 7.2 through 7.5** present the methodology, assumptions, and results on the Project's impacts related to energy, including the Project's energy consumption during construction (**Section 7.2**) and operations (**Section 7.3**), a detailed discussion of the Project's energy consumption and energy-saving features with respect to the local, regional, and State's energy conservation landscape (**Section 7.4**), and analysis of the Project's consistency with applicable energy plans, policies, and regulations in California and Nevada (**Section 7.5**).

7.1 Applicable Thresholds and Methodology Overview

Section 15126.2(b) of the State CEQA Guidelines requires a CEQA document to analyze energy impacts to the extent relevant and applicable to the project.[56] In accordance with the environmental checklist in the State CEQA Guidelines (Appendix G), a project would result in potentially significant impacts if it would:

- Result in potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project construction or operation; or
- Conflict with or obstruct a state or local plan for renewable energy or energy efficiency.[57]

Appendix G of the CEQA Guidelines, the Environmental Checklist Form, is often used as the basis for lead agencies' selection of significance thresholds. The Environmental Checklist questions do not prescribe specific thresholds, which are selected at a lead agency's discretion.

Appendix F of the State CEQA Guidelines requires a discussion of the Project's environmental impacts related to energy conservation in six categories:

1. The project's energy requirements and its energy use efficiencies by amount and fuel type for each stage of the project including construction, operation, maintenance, and/or removal. If appropriate the energy intensiveness of materials may be discussed.
2. The effects of the project on local and regional energy supplies and requirements for additional capacity.
3. The effects of the project on peak and base period demands for electricity and other forms of energy.
4. The degree to which the project complies with existing energy standards.
5. The effects of the project on energy resources.
6. The project's projected transportation energy use requirements and its overall use of efficient transportation alternatives.

[56] CCR, Title 14, § 15126.2. https://www.law.cornell.edu/regulations/california/14-CCR-15126.2. Accessed August 2025.

[57] Association of Environmental Professionals. 2023. 2023 CEQA Statute and Guidelines. https://www.califaep.org/docs/CEQA_Handbook_2023_final.pdf. Accessed August 2025.

The analysis of energy-related impacts in **Sections 7.2 through 7.5** of this technical report discloses fossil fuel, renewable energy, and electricity consumption of the Project during both construction and operation, reviews the Project's impacts related to energy conservation in identified categories, and discusses consistency of the Project with applicable plans, policies, or energy regulations.

7.2 Energy Used During Project Construction

Construction of the Project is expected to occur over a period of 18 months, starting as early as 2026. Project construction may commence after this date, which would likely reduce any energy estimates presented here due to improving technology and increased regulation.

During the Project's construction period, there would be a temporary increase in energy consumption due to the on-road and off-road vehicle activity. This increase in energy consumption would be small compared to the energy used by the operations of the Project. To assist in the assessment of the potential energy-related impacts of the Project, the estimated fuel use during the construction phase is summarized in **Table E-1**.

Detailed fuel consumption by off-road equipment used during Project construction is summarized in **Table E-2**. The Project will use renewable diesel in all its off-road equipment, when available from suppliers. Implementation of this commitment by the Project reduces non-biogenic CO_2 emissions.

Detailed fuel consumption by on-road vehicles during Project construction is summarized in **Table E-3**. Fuel efficiency was estimated by vehicle and fleet type based on EMFAC2021 v1.0.1 data for MDAQMD, with assumed years of 2026 and 2027. Commuting trips to and from the vanpool were assumed to comprise a default fleet mix, while single-axle vehicles were assumed to have a 50/50 gasoline/diesel fleet, double-axle vehicles were assumed to be all diesel-fueled, and vanpool buses were assumed to be entirely gasoline-fueled.

7.3 Energy Used During Project Operation

Project operations would require long-term consumption of energy in the form of diesel fuel (renewable and conventional), electricity, natural gas (conventional transported in liquefied form and renewable used in compressed form), and gasoline. **Table E-4** summarizes the maximum annual energy consumption by the Project's operational activities. Proposed mining and processing activity is estimated to last approximately 25 years. To conservatively capture variations in year-to-year operations and to present a potential peak year of operation, maximum annual activity data was selected from each activity type, regardless of overlapping year. For example, maximum hauling operations and maximum equipment counts utilized in the energy inventory are projected to occur in different years but are conservatively used together in this energy assessment.

Energy use estimates presented and evaluated in this report also include the portion of mining activity that is currently approved and thus represent a conservative evaluation of the Project's potential energy impacts.

Project operations are conservatively estimated to begin as early as 2027, however operations may commence after this year, and emissions would be expected to decrease as improved technology, vehicle regulation, and additional renewable resources grow. For purposes of quantifying energy use, year 2027 EMFAC data was conservatively utilized for on-road travel.

Detailed fuel consumption by off-road vehicle fuel use during Project operations is summarized in **Table E-5**. The Project will use renewable diesel in all its off-road equipment, when available from suppliers. Implementation of this commitment by the Project reduces non-biogenic CO_2 emissions.

Detailed fuel consumption by on-road vehicles during Project operations, off-site and on-site, are summarized in **Table E-6** and **Table E-7**, respectively. Fuel efficiency was estimated by vehicle and fleet type based on EMFAC2021 v1.0.1 data for MDAQMD, with an assumed year of 2027. On-site pickup trucks, fuel delivery, product delivery, contractor, other delivery, and reagent delivery trucks are assumed to be entirely diesel-fueled, apart from the LNG fuel delivery trucks which are exclusively fueled by compressed renewable natural gas (RNG). Vanpool vans/buses are assumed to be entirely gasoline-fueled. Employee vehicles were assumed to comprise a default fleet mix.

Other forms of energy consumption of the Project operation would include renewable diesel consumed by emergency generators and diesel water well generators (**2022 Mine Plan of Operations Table O-25**), electricity used to power on-site facilities (e.g., crushing, agglomeration, and processing facilities) and off-site facilities (primarily water sourcing) (**2022 Mine Plan of Operations, Table O-29**), and NG consumed by the on-site power generating turbines (**2022 Mine Plan of Operations: Table O-32**). The Project will also have an on-site gasoline dispensing facility that will be used to fuel gasoline-fueled vehicles (**2022 Mine Plan of Operations: Table O-27**).

The electricity used to power on-site facilities is assumed to be met with 10 MW of energy generated on-site using NG turbines and 10 MW of grid power provided by NV Energy, with power for off-site water sourcing provided by SCE.

7.4 Analysis of Factors Identified in CEQA Guidelines Appendix F

Appendix F of the CEQA Guidelines identifies factors relating to whether a project would result in the wasteful, inefficient, or unnecessary consumption of fuel or energy and conversely whether the project would fail to incorporate renewable energy or energy efficiency measures into building design, equipment uses, transportation or other project features. The Appendix F factors are addressed below and used as guidance to evaluate the energy impact of the Proposed Project relative to the identified significance criteria.

7.4.1 Appendix F.II.C.1: Energy Requirements and Energy Use Efficiencies

CEQA Guidelines Appendix F, Section II.C.1, includes the following impact guidance factor:

The project's energy requirements and its energy use efficiencies by amount and fuel type for each stage of the project including construction, operation, maintenance and/or removal. If appropriate the energy intensiveness of materials may be discussed.

The energy estimates in this evaluation include electricity, fossil fuels, and renewable energy used for construction and operation of the Proposed Project. These energy use requirements are summarized in **Table E-1** for the construction activities and in **Table E-4** for a maximum year of proposed Project operations.

Energy consumption during construction will vary depending on factors such as the duration of the construction period, specific construction operations, equipment types, and number of workers. However, it is anticipated that fuel conservation would be prioritized during construction, as there is a financial disincentive for the contractor to waste fuel.

Energy consumption during operations will vary year to year. Conservatively, the estimates for renewable diesel consumption in **Table E-5** sum the maximum annual fuel usage for each piece of equipment regardless of the year. Many pieces of equipment achieve their maximum fuel usage rate in different years. As a result, the total renewable diesel shown in **Table E-4** is a conservative overestimate of annual fuel consumption and actual fuel consumption during the Project operations is expected to be lower, particularly near the beginning and end of the mine life. Specifically, when comparing the maximum annual projected fuel use to the minimum year of projected fuel use, 92% less fuel is consumed.

7.4.2 Appendix F.II.C.2: Local and Regional Energy Supplies

CEQA Guidelines Appendix F, Section II.C.2, includes the following impact guidance factor:

The effects of the project on local and regional energy supplies and on requirements for additional capacity.

As discussed above, the proposed Project would result in the consumption of electricity, gasoline, natural gas (LNG and RNG), and conventional and renewable diesel associated with mobile vehicle sources, facility energy use, on-site power generation, and construction activities. The Project's electricity is anticipated to be both generated on-site and sourced by NV Energy (for on-site power demands) and SCE (for off-site water sourcing). Total energy use requirements are shown in **Table E-1** for construction and **Table E-4** for a maximum year of proposed Project operations.

The Project would include RNG used by on-road LNG fuel delivery trucks and natural gas (transported to the site as LNG) to fuel the on-site power generating turbines. The Project would not include any propane fuel to fire stationary sources. Other types of fossil fuels consumed during Project operation would be conventional diesel used by on-road vehicles, renewable diesel fuel used by off-road equipment and emergency and water well generators (when available from suppliers), and gasoline fuel used by on-road vehicles.

The demand for gasoline during the entire construction period is estimated to be 266 thousand gallons. The demand for conventional diesel is estimated to be 159 thousand gallons and is only used for on-road vehicles. These amounts represent approximately 0.003% and 0.007% of the Southern California region's 2024 annual average gasoline and diesel production throughput,[58] respectively.

Given the Project's location, it is possible that fuel will be sourced from Nevada. The demand for gasoline and conventional diesel during construction represents approximately 0.02% and 0.04% of Nevada's 2021 annual gasoline consumption and 2020 annual diesel consumption,[59] respectively. According to the Governor's Office of Energy, 83% of the fuel used within Nevada for energy is sourced from outside of the state.[60] Nevada has one crude oil refinery which produces only asphalt and road oil; therefore, this 83% includes various petroleum products.[61] Nevada gets all gasoline and

[58] California Energy Commission (CEC). 2025. Refinery Inputs and Production. Available: https://www.energy.ca.gov/media/6522. Accessed August 2025.

[59] United States Department of Energy. 2023. Nevada Transportation Data for Alternative Fuels and Vehicles. Available: https://afdc.energy.gov/states/nv. Accessed August 2025.

[60] Governor's Office of Energy. January 2024. 2024 Status of Energy Report. Available: https://www.energy.nv.gov/siteassets/content/media/2024_Status_of_Energy_Report_Final.pdf. Accessed August 2025.

[61] United States Energy Information Administration. 2023. Nevada. https://www.eia.gov/state/analysis.php?sid=NV#81. Accessed August 2025.

diesel from out of state; Las Vegas specifically gets both fuels from refineries from Utah and California.[62]

The demand for renewable diesel during construction is estimated to be 1.11 million gallons, for use in off-road equipment. The Project's renewable diesel demand during construction represents approximately 0.4% of the estimated 2022 off-road vehicle diesel fuel consumption in California and 0.02% of the total existing and new[63] renewable diesel production nationwide.[64] Therefore, the impact of the Project construction on local and regional fuel supplies would be temporary and minimal.

Based on annual consumption of fuel during a maximum year of Project operations, as summarized in **Table E-4**, the annual demand for gasoline during operations is estimated to be 124 thousand gallons, and the demand for conventional diesel is estimated to be 196 thousand gallons for use in on-road vehicles. These amounts represent approximately 0.001% and 0.009% of the Southern California region's 2024 annual average gasoline and diesel production throughput,[65] respectively. These amounts represent approximately 0.01% and 0.05% of Nevada's 2021 annual gasoline consumption and 2020 annual diesel consumption,[66] respectively.

The demand for renewable diesel in the Project's maximum potential year of operation is estimated to be 8.29 million gallons, for use in off-road equipment. As discussed above, this is a conservative estimate of potential fuel use in a single year and will vary significantly over the mine life, with some years projected to be up to 92% lower. The Project's renewable diesel demand during this maximum potential year represents approximately 3.1% of the estimated 2022 off-road vehicle diesel-fuel consumption in California, 0.30% of the total renewable diesel reported into CARB's Low Carbon Fuel Standard (LCFS) program in 2024,[67] and 0.17% of the total existing and new[68] renewable diesel production nationwide.[69] These percentages were conservatively calculated using the maximum annual fuel demand of the Project, which is expected to occur well into the Project life. The availability of renewable diesel in future years is likely to be higher than it is today, meaning that these percentages would become smaller as the supply grows.

Presently, California's renewable diesel supply, including imports from outside of the state, is large enough and capable of providing fuel for the Project's demand. A number of refineries in the United States, including within California, are in the process of converting their production to export

[62] Ibid.

[63] "New" refers to the ongoing expansions of existing refineries and construction of new refineries committed to producing renewable diesel.

[64] California Air Resources Board (CARB). 2022. Public Hearing to Consider Proposed Amendments to the In-Use Off-Road Diesel-Fueled Fleet Regulation. Staff Report: Initial Statement of Reasons. Available: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/off-roaddiesel/isor.pdf. Accessed August 2025.

[65] California Energy Commission (CEC). 2023. Refinery Inputs and Production. Available: https://www.energy.ca.gov/media/6522. Accessed August 2025.

[66] United States Department of Energy. 2023. Nevada Transportation Data for Alternative Fuels and Vehicles. Available: https://afdc.energy.gov/states/nv. Accessed August 2025.

[67] California Air Resources Board (CARB). Low Carbon Fuel Standard (LCFS) Data Dashboard. Figure 2. https://ww2.arb.ca.gov/resources/documents/lcfs-data-dashboard. Accessed August 2025.

[68] "New" refers to the ongoing expansions of existing refineries and construction of new refineries committed to producing renewable diesel.

[69] California Air Resources Board (CARB). 2022. Public Hearing to Consider Proposed Amendments to the In-Use Off-Road Diesel-Fueled Fleet Regulation. Staff Report: Initial Statement of Reasons. Available: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/off-roaddiesel/isor.pdf. Accessed August 2025.

renewable diesel.[70] Operations of the Project are not expected to begin before 2027, which is after the anticipated completion dates of the modifications to these refineries.

Natural gas (transported to the site as LNG) will be consumed by the on-site power generating turbines. As show in **Table E-4**, the maximum annual natural gas usage is expected to be 940,000 million British thermal units (MMBTU) during Project operations. CMM will receive LNG directly from a supplier that sources the LNG from existing liquefaction plants in both Arizona and California. The supplier has identified three primary sources of LNG as well as two alternative sources to meet the Project's expected demand. With the combination of these sources providing LNG to CMM's supplier, the LNG consumption of the on-site turbines should not impact local supply. The Project's LNG demand during this maximum potential year represents approximately 0.07% of the natural gas consumption in California in 2023[71] and 0.17% of the natural gas consumption in Arizona in 2023[72]. The United States is a net exporter of LNG. In 2023, total baseload export capacity in the United States was 11.4 billion cubic feet per day (or 4.2 billion MMBtu per year).[73] The Project would consume approximately 0.02% of the United States' 2023 export capacity.

Compressed RNG will be consumed by the LNG fuel delivery trucks. As summarized in **Table E-4**, the annual demand for RNG during operations is estimated to be 8.4 MMBTU, (equivalent to 0.0083 million cubic feet [MMcf]). The Project's RNG demand during this maximum potential year represents approximately 0.00003% of the total biomethane reported into CARB's LCFS program in 2024[74] and 0.00002% of the United States' natural gas vehicle fuel consumption in 2024[75]. Across the country, transportation sectors are expected to have increases in demand for CNG as a result of the transportation decarbonization trends. California is currently the largest distributor of CNG in the United States, with 158 CNG fueling stations.[76]

As shown in **Table E-4**, the majority of the electricity consumption during Project operations would be from on-site facilities (e.g., crushing operations) and water sourcing which will be sourced from both on-site NG turbines and grid power. During Project operations, the electricity load from the grid is expected to be 111,800 megawatt hours (MWh), which includes 10 MW for on-site facilities, 1.3 MW for offsite water sourcing, and any supporting electricity use for EV or hybrid employee vehicle use. Due to the Project's location, it is expected that the primary 10 MW of grid-based electricity will be provided by NV Energy, and the 1.3 MW of off-site water sourcing will be provided by SCE. With this assumed sourcing distribution, the Project's on-site power demand would consume approximately

[70] Ibid.

[71] California Energy Commissions. 2025. Natural Gas Consumption. Available at: https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/california-energy-consumption-dashboards-1. Accessed August 2025.

[72] United States Energy Information Administration (EIA) 2025. Arizona. Available: https://www.eia.gov/state/?sid=AZ. Accessed August 2025.

[73] United States Energy Information Administration (EIA) 2024. Natural Gas Explained, Liquefied Natural Gas. Available: https://www.eia.gov/energyexplained/natural-gas/liquefied-natural-gas.php. Accessed August 2025.

[74] California Air Resources Board (CARB). Low Carbon Fuel Standard (LCFS) Data Dashboard. Figure 2. https://ww2.arb.ca.gov/resources/documents/lcfs-data-dashboard. Accessed August 2025.

[75] United States Energy Information Administration (EIA) 2024. Natural Gas, U.S. Natural Gas Vehicle Fuel Consumption. Available: https://www.eia.gov/dnav/ng/hist/n3025us2A.htm. Accessed August 2025.

[76] United States Department of Energy, Alternative Fuels Data Center. 2025. Compressed Natural Gas Fueling Stations by State. Available at: https://afdc.energy.gov/data/10368. Accessed August 2025.

0.2% of NV Energy's 2023 net generation[77], and the Project's off-site power demand would consume approximately 0.02% of SCE's 2023 net generation[78].

Regionally, and particularly in California, building and transportation sectors are expected to have increases in demand for electricity as a result of the building decarbonization and transportation electrification trends. At a State level, the California Energy Commission (CEC) reviews the integrated resources plans required by Senate Bill (SB) 350 that guide load-serving entities, such as community choice aggregators, to meet demand reliably and cost-effectively while meeting state policy goals and mandates.[79]

7.4.3 Appendix F.II.C.3: Peak and Base Period Demands

CEQA Guidelines Appendix F, Section II.C.3, includes the following impact guidance factor:

The effects of the project on peak and base period demands for electricity and other forms of energy.

Peak period electrical demand is the short period of time during which electrical power is needed when electricity is in highest demand. Base period electrical load is the minimum amount of electrical demand needed over a 24-hour time period. Wasteful, inefficient, or unnecessary consumption or use of energy during the peak period of electrical demand has greater potential to cause adverse environmental effects compared to during the base period because of the higher demand during the peak period. The Proposed Project's base energy consumption compared to regional and statewide energy consumption is discussed above. Further details on the peak demand are described below.

In 2024, NV Energy's Southern Nevada peak grid demand was 6,649 MW.[80] In 2024, California Independent System Operator (ISO)'s peak demand was 48,323 MW.[81] In comparison, the maximum grid-based peak demand for on-site power is anticipated to be consistent with the 10 MW grid supply. This potential peak demand would represent 0.2% of NV Energy's peak demand and 0.02% of California ISO's peak demand. Should short term spikes in power demand occur (e.g. during start-ups), the on-site power generating turbines can absorb 2-3 additional MW of generation. With proper planning of the power generation inventory, and the supplemental support of 10 MW of baseload on-site power, the Project would have a negligible effect on the grid-wide peak demand. Additionally, future improvements in demand response would further reduce peak demand through performance standards that are based on the time-dependent valuation of energy, which uses the value of the electricity or natural gas used during every hour of the year to incentivize load shifting from peak use periods.

---

[77] U.S. Energy Information Administration. 2024. Nevada Electricity Profile 2024. https://www.eia.gov/electricity/state/nevada/. Accessed August 2025.

[78] Edison Energy International (EEI). 2024. Electric Company ESG/Sustainability Quantitative Information. Available: https://download.edison.com/406/files/202410/eix-2024-esg-quantitative-section.pdf?Signature=g3zDixTh7LgM2UrjD9GlmXUVgmE%3D&Expires=1755084326&AWSAccessKeyId=AKIATACLJRQCT2IBV7MN&versionId=Fl8W1bOxoGGsI.Bit2T0_QfBClIzbXfF&response-content-disposition=attachment. Accessed August 2025.

[79] California Energy Commission (CEC) 2024. 2023 Integrated Energy Policy Report. https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2023-integrated-energy-policy-report. Accessed August 2025.

[80] NV Energy. 2024. NV Energy by the Numbers. https://www.nvenergy.com/about-nvenergy/our-company/facts. Accessed August 2025.

[81] California Independent System Operator Corporation (ISO). 2024. California ISO Peak Load History 1998 through 2024. https://www.caiso.com/documents/californiaisopeakloadhistory.pdf. Accessed August 2025.

7.4.4 Appendix F.II.C.4: Existing Energy Standards

CEQA Guidelines Appendix, Section II.C.4, includes the following impact guidance factor:

The degree to which the project complies with existing energy standards.

The Project would comply with existing energy standards and would not conflict with or obstruct the State and local plans for renewable energy or energy efficiency. During construction, the Project would adhere to the State's standards designed to minimize use of fuel in construction equipment and vehicles, such as the limit on equipment idling. A similar practice would be followed during operations for any off-road equipment. During operation, the Project would adhere to the State's and County's energy plans to minimize fossil fuel use by electrifying its stationary equipment, incorporating energy efficient design, and using alternative fuels for off-road equipment. The Project would also develop a vanpool program to reduce commute vehicle miles traveled (VMT) by workers during both construction and operation, which will effectively reduce petroleum consumption from vehicles. Therefore, construction and operation of the Project would be consistent with the State and local plans for renewable energy and energy efficiency.

7.4.5 Appendix F.II.C.5: Energy Resources

CEQA Guidelines Appendix F, Section II.C.5, includes the following impact guidance factor:

The effects of the project on energy resources.

As discussed above, the Project's energy use would be primarily associated with vehicle travel during construction, vehicle travel during operations, grid-based electricity use for on-site facilities (e.g., crushing operations), and LNG consumption for supplemental power generating turbines. The project would depend on the existing infrastructure for the distribution of liquid fuels, and electric power supply would be restored to the site to reduce the need for fossil fuels in stationary sources. Renewable diesel will be utilized to power construction equipment and operational off-road equipment, including the full mining fleet, when available from suppliers. The LNG used in the on-site power generating turbines will be sourced directly from a supplier with access to existing liquefaction plants, and the supporting fuel trucks will utilize compressed RNG fuel. Additionally, specific stationary source equipment will be electric-powered in place of traditional fuel sources such as propane, and overall energy use has been minimized where possible (e.g., exclusion of a mill in Project designs). The restoration of grid-based power supply to the site will allow an increasing mix of renewable energy via NV Energy to supply the site's power needs. While a maximum annual operational year was evaluated as part of this energy analysis, total fuel use during other years of the mine life will be lower and will subsequently have a lower impact on local energy resources. The Project's use of energy would not have a substantial adverse effect on statewide or regional energy resources relative to wasteful, inefficient, or unnecessary use of energy.

7.4.6 Appendix F.II.C.6: Transportation Energy Use

CEQA Guidelines Appendix F, Section II.C.6, includes the following impact guidance factor:

The project's projected transportation energy use requirements and its overall use of efficient transportation alternatives.

The Project's transportation energy use requirements in terms of gasoline, diesel, RNG, and electricity quantities for construction and operation of the Project are presented in **Table E-1** and **Table E-4**,

respectively. SB 743 requires the Office of Planning and Research (OPR) to identify new metrics for identifying and mitigating transportation impacts within CEQA. OPR has identified net VMT as well as VMT per capita and per employee as metrics for land use project transportation analyses. The quantification of VMT associated with Proposed Project operations, which is used to quantify the total operational transportation-related energy use requirements, is presented in **2022 Mine Plan of Operations Tables O-13a and O-13b**. The utilization of renewable diesel for off-road equipment, when available from suppliers, and vanpooling for both construction and operation reduces transportation energy use requirements. In addition, the implementation of enforceable statewide policies will guarantee that energy usage in transportation becomes increasingly efficient over time.

7.4.7 Summary of Energy Impact Analysis Based on Appendix F Guidelines

In conclusion, construction and operation of the Project would not result in wasteful, inefficient, and unnecessary consumption of energy resources. The Project would be consistent with relevant state and local plans for renewable energy and energy efficiency.

7.5 Consistency with Energy Plans

Appendix G of CEQA Guidelines requires a Project to analyze whether it would conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing environmental impacts related to energy. As discussed in this section, several State level plans (both California and Nevada), regional programs, as well as the County's adopted General Plan include energy conservation and energy efficiency strategies intended to enable the State and the County to achieve GHG reduction and energy conservation goals. The Project is evaluated for consistency with the following plans, polices, and regulations specific to energy:

- 2023 Integrated Energy Policy Report,
- AB 2076 Reducing Dependence on Petroleum,
- AB 1007 State Alternative Fuels Plans,
- Bioenergy Action Plan EO S-06-06,
- NV Energy's 2021 Integrated Resource Plan, and
- County of San Bernardino General Plan, Renewable Energy and Conservation Element.

Due to the Project's location, various aspects of the above plans may not be applicable; however, for completeness, a consistency analysis with all local, regional, and State plans, including Nevada, has been included below.

Descriptions of each plan, policy, and regulation are presented below. **Table 7.4-1** summarizes the Project consistency with each plan, policy, and regulation.

2023 Integrated Energy Policy Report

The CEC published the 2023 Integrated Energy Policy Report[82] to identify pathways to deeply decarbonize the state's electricity system in response to meeting the SB 100 goal of zero-carbon by 2045. The report provides an analysis of electricity sector trends, building decarbonization and energy

[82] California Energy Commission (CEC) 2024. 2023 Integrated Energy Policy Report. https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2023-integrated-energy-policy-report. Accessed August 2025.

efficiency, zero-emission vehicles, energy equity, climate change adaptation, electricity reliability, natural gas assessment, and electricity, natural gas, and transportation energy demand forecasts. The aim is to leverage California's clean electricity system to decarbonize, or remove carbon from, other portions of the state's energy system. SB 1389 (Chapter 568, Statutes of 2002) requires the CEC to conduct assessments and forecasts of all aspects of energy industry supply, production, transportation, delivery, distribution, electricity demand, and price to develop energy policies that conserve resources, protect the environment, ensure energy reliability, enhance the State's economy, and protect public health and safety.

AB 2076 Reducing Dependence on Petroleum

Pursuant to AB 2076,[83] in 2003, the CEC and CARB prepared and adopted a joint agency report, Reducing California's Petroleum Dependence. AB 2076 emphasizes the importance of adopting measures to improve transportation energy efficiency and expand the use of non-petroleum fuels to allow for a smooth transition away from petroleum dependence in the transportation sector. The areas of influence include legislative direction, fuel efficiency, and fuel substitution.

AB 1007 State Alternative Fuels Plans

AB 1007 (Chapter 371, Statutes 2005)[84] required the CEC to prepare a State plan to increase the use of alternative fuels in California. The CEC prepared the State Alternative Fuels (SAF) Plan in partnership with CARB and in consultation with other State, Federal, and local agencies. The SAF Plan presents strategies and actions California must take to increase the use of alternative, nonpetroleum fuels in a manner that minimizes costs to California and maximizes the economic benefits of in-State production. The SAF Plan assessed various alternative fuels and developed fuel portfolios to meet California's goals to reduce petroleum consumption, increase alternative fuel use, reduce GHG emissions, and increase in-State production of biofuels without causing a significant degradation of public health and environmental quality.

Executive Order S-06-06, Bioenergy Action Plan

EO S-06-06,[85] adopted April 25, 2006, establishes targets for the use and production of biofuels and biopower and directs State agencies to work together to advance biomass programs in California while providing environmental protection and mitigation. The EO establishes the following target to increase the production and use of bioenergy, including ethanol and biodiesel fuels made from renewable resources: produce a minimum of 20 percent of its biofuels in California by 2010, 40 percent by 2020, and 75 percent by 2050. EO S-06-06 also calls for the State to meet a target for use of biomass electricity.

The 2011 Bioenergy Action Plan[86] identifies significant financial and implementation barriers and recommends actions to address them so that the State can meet its clean energy, waste reduction,

[83] Assembly Bill (AB) 2076, 2000. http://www.leginfo.ca.gov/pub/99-00/bill/asm/ab_2051-2100/ab_2076_bill_20000930_chaptered.html. Accessed August 2025.

[84] AB 1007, 2005. http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_1001-1050/ab_1007_bill_20050616_amended_sen.html. Accessed August 2025.

[85] Executive Order (EO) S-06-06, 2006. https://www.dgs.ca.gov/-/media/Divisions/PD/OSDS/Outreach/Resources/SBExecOrderS-02-06.pdf?la=en&hash=63E3BA0346C5EDB69B664220CEF403E06734F95C. Accessed August 2025.

[86] CEC 2011. California's Bioenergy Action Plan. https://archive.epa.gov/region9/organics/web/pdf/cba-session5-cali-bioenergy-action-plan-mariscal.pdf. Accessed August 2025.

and climate protection goals. The 2012 Bioenergy Action Plan[87] updates the 2011 Plan and provides a more detailed action plan to achieve the following goals.

- Increase environmentally and economically sustainable energy production from organic waste.
- Encourage development of diverse bioenergy technologies that increase local electricity generation, combined heat and power facilities, renewable natural gas, and renewable fuels for transportation and fuel cell applications.
- Create jobs and stimulate economic development, especially in rural regions of the State.
- Reduce fire danger, improve air and water quality, and reduce waste.

NV Energy's 2021 Integrated Resource Plan

The Nevada Power Company ("Nevada Power") and Sierra Pacific Power Company ("Sierra," and together with Nevada Power, "NV Energy") filled a joint Integrated Resource Plan (IRP) in 2021 (i.e., 2021 NVE IRP). This plan discussed a path moving forward that will meet the state's green energy policies and meet the energy demands of their customers. The 2021 NV Energy IRP identified a Net-Zero plan as its preferred plan for next 30 years. The 2021 Joint IRP will exceed the requirement for a 50 percent RPS by 2030 and target the State's goal of net-zero carbon dioxide emissions by 2050. Specifically, the 2021 NVE IRP addresses how NV Energy will meet the following state goals by managing a portfolio of energy and capacity resources:

- Encourage and accelerate the development of new renewable energy projects for the economic, health and environmental benefits provided to the people of this state;
- Become a leading producer and consumer of clean and renewable energy, with a goal of achieving by 2050 an amount of energy production from zero carbon dioxide emission resources equal to the total amount of electricity sold by providers of electric service in this state; and
- Ensure that the benefits of the increased use of renewable energy systems and energy efficiency measures are received by the residents of this state. Such benefits include, without limitation, improved air quality, reduced water use, a more diverse portfolio of resources for generating electricity, reduced fossil fuel consumption and more stable rates for retail customers of electric service.[88]

County of San Bernardino General Plan, Renewable Energy and Conservation Element

This Renewable Energy and Conservation Element[89] is a specific component of the General Plan that addresses issues related to renewable energy development and conservation in the County of San Bernardino. This Element is focused on sustainability, public health and wellness, and stewardship of land to promote an environment of prosperity and well-being for those who reside and invest in the

[87] CEC 2012. 2012 Bioenergy Action Plan. https://resources.ca.gov/CNRALegacyFiles/docs/energy_and_climate_change/2012_Bioenergy_Action_Plan.pdf. Accessed August 2025.

[88] Nevada Energy, 2022. NV Energy's 2021 Integrated Resource Plan. Available at: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/about-nvenergy/rates-regulatory/recent-regulatory-filings/nve/irp/2021-irp-filings/NVE-21-06-IRP-VOL4.pdf. Accessed August 2025.

[89] County of San Bernardino. County of San Bernardino General Plan Renewable Energy and Conservation Element. https://countywideplan.com/wp-content/uploads/sites/68/2021/02/REC-Element.pdf?x23421. Accessed August 2025.

County. It provides a road map for the County to achieve its energy goals, with a focus on energy efficiency, renewable energy systems, and sustainable energy production and consumption.

Table 7.4-1. Project's Consistency with Applicable State and County Energy Plans

Renewable Energy or Energy Efficiency Plan	Applicability/Project Consistency
2023 Integrated Energy Policy Report: The 2023 report highlights the implementation of California's innovative policies and the role they have played in establishing a clean energy economy, as well as provides more detail on several key energy policies, including increasing energy efficiency measures, shifting away from fossil fuel, and integrating more renewable energy into the electricity system.	**Consistent.** The Project will include an overhead (69 kilovolt) powerline to receive electricity from the grid. The Project will install NG-fired turbines to generate supplemental electricity and support operations. This will eliminate the need for fossil fuels in other stationary sources at the site and will allow for an increasing mix of renewable energy to supply the site's power needs. Project design features (e.g., the exclusion of a mill) have been incorporated to increase the energy efficiency of the Facility and reduce unnecessary energy and water needs. The Project will also fuel all off-road equipment with renewable diesel, when available from suppliers. Therefore, the Project will not conflict with or obstruct implementation of the 2023 Integrated Energy Policy.
Assembly Bill 2076: **Reducing Dependence on Petroleum:** Pursuant to AB 2076, the CEC and CARB prepared and adopted a joint-agency report, Reducing California's Petroleum Dependence, in 2003. Included in this report are recommendations to increase the use of alternative fuels to 20 percent of on-road transportation fuel use by 2020 and 30 percent by 2030, significantly increase the efficiency of motor vehicles, and reduce per capita VMT. One of the performance-based goals of AB 2076 is to reduce petroleum demand to 15 percent below 2003 demand by 2030.	**Consistent.** The Project plans to re-establish grid-based power supply for a portion of on-site power needs to reduce reliance on liquid petroleum fuels. The Project features also include a vanpool program to reduce commute VMT by workers (both construction and operational), which will effectively reduce petroleum consumption from vehicles. Additionally, the Project is committed to non-petroleum fuel sources (renewable diesel, when available from suppliers) for all construction and operational off-road equipment. Therefore, the Project will not conflict with or obstruct implementation of AB 2076.
AB 1007: State Alternative Fuels Plans: The State Alternative Fuels Plan assessed various alternative fuels and developed fuel portfolios to meet California's goals to reduce petroleum consumption, increase alternative fuels use, reduce GHG emissions, and increase in-State production of biofuels without causing a significant degradation of public health and environmental quality. **Bioenergy Action Plan, EO S-06-06**. The EO establishes the following targets to increase the production and use of bioenergy, including ethanol and biodiesel fuels made from renewable resources: produce a minimum of 20 percent of its biofuels in California by 2010, 40 percent by 2020, and 75 percent by 2050.	**Consistent.** Construction equipment and the off-road mining fleet during the Project operation will be fueled by renewable diesel, when available from suppliers. The Project will not interfere with or obstruct the production of biofuels and alternative fuels in California. Therefore, the Project will not conflict with or obstruct implementation of the Bioenergy Action Plan or the State Alternative Fuels Plan.

Renewable Energy or Energy Efficiency Plan	Applicability/Project Consistency
NV Energy's 2021 Integrated Resource Plan: The NVE 2021 IRP set up a Net-Zero plan as to achieve 50% renewable energy by 2030 and net-zero GHG emissions by 2050. It also highlights the implementation plan to expand renewable energy production and ensure customer benefits.	**Consistent.** The Project plans to re-establish grid-based power supply for a portion of on-site power needs to reduce reliance on liquid petroleum fuels. The Project design also uses a gravity circuit to replace an energy-intensive mill which will serve to conserve both energy and water and reduce the overall electric load. All construction equipment and off-road vehicles during project operation will be fueled by renewable diesel, when available from suppliers. Therefore, the project will not conflict with or obstruct implementation of the NVE 2021 Integrated Resource Plan.
County of San Bernardino General Plan Renewable Energy and Conservation Element: The County Renewable Energy and Conservation Element highlights the energy efficiency and renewable energy requirements, to ensure the county can comply with and support the state's energy and climate goals, while also promoting an environment of prosperity and well-being.	**Consistent.** As discussed above, several features of the proposed Project are designed to reduce overall energy needs, reduce dependence on petroleum by connecting to the grid and electrifying stationary source equipment within processing lines, and increase the use of renewable fuels including renewable diesel in construction and operational off-road equipment, when available from suppliers. Vanpooling will also be employed for both construction and operational workers to reduce vehicle trips to the site and the associated fuel use. Additionally, re-establishing a connection to the grid will allow for the future incorporation of additional renewable energy. Therefore, the Project will not conflict with or obstruct implementation of the County of San Bernardino General Plan Renewable Energy and Conservation Element.

TABLES

OPERATIONAL EMISSIONS INVENTORY, SUMMARY TABLES

Table 1
2022 Plan
Proposed Air Contaminant Total Emissions[1] - Including 1998 Plan Approved Emissions

Emission Source	Maximum Daily Emissions (lbs/day)						Annual Emissions (tons/yr)						Annual Emissions (MT/yr)	
	ROG/ VOC	NO_x	SO_x	CO	PM_{10}	$PM_{2.5}$	ROG/ VOC	NO_x	SO_x	CO	PM_{10}	$PM_{2.5}$	Biogenic CO_2e	Non-Biogenic CO_2e
Onsite Stationary Exhaust and Fugitive Sources														
Blasting		569	0.10	2,309				87	0.015	351				8,921
Ore Processing Equipment					52	10					6.5	1.2		
Emergency Generators	0.99	16	0.058	0.56	0.15	0.15	0.17	2.9	0.0068	0.034	0.020	0.020		663
Power Generation	23	85	1.5	231	17	17	4.2	16	0.28	42	3.1	3.1		49,816
Fuel Storage and Dispensing	3.0						0.55							111
Onsite Mobile Exhaust Sources														
Diesel-Powered Equipment Exhaust	202	3,046	6.6	3,510	38	38	30	464	0.98	514	5.6	5.6	86,411	2,429
Onsite Fugitive Dust Sources														
Mining Operations (Drilling, Blasting, Loading)					282	29					29	3.3		
Haul Roads					1,291	129					171	17		
Ore and Overburden Dumping					185	28					31	4.6		
Wind Erosion (Disturbed Areas, Stockpiles)					18	6.4					2.8	1.1		
Offsite Mobile Exhaust Sources														
Employee and Vendor Travel	1.1	38	0.41	29	4.3	1.9	0.14	2.3	0.027	4.4	0.31	0.13	437	2,681
Offsite Fugitive Dust Sources														
Employee and Vendor Travel					168	17					19	1.9		
Indirect GHG Sources														
Electricity Usage														28,977
Solid Waste													60	494
Wastewater														68
Total	**230**	**3,754**	**8.7**	**6,079**	**2,055**	**277**	**35**	**571**	**1.3**	**912**	**267**	**38**	**86,908**	**94,160**

[1] Maximum annual operations evaluated account for up to 19 million tons of ore processed and up to 60.6 million tons of overburden material mined, which include the portions of ore and overburden processing that are currently approved (6.25 million tons annually and 16.3 million tons annually, respectively). Power demands assume up to a 20 MW load for on-site operations, with 10 MW provided by NV Energy via the grid and 10 MW supplied by on-site NG turbines, plus 1,314 kW for off-site power for water supply (provided by SCE). The inventory developed accounts for the following commitments to clean technology and control options: on-site diesel off-road units, including emergency generators, are assumed to meet Tier 4 Final emission standards, consistent with equipment currently operating at the site; haul roads are controlled with chemical suppressant application; watering is used for fugitive dust control from disturbed areas; and watering, bin vent, or baghouse controls are used for several stationary sources of particulate matter.

Table 2
1998 Plan
Approved Air Contaminant Emissions[2]

Emission Source	Maximum Daily Emissions (lbs/day)						Annual Emissions (tons/yr)						(MT/yr)	
	ROG/ VOC	NO_x	SO_x	CO	PM_{10}	$PM_{2.5}$	ROG/ VOC	NO_x	SO_x	CO	PM_{10}	$PM_{2.5}$	Biogenic CO_2e	Non-Biogenic CO_2e
Onsite Stationary Exhaust and Fugitive Sources														
Blasting		160	0.028	651				24	0.0043	99				2,520
Ore Processing Equipment					17	3.3					2.1	0.40		
Emergency Generators	0.99	16	0.058	0.56	0.15	0.15	0.17	2.9	0.0068	0.034	0.020	0.020		663
Power Generation	3.9	18	1.0	18	1.8	1.8	0.72	3.4	0.18	3.4	0.34	0.34		17,979
Fuel Storage and Dispensing	0.38						0.069							
Onsite Mobile Exhaust Sources														
Diesel-Powered Equipment Exhaust	78	1,035	2.6	1,358	14	14	8.4	131	0.28	145	1.6	1.6	24,211	692
Onsite Fugitive Dust Sources														
Mining Operations (Drilling, Blasting, Loading)					71	11					6.2	0.83		
Haul Roads					594	59					48	4.8		
Ore and Overburden Dumping					53	8.0					8.6	1.3		
Wind Erosion (Disturbed Areas, Stockpiles)					18	6.4					2.8	1.1		
Offsite Mobile Exhaust Sources														
Employee and Vendor Travel	0.44	24	0.25	5.7	2.5	1.2	0.043	1.1	0.012	0.70	0.12	0.054		1,206
Offsite Fugitive Dust Sources														
Employee and Vendor Travel					77	8.0					7.2	0.74		
Indirect GHG Sources														
Electricity Usage														9,433
Solid Waste													17	140
Wastewater														19
Total	**83**	**1,254**	**3.9**	**2,033**	**848**	**113**	**9.4**	**163**	**0.48**	**249**	**77**	**11**	**24,428**	**32,652**

[2] The emissions inventory developed for approved operations reflects potential activity and emissions associated with mining and processing of materials as authorized in the 1998 Plan and recent revisions (1998 Plan Ver 2.0 and Ver 2.1). Ore processing is currently authorized and permitted for up to 6.25 million tons annually and overburden mining is currently authorized for up to 16.3 million tons annually. Emission estimates for approved operations account for commitments to clean technology and control options consistent with Proposed 2022 Mine Plan of Operations, reflect updated emission factors and methodologies, and incorporate additional pollutant and source category review, as compared to Appendix F of the 1997 Castle Mountain Mine Expansion Project Draft EIS/EIR, March 1997.

Table 3
2022 Plan
Proposed Air Contaminant Emissions – Excluding 1998 Plan Approved Emissions[3]

Emission Source	Maximum Daily Emissions (lbs/day)						Annual Emissions (tons/yr)						(MT/yr)	
	ROG/ VOC	NO_x	SO_x	CO	PM_{10}	$PM_{2.5}$	ROG/ VOC	NO_x	SO_x	CO	PM_{10}	$PM_{2.5}$	Biogenic CO_2e	Non-Biogenic CO_2e
Onsite Stationary Exhaust and Fugitive Sources														
Blasting		409	0.072	1,658				62	0.011	252				6,401
Ore Processing Equipment					35	6.8					4.4	0.83		
Emergency Generators	0	0	0	0	0	0	0	0	0	0	0	0		0
Power Generation	19	67	0.50	212	15	15	3.5	12	0.092	39	2.8	2.8		31,837
Fuel Storage and Dispensing	2.6						0.48							111
Onsite Mobile Exhaust Sources														
Diesel-Powered Equipment Exhaust	124	2,011	4.1	2,151	24	24	21	333	0.70	369	4.0	4.0	62,000	1,737
Onsite Fugitive Dust Sources														
Mining Operations (Drilling, Blasting, Loading)					211	18					23	2.5		
Haul Roads					697	70					123	12		
Ore and Overburden Dumping					133	20					22	3.3		
Wind Erosion (Disturbed Areas, Stockpiles)					0	0					0	0		
Offsite Mobile Exhaust Sources														
Employee and Vendor Travel	0.65	14	0.16	23	1.7	0.75	0.093	1.2	0.015	3.7	0.19	0.076	437	1,475
Offsite Fugitive Dust Sources														
Employee and Vendor Travel					91	9.4					12	1.2		
Indirect GHG Sources														
Electricity Usage														19,545
Solid Waste													43	354
Wastewater														49
Total	**146**	**2,501**	**4.8**	**4,045**	**1,208**	**164**	**25**	**408**	**0.82**	**663**	**190**	**27**	**62,480**	**61,508**

[3] Emissions presented in this table reflect the increase in emissions for the Proposed 2022 Mine Plan of Operations (Table 1) from the emissions for the Approved 1998 Plan operation (Table 2). As emission factors and methodologies are consistent between Table 1 and Table 2, this table reflects a more direct comparison of potential emission differences as a result of proposed changes to mining activity under the 2022 Mine Plan of Operations.

Table 4
Comparison of 1997 EIR/EIS Approved Emissions and 2022 Plan Total Emissions

Emission Scenario	Maximum Daily Emissions (lbs/day)						Annual Emissions (tons/yr)						Annual Emissions (MT/yr)	
	ROG/ VOC	NO_x	SO_x	CO	PM_{10}	$PM_{2.5}$	ROG/ VOC	NO_x	SO_x	CO	PM_{10}	$PM_{2.5}$	Biogenic CO_2e	Non-Biogenic CO_2e
Proposed 2022 Mine Plan of Operations (Including Approved Operations)	230	3,754	8.7	6,079	2,055	277	35	571	1.3	912	267	38	86,908	94,160
Approved 1997 EIR/EIS[4]	83	2,622	181	1,487	592	--[5]	13	391	26	151	83	--[5]	--[5]	--[5]
Change in Emissions	**147**	**1,133**	**-172**	**4,592**	**1,463**	**--[5]**	**21**	**180**	**-25**	**761**	**184**	**--[5]**	**--[5]**	**--[5]**

[4] Note that off-site emissions were not included in the Approved 1997 EIR/EIS emissions but are included in the emissions for the Proposed 2022 Mine Plan of Operations and Approved Operations. Emission factors and methodologies utilized at the time of the 1997 EIR/EIS may reflect older guidance, less advanced technologies, fewer control technology commitments, and other differences. Refer to Table 3 for a more direct comparison of potential emission differences as a result of proposed changes to mining activity under the 2022 Mine Plan of Operations.

[5] Emissions for these pollutants were not included in the 1997 EIR/EIS.

OPERATIONAL EMISSIONS INVENTORY: PROPOSED 2022 MINE PLAN OF OPERATIONS, DETAILED TABLES

2022 Mine Plan of Operations: Table O-1
Criteria Air Pollutant and Greenhouse Gas Emissions Summary
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Type[1]	Maximum Daily Emissions (lb/day)						Annual Emissions (tpy)						Annual GHG Emissions (MT/yr)	
	PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	VOC	Biogenic	Non-biogenic
Material Transfers (fugitive)	185	28					31	4.6						
Material Transfers (stationary)	18	4.5					2.3	0.57						
Crushing	8.7	1.6					1.1	0.20						
Screening	26	3.9					3.1	0.47						
Diesel Generators[2]	0.15	0.15	16	0.058	0.56	0.99	0.020	0.020	2.9	0.0068	0.034	0.17		663
Power Generation (NG turbines)	17	17	85	1.5	231	23	3.1	3.1	16	0.28	42	4.2		49,816
On-site Unpaved Road Mobile Equipment (fugitive dust)	1,291	129					171	17						
Other On-site Off-Road Mobile Equipment (fugitive dust)	52	16					6.7	2.1						
On-site Mobile Equipment (exhaust)	38	38	3,046	6.6	3,510	202	5.6	5.6	464	0.98	514	30	86,411	2,429
Off-site Mobile Equipment (fugitive dust)	168	17					18.7	1.92						
Off-site Mobile Equipment (exhaust)	4.3	1.9	38	0.41	29	1.1	0.31	0.13	2.3	0.027	4.4	0.14	437	2,681
Disturbed Operational Areas	3.2	0.48					0.077	0.012						
Stockpile Wind Erosion	15	5.9					2.7	1.1						
Blasting and Blast Hole Drilling	230	13	569	0.10	2,309		22	1.3	87	0.015	351			8,921
Gasoline Dispensing Facility						0.42						0.076		
Fuel Storage Tanks						2.6						0.47		111
Electricity Usage														28,977
Solid Waste													60	494
Wastewater														68
Total Emissions	**2,055**	**277**	**3,754**	**8.7**	**6,079**	**230**	**267**	**38**	**571**	**1.3**	**912**	**35**	**86,908**	**94,160**

Notes:

1. Detailed emission calculations are presented in Tables O-3 through O-33.
2. Diesel generators are expected to use renewable diesel fuel, consistent with other offroad equipment, but have conservatively been assumed to use conventional diesel in this inventory, and thus resulting CO_2 emissions are characterized as non-biogenic.

Abbreviations:

CO - carbon monoxide
GHG - greenhouse gas
lb - pounds
MT - metric tons
NG - natural gas
NO_x - nitrogen oxides
PM - particulate matter
SO_x - sulfur oxides
tpy - tons per day
VOC - volatile organic gases
yr - year

2022 Mine Plan of Operations: Table O-2
Toxic Air Contaminant and Hazardous Air Pollutant Emissions Summary, On-Site Sources
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

TAC	CAS Number	Annual Emissions[1] (lb/yr)																	
		Refinery	Acid Tank Evaporation	Heap Leach Pad and Various Process Tanks	Material Transfers	Crushing	Screening	Power Generation (NG Turbines)	Diesel Generators (Emergency/ Supporting)[2]	Stockpile Erosion	On-Site Unpaved Road Mobile Equipment Fugitive Dust	On-Site Unpaved Road Mobile Equipment Exhaust[2]	Other On-Site Off-Road Mobile Equipment Fugitive Dust	Other On-Site Off-Road Mobile Equipment Exhaust[2]	Disturbed Operational Area	Blasting and Blast Hole Drilling	Gasoline Dispensing Facility	Storage Tanks	Total
1,2,4-Trimethylbenzene	95636											0.24		313					314
1,3-Butadiene	106990							0.12	14			0.14		112					127
2,2,4-Trimethylpentane	540841											0.31		177					178
2-Chloronaphthalene	91587							2.5E-04											2.5E-04
2-Methylnaphthalene	91576							0.0049											0.0049
Acenaphthene	83329							0.017	1.3										1.3
Acenaphthylene	208968							0.014	0.95										0.96
Acetaldehyde	75070							126	51			1.0		4,346					4,523
Acrolein	107028							17	2.2			0.025							20
Aluminum	7429905				3,702	120	355			308	13,688	0.0014	766	2.0	8.7	2,529			21,479
Ammonia	7664417							2,944	72							918			3,934
Ammonium	14798039										14								14
Anthracene	120127							0.031	0.43										0.47
Antimony	7440360				1.1	0.036	0.11			0.093	4.1	3.0E-04	0.23	0.40	0.0026	0.76			6.9
Arsenic	7440382				3.3	0.11	0.31		0.50	0.27	19	4.1E-05	0.68	0.056	0.0077	2.2			27
Barium	7440393				12	0.40	1.2			1.0	205		2.6		0.029	8.4			231
Benzene	71432							12	12			0.72		1,182			0.80		1,208
Benzaldehyde	100527								0.87										0.87
Benzo(a)anthracene	56553							0.021	0.013										0.034
Benzo(a)pyrene	50328							0.013	9.0E-04										0.014
Benzo(b)fluoranthene	205992							0.010	0.0024										0.013
Benzo(e)pyrene	192972							5.0E-04											5.0E-04
Benzo(g,h,i)perylene	191242							0.013	0.43										0.45
Benzo(k)fluoranthene	207089							0.010	7.4E-04										0.011
Beryllium	7440417				0.32	0.011	0.031			0.027			0.067		7.7E-04	0.22			0.68
Bromine	7726956										23	6.8E-04		0.20					23
Cadmium	7440439				0.011	3.6E-04	0.0011		0.097	9.2E-04	4.4	3.3E-04	0.0023	0.45	2.6E-05	0.0076			4.9
Chlorine	7782505											0.078		3.9					3.9
Chromium (hexavalent)	18540299								0.013										0.013
Chromium (total)	7440473				6.0	0.19	0.57		0.21	0.50	44	6.3E-04	1.2	0.13	0.014	4.1			57
Chrysene	218019							0.023	0.43										0.46
Cobalt	7440484										28	6.3E-04		0.12					28
Copper	7440508				0.91	0.029	0.087		0.27	0.076	74	7.4E-04	0.19	0.28	0.0022	0.62			76
Crotonaldehyde	4170303											0.018							0.018
Cumene	98828											0.0094		12					12
Cyclohexane	110827											0.066		17.7					18
Dibenz(a,h)anthracene	53703							0.022	0.0024										0.024
Diesel PM	9901								41			8,242		2,980					11,262
Ethanol	64175											0.0026		5.9					5.9
Ethyl Benzene	100414							16	0.71			0.25		183			0.66		201
Ethylene	74851											3.0		8,502					8,505
Fluoranthene	206440							0.040	0.43										0.47
Fluorene	86737							0.053	2.8										2.9
Formaldehyde	50000							844	112			2.3		8,697					9,655
n-Hexane	110543							238	1.7			0.20		95			2.8		338
Hydrogen Chloride	7647010		3.7						12									783	799
Hydrogen Cyanide[3]	74908			13,061												597			13,658
Indeno(1,2,3-c,d)pyrene	193395							0.022	0.0017										0.023
Isoprene	78795											0.019							0.019
Lead	7439921				1.9	0.062	0.18		0.54	0.16	16	3.4E-04	0.40	0.47	0.0045	1.3			22
Manganese	7439965				14	0.44	1.3		0.20	1.1	261	8.6E-04	2.8	0.45	0.032	9.3			290
Mercury	7439976	13			0.068	0.0022	0.0066		0.15	0.0057	5.6	2.5E-04	0.014	0.34	1.6E-04	0.047			19
Methanol	67561											0.10		18					18
Methyl Ethyl Ketone	78933											0.19		875					875
Methyl Tert-Butyl Ether	1634044											0.26							0.26
Naphthalene	91203							1.5	1.3			0.029		53			0.074		56
Nickel	7440020				0.30	0.0097	0.029		0.25	0.025	12	6.9E-04	0.062	0.21	7.1E-04	0.20			14
n-Pentane	109660											0.32		106					107
Perylene	198550							6.4E-04											6.4E-04
Phenanthrene	85018							0.29	5.6										5.9
Phosphorus	7723140				12	0.40	1.2			1.0	152	0.0010	2.6	1.4	0.029	8.4			180
Phosphorus pentoxide	1314563				33	1.1	3.1			2.7			6.7		0.077	22			68
Propionaldehyde	123386											0.14		574					574
Propylene	115071							709	30			1.0		1,537			0.0040		2,278
Propylene Oxide	75569							44											44
Pyrene	129000							0.025	0.95										0.98
Selenium	7782492				0.065	0.0021	0.0062		0.63	0.0054	0.68	8.2E-05	0.013	0.11	1.5E-04	0.044			1.6
Silica	14808607				50,687	1,640	4,866			4,215			10,482		120	34,626			106,636

TAC	CAS Number	Annual Emissions[1] (lb/yr)																	
		Refinery	Acid Tank Evaporation	Heap Leach Pad and Various Process Tanks	Material Transfers	Crushing	Screening	Power Generation (NG Turbines)	Diesel Generators (Emergency/ Supporting)[2]	Stockpile Erosion	On-Site Unpaved Road Mobile Equipment Fugitive Dust	On-Site Unpaved Road Mobile Equipment Exhaust[2]	Other On-Site Off-Road Mobile Equipment Fugitive Dust	Other On-Site Off-Road Mobile Equipment Exhaust[2]	Disturbed Operational Area	Blasting and Blast Hole Drilling	Gasoline Dispensing Facility	Storage Tanks	Total
Silver	7440224				0.12	0.0040	0.012			0.010	2.5	2.3E-04	0.026	0.31	2.9E-04	0.085			3.1
Styrene	100425											0.025		35					36
Thallium	7440280				0.10	0.0033	0.0097			0.0084			0.021		2.4E-04	0.069			0.21
Toluene	108883							65	6.8			1.1		869			3.6		946
Vanadium	7440622				1.0	0.034	0.10			0.087	57	2.4E-04	0.22	0.33	0.0025	0.71			59
Xylenes	1330207							24	2.7			0.96		621			3.2		652
Zinc	7440666				5.5	0.18	0.52		1.4	0.45	65	0.0041	1.13	4.9	0.013	3.7			83

Notes:

1. Detailed emission calculations are presented in Tables O-3 through O-33. TAC and HAP emissions are quantified for on-site emission sources only.
2. For sources of diesel exhaust (e.g. generators, mobile equipment), both diesel particulate matter (Diesel PM) and speciated TAC and HAP emissions are presented, though Diesel PM is considered a surrogate for all diesel exhaust.
3. Hydrogen cyanide emissions from heap leaching operations and cyanide containing tanks are highly dependent on the characterization of the heap leach pad, solution pH, and temperatures. Conservative estimates of potential operating conditions have been utilized here.

Abbreviations:

HAP - Hazardous Air Pollutant
lb - pounds
NG - natural gas
PM - particulate matter
SCR - Selective Catalytic Reduction
TAC - Toxic Air Contaminant
yr - year

2022 Mine Plan of Operations: Table O-3
Material Transfer Emissions
Criteria Air Pollutants
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Description[1]	Source Area	Material Profile	Material Moisture Content[2] (%)	Process Rates[3]		Emission Factor[4,5,6,7] (lb/ton)		Add-On Control Method[8]	Control Efficiency[9,10]	Controlled Emissions			
				Daily (tpd)	Annual (tpy)					Daily (lb/day)		Annual (tpy)	
						PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Ore to Haul Trucks	Pits	Ore	3.0	79,200	19,200,000	0.0013	2.0E-04	Pit Enclosure	75%	26	3.9	3.2	0.48
Overburden to Haul Trucks	Pits	Overburden	5.0	166,089	60,622,662	6.4E-04	9.7E-05	Pit Enclosure	75%	27	4.0	4.9	0.74
Haul Trucks to Overburden Area	Overburden Area	Overburden	5.0	166,089	60,622,662	6.4E-04	9.7E-05	--	0%	107	16	19	2.9
Haul Trucks to Interim Ore Stockpile	Interim Ore Stockpile	Ore	3.0	19,800	4,800,000	0.0013	2.0E-04	--	0%	26	3.9	3.2	0.48
Haul Truck to Dump Hopper	Primary Crushing	Ore	3.0	79,200	19,200,000	4.6E-05	1.3E-05	Enclosure + Watering	0%	3.6	1.0	0.44	0.12
Dump Hopper to Feeder	Primary Crushing	Ore	3.0	79,200	19,200,000	4.6E-05	1.3E-05	Enclosure + Watering	0%	3.6	1.0	0.44	0.12
Feeder to Vibrating Grizzly	Primary Crushing	Ore	3.0	79,200	19,200,000	4.6E-05	1.3E-05	Enclosure + Watering	0%	3.6	1.0	0.44	0.12
Vibrating Grizzly to Primary Crusher Discharge Conveyor	Primary Crushing	Ore	3.0	65,714	15,930,775	4.6E-05	1.3E-05	Enclosure + Watering	0%	3.0	0.85	0.37	0.10
Crushed Ore Stockpile Reclaim Feeders to Secondary Screen Feed Conveyors	Secondary/Tertiary Crushing and Screening	Ore	3.0	79,200	19,200,000	0.0011	1.7E-04	Secondary/Tertiary Screening Dust Scrubber	99.5%	0.44	0.066	0.053	0.0080
Tertiary Screen Oversize Transfer Conveyor to Tertiary Crushing Feed Conveyor	Secondary/Tertiary Crushing and Screening	Ore	3.0	49,465	11,991,626	0.0011	1.7E-04	Secondary/Tertiary Crushing Dust Scrubber	99.5%	0.27	0.041	0.033	0.0050
Tertiary Crushing Feed Conveyor to Tertiary Crusher Surge Bin	Secondary/Tertiary Crushing and Screening	Ore	3.0	49,438	11,984,927	0.0011	1.7E-04	Secondary/Tertiary Crushing Dust Scrubber	99.5%	0.27	0.041	0.033	0.0050
Tertiary Crusher Discharge Conveyor to Stockpile Feed Conveyor	Product Stockpile	Ore	3.0	49,438	11,984,927	0.0011	1.7E-04	Secondary/Tertiary Crushing Dust Scrubber	99.5%	0.27	0.041	0.033	0.0050
Gravity Concentrate Storage Tank to Truck	Fine Ore Storage and Gravity Circuit	Ore	10	2.8	670	2.4E-04	3.7E-05	--	0%	6.7E-04	1.0E-04	8.1E-05	1.2E-05
Truck to Concentrate Feed Storage Cone	Fine Ore Storage and Gravity Circuit	Ore	10	2.8	670	2.4E-04	3.7E-05	--	0%	6.7E-04	1.0E-04	8.1E-05	1.2E-05
Stockpile Discharge Conveyor to Agglomeration Feed Bin	Agglomeration and Stacking	Ore	2.6	63,835	15,475,227	0.0016	2.4E-04	Agglomerator Feed Bin Vent	99.5%	0.51	0.078	0.062	0.0094
Truck to Cement Storage Silo	Cement	Cement	0.5	263	96,000	0.47	0.071	Cement Silo Bin Vent	99.5%	0.62	0.094	0.11	0.017
Cement Silo Feeder to Agglomerator Feed Bin	Cement	Cement	0.5	263	96,000	0.0028	4.2E-04	--	0%	0.74	0.11	0.13	0.020
Truck to Pebble Lime Silo	Heap Leach Pebble Lime	Lime	0.5	132	48,000	0.47	0.071	Pebble Lime Silo Bin Vent	99.5%	0.31	0.047	0.056	0.0085
Pebble Lime Silo Feeder to Agglomerator Feed Bin	Heap Leach Pebble Lime	Lime	0.5	132	48,000	0.0028	4.2E-04	--	0%	0.37	0.056	0.067	0.010
Carbon Handling Crane to Carbon Feed Tank	Carbon Regeneration	Carbon	0.5	0.016	6.0	0.016	0.0024	--	0%	2.7E-04	4.0E-05	4.8E-05	7.3E-06
									Total Emissions	**203**	**33**	**33**	**5.2**

Notes:

1. Material handling sources with high moisture contents will have negligible emissions. Therefore, emissions from these sources were not quantified in this table.
2. Material moisture contents were provided by Castle Mountain Venture.
3. Equipment specific information provided by Castle Mountain Venture.
4. Emission factors for primary crushing system material transfer points with watering controls are based on controlled conveyor transfer point emission factors from AP-42, Section 11.19.2, Table 11.19.2-2, consistent with NDEP guidance for the mining industry.
5. Emission factors for all other material transfer points within the crusher system are based on uncontrolled conveyor transfer point emission factors from AP-42, Section 11.19.2, Table 11.19.2-2, consistent with NDEP Guidance. AP-42, Section 11.19.2, Table 11.19.2-2 does not include an uncontrolled conveyor transfer point emission factor for $PM_{2.5}$ so the emission factor was estimated using the uncontrolled conveyor transfer point emission factor for PM_{10} and a multiplier of 0.053/0.35 based on AP-42, Chapter 13.2.4, consistent with NDEP guidance for the mining industry.

6. PM_{10} emission factors for pebble lime and cement material handling points were based on silo loading and unloading emission factors from AP-42, Section 11.12 and a multiplier of 0.053/0.35 for $PM_{2.5}$ based on AP-42, Chapter 13.2.4, consistent with NDEP guidance for the mining industry.
7. Emission factors for material transfer points that are not within the crusher system or associated with pebble lime and cement material handling were estimated using MDAQMD's "most complex" Material Handling Operations methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 PM_{10} and $PM_{2.5}$ multipliers (AP-42 Section 13.2.4, "Aerodynamic Particle Size Multiplier (k) for Equation 1" table) at the time of inventory preparation. A windspeed of 8.7 mph was used consistent with the annual average site-specific meteorological measurements for the period of January 2021 through December 2021.
8. Additional or revised controls may be evaluated at the time of engineering design.
9. A control efficiency of 75% is applied consistent with MDAQMD guidance for "complete coverage by windscreens (on the windward side)", assuming that the pit in which loading activities take place will effectively act as a windscreen and reduce particulate matter emissions. The dust scrubber and bin vent control efficiencies will be confirmed with vendor guarantees upon equipment design.
10. Material transfer points will be controlled with watering and enclosures, but the watering control is already accounted for in the controlled emission factor utilized so no additional control efficiency is included here.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768
NDEP. 2017. Guidance on Emission Factors for the Mining Industry. Available online at: https://ndep.nv.gov/uploads/air-permitting-docs/ndep-mining-emissions-guidance.pdf. May 31.
USEPA. 2004. AP-42, Section 11.19.2. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s1902.pdf. August.
USEPA. 2006. AP-42, Section 13.2.4. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/13.2.4_aggregate_handling_and_storage_piles.pdf. November.
USEPA. 2012. AP-42, Section 11.12. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s12.pdf. January.

Abbreviations:

lb - pound
MDAQMD - Mojave Desert Air Quality Management District
NDEP - Nevada Division of Environmental Protection
PM - particulate matter
tpd - tons per day
tpy - tons per year
USEPA - United States Environmental Protection Agency

2022 Mine Plan of Operations: Table O-4
Refinery Mercury Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Equipment	Source Area	Concentrate Throughput[1]		Mercury Concentration[2] (lb/ton)	Mercury Emissions	
		Daily (tpd)	Annual (tpy)		Daily (lb/day)	Annual (tpy)
Kiln Abatement, EQ Abatement, and Retort Carbon Bed	Refinery	0.045	17	0.8	0.036	0.0066

Notes:

1. Equipment specific information was provided by Castle Mountain Venture. Equipment is assumed to operate 24 hours per day and 365 days per year.
2. Mercury concentration of retort concentrate was assumed to be 0.8 lb/ton based on NESHAP Subpart EEEEEEE limit for new carbon processes with mercury retorts.

References:

USEPA. 2011. NESHAP for Gold Mine Ore Processing and Production (40 CFR Part 63 Subpart EEEEEEE). Available online at: https://www.govinfo.gov/content/pkg/FR-2011-02-17/pdf/2011-2608.pdf#page=2. February.

Abbreviations:

lb - pounds
NESHAP - National Emission Standards for Hazardous Air Pollutants
tpd - tons per day
tpy - tons per year

2022 Mine Plan of Operations: Table O-5a
Acid Tank Evaporative Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source	Source Area	Exposed Surface Area[1] (ft^2)	Liquid Molecular Weight (g/mol)	Annual Average Wind Speed[2] (m/s)	Percent HCl[3] (liquid wt%)	Liquid Vapor Pressure at Given Temperature[3] (mmHg)	Liquid Temperature[4] (K)	HCl Emissions[5]	
								Daily (lb/day)	Annual (tpy)
Acid Mix Tank	Refinery	8.6	36	3.9	5	7.6E-04	291	0.0036	6.5E-04
Acid Wash Tank	Refinery	16	36	3.9	5	7.6E-04	291	0.0066	0.0012

Notes:

1. Surface area was estimated from tank diameters provided by Castle Mountain Venture assuming a completely open topped cylindrical vertical tank, a highly conservative assumption, as these tanks are expected to be closed top tanks with vents.
2. For outdoor sources, a windspeed of 3.9 m/s was used consistent with the annual average site-specific meteorological measurements between January 2021 and December 2021.
3. Liquid vapor pressure were calculated using vapor pressure profiles from Perry et al. 1997, and conservatively rounding up the expected liquid temperature to the next highest value in the vapor pressure profile (20 C) and the next highest liquid weight percent (6%).
4. For outdoor sources, the liquid temperature was conservatively assumed to be equivalent to the annual average temperature (291 degrees K) from on-site meteorological measurements between January 2021 and December 2021.
5. Evaporative emissions were calculated using USEPA Risk Management Program guidance for evaporative losses from a defined surface area.

References:

Perry, Robert H et al. 1997. Perry's Chemical Engineers' Handbook. 7th Edition. Table 2-10. Partial Pressures of HCl over Aqueous Solutions of HCl.
USEPA. 2009. Risk Management Program for Offsite Consequence Analysis. Appendix D: D-1. Available online at: https://www.epa.gov/sites/production/files/2017-05/documents/oca-apds.pdf

Abbreviations:

ft^2 - square feet
g/mol - grams per mole
K - degrees Kelvin
lb - pounds
m/s - meters per second
mmHg - millimeters of mercury
tpy - tons per year
USEPA - United States Environmental Protection Agency
wt% - weight percent

2022 Mine Plan of Operations: Table O-5b
Heap Leach and Process Tank HCN Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Area[1] (acres)	pH[2]	NaCN Concentration[3] (lb/ton)	Free Cyanide Concentration[4] (g/m^3)	Temperature[5] (deg C)	Gas Phase Mass Transfer Coefficient[6] (m/s)	Flux[7] (g/m^2-s)	Flux Chamber Adjustment for Area (F_a)	Flux Chamber Adjustment for Wind Speed (F_w)[8]	F_a*F_w	Annual HCN Emissions[9] (lb/yr)
Active Pad, Wet Surface	100	10	0.40	106	17	7.0E-06		0.40	1.2	0.49	9,208
Active Pad, Dry Surface	285						7.9E-08	0.40	1.2	0.49	3,072
Inactive Pad	285						2.0E-08	0.40	1.2	0.49	762
Various Process Tanks	1	10	0.06	16	17	9.3E-06		0.40	1.2	0.49	18

Notes:

1. The Heap Leach Pad area was assumed to have up to 100 acres of wet active area, with the remaining area split between dry active area and inactive area. The surface area for the various process tanks at the facility was conservatively assumed to be 1 acre.
2. Average pH based on expected operating levels.
3. NaCN concentrations are based on expected operating levels, including a conservative buffer.
4. Free cyanide concentrations are calculated based on NaCN concentrations.
5. Average temperature based on hourly site-specific meteorological data for the period of January 2021 through December 2021.
6. Gas phase mass transfer coefficient values based on source category and EPA flux box results (EPA 2010).
7. Flux values based on source category and EPA flux box results (EPA 2010).
8. Annual mean wind speed based on site-specific meteorological data for the period of January 2021 through December 2021.
9. Gas phase mass transfer coefficients are used when the source area is wet and has a measurable pH level. Flux values are used for the dry active pad and inactive pad sources.

References:

Quality Assurance Project Plan, Comprehensive Air Emissions Testing for Hydrogen Cyanide *at Three Nevada Gold Mines Sites Using the USEPA Surface Isolation Flux Chamber Technology, Revision 2* (November 18, 2009). EPA-HQ-OAR-2010-0239-0163_attachment 5.

Evaluation of Air Emissions of Hydrogen Cyanide from Fugitive Sources at Nevada Gold Mines Using the USEPA Surface Insolation Flux Chamber Technology: Cortez, Gold Quarry & Round Mountain Mines. April 2010. Prepared by Dr. C.E. Schmidt and Tom Card. EPA-HQ-OAR-2010-0239-0163

USEPA. HCN Flux Box Results. 2010. EPA-HQ-OAR-2010-0239-0403. Available online at: https://downloads.regulations.gov/EPA-HQ-OAR-2010-0239-0403/content.pdf.

Abbreviations:

deg C = degrees Celsius
g = grams
lb = pound
m = meters
m^3 = cubic meters
s = seconds
yr = year

2022 Mine Plan of Operations: Table O-6
Crushing Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Source Area	Process Rates[1]		Emission Factor[2,3,4] (lb/ton)		Add-On Control Method	Control Efficiency[5,6]	Controlled Emissions			
		Daily (tpd)	Annual (tpy)					Daily (lb/day)		Annual (tpy)	
				PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Rock Breaker	Primary Crushing	792	192,000	8.0E-05	8.0E-05	Watering	0%	0.063	0.063	0.0077	0.0077
Primary Crusher and transfers in and out	Primary Crushing	13,486	3,269,225	5.4E-04	1.0E-04	Watering + Enclosure	0%	7.3	1.3	0.88	0.16
Secondary Crushers (2) and transfers in and out	Secondary/Tertiary Crushing	62,011	15,033,077	0.0024	3.6E-04	Secondary/Tertiary Crushing Dust Scrubber	99.5%	0.74	0.11	0.090	0.014
Tertiary Crusher and transfers in and out	Secondary/Tertiary Crushing	49,410	11,978,227	0.0024	3.6E-04	Secondary/Tertiary Crushing Dust Scrubber	99.5%	0.59	0.090	0.072	0.011
							Total Emissions	**8.7**	**1.6**	**1.1**	**0.20**

Notes:

1. Equipment specific information was provided by Castle Mountain Venture.
2. Emissions factors for the rock breaker are from AP-42, Section 11.19.2 for "Wet Drilling - Unfractured Stone". AP-42, Section 11.19.2 (Crushed Stone Processing and Pulverized Mineral Processing) defines wet material as material containing >1.5% water. $PM_{2.5}$ is conservatively assumed to be equal to PM_{10}.
3. Emission factors for the primary crusher were based on controlled tertiary crushing emission factors from AP-42, Section 11.19.2, Table 11.19.2-2. Tertiary crushing controlled emission factors were conservatively applied to the primary crusher units based on data availability, and per NDEP guidance.
4. Emission factors for the secondary and tertiary crushers were based on uncontrolled tertiary crushing emission factors from AP-42, Section 11.19.2, Table 11.19.2-2. Tertiary crushing emission factors were conservatively applied to the primary and secondary crusher units based on data availability, and per NDEP guidance. AP-42, Section 11.19.2, Table 11.19.2-2 does not include an uncontrolled tertiary crushing emission factor for $PM_{2.5}$ so the emission factor was estimated using the uncontrolled tertiary crushing emission factor for PM_{10} and a multiplier of 0.053/0.35 based on AP-42, Chapter 13.2.4, consistent with NDEP guidance for the mining industry.
5. The rock breaker will be controlled with watering, but this control is already accounted for in the wet drilling emission factor utilized so 0% control efficiency is listed here. The primary crusher will be controlled with watering and enclosure. The watering control is already accounted for in the controlled emission factor utilized, so no additional control efficiency is listed .
6. The dust scrubber control efficiencies will be confirmed with vendor guarantees upon equipment design.

References:

NDEP. 2017. Guidance on Emission Factors for the Mining Industry. Available online at: https://ndep.nv.gov/uploads/air-permitting-docs/ndep-mining-emissions-guidance.pdf. May 31.

USEPA. 2004. AP-42, Section 11.19.2 (Crushed Stone Processing and Pulverized Mineral Processing). Available online at: https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s1902.pdf

USEPA. 2006. AP-42, Section 13.2.4. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/13.2.4_aggregate_handling_and_storage_piles.pdf. November.

Abbreviations:

lb - pounds
NDEP - Nevada Division of Environmental Protection
PM - particulate matter
tpd - tons per day
tpy - tons per year
USEPA - United States Environmental Protection Agency

2022 Mine Plan of Operations: Table O-7
Screening Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Source Area	Process Rates[1]		Emission Factor[2] (lb/ton)		Add-On Control Method	Control Efficiency[3]	Controlled Emissions			
		Daily (tpd)	Annual (tpy)					Daily (lb/day)		Annual (tpy)	
				PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Secondary Screens (2) and transfers in and out	Secondary/Tertiary Screening	79,200	19,200,000	0.0087	0.0013	Secondary/Tertiary Screening Dust Scrubber	99.5%	3.4	0.52	0.42	0.063
Tertiary Screen and transfers in and out	Secondary/Tertiary Screening	62,011	15,033,077	0.072	0.011	Secondary/Tertiary Screening Dust Scrubber	99.5%	22	3.4	2.7	0.41
							Total Emissions	**26**	**3.9**	**3.1**	**0.47**

Notes:

1. Equipment specific information was provided by Castle Mountain Venture.
2. Emission factors for the secondary and tertiary screens were based on uncontrolled screening (secondary screens) and uncontrolled fines screening (tertiary screens) emission factors from AP-42, Section 11.19.2, Table 11.19.2-2. AP-42, Section 11.19.2, Table 11.19.2-2 does not include an uncontrolled screening or fines screening emission factors for $PM_{2.5}$ so these emission factors were estimated using the uncontrolled screening and fines screening emission factors for PM_{10} and a multiplier of 0.053/0.35 based on AP-42, Chapter 13.2.4, consistent with NDEP guidance for the mining industry.
3. The dust scrubber control efficiencies will be confirmed with vendor guarantees upon equipment design.

References:

NDEP. 2017. Guidance on Emission Factors for the Mining Industry. Available online at: https://ndep.nv.gov/uploads/air-permitting-docs/ndep-mining-emissions-guidance.pdf. May 31.

USEPA. 2004. AP-42, Section 11.19.2 (Crushed Stone Processing and Pulverized Mineral Processing). Available online at: https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s1902.pdf

USEPA. 2006. AP-42, Section 13.2.4. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/13.2.4_aggregate_handling_and_storage_piles.pdf.

Abbreviations:

lb - pounds
NDEP - Nevada Division of Environmental Protection
PM - particulate matter
tpd - tons per day
tpy - tons per year
USEPA - United States Environmental Protection Agency

2022 Mine Plan of Operations: Table O-8
On-site Mobile Fugitive Dust Emissions
Unpaved Road Travel
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Equipment Quantity[1]	Equipment Description	Average Vehicle Weight[2] (tons)	Unpaved Surface Silt Content (%)[3]	Emission Factor (lb/VMT)[4]		Maximum Equipment Hours[5]		Total Miles Traveled[6]		Control Efficiency (%)[7]	Number of Days with >0.01 Inches Precipitation[8] (days/yr)	Controlled Emissions			
													Daily (lb/day)		Annual (tpy)	
					PM_{10}	$PM_{2.5}$	Daily	Annual	Daily	Annually			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Haul Trucks	20	Caterpillar 793F	296	5	5.4	0.54	18	--	3,085	1,125,844	95%	31	831	83	139	14
Water Truck	2	Caterpillar 785G WTR MEGA	208	5	4.6	0.46	18	5,957	180	59,568	95%	31	83	8.3	6.3	0.63
Haul Truck	3	Caterpillar 773G	83	5	3.0	0.30	18	11,169	180	111,690	95%	31	82	8.2	7.8	0.78
Articulated Truck	1	Caterpillar 740GC	55.7	5	2.5	0.25	18	1,862	180	18,615	95%	31	23	2.3	1.1	0.11
Fuel and Lube Truck	1	Caterpillar 777 Mega System	132	5	3.7	0.37	18	4,468	180	44,676	95%	31	34	3.4	3.8	0.38
Tractor and Low Bed	1	--	160	5	4.1	0.41	18	745	180	7,446	95%	31	37	3.7	0.70	0.070
Flatbed Hiab Truck	1	--	10	5	1.2	0.12	18	2,606	180	26,061	95%	31	11	1.1	0.70	0.070
Mechanics Truck	1	8100 National	36.5	5	2.1	0.21	18	1,862	180	18,615	95%	31	19	1.9	0.89	0.089
Welding Truck	1	--	13.0	5	1.3	0.13	18	2,234	180	22,338	95%	31	12	1.2	0.67	0.067
Staff Pickup Trucks	10	--	1.0	5	0.42	0.042	24	29,784	240	297,840	95%	31	50	5.0	2.8	0.28
Pit Services Pickup	6	--	1.0	5	0.42	0.042	24	31,273	240	312,732	95%	31	30	3.0	3.0	0.30
Staff Pickup Trucks (Crewcab)	3	--	1.0	5	0.42	0.042	24	8,935	240	89,352	95%	31	15	1.5	0.85	0.085
Pit Services Pickup (Crewcab)	3	--	1.0	5	0.42	0.042	24	8,935	240	89,352	95%	31	15	1.5	0.85	0.085
Shovel Crew Flat Deck	1	--	7.5	5	1.0	0.10	18	1,489	180	14,892	95%	31	9.3	0.93	0.35	0.035
Shovel Crew Hiab	1	--	10	5	1.2	0.12	18	1,862	180	18,615	95%	31	11	1.1	0.50	0.050
Surface Crew Hiab	1	--	10	5	1.2	0.12	18	1,862	180	18,615	95%	31	11	1.1	0.50	0.050
Mine Rescue Vehicle	1	--	11.8	5	1.3	0.13	18	1,862	180	18,615	95%	31	11	1.1	0.54	0.054
Fuel Delivery Trucks	--	--	16.5	5	1.5	0.15	4	--	7.2	1,872	95%	31	0.53	0.053	0.063	0.0063
Product Delivery Trucks	--	--	16.5	5	1.5	0.15	1	--	3.8	99	95%	31	0.28	0.028	0.0033	3.3E-04
Contractor Trucks	--	--	16.5	5	1.5	0.15	3	--	11	3,960	95%	31	0.84	0.084	0.13	0.013
Other Delivery Trucks	--	--	16.5	5	1.5	0.15	14	--	53	14,049	95%	31	3.9	0.39	0.47	0.047
Reagent Delivery Trucks	--	--	16.5	5	1.5	0.15	11	--	42	3,751	95%	31	3.1	0.31	0.13	0.013
												Total Emissions	**1,291**	**129**	**171**	**17**

Notes:

1. Equipment counts provided by Castle Mountain Venture.
2. With the exception of Delivery Trucks, average weights are from Table 16-3 of Technical Report on the Castle Mountain Project Feasibility Study (March 2021) or based on equipment model specifications. Delivery truck weights assume heavy heavy-duty trucks (HHDT).
3. A roadway surface silt content of 5% was used, consistent with data provided by Castle Mountain Venture.
4. Fugitive dust emission factors calculated following MDAQMD's "most complex" Unpaved Roads methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 correlations for industrial roads (Equation 1a, Table 13.2.2-2, AP-42 Section 13.2.2) at the time of inventory preparation.
5. Maximum daily hours assumed to be 24 hours per day per piece of equipment for equipment with non-zero vehicle miles traveled except for the Fuel, Propane, Product, and Reagent Delivery Trucks. Delivery Trucks are assumed to make a maximum of one round-trip per hour, so the maximum daily hours are set equal to the number of daily trips presented in Table O-13b. Maximum annual hours provided by Castle Mountain Venture. Maximum annual hours are not presented for Caterpillar 793F Haul Trucks and Delivery Trucks as this information is not required for the calculation of vehicle miles traveled (VMT) or emissions.
6. Annual VMT for Caterpillar 793F Haul Trucks was provided by Castle Mountain Venture and daily VMT was set equal to annual VMT divided by 365 days per year. Annual VMT for Fuel, Propane, Product, and Reagent Delivery Trucks is shown in Table O-13b and daily VMT was calculated assuming 365 days per year and the days per year shown in Table O-13b. Annual and daily VMT for all other equipment was estimated based on hours of operation and a vehicle speed of 10 mph.
7. A control efficiency of 95% was used consistent with assumptions for watering, graveling surface, treatment with chemical stabilizers, and speed control from the 1997 Castle Mountain Mine Expansion Project EIS/EIR, and the understanding that chemical suppressants will be applied to all unpaved roadways.
8. Consistent with the AP-42 Section 13.2.2 unpaved roads methodology for industrial sites, Ramboll applied a precipitation reduction based on the number of days with greater than 0.01 inches precipitation per year based on site-specific meteorological measurements between January 2021 and December 2021.

References:

Bureau of Land Management. 1997. Castle Mountain Mine Expansion Project Final Environmental Impact Statement/Environmental Impact Report. October.

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

USEPA. 2006. AP-42, Section 13.2.2, Unpaved Roads. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0202.pdf. November.

Abbreviations:

HHDT - heavy heavy-duty truck
lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
mph - miles per hour
LNG - liquefied natural gas
PM - particulate matter
tpy - tons per year
USEPA - United States Environmental Protection Agency
VMT - vehicle miles traveled
yr - year

2022 Mine Plan of Operations: Table O-9
On-site Mobile Fugitive Dust Emissions
Dozing/Scraping/Grading and Similar Activity
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Equipment Quantity[1]	Equipment Description	Maximum Equipment Hours[1]		Control Efficiency[2] (%)	Emission Factor[3,4] (lb/hr)		Controlled Emissions			
								Daily (lb/day)		Annual (tpy)	
			Daily	Annual		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Production Blasthole Drill	3	Epiroc Pit Viper 235	18	19,859	98%	0.10	0.032	5.6	1.7	1.0	0.31
Wall Control Drill	2	Epiroc - SmartROC D65	18	13,190	98%	0.10	0.032	3.7	1.1	0.68	0.21
Hydraulic Shovel	3	Caterpillar 6060 FS	18	16,240	98%	0.10	0.032	5.6	1.7	0.84	0.26
Wheel Loader	2	Caterpillar 994K	18	11,315	98%	0.10	0.032	3.7	1.1	0.58	0.18
Track Dozer	5	Caterpillar D10T2	18	27,923	98%	0.10	0.032	9.3	2.8	1.4	0.44
Wheel Dozer	2	Caterpillar 844K	18	10,424	98%	0.10	0.032	3.7	1.1	0.54	0.16
Grader	3	Caterpillar 16MG	18	15,637	98%	0.10	0.032	5.6	1.7	0.81	0.25
Wheel Loader	1	Caterpillar 988KXE	18	4,468	98%	0.10	0.032	1.9	0.57	0.23	0.071
Excavator	1	Caterpillar 390D L	18	1,489	98%	0.10	0.032	1.9	0.57	0.077	0.024
Tire Manipulator	1	Caterpillar 988K CWS TM30P	18	1,117	98%	0.10	0.032	1.9	0.57	0.058	0.018
Vibratory Compactor	1	Caterpillar CS64	18	1,117	98%	0.10	0.032	1.9	0.57	0.058	0.018
Backhoe	1	Caterpillar 440	18	1,862	98%	0.10	0.032	1.9	0.57	0.096	0.029
Rough Terrain Forklift	1	Hyster 700	18	1,862	98%	0.10	0.032	1.9	0.57	0.096	0.029
Shop Forklift	1	Taylor-360M Forklift	18	1,862	98%	0.10	0.032	1.9	0.57	0.096	0.029
Hydraulic Hammer	1	TB-XC Hydraulic Breaker	18	1,862	98%	0.10	0.032	1.9	0.57	0.096	0.029
							Total Emissions	**52**	**16**	**6.7**	**2.1**

Notes:

1. Equipment specific information provided by Castle Mountain Venture.
2. Control efficiencies were calculated consistent with MDAQMD guidance for Dust Entrainment from Unpaved Roads as shown in Table O-18.
3. Fugitive dust emission factors for off-road equipment were calculated using Mojave Desert Air Quality Management District (MDAQMD) Bulldozing, Scraping and Grading of Materials "most complex" methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries document.
4. Emission factors are based on a material moisture content of 2% and a silt content of 5%, consistent with data provided by Castle Mountain Venture.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

Abbreviations:

lb - pounds
hr - hour
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
tpy - tons per year

2022 Mine Plan of Operations: Table O-10
On-site Mobile Vehicles
Exhaust Emission Factors
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Make/Model	Equipment Quantity[1]	Engine Size[1] (hp)	Equipment Tier[2]	OFFROAD2017 Equipment Type[3]	Load Factor[3]	Operating Hours[1]		Emission Factors (g/bhp-hr)[4]					
							(hr/yr)	(hr/day)	NO_x	SO_x	CO	ROG	PM_{10}	$PM_{2.5}$
Production Blasthole Drill	Epiroc Pit Viper 235	3	860	Tier 4 Final	Bore/Drill Rigs	0.50	19,859	18	2.6	0.0049	2.6	0.15	0.030	0.030
Wall Control Drill	Epiroc - SmartROC D65	2	540	Tier 4 Final	Bore/Drill Rigs	0.50	13,190	18	0.30	0.0049	2.6	0.15	0.015	0.015
Hydraulic Shovel	Caterpillar 6060 FS	3	2,996	Tier 4 Final	Other Construction Equipment	0.42	16,240	18	2.6	0.0049	2.6	0.15	0.030	0.030
Wheel Loader	Caterpillar 994K	2	1,739	Tier 4 Final	Rubber Tired Loaders	0.36	11,315	18	2.6	0.0049	2.6	0.15	0.030	0.030
Haul Trucks	Caterpillar 793F	20	2,650	Tier 4 Final	Off-Highway Trucks	0.38	114,040	18	2.6	0.0049	2.6	0.15	0.030	0.030
Track Dozer	Caterpillar D10T2	5	600	Tier 4 Final	Other Construction Equipment	0.42	27,923	18	0.30	0.0049	2.6	0.15	0.015	0.015
Wheel Dozer	Caterpillar 844K	2	620	Tier 4 Final	Rubber Tired Dozers	0.40	10,424	18	0.30	0.0049	2.6	0.15	0.015	0.015
Grader	Caterpillar 16MG	3	290	Tier 4 Final	Graders	0.41	15,637	18	0.30	0.0049	2.6	0.15	0.015	0.015
Water Truck	Caterpillar 785G WTR MEGA	2	1,450	Tier 4 Final	Off-Highway Trucks	0.38	5,957	18	2.6	0.0049	2.6	0.15	0.030	0.030
Wheel Loader	Caterpillar 988KXE	1	541	Tier 4 Final	Rubber Tired Loaders	0.36	4,468	18	0.30	0.0049	2.6	0.15	0.015	0.015
Haul Truck	Caterpillar 773G	3	825	Tier 4 Final	Off-Highway Trucks	0.38	11,169	18	2.6	0.0049	2.6	0.15	0.030	0.030
Excavator	Caterpillar 390D L	1	524	Tier 4 Final	Excavators	0.38	1,489	18	0.30	0.0049	2.6	0.15	0.015	0.015
Tire Manipulator	Caterpillar 988K CWS TM30P	1	541	Tier 4 Final	Other Construction Equipment	0.42	1,117	18	0.30	0.0049	2.6	0.15	0.015	0.015
Vibratory Compactor	Caterpillar CS64	1	130	Tier 4 Final	Other Construction Equipment	0.42	1,117	18	0.30	0.0049	3.7	0.15	0.015	0.015
Backhoe	Caterpillar 440	1	105	Tier 4 Final	Tractors/Loaders/Backhoes	0.37	1,862	18	0.30	0.0049	3.7	0.15	0.015	0.015
Articulated Truck	Caterpillar 740GC	1	450	Tier 4 Final	Off-Highway Trucks	0.38	1,862	18	0.30	0.0049	2.6	0.15	0.015	0.015
Fuel and Lube Truck	Caterpillar 777 Mega System	1	1,025	Tier 4 Final	Off-Highway Trucks	0.38	4,468	18	2.6	0.0049	2.6	0.15	0.030	0.030
Tractor and Low Bed	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	745	18	0.30	0.0049	2.6	0.15	0.015	0.015
Flatbed Hiab Truck	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	2,606	18	0.30	0.0049	2.6	0.15	0.015	0.015
Rough Terrain Forklift	Hyster 700	1	260	Tier 4 Final	Rough Terrain Forklifts	0.40	1,862	18	0.30	0.0049	2.6	0.15	0.015	0.015
Shop Forklift	Taylor-360M Forklift	1	173	Tier 4 Final	Forklifts	0.20	1,862	18	0.30	0.0049	3.7	0.15	0.015	0.015
Mechanics Truck	8100 National	1	330	Tier 4 Final	Off-Highway Trucks	0.38	1,862	18	0.30	0.0049	2.6	0.15	0.015	0.015
Welding Truck	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	2,234	18	0.30	0.0049	2.6	0.15	0.015	0.015
Shovel Crew Flat Deck	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	1,489	18	0.30	0.0049	2.6	0.15	0.015	0.015
Shovel Crew Hiab	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	1,862	18	0.30	0.0049	2.6	0.15	0.015	0.015
Surface Crew Hiab	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	1,862	18	0.30	0.0049	2.6	0.15	0.015	0.015
Lighting Tower	Amida	6	11	Tier 4 Final	Other Construction Equipment	0.42	11,169	18	5.3	0.0049	6.0	0.30	0.30	0.30
Hydraulic Hammer	TB-XC Hydraulic Breaker	1	172	Tier 4 Final	Other Construction Equipment	0.42	1,862	18	0.30	0.0049	3.7	0.15	0.015	0.015
Mine Rescue Vehicle	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	1,862	18	0.30	0.0049	2.6	0.15	0.015	0.015

Notes:

1. Equipment specific information provided by Castle Mountain Venture with the following exceptions: horsepower for Tractor and Low Bed, Flatbed Hiab Truck, Welding Truck, Shovel Crew Flat Deck, Shovel Crew Hiab, Surface Crew Hiab, and Hydraulic Hammer were obtained from EMFAC2021 in offroad emissions mode for MDAQMD in Calendar Year 2025.
2. All off-road equipment used at the facility will be Tier 4 Final.
3. Average equipment load factors were based on the CARB OFFROAD2017 Emission Factor Workbook (CARB 2017).
4. PM, CO, NO_x and VOC engine emission factors were based on CARB Tier 4 Final diesel engine standards. Emission factors for ROG were converted from NMHC Tier standards using USEPA hydrocarbon conversion factors (USEPA 2010). When applicable, the NMHC/NO_x combined Tier standard was split into NMHC and NO_x per BAAQMD guidance (assumed 5% NMHC, 95% NO_x). Emission factors for SO_x from diesel fuel are calculated from the California standard for diesel fuel of 15 ppm (http://www.arb.ca.gov/fuels/diesel/081404dslregs.pdf). Emission factor calculations assume a diesel fuel density of 7.1 lb/gal, heating value of 19,300 BTU/lb, BSFC of 7,000 BTU/hp-hr (USEPA 1996), and that all sulfur is converted to SO_2.

References:

BAAQMD. 2004. CARB Emission Factors for CI Diesel Engines - Percent HC in Relation to NMHC + NO_x.

CARB. Table 1: ARB and USEPA Off-Road Compression-Ignition (Diesel) Engine Standards. www.arb.ca.gov/msprog/ordiesel/documents/Off-Road_Diesel_Stds.xls.

CARB. 2017. 2017 Off-road Diesel Emission Factors. Available online at: https://ww2.arb.ca.gov/sites/default/files/2022-05/Off-road_CI_engine_standards_chart_04212022.pdf.

CARB 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250

USEPA. 2010. Conversion Factors for Hydrocarbon Emission Components, NR-002d. EPA-420-R-10-015. July. Available online at: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10081RP.pdf.

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
BSFC - brake-specific fuel consumption
BTU - British thermal units
CARB - California Air Resources Board
CO - carbon monoxide
EMFAC2021 - California Air Resources Board EMission FACtor model
g/bhp-hr - grams per brake horsepower-hour
gal - gallon
hp - horsepower
hr - hour
lb - pound
MDAQMD - Mojave Desert Air Quality Management District
NMHC - non-methane hydrocarbons
NO_x - nitrogen oxides
PM - particulate matter
ppm - parts per million
ROG - reactive organic gases
SO_x - sulfur oxides
USEPA - United States Environmental Protection Agency

2022 Mine Plan of Operations: Table O-11
On-site Mobile Vehicles
CAP Exhaust Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Daily Emissions[1] (lb/day)						Annual Emissions[1] (tpy)					
	NO_x	SO_x	CO	ROG	PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	ROG	PM_{10}	$PM_{2.5}$
Production Blasthole Drill	133	0.25	133	7.7	1.5	1.5	24	0.046	24	1.4	0.28	0.28
Wall Control Drill	6.4	0.11	56	3.2	0.32	0.32	1.2	0.019	10	0.59	0.059	0.059
Hydraulic Shovel	389	0.74	389	22	4.5	4.5	59	0.11	59	3.4	0.68	0.68
Wheel Loader	129	0.24	129	7.4	1.5	1.5	20	0.038	20	1.2	0.23	0.23
Haul Trucks	2,078	3.9	2,078	120	24	24	329	0.62	329	19	3.8	3.8
Track Dozer	15	0.25	130	7.5	0.75	0.75	2.3	0.038	20	1.2	0.12	0.12
Wheel Dozer	5.9	0.097	51	2.9	0.30	0.30	0.85	0.014	7.4	0.43	0.043	0.043
Grader	4.2	0.070	37	2.1	0.21	0.21	0.61	0.010	5.3	0.31	0.031	0.031
Water Truck	114	0.22	114	6.6	1.3	1.3	9.4	0.018	9.4	0.54	0.11	0.11
Wheel Loader	2.3	0.038	20	1.2	0.12	0.12	0.29	0.0047	2.5	0.14	0.014	0.014
Haul Truck	97	0.18	97	5.6	1.1	1.1	10	0.019	10	0.58	0.12	0.12
Excavator	2.4	0.039	21	1.2	0.12	0.12	0.098	0.0016	0.85	0.049	0.0049	0.0049
Tire Manipulator	2.7	0.044	23	1.4	0.14	0.14	0.084	0.0014	0.73	0.042	0.0042	0.0042
Vibratory Compactor	0.65	0.011	8.0	0.32	0.033	0.033	0.020	3.3E-04	0.25	0.010	0.0010	0.0010
Backhoe	0.46	0.008	5.7	0.23	0.023	0.023	0.024	3.9E-04	0.29	0.012	0.0012	0.0012
Articulated Truck	2.0	0.033	18	1.0	0.10	0.10	0.11	0.0017	0.91	0.053	0.0053	0.0053
Fuel and Lube Truck	40	0.076	40	2.3	0.46	0.46	5.0	0.0095	5.0	0.29	0.058	0.058
Tractor and Low Bed	1.8	0.030	16	0.91	0.092	0.092	0.038	6.2E-04	0.33	0.019	0.0019	0.0019
Flatbed Hiab Truck	1.8	0.030	16	0.91	0.092	0.092	0.13	0.0022	1.1	0.066	0.0066	0.0066
Rough Terrain Forklift	1.2	0.020	11	0.62	0.062	0.062	0.064	0.0011	0.55	0.032	0.0032	0.0032
Shop Forklift	0.41	0.0068	5.1	0.21	0.021	0.021	0.021	3.5E-04	0.26	0.011	0.0011	0.0011
Mechanics Truck	1.5	0.025	13	0.75	0.075	0.075	0.077	0.0013	0.67	0.039	0.0039	0.0039
Welding Truck	1.8	0.030	16	0.91	0.092	0.092	0.11	0.0019	0.98	0.057	0.0057	0.0057
Shovel Crew Flat Deck	1.8	0.030	16	0.91	0.092	0.092	0.076	0.0012	0.66	0.038	0.0038	0.0038
Shovel Crew Hiab	1.8	0.030	16	0.91	0.092	0.092	0.095	0.0016	0.82	0.047	0.0047	0.0047
Surface Crew Hiab	1.8	0.030	16	0.91	0.092	0.092	0.095	0.0016	0.82	0.047	0.0047	0.0047
Lighting Tower	5.7	0.0053	6.4	0.32	0.32	0.32	0.30	2.7E-04	0.33	0.017	0.017	0.017
Hydraulic Hammer	0.86	0.014	11	0.43	0.043	0.043	0.045	7.3E-04	0.55	0.022	0.0022	0.0022
Mine Rescue Vehicle	1.8	0.030	16	0.91	0.092	0.092	0.095	0.0016	0.82	0.047	0.0047	0.0047
Total Emissions	**3,045**	**6.6**	**3,507**	**202**	**38**	**38**	**464**	**0.97**	**513**	**30**	**5.6**	**5.6**

Notes:

[1.] Emissions based on parameters and emission factors presented in Table O-10.

Abbreviations:

CO - carbon monoxide
lb - pounds
NO_x - nitrogen oxides
PM - particulate matter
ROG - reactive organic gases
SO_x - sulfur oxides
tpy - tons per year

2022 Mine Plan of Operations: Table O-12
On-site Mobile Vehicles
GHG Exhaust Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Annual Fuel Usage[1] (gal/yr)	Emission Factors (kg/gal)[2,3]			Annual Emissions[4,5] (MT/yr)				
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Biogenic CO_2e	Non-biogenic CO_2e
Production Blasthole Drill	556,062	10.21	9.4E-04	8.7E-04	5,675	0.52	0.48	5,675	157
Wall Control Drill	224,235	10.21	9.4E-04	8.7E-04	2,289	0.21	0.20	2,289	63
Hydraulic Shovel	1,380,394	10.21	9.4E-04	8.7E-04	14,089	1.3	1.2	14,089	390
Wheel Loader	429,977	10.21	9.4E-04	8.7E-04	4,389	0.40	0.37	4,389	122
Haul Trucks	4,298,331	10.21	9.4E-04	8.7E-04	43,871	4.0	3.7	43,871	1,215
Track Dozer	530,528	10.21	9.4E-04	8.7E-04	5,415	0.50	0.46	5,415	150
Wheel Dozer	166,790	10.21	9.4E-04	8.7E-04	1,702	0.16	0.15	1,702	47
Grader	125,093	10.21	9.4E-04	8.7E-04	1,277	0.12	0.11	1,277	35
Water Truck	142,963	10.21	9.4E-04	8.7E-04	1,459	0.13	0.12	1,459	40
Wheel Loader	53,611	10.21	9.4E-04	8.7E-04	547	0.050	0.047	547	15
Haul Truck	134,028	10.21	9.4E-04	8.7E-04	1,368	0.126	0.12	1,368	38
Excavator	17,870	10.21	9.4E-04	8.7E-04	182	0.017	0.016	182	5.1
Tire Manipulator	12,286	10.21	9.4E-04	8.7E-04	125	0.012	0.011	125	3.5
Vibratory Compactor	7,818	10.21	9.4E-04	8.7E-04	80	0.0073	0.0068	80	2.2
Backhoe	9,308	10.21	9.4E-04	8.7E-04	95	0.0087	0.0081	95	2.6
Articulated Truck	7,446	10.21	9.4E-04	8.7E-04	76	0.0070	0.0065	76	2.1
Fuel and Lube Truck	53,611	10.21	9.4E-04	8.7E-04	547	0.050	0.047	547	15
Tractor and Low Bed	2,234	10.21	9.4E-04	8.7E-04	23	0.0021	0.0019	23	0.63
Flatbed Hiab Truck	7,818	10.21	9.4E-04	8.7E-04	80	0.0073	0.0068	80	2.2
Rough Terrain Forklift	5,585	10.21	9.4E-04	8.7E-04	57	0.0052	0.0049	57	1.6
Shop Forklift	3,723	10.21	9.4E-04	8.7E-04	38	0.0035	0.0032	38	1.1
Mechanics Truck	5,585	10.21	9.4E-04	8.7E-04	57	0.0052	0.0049	57	1.6
Welding Truck	6,701	10.21	9.4E-04	8.7E-04	68	0.0063	0.0058	68	1.9
Staff Pickup Trucks	89,352	10.21	9.4E-04	8.7E-04	912	0.084	0.078	912	25
Pit Services Pickup	93,820	10.21	9.4E-04	8.7E-04	958	0.088	0.082	958	27
Staff Pickup Trucks (Crewcab)	26,806	10.21	9.4E-04	8.7E-04	274	0.025	0.023	274	7.6
Pit Services Pickup (Crewcab)	26,806	10.21	9.4E-04	8.7E-04	274	0.025	0.023	274	7.6
Shovel Crew Flat Deck	4,468	10.21	9.4E-04	8.7E-04	46	0.0042	0.0039	46	1.3
Shovel Crew Hiab	7,446	10.21	9.4E-04	8.7E-04	76	0.0070	0.0065	76	2.1
Surface Crew Hiab	7,446	10.21	9.4E-04	8.7E-04	76	0.0070	0.0065	76	2.1
Lighting Tower	22,338	10.21	9.4E-04	8.7E-04	228	0.021	0.019	228	6.3
Mine Rescue Vehicle	5,585	10.21	9.4E-04	8.7E-04	57	0.0052	0.0049	57	1.6
Total Emissions					**86,409**	**8.0**	**7.4**	**86,409**	**2,394**

Notes:

1. Annual fuel usage was provided by Castle Mountain Venture.
2. CO_2 emission factor is from 40 CFR Part 98, Subpart C, Table C-1.
3. CH_4 and N_2O emission factors are from the EPA Center for Corporate Climate Leadership (2022, April 1) Emission Factors for Greenhouse Gas Inventories, Table 5 (available at https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf) which are calculated from the USEPA Inventory of U.S. Greenhouse Gas Emission and Sinks: 1990-2019.
4. Annual CO_2e emissions were calculated using global warming potentials (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).
5. CO_2 emissions are assumed to be 100% biogenic based on the assumption of the use of 100% renewable diesel fuel in off-road equipment, consistent with regulatory requirements under the CARB In-Use Off-Road Diesel-Fueled Fleets Regulation and CMV commitments.

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

CARB. 2022. In-Use Off-Road Diesel-Fueled Fleets regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/off-roaddiesel/appa-1.pdf

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

USEPA. 2021. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019. Available at: https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-annexes.pdf

Abbreviations:

CARB - California Air Resources Board
CH_4 - methane
CMV - Castle Mountain Venture
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
gal - gallons
GHG - greenhouse gas
GWP - global warming potential
kg - kilograms
MRR - Mandatory Reporting Regulation
MT - metric tons
N_2O - nitrous oxide
USEPA - United States Environmental Protection Agency
yr - year

2022 Mine Plan of Operations: Table O-13a
Off-site On-Road Mobile Vehicles
Trip Rates
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type[1]	Trip Type	Trip Rate (RT/day)	Trip Length (miles/RT)	Annual Activity (days/yr)	Annual Trips (RT/yr)	Daily VMT (miles/day)	Annual VMT (miles/yr)
Employee Vehicles[2]	Employee Vehicles - Full Commute	30	170	200	6,000	5,100	1,020,000
	Employee Vehicles - To/From Vans/Buses	160	12	365	58,400	1,920	700,800
Vans/Buses[3]	Vans/Buses	5	170	365	1,825	850	310,250
Fuel Delivery Trucks[4]	Fuel Delivery Trucks	4	206	260	1,040	824	214,240
LNG Delivery Trucks[5]	LNG Delivery Trucks	3	368	365	1,095	1,104	402,960
Product Delivery Trucks[6]	Product Delivery Trucks (gold to market)	1	836	26	26	836	21,736
Contractor Trucks[7]	Blasting Contractor Trucks	1	206	312	312	206	64,272
	Maintenance Contractor Trucks	2	206	365	730	412	150,380
Other Delivery Trucks[7]	Other Delivery Trucks (Warehouse to Coyote)	9	52	208	1,872	468	97,344
	Other Delivery Trucks (Las Vegas Origin)	5	206	365	1,825	1,030	375,950
Reagent Delivery Trucks[7]	Reagent Delivery Trucks (Antiscalant)	1	1,442	5	5	1,442	7,210
	Reagent Delivery Trucks (Carbon)	1	1,024	2	2	1,024	2,048
	Reagent Delivery Trucks (Caustic Soda)	1	578	26	26	578	15,028
	Reagent Delivery Trucks (Flocculant, Anionic)	1	574	12	12	574	6,888
	Reagent Delivery Trucks (Fluxes)	1	574	6	6	574	3,444
	Reagent Delivery Trucks (Pebble Lime)	3	206	260	780	618	160,680
	Reagent Delivery Trucks (Sodium Cyanide)	3	1,118	52	156	3,354	174,408

Notes:

1. Fleet mixes are defined in Table O-14a.
2. Employee vehicle trip rates were based on the number of employees working at the facility and were provided by Castle Mountain Venture. Each employee was assumed to make one roundtrip per day, to and from the Project site. Employee activity was assumed to occur 365 days per year. A portion of the employees were assumed to commute the full distance between home and the facility in their personal vehicles. The remainder of the employees were assumed to commute an average of 12 miles roundtrip between home and the van/bus pickup locations in their personal vehicles. Potential van/bus pick up locations may include Las Vegas, NV, Henderson, NV, and Bullhead City/Laughlin, NV.
3. Van/bus trip rates were calculated based on the number of van/bus commuters and an assumption of 35 passengers/vehicle. An average roundtrip distance between the Henderson, NV, Bullhead City/Laughlin, NV, and Las Vegas, NV bus/van locations and the facility was assumed.
4. Annual trip rates for Fuel Delivery calculated based on daily average trip rates provided by Castle Mountain Venture and 260 days per year of activity. Daily trip rates were conservatively rounded up to the nearest whole number. Trip lengths assume all fuel would be delivered from Las Vegas, NV.
5. Annual trip rates for LNG Delivery calculated based on daily average trip rates provided by Castle Mountain Venture and 365 days per year of activity. Trip length was provided by Castle Mountain Venture based on expected supplier.
6. Daily and annual trip rates assume one Product Delivery trip every other week. Trip length was provided by Castle Mountain Venture.
7. Daily trip rates, trip lengths, and annual activity for Contractors, Other Delivery Trucks, and Reagent Delivery Trucks were provided by Castle Mountain Venture.

Abbreviations:

LNG - liquefied natural gas
RT - roundtrips
VMT - vehicle miles traveled
yr - year

2022 Mine Plan of Operations: Table O-13b
On-site On-Road Mobile Vehicles
Trip Rates
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type[1]	Trip Type	Trip Rate (RT/day)	Trip Length (miles/RT)	Annual Activity (days/yr)	Annual Trips[1] (RT/yr)	Annual VMT[2] (miles/yr)
On-site Pickup Trucks	Staff Pickup Trucks			365		297,840
	Pit Services Pickup			365		312,732
	Staff Pickup Trucks (Crewcab)			365		89,352
	Pit Services Pickup (Crewcab)			365		89,352
Fuel Delivery Trucks	Fuel Delivery Trucks	4	1.8	260	1,040	1,872
LNG Delivery Trucks	LNG Delivery Trucks	3	1.8	365	1,095	1,971
Product Delivery Trucks	Product Delivery Trucks (gold to market)	1	3.8	26	26	99
Contractor Trucks	Blasting Contractor Trucks	1	3.8	312	312	1,186
	Maintenance Contractor Trucks	2	3.8	365	730	2,774
Other Delivery Trucks	Other Delivery Trucks (Warehouse to Coyote)	9	3.8	208	1,872	7,114
	Other Delivery Trucks (Las Vegas Origin)	5	3.8	365	1,825	6,935
Reagent Delivery Trucks	Reagent Delivery Trucks (Antiscalant)	1	3.8	5	5	19
	Reagent Delivery Trucks (Carbon)	1	3.8	2	2	7.6
	Reagent Delivery Trucks (Caustic Soda)	1	3.8	26	26	99
	Reagent Delivery Trucks (Flocculant, Anionic)	1	3.8	12	12	46
	Reagent Delivery Trucks (Fluxes)	1	3.8	6	6	23
	Reagent Delivery Trucks (Pebble Lime)	3	3.8	260	780	2,964
	Reagent Delivery Trucks (Sodium Cyanide)	3	3.8	52	156	593

Notes:

1. Fleet mixes are defined in Table O-14b. Diesel MDVs (on-site pickup trucks fleet) only generate emissions on a per mile basis, therefore annual trip rates are not presented in this table. On-site pickup trucks are assumed to operate 365 days per year. Delivery truck trips originate off-site and the emissions generated on a per trip basis are already accounted for in the off-site mobile calculations (Tables O-13a, O-14a, O-15a, O-16a, and O-17a. Trip rate data for delivery trucks is still presented, however, as part of the calculation of annual VMT.
2. Annual VMT for the on-site pickup trucks is calculated in Table O-8. Delivery trucks to the site will travel a short distance on-site in addition to the off-site activity presented in Table O-13a. Total annual onsite VMT was calculated based on the on-site mileage per trip (provided by Castle Mountain Venture) and the annual trip rates shown in Table O-13a.

Abbreviations:

LNG - liquefied natural gas
MDV - medium-duty truck
RT - roundtrips
VMT - vehicle miles traveled
yr - year

2022 Mine Plan of Operations: Table O-14a
Off-site On-Road Mobile Vehicles
Fleet Mix Distribution
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type	Vehicle Type	Percentage of Fleet Mix[1]	Percent by Fuel Type[1]				
			Gas	Diesel	Renewable Natural Gas	Electric	Plug-in Hybrid
Employee Vehicles	LDA	55.2%	89.5%	0%	0%	6.9%	3.4%
	LDT1	3.9%	99.0%	0.008%	0%	0.52%	0.45%
	LDT2	24.0%	97.3%	0.35%	0%	0.96%	1.4%
	MCY	0.39%	100%	0%	0%	0%	0%
	MDV	16.6%	95.8%	1.5%	0%	1.5%	1.2%
Vans/Buses	LHDT1	78.5%	100%	0%	0%	0%	0%
	LHDT2	21.5%	100%	0%	0%	0%	0%
Fuel Delivery Trucks	HHDT	100%	0%	100%	0%	0%	0%
LNG Delivery Trucks	HHDT	100%	0%	0%	100%	0%	0%
Product Delivery, Contractor, Other Delivery, and Reagent Delivery Trucks	MHDT	6.9%	0%	100%	0%	0%	0%
	HHDT	93.1%	0%	100%	0%	0%	0%

Notes:

1. Fleet mixes and percentages by fuel type are calculated based on EMFAC2021 v1.0.2 vehicle miles traveled projections for MDAQMD with the exception of Vans which are assumed to be exclusively gasoline-fueled, LNG Delivery Trucks which are assumed to be fueled exclusively with renewable compressed natural gas, and Delivery Trucks which are assumed to be exclusively diesel-fueled. EMFAC2021 v1.0.2 was run in Emission Rates mode for calendar year 2027 in the annual season.

References:

California Air Resources Board (ARB) 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250

Abbreviations:

EMFAC2021 - California Air Resources Board EMission FACtor model
HHDT - heavy-heavy-duty truck
LDA - passenger car
LDT - light-duty truck
LHDT - light-heavy-duty truck
LNG - liquefied natural gas
MCY - motorcycle
MDAQMD - Mojave Desert Air Quality Management District
MDV - medium-duty truck
MHDT - medium-heavy-duty truck

2022 Mine Plan of Operations: Table O-14b
On-site On-Road Mobile Vehicles
Fleet Mix Distribution
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type	Vehicle Type	Percentage of Fleet Mix[1]	Percent by Fuel Type[1]				
			Gas	Diesel	Renewable Natural Gas	Electric	Plug-in Hybrid
On-site Pickup Trucks	MDV	100%	50%	50%	0%	0%	0%
Fuel Delivery Trucks	HHDT	100%	0%	100%	0%	0%	0%
LNG Delivery Trucks	HHDT	100%	0%	0%	100%	0%	0%
Product Delivery, Contractor, Other Delivery, and Reagent Delivery Trucks	MHDT	6.9%	0%	100%	0%	0%	0%
	HHDT	93.1%	0%	100%	0%	0%	0%

Notes:

1. On-site Pickup Trucks are assumed to be 50% gasoline-fueled and 50% diesel-fueled. Delivery Trucks are assumed to be 100% diesel-fueled. LNG Delivery Trucks are assumed to be 100% renewable compressed natural gas-fueled. EMFAC2021 v1.0.2 was run in Emission Rates mode for MDAQMD for calendar year 2027 in the annual season.

References:

California Air Resources Board (ARB) 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250

Abbreviations:

EMFAC2021 - California Air Resources Board EMission FACtor model
HHDT - heavy heavy-duty truck
LNG - liquefied natural gas
MDAQMD - Mojave Desert Air Quality Management District
MDV - medium-duty truck
MHDT - medium heavy-duty truck

2022 Mine Plan of Operations: Table O-15a
Off-site On-Road Mobile Vehicles
Exhaust and Brake Wear/Tire Wear Emission Factors
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Scenario		Emission Factor Units	Mobile Emission Factors[1]									
			CAPs						GHGs[2]			
Year	Fleet Type		ROG	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x	CO_2	CH_4	N_2O	CO_2e
2027	Employee Vehicles	g/mile	0.014	0.056	0.015	0.0050	0.76	0.0029	294	0.0031	0.0054	296
		g/trip	1.1	0.26	0.0019	0.0018	3.0	7.2E-04	73	0.069	0.032	84
	Vans/Buses	g/mile	0.023	0.17	0.090	0.031	1.2	0.0061	615	0.0047	0.0095	618
		g/trip	0.77	0.61	3.2E-04	3.0E-04	3.4	3.3E-04	34	0.040	0.049	49
	Fuel Delivery Trucks	g/mile	0.012	1.4	0.14	0.067	0.034	0.014	1,450	5.6E-04	0.23	1,518
		g/trip	0.48	7.7	0.0021	0.0020	7.0	0.0098	1,030	0.022	0.16	1,079
	LNG Delivery Trucks	g/mile	0.012	0.28	0.12	0.038	5.0	0	1,080	0.83	0.22	1,167
		g/trip	0.057	1.5	0.0044	0.0041	7.9	0	1,149	4.0	0.23	1,320
	Product Delivery, Contractor, Other Delivery, and Reagent Delivery Trucks	g/mile	0.012	1.3	0.14	0.064	0.035	0.013	1,423	5.6E-04	0.22	1,490
		g/trip	0.44	7.4	0.0020	0.0019	6.6	0.0092	969	0.021	0.15	1,015

Notes:

1. Emission factors were estimated using EMFAC2021 for MDAQMD. EMFAC2021 was run in Emission Rates mode for calendar year 2027 in the annual season. The following processes have units of g/trip: DIURN, HOTSOAK, RESTLOSS, STREX, and IDLEX. The following processes have units of g/mile: PMBW, PMTW, RUNEX, and RUNLOSS. Processes with units of g/vehicle/day were converted to g/trip using the population and trip rate values given in the EMFAC2021 run.
2. Annual CO_2e emissions were calculated using GWP values from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

CARB 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CAP - Criteria Air Pollutant
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
DIURN - diurnal evaporative hydrocarbon emissions
EMFAC2021 - California Air Resources Board EMission FACtor model
g - grams
GHG - greenhouse gas
GWP - global warming potential
HOTSOAK - hot soak evaporative hydrocarbon emissions
IDLEX - idle exhaust emissions
LNG - liquefied natural gas
MDAQMD - Mojave Desert Air Quality Management District
MRR - Mandatory Reporting Regulation
N_2O - nitrous oxide
NO_x - nitrogen oxides
PM - particulate matter
PMBW - brake wear particulate matter emissions
PMTW - tire wear particulate matter emissions
RESTLOSS - resting evaporative losses
ROG - reactive organic gases
RUNEX - running exhaust emissions
RUNLOSS - running loss evaporative hydrocarbon emissions
STREX - start exhaust tailpipe emissions
SO_x - sulfur oxides
USEPA - United States Environmental Protection Agency

2022 Mine Plan of Operations: Table O-15b
On-site On-Road Mobile Vehicles
Exhaust and Brake Wear/Tire Wear Emission Factors
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Scenario		Emission Factor Units	Mobile Emission Factors[1]									
			CAPs						GHGs[2]			
Year	Fleet Type		ROG	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x	CO_2	CH_4	N_2O	CO_2e
2027	On-site Pickup Trucks	g/mile	0.015	0.11	0.019	0.0084	0.59	0.0040				
		g/trip	0.70	0.20	0.0010	9.6E-04	1.9	5.1E-04				
	Fuel Delivery Trucks	g/mile	0.012	1.4	0.14	0.067	0.034	0.014	1,450	5.6E-04	0.23	1,518
	LNG Delivery Trucks	g/mile	0.012	0.28	0.12	0.038	5.0	0	1,080	0.83	0.22	1,167
	Product Delivery, Contractor, Other Delivery, and Reagent Delivery Trucks	g/mile	0.012	1.3	0.14	0.064	0.035	0.013	1,423	5.6E-04	0.22	1,490

Notes:

1. Emission factors were estimated using EMFAC2021 for MDAQMD. EMFAC2021 was run in Emission Rates mode for calendar year 2027 in the annual season. The following processes have units of g/mile: PMBW, PMTW, RUNEX, and RUNLOSS. For the Delivery Truck fleets, the g/trip emission factors are not presented because these trips originate off-site and the emissions generated on a per trip basis are already accounted for in Tables O-13a, O-14a, O-15a, O-16a, and O-17a.
2. GHG emissions for the On-site Pickup Trucks are based on fuel consumption rates and are calculated in Table O-12. Annual CO2e emissions for the Delivery Truck fleets are calculated using GWP values from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

California Air Resources Board (CARB) 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CAP - Criteria Air Pollutant
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
EMFAC2021 - California Air Resources Board EMission FACtor model
g - grams
GHG - greenhouse gas
GWP - global warming potential
LNG - liquefied natural gas
MDAQMD - Mojave Desert Air Quality Management District
MRR - Mandatory Reporting Rule
N_2O - nitrous oxide
NO_x - nitrogen oxides
PM - particulate matter
PMBW - brake wear particulate matter emissions
PMTW - tire wear particulate matter emissions
ROG - reactive organic gases
RUNEX - running exhaust emissions
RUNLOSS - running loss evaporative hydrocarbon emissions
SO_x - sulfur oxides
USEPA - United States Environmental Protection Agency

2022 Mine Plan of Operations: Table O-16a
Off-site On-Road Mobile Vehicles
Exhaust and Brake Wear/Tire Wear Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Daily Emission Rates[1]

Year	Fleet Type	Emissions from Mobile Sources					
		ROG[2]	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x
		(lb/day)					
2027	Employee Vehicles	0.66	0.97	0.23	0.079	13	0.045
	Vans/Buses	0.051	0.32	0.17	0.059	2.3	0.011
	Fuel Delivery Trucks	0.026	2.6	0.26	0.12	0.12	0.025
	LNG Delivery Trucks	0.029	0.69	0.28	0.092	12	0
	Product Delivery Trucks	0.023	2.5	0.25	0.12	0.079	0.025
	Contractor Trucks	0.019	1.9	0.19	0.087	0.091	0.018
	Other Delivery Trucks	0.053	4.6	0.45	0.21	0.32	0.045
	Reagent Delivery Trucks	0.23	24	2.5	1.2	0.79	0.24
Total Emissions		**1.1**	**38**	**4.3**	**1.9**	**29**	**0.41**

Annual Emission Rates[1]

Year	Fleet Type	Emissions from Mobile Sources										
		ROG[2]	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x	CO_2	CH_4	N_2O	Biogenic CO_2e	Non-biogenic CO_2e
		(tons/yr)						(MT/yr)				
2027	Employee Vehicles	0.10	0.12	0.028	0.0097	1.7	0.0056	510	0.010	0.011	0	514
	Vans/Buses	0.0094	0.059	0.031	0.011	0.43	0.0021	191	0.0015	0.0030	0	192
	Fuel Delivery Trucks	0.0034	0.34	0.033	0.016	0.016	0.0033	312	1.4E-04	0.049	0	326
	LNG Delivery Trucks[3]	0.0053	0.13	0.051	0.017	2.2	0	437	0.34	0.089	437	35
	Product Delivery Trucks	3.0E-04	0.032	0.0033	0.0015	0.0010	3.2E-04	31	1.3E-05	0.0049	0	32
	Contractor Trucks	0.0033	0.32	0.032	0.015	0.016	0.0032	306	1.4E-04	0.048	0	321
	Other Delivery Trucks	0.0080	0.73	0.071	0.033	0.045	0.0071	677	3.4E-04	0.11	0	709
	Reagent Delivery Trucks	0.0054	0.55	0.056	0.026	0.021	0.0055	527	2.3E-04	0.083	0	552
Total Emissions		**0.14**	**2.3**	**0.31**	**0.13**	**4.4**	**0.027**	**2,991**	**0.35**	**0.40**	**437**	**2,681**

Notes:

1. Trip generation rates and emission factors used in emissions calculations are shown in Tables O-13a and O-15a, respectively.
2. ROG is assumed to equal VOC.
3. LNG Delivery Trucks will be fueled exclusively by renewable compressed natural gas. Therefore, the associated CO_2 emissions are treated as biogenic.

Abbreviations:

CO - carbon monoxide
CO_2e - carbon dioxide equivalents
lb - pound
LNG - liquefied natural gas
MT - metric ton(s)
NO_x - nitrogen oxides
PM - particulate matter
ROG - reactive organic gases
SO_x - sulfur oxides
VOC - volatile organic compounds
yr - year

2022 Mine Plan of Operations: Table O-16b
On-site On-Road Mobile Vehicles
Exhaust and Brake Wear/Tire Wear Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Daily Emission Rates[1]

Year	Fleet Type	Emissions from Mobile Sources					
		ROG[2]	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x
		(lb/day)					
2027	On-site Pickup Trucks	0.070	0.52	0.090	0.040	2.8	0.019
	Fuel Delivery Trucks	1.9E-04	0.022	0.0023	0.0011	5.5E-04	2.2E-04
	LNG Delivery Trucks	1.4E-04	0.0033	0.0014	4.5E-04	0.060	0
	Product Delivery Trucks	1.0E-04	0.011	0.0011	5.4E-04	2.9E-04	1.1E-04
	Contractor Trucks	3.0E-04	0.034	0.0034	0.0016	8.8E-04	3.4E-04
	Other Delivery Trucks	0.0014	0.16	0.016	0.0075	0.0041	0.0016
	Reagent Delivery Trucks	0.0011	0.12	0.013	0.0059	0.0032	0.0012
Total Emissions		**0.073**	**0.87**	**0.13**	**0.057**	**2.9**	**0.023**

Annual Emission Rates[1]

Year	Fleet Type	Emissions from Mobile Sources										
		ROG[2]	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x	CO_2	CH_4	N_2O	Biogenic CO_2e	Non-biogenic CO_2e
		(tpy)						(MT/yr)				
2027	On-site Pickup Trucks	0.013	0.095	0.016	0.0073	0.52	0.0035	0	0	0	0	0
	Fuel Delivery Trucks	2.5E-05	0.0029	2.9E-04	1.4E-04	7.1E-05	2.8E-05	2.7	1.0E-06	4.3E-04	0	2.8
	LNG Delivery Trucks[3]	2.6E-05	6.1E-04	2.5E-04	8.2E-05	0.011	0	2.1	0.0016	4.3E-04	2.1	0.17
	Product Delivery Trucks	1.3E-06	1.5E-04	1.5E-05	7.0E-06	3.8E-06	1.5E-06	0.14	5.5E-08	2.2E-05	0	0.15
	Contractor Trucks	5.2E-05	0.0058	6.0E-04	2.8E-04	1.5E-04	5.9E-05	5.6	2.2E-06	8.9E-04	0	5.9
	Other Delivery Trucks	1.9E-04	0.021	0.0021	9.9E-04	5.4E-04	2.1E-04	20	7.8E-06	0.0031	0	21
	Reagent Delivery Trucks	4.9E-05	0.0055	0.00056	2.6E-04	1.4E-04	5.6E-05	5.3	2.1E-06	8.4E-04	0	5.6
Total Emissions		**0.013**	**0.13**	**0.020**	**0.0091**	**0.53**	**0.0039**	**36**	**0.0017**	**0.0058**	**2.1**	**36**

Notes:

1. Trip generation rates, VMT, and emission factors used in emissions calculations are shown in Tables O-13b and O-15b, respectively. GHG emissions from on-site pickup trucks are calculated based on fuel consumption and are presented in Table O-12.
2. ROG is assumed to equal VOC.
3. LNG Delivery Trucks will be fueled exclusively by renewable compressed natural gas. Therefore, the associated CO_2 emissions are treated as biogenic.

Abbreviations:

CO - carbon monoxide
CO_2e - carbon dioxide equivalent
lb - pound
LNG - liquefied natural gas
MT - metric ton
NO_x - nitrogen oxides
PM - particulate matter
ROG - reactive organic gases
SO_x - sulfur oxides
VMT - vehicle miles traveled
VOC - volatile organic compound
tpy - tons per year
yr - year

2022 Mine Plan of Operations: Table O-17a
Off-site On-Road Mobile Vehicles
Fugitive Dust Emissions - Paved Roads
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Entrained Roadway Dust Constants for San Bernardino County (MDAQMD)		
Roadway Category	**Silt Loading[1] (g/m^2)**	**Travel Fraction[1]**
Freeway	0.015	52%
Major	0.08	32%
Collector	0.08	9.0%
Local	0.84	7.0%
Weighted Silt Loading Factor	**0.099**	**100%**

Road Dust Equation[2]
E = k*(sL)^0.91 * (W)^1.02 * (1-P/4N)

Parameter[2]	**Value**
E = annual average emission factor in the same units as k	[calculated]
k = particle size multiplier for particle size range and units of interest	
PM_{10} (lb/VMT)	0.0022
$PM_{2.5}$ (lb/VMT)	3.3E-04
sL = road surface silt loading (grams per square meter) (g/m^2)	0.099
W = average weight (tons) of all the vehicles traveling the road	2.4
P = number of "wet" days with at least 0.01 inches of precipitation during averaging period[3]	45
N number of days in the averaging period	365

Vehicle Miles Traveled[4]

Fleet Type	**Miles/Day**	**Miles/Year**
Employee Vehicles	5,940	1,504,800
Vans/Buses	670	244,550
Fuel Delivery Trucks	680	176,800
LNG Delivery Trucks	996	363,540
Product Delivery Trucks	800	20,800
Contractor Trucks	510	177,140
Other Delivery Trucks	994	340,202
Reagent Delivery Trucks	7,768	334,174

Parameter[5]	**Fugitive PM_{10}**	**Fugitive $PM_{2.5}$**	**Units**
Emission Factor	6.4E-04	9.6E-05	lb/VMT

Fleet Type	**Daily Emissions (lb/day)**		**Annual Emissions (tpy)**	
	PM_{10}	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Employee Vehicles	3.8	0.57	0.48	0.072
Vans/Buses	0.43	0.064	0.078	0.012
Fuel Delivery Trucks	0.43	0.065	0.056	0.0085
LNG Delivery Trucks	0.63	0.095	0.12	0.017
Product Delivery Trucks	0.51	0.077	0.0066	9.9E-04
Contractor Trucks	0.33	0.049	0.056	0.0085
Other Delivery Trucks	0.63	0.095	0.11	0.016
Reagent Delivery Trucks	5.0	0.74	0.11	0.016
Total Emissions	**12**	**1.8**	**1.0**	**0.15**

Notes:

1. Travel fraction by roadway category and silt loading are from the ARB's March 2021 update to Entrained Road Travel Emission Inventory Source Methodology, Tables 2 and 4, respectively.
2. The road dust equation for paved roads is from the ARB's March 2021 update to Entrained Road Travel Emission Inventory Source Methodology.

3. The number of "wet" days for San Bernardino County (MDAQMD) from Table 5 of the ARB's March 2021 update to Entrained Road Travel Emission Inventory Source Methodology.
4. Vehicle miles traveled from O-13a account for the fact that the last 18 miles to and from Castle Mountain Mine are unpaved. Fugitive dust emissions associated with the unpaved portion of vehicle miles traveled are presented in Table O-17b.
5. $PM_{2.5}$ is assumed to be 15% of PM_{10} based on paved road dust sampling in California (ARB Speciation Profile #471), which is a more representative fraction than provided in the older AP-42 fugitive dust methodology as discussed in ARB 2021 (page 36).

References:

California Air Resources Board. 2021. Miscellaneous Process Methodology 7.9, Entrained Road Travel, Paved Road Dust. March. Available online at: https://ww3.arb.ca.gov/ei/areasrc/fullpdf/2021_paved_roads_7_9.pdf

USEPA. 2011. AP 42. Compilation of Air Pollutant Emission Factors, Volume 1. Fifth Edition. Chapter 13.2.1, Paved Roads. Available online at: http://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0201.pdf.

Abbreviations:

ARB - California Air Resources Board
g - gram(s)
lb - pounds
LNG - liquefied natural gas
MDAQMD - Mojave Desert Air Quality Management District
m^2 - square meter
PM - particulate matter
tpy - tons per year
USEPA - United States Environmental Protection Agency
VMT - vehicle miles traveled

2022 Mine Plan of Operations: Table O-17b
Off-site On-Road Mobile Vehicles
Fugitive Dust Emissions - Unpaved Roads
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type	Daily Unpaved Road VMT Traveled (miles/day)[1]	Annual Unpaved Road VMT Traveled (miles/yr)[1]	Mean Vehicle Weight (tons)[2]	Emission Factor (lb/VMT)[3]		Control Efficiency (%)[4]	Number of Days with >0.01 Inches Precipitation[5] (day/yr)	Controlled Emissions			
								Daily (lb/day)		Annual (tpy)	
				PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Employee Vehicles	1,080	216,000	2.4	0.62	0.062	95%	30	31	3.1	3.1	0.31
Vans/Buses	180	65,700	15	1.4	0.14	95%	30	12	1.2	2.1	0.21
Fuel Delivery Trucks	144	37,440	30	1.9	0.19	95%	30	13	1.3	1.7	0.17
LNG Delivery Trucks	108	39,420	30	1.9	0.19	95%	30	9.5	0.95	1.7	0.17
Product Delivery Trucks	36	936	30	1.9	0.19	95%	30	3.2	0.32	0.041	0.0041
Contractor Trucks	108	37,512	30	1.9	0.19	95%	30	9.5	0.95	1.7	0.17
Other Delivery Trucks	504	133,092	30	1.9	0.19	95%	30	44	4.4	5.9	0.59
Reagent Delivery Trucks	396	35,532	30	1.9	0.19	95%	30	35	3.5	1.6	0.16
							Total Emissions	**157**	**16**	**18**	**1.8**

Notes:

1. Vehicle miles traveled are from Table O-13a and account for the fact that the last 18 miles to and from Castle Mountain Mine are unpaved. Fugitive dust emissions associated with the paved portion of vehicle miles traveled are presented in Table O-17a.
2. Mean vehicle weights estimated based on typical vehicle weights for each vehicle type as shown in Table O-14a.
3. Emission factors for fugitive dust were calculated following MDAQMD's "most complex" Unpaved Roads methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 correlations for industrial roads (Equation 1a, Table 13.2.2-2, AP-42 Section 13.2.2) at the time of inventory preparation. A surface silt loading content of 5% was provided by Castle Mountain Venture.
4. A control efficiency of 95% used consistent with assumptions from the 1997 Castle Mountain Mine Expansion Project EIS/EIR, and the understanding that chemical suppressants will be applied to all unpaved roadways.
5. Consistent with the AP-42 Section 13.2.2 unpaved roads methodology for industrial sites, Ramboll applied a precipitation reduction based on the number of days with greater than 0.01 inches precipitation per year based on guidance in AP-42 Section 13.2.2, Figure 13.2.2-1.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

USEPA. 2006. AP-42, Section 13.2.2, Unpaved Roads. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0202.pdf. November.

Abbreviations:

lb - pounds
LNG - liquefied natural gas
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
tpy - tons per year
USEPA - United States Environmental Protection Agency
VMT - vehicle miles traveled
yr - year

2022 Mine Plan of Operations: Table O-18
Watering Assumptions for Disturbed Operational Areas
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter	Value	Data Source
Average Hourly Traffic Rate	3 vehicles/hr	Only loaders and water trucks would disturb ore areas (haul trucks travel exclusively on roads). Per Castle Mountain Venture, a maximum of two loaders plus a water truck per hour is expected.
Time Between Water Applications	1 hours	Per Castle Mountain Venture, watering occurs approximately once per hour.
Average Annual Class A Pan Evaporation	75 inches	MDAQMD Mineral Guidance, conservative default
Water Application Intensity	0.11 gallons/yd^2	MDAQMD Mineral Guidance, conservative default
Control Efficiency	98 %	MDAQMD Mineral Guidance, Pg. 26

Notes:

1. Watering control efficiencies calculated consistent with MDAQMD guidance for Dust Entrainment from Unpaved Roads.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

Abbreviations:

hr - hour
MDAQMD - Mojave Desert Air Quality Management District
yd^2 - square yard

2022 Mine Plan of Operations: Table O-19
Disturbed Operational Area Emissions
Wind Erosion
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Daily Disturbed Surface Area[1] (acres)		Control Efficiency[2] (%)	Daily Emissions[3,4,5] (lb/day)		Annual Emissions[3,4,5] (tpy)	
	Average	Maximum		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Disturbed Areas	0.77	0.77	98%	3.2	0.48	0.077	0.012
Total Emissions				**3.2**	**0.48**	**0.077**	**0.012**

Notes:

1. Average and maximum daily disturbed surface area based on information provided by Castle Mountain Venture.
2. Control efficiency accounts for watering of disturbed areas. The watering control efficiency was calculated consistent with MDAQMD guidance for Dust Entrainment from Unpaved Roads as shown in Table O-18.
3. Windblown dust from disturbed areas assumed to be a "limited" reservoir consistent with MDAQMD definitions due to the significant crusting that occurs on the mine ore and overburden areas.
4. Emissions estimated using MDAQMD's "most complex" Wind Erosion from Unpaved Operational Areas and Roads methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest $PM_{2.5}$ aerodynamic factor from AP-42 (Table 13.2.5-1 in AP-42 Section 13.2.5). Threshold friction velocity selected from the MDAQMD guidance based on an area use of "disturbed desert".
5. The maximum daily windspeeds required for input into the MDAQMD equation were assumed to be the "fastest mile" windspeed from each day (consistent with AP-42 Section 13.2.5 guidance, which the MDAQMD equation is based on). The fastest mile wind speeds were calculated using hourly site-specific meteorological data from January 2021 through December 2021 by scaling up the maximum hourly average wind speed to a fastest mile windspeed using the equation:

$$u+ = 1.52u/1.2$$

Where: u+ = fastest mile wind speed, and u = hourly mean wind speed. This empirical relationship is based on a conversion of the hourly average wind speed to a 3-second gust wind speed with the coefficient 1.52 (Dregger 2005), then a conversion of the 3-second gust windspeed to a fastest mile of wind with the coefficient 1/1.2 (Fouad and Calvert 2002).

References:

Dregger. 2005. The Wind Investigator: How to Approximate Wind Velocities at Roof Level. October.

Fouad and Calvert. 2002. Wind Load Provisions in the 2001 Supports Specification. November.

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

USEPA. 2006. AP-42, Section 13.2.5, Industrial Wind Erosion. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0205.pdf. November.

Abbreviations:

lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
USEPA - United States Environmental Protection Agency
tpy - tons per year

2022 Mine Plan of Operations: Table O-20
Stockpile Wind Erosion Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Storage Pile Area[1] (acres)	Storage Pile Silt Loading[2] (%)	Percentage of Year Stockpile Operates[3] (%)	Percentage of Time with Wind Speed > 12 mph[4] (%)	Number of Days with >0.01 Inches Precipitation[5] (day/yr)	Daily Water Application Rate[6] (gal/acre)	Watering Control Efficiency[7] (%)	Daily PM_{10} Emissions[8] (lb/day)	Daily $PM_{2.5}$ Emissions[8] (lb/day)	Annual PM_{10} Emissions[8] (tpy)	Annual $PM_{2.5}$ Emissions[8] (tpy)
Interim Ore Stockpile	6.2	15	25	24	31	2,130	50	15	5.9	2.7	1.1

Notes:

1. Storage pile area based on information provided by Castle Mountain Venture.
2. Storage pile silt loading of 15% was used, consistent with the default value for "blend ore and dirt" in MDAQMD guidance for Wind Erosion from Stockpiles.
3. Ore stockpile will operate during crushing stoppages, assumed to be 25% of the year based on crushing circuit design availability.
4. Percentage of time with wind speed greater than 12 mph based on hourly site-specific meteorological data for the period of January 2021 through December 2021.
5. Number of days with greater than 0.01 inches precipitation per year based on site-specific meteorological data for the period of January 2021 through December 2021.
6. Daily water application rate based on MDAQMD default watering intensity of 0.11 gal/yd^2 for unpaved road control, assuming water is applied 4 times per day to the Ore Stockpile.
7. Control efficiency for watering based on MDAQMD guidance for Wind Erosion from Stockpiles and daily water application rate.
8. Fugitive dust emissions calculated consistent with the most complex method from MDAQMD guidance for Wind Erosion from Stockpiles.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

Abbreviations:

gal = gallon
lb = pound
MDAQMD = Mojave Desert Air Quality Management District
mph = miles per hour
$PM_{2.5}$ = particulate matter less than 2.5 microns in diameter
PM_{10} = particulate matter less than 10 microns in diameter
tpy = tons per year

2022 Mine Plan of Operations: Table O-21
Fugitive Blast Hole Drilling Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Maximum Blast Holes[1]		Emission Factor[2] (lb/hole)		Control Efficiency[3] (%)	Maximum Daily Emissions (lb/day)		Annual Emissions (tpy)	
	Annual (holes/yr)	Daily (holes/day)	PM_{10}	$PM_{2.5}$		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Blast Hole Drilling	87,599	281	0.68	0.039	75%	47	2.7	7.4	0.43

Notes:

1. Facility specific information provided by Castle Mountain Venture. Quantity of blast holes includes ROM Ore, Waste Rock, Trim/Buffer drilling and conservatively includes Pre-shear. Maximum daily holes blasted assumes 6 days/week.
2. Emission factors are calculated using MDAQMD's "most complex" Blast Hole Drilling methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 PM2.5 multiplier (AP-42 Section 11.9, Table 11.9-1) at the time of inventory preparation.
3. A control efficiency of 75% is applied consistent with MDAQMD guidance for "complete coverage by windscreens (on the windward side)", assuming that the pit in which blasting activities take place will effectively act as a windscreen and reduce particulate matter

References:

USEPA. 1998. AP-42, Section 11.9, Western Surface Coal Mining. Available online at: https://www3.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf. October.

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

Abbreviations:

lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
tpy - tons per year
USEPA - United States Environmental Protection Agency
yr - year

2022 Mine Plan of Operations: Table O-22
Fugitive Dust Entrainment from Blasting Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Maximum Blast Holes[1]		Maximum Blasts[1]		Horizontal Area Shifted per Blast (sf)	Emission Factor[2] (lb/blast)		Control Efficiency[3] (%)	Maximum Daily Emissions (lb/day)		Annual Emissions (tpy)	
	Annual (holes/yr)	Daily (holes/day)	Annual (blasts/yr)	Daily (blasts/day)		PM_{10}	$PM_{2.5}$		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
ROM Ore	15,750	110	72	1	116,380	289	16.7	75%	72	4.2	2.6	0.15
Waste Rock	46,924	110	214	1	153,913	440	25.4	75%	110	6.3	12	0.68
Trim/Buffer	5,394	0	25	0	74,483	148	8.5	75%	0	0	0.46	0.027
								Total Emissions	**182**	**11**	**15**	**0.86**

Notes:

1. Facility specific information provided by Castle Mountain Venture. Pre-shear blasting is not shown here as it does not significantly shift material. Daily maximum blast holes were calculated using the total annual quantity of ROM Ore, Waste Rock, and Trim/Buffer blast holes and 312 days per year of operations, resulting in a lower maximum daily blast holes compared to Table O-21 due to the exclusion of the Pre-shear quantity. Although daily activity may correspond to any of the blast types, a typical blast with an even split between ROM Ore and Waste rock holes was assumed. The number of blasts was calculated assuming 220 holes/blast.
2. Emission factors are calculated based on MDAQMD's "most complex" Dust Entrainment from Blasting methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 correlations (AP-42, Chapter 11.9, Table 11.9-1) including corrections to typographical errors included in the 1995 version.
3. A control efficiency of 75% is applied consistent with MDAQMD guidance for "complete coverage by windscreens (on the windward side)", assuming that the pit in which blasting activities take place will effectively act as a windscreen and reduce particulate matter emissions.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

USEPA. 1998. AP-42, Section 11.9, Western Surface Coal Mining. Available online at: https://www3.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf. October.

Abbreviations:

lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
sf - square feet
tpy - tons per year
USEPA - United States Environmental Protection Agency
yr - year

2022 Mine Plan of Operations: Table O-23
Emissions from Blasting Explosives
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Blasting Explosives					Units
Explosive Type[1]		ANFO	TNT	PETN	RDX	Total	--
Amount of Explosive Detonated[1]		10,184	22	6.0	6.0		tpy
		33	0.072	0.019	0.019		tons/day
Emission Factors[2,3]	CO	67	796	297	196		lb/ton
	NO_x	17					lb/ton
	SO_2	0.0030					lb/ton
	Ammonia		29	2.5	44		lb/ton
	HCN		27				lb/ton
	CO_2	0.189					ton/ton
	CH_4		14.3				lb/ton
Maximum Daily Emissions	CO	2,243	57	5.7	3.8	2,309	lb/day
	NO_x	569				569	lb/day
	SO_2	0.10				0.10	lb/day
	Ammonia		2.1	0.048	0.85	3.0	lb/day
	HCN		1.9			1.9	lb/day
Maximum Annual Emissions	CO	341	8.8	0.88	0.58	351	tpy
	NO_x	87				87	tpy
	SO_2	0.015				0.015	tpy
	Ammonia		0.32	0.0074	0.13	0.46	tpy
	HCN		0.30			0.30	tpy
	CO_2	1,746				1,746	MT/yr
	CH_4		287			287	MT/yr

Notes:

1. Explosive type and amount of explosive detonated per year was provided by Castle Mountain Venture. The amount of explosive detonated per day was calculated using the maximum daily blast holes from Table O-22 and the maximum quantity of explosive per blast hole provided by Castle Mountain Venture.
2. Emission factors for all species other than SO_2 and CO_2 are based on AP-42, Section 13.3, Table 13.3.
3. Emission factor for SO_2 is based on diesel fuel sulfur content limit of 15 ppm and the assumption that the amount of diesel fuel is equal to 5% of the amount of ANFO.
4. Emission factor for CO_2 is based on guidance from The Mining Association of Canada.

References:

The Mining Association of Canada. 2014. Toward Sustainable Mining: Energy and GHG Emissions Management Reference Guide. June. Available online at: https://mining.ca/wp-content/uploads/dlm_uploads/2021/06/EnergyandGreenhouseGasEmissionsManagementReferenceGuide2014.

USEPA. 1980. AP-42, Section 13.3, Explosives Detonation. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s03.pdf. February.

Abbreviations:

ANFO - ammonium nitrate fuel oil
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
HCN - hydrogen cyanide
lb - pounds
MT - metric tons
NO_x - nitrogen oxides
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive
SO_2 - sulfur dioxide
TNT - trinitrotoluene
tpy - tons per year
USEPA - United States Environmental Protection Agency
yr - year

2022 Mine Plan of Operations: Table O-24a
Toxic Air Contaminant and Hazardous Air Pollutant Emissions (On-Site Dust Emissions from Fugitive and Stationary Points)
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source		Material Transfer		Crushing	Screening	Stockpile Erosion	Haul Road Fugitive Dust	Off-Road Fugitive Dust	Disturbed Operational Area	Blast Hole Drilling	Blasting Fugitive Dust Entrainment	Total
Material Profile[1,2]		Ore	Overburden	Ore	Ore	Ore	Desert Dust	Ore/ Overburden	Ore/ Overburden	Ore/ Overburden	Ore/ Overburden	
Annual PM_{10} Emissions (lb/yr)		16,412	48,655	2105	6,247	5,411	341,796	13,455	154	14,804	29,645	
Annual Emissions (lb/yr)	Aluminum	934	2,768	120	355	308	13,688	766	8.7	842	1,687	**21,477**
	Ammonium						14					**14**
	Antimony	0.28	0.84	0.036	0.11	0.093	4.1	0.23	0.0026	0.25	0.51	**6.5**
	Arsenic	0.83	2.4	0.11	0.31	0.27	19	0.68	0.0077	0.74	1.5	**26**
	Barium	3.1	9.2	0.40	1.2	1.0	205	2.6	0.029	2.8	5.6	**231**
	Beryllium	0.082	0.24	0.011	0.031	0.027		0.067	7.7E-04	0.074	0.15	**0.68**
	Bromine						23					**23**
	Cadmium	0.0028	0.0083	3.6E-04	0.0011	9.2E-04	4.4	0.0023	2.6E-05	0.0025	0.0050	**4.4**
	Chromium (total)	1.5	4.5	0.19	0.57	0.50	44	1.2	0.014	1.4	2.7	**56**
	Cobalt						28					**28**
	Copper	0.23	0.68	0.029	0.087	0.076	74	0.19	0.0022	0.21	0.42	**76**
	Lead	0.48	1.4	0.062	0.18	0.16	16	0.40	0.0045	0.44	0.87	**21**
	Manganese	3.4	10	0.44	1.31	1.1	261	2.8	0.032	3.1	6.2	**289**
	Mercury	0.017	0.051	0.0022	0.0066	0.0057	5.6	0.014	1.6E-04	0.016	0.031	**5.8**
	Nickel	0.075	0.22	0.0097	0.0287	0.025	12	0.062	7.1E-04	0.068	0.14	**13**
	Phosphorus	3.1	9.2	0.40	1.2	1.0	152	2.6	0.029	2.8	5.6	**178**
	Phosphorus pentoxide	8.2	24	1.1	3.1	2.7		6.7	0.077	7.4	15	**68**
	Selenium	0.016	0.049	0.0021	0.0062	0.0054	0.68	0.013	1.5E-04	0.015	0.030	**0.82**
	Silica	12,785	37,902	1,640	4,866	4,215		10,482	120	11,532	23,094	**106,636**
	Silver	0.031	0.093	0.0040	0.012	0.010	2.5	0.026	2.9E-04	0.028	0.057	**2.7**
	Thallium	0.025	0.075	0.0033	0.0097	0.0084		0.021	2.4E-04	0.023	0.046	**0.21**
	Vanadium	0.26	0.78	0.034	0.10	0.087	57	0.22	0.0025	0.24	0.47	**59**
	Zinc	1.4	4.1	0.18	0.52	0.45	65	1.1	0.013	1.2	2.5	**77**

Notes:

1. Ramboll applied the maximum of material hazardous air pollutant (HAP) and toxic air contaminant (TAC) profiles from two Castle Mountain samples to all Ore and Overburden fugitive material handling PM_{10} emissions. Emission factors for desert soils from MDAQMD. Silver content of sludge was provided by Castle Mountain Venture.
2. Material composition data, and subsequent emission estimates, are subject to future refined testing of ore and overburden materials.

Reference:

Mojave Desert Air Quality Management District (MDAQMD). 2005. *Default Emission Factors for Desert Soils.*

Abbreviations:

lb - pounds
HAP - hazardous air pollutant
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
TAC - toxic air contaminant
yr - year

2022 Mine Plan of Operations: Table O-24b
Toxic Air Contaminant and Hazardous Air Pollutant Emissions (On-Site Mobile Exhaust)
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source		PM_{10} Weight Fractions[1,3]		VOC Weight Fractions[2,4]		Mobile Diesel Equipment Exhaust		Mobile Gasoline Equipment Exhaust	Total
Material Profile		Mobile Source Diesel Combustion	Mobile Source Gasoline Combustion	Mobile Source Diesel Combustion	Mobile Source Gasoline Combustion	Onroad	Offroad	Onroad	
Annual PM_{10} Emissions[5] (lb/yr)						8.2	11,222	1.1	
Annual VOC Emissions[6] (lb/yr)						12	59,125	14	
Annual Emissions (lb/yr)	1,2,4-Trimethylbenzene			0.0053	0.013	0.066	313	0.17	**314**
	1,3-Butadiene			0.0019	0.0083	0.024	112	0.11	**112**
	2,2,4-Trimethylpentane			0.0030	0.020	0.037	177	0.27	**178**
	Acetaldehyde			0.074	0.0075	0.91	4,346	0.10	**4,347**
	Acrolein				0.0018			0.025	**0.025**
	Aluminum	1.8E-04				0.0014	2.0		**2.0**
	Antimony	3.6E-05				3.0E-04	0.40		**0.40**
	Arsenic	5.0E-06				4.1E-05	0.056		**0.056**
	Benzene			0.020	0.034	0.25	1,182	0.47	**1,183**
	Bromine	1.8E-05	5.0E-04			1.5E-04	0.20	5.3E-04	**0.20**
	Cadmium	4.0E-05				3.3E-04	0.45		**0.45**
	Chlorine	3.4E-04	0.070			0.0028	3.9	0.075	**3.9**
	Chromium (total)	1.2E-05	5.0E-04			9.8E-05	0.13	5.3E-04	**0.14**
	Cobalt	1.1E-05	5.0E-04			9.0E-05	0.12	5.3E-04	**0.12**
	Copper	2.5E-05	5.0E-04			2.0E-04	0.28	5.3E-04	**0.28**
	Crotonaldehyde				0.0013			0.018	**0.018**
	Cumene			2.0E-04	5.0E-04	0.0025	12	0.0069	**12**
	Cyclohexane			3.0E-04	0.0045	0.0037	18	0.062	**18**
	Ethanol			1.0E-04	1.0E-04	0.0012	5.9	0.0014	**5.9**
	Ethyl Benzene			0.0031	0.015	0.038	183	0.21	**184**
	Ethylene			0.14	0.089	1.8	8,502	1.2	**8,505**
	Formaldehyde			0.15	0.031	1.8	8,697	0.43	**8,699**
	Hexane			0.0016	0.013	0.020	95	0.18	**95**
	Isoprene				0.0014			0.019	**0.019**
	Lead	4.2E-05				3.4E-04	0.47		**0.47**
	Manganese	4.0E-05	5.0E-04			3.3E-04	0.45	5.3E-04	**0.45**
	Mercury	3.0E-05				2.5E-04	0.34		**0.34**
	Methanol			3.0E-04	0.0070	0.0037	18	0.097	**18**
	Methyl Ethyl Ketone			0.015	6.0E-04	0.18	875	0.0083	**875**
	Methyl Tert-Butyl Ether				0.019			0.257	**0.26**
	Naphthalene			9.0E-04	0.0013	0.011	53	0.018	**53**
	Nickel	1.9E-05	5.0E-04			1.6E-04	0.21	5.3E-04	**0.21**
	n-Pentane			0.0018	0.022	0.022	106	0.30	**107**
	Phosphorus	1.3E-04				0.0010	1.4		**1.4**
	Propionaldehyde			0.0097	0.0013	0.12	574	0.018	**574**
	Propylene			0.026	0.049	0.32	1,537	0.68	**1,538**
	Selenium	1.0E-05				8.2E-05	0.11		**0.11**
	Silver	2.8E-05				2.3E-04	0.31		**0.31**
	Styrene			6.0E-04	0.0013	0.0074	35	0.018	**36**
	Toluene			0.015	0.068	0.18	869	0.94	**870**
	Vanadium	2.9E-05				2.4E-04	0.33		**0.33**
	m-Xylene			0.0061	0.045	0.075	361	0.61	**361**
	o-Xylene			0.0034	0.016	0.042	201	0.21	**201**
	p-Xylene			0.0010		0.012	59		**59**
	Zinc	4.4E-04	5.0E-04			0.0036	4.9	5.3E-04	**4.9**

Notes:

1. Diesel combustion PM weight fractions are based on ARB particulate matter chemical profile 425 from ARB speciation profiles. Profile selection based on ARB reference numbers for PM profiles.
2. Gasoline combustion PM weight fractions are based on ARB particulate matter chemical profile 399 from ARB speciation profiles. Profile selection based on ARB reference numbers for PM profiles.
3. Diesel combustion VOC weight fractions are based on ARB organic chemical profile 818 from ARB speciation profiles. Profile selection based on ARB reference numbers for VOC profiles.
4. Gasoline combustion VOC weight fractions are based on ARB organic chemical profile 401 from ARB speciation profiles. Profile selection based on ARB reference numbers for VOC profiles.
5. PM_{10} emissions for each source category are based on emissions from Table O-11 and Table O-16b. PM_{10} emissions from onroad mobile sources represent exhaust emissions only and are split by diesel and gasoline fuel sources for purposes of applying corresponding chemical profiles. TAC and HAP emissions from NG mobile
6. VOC emissions for each source category are based on emissions from Table O-11 and Table O-16b. VOC emissions from onroad mobile sources are split by diesel and gasoline fuel sources for purposes of applying corresponding chemical profiles. TAC and HAP emissions from NG mobile sources are de minimis.

Reference:

California Air Resources Board (ARB). *Speciation Profiles Used in CARB Modeling.* Available at: https://ww2.arb.ca.gov/speciation-profiles-used-carb-modeling
California Air Resources Board (ARB). Particulate Matter chemical speciation profiles for source categories. Available at: https://ww2.arb.ca.gov/sites/default/files/2025-05/pmchemprofile29apr25.xlsx

California Air Resources Board (ARB). Particulate Matter reference number for particulate matter profiles. Available at: https://ww2.arb.ca.gov/sites/default/files/2025-05/pmprof_ref29apr25.xlsx

California Air Resources Board (ARB). VOC chemical speciation profiles for source categories. Available at: https://ww2.arb.ca.gov/sites/default/files/2024-10/orgprofile20sep24.xlsx

California Air Resources Board (ARB). VOC reference number for VOC profiles. Available at :https://ww2.arb.ca.gov/sites/default/files/2024-

Abbreviations:

ARB - California Air Resources Board
lb - pounds
HAP - hazardous air pollutant
LNG - liquefied natural gas
PM - particulate matter
TAC - toxic air contaminant
yr - year

2022 Mine Plan of Operations: Table O-25
Diesel Generators
Criteria Air Pollutants and Greenhouse Gases
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Emergency Generators #1 through #4	Diesel Water Well Generators #1 and #2	Units
Quantity		4	2	--
Maximum Engine Rating		778	65.7	HP
		580	49	KW
Generator Power		455	36	kW
Fuel Type		Diesel	Diesel	--
Fuel Consumption		33.4	2.93	gallons/hr
Load		100%	100%	--
Maximum Daily Hours		1	24	hrs
Annual Hours		100	8,760	hrs
Emission Factors[1,2,3,4]	ROG/VOC	0.021	0.17	g/kW-hr
	NO_x	0.10	3.0	g/kW-hr
	SO_x	0.0055	0.0057	g/kW-hr
	CO	0.10	0.0094	g/kW-hr
	PM	0.010	0.019	g/kW-hr
	PM_{10}	0.010	0.019	g/kW-hr
	$PM_{2.5}$	0.010	0.019	g/kW-hr
	CO_2	73.96	73.96	kg/MMBtu
	CH_4	0.0030	0.0030	kg/MMBtu
	N_2O	6.0E-04	6.0E-04	kg/MMBtu
Maximum Daily Emissions[5]	ROG/VOC	0.11	0.89	lb/day
	NO_x	0.51	16	lb/day
	SO_x	0.028	0.030	lb/day
	CO	0.51	0.049	lb/day
	PM	0.051	0.097	lb/day
	PM_{10}	0.051	0.097	lb/day
	$PM_{2.5}$	0.051	0.097	lb/day
	CO_2	1.4	1.4	MT/day
	CH_4	5.5E-05	5.8E-05	MT/day
	N_2O	1.1E-05	1.2E-05	MT/day
	CO_2e	1.4	1.4	MT/day
Maximum Annual Emissions[5]	ROG/VOC	0.0055	0.16	tpy
	NO_x	0.026	2.9	tpy
	SO_x	0.0014	0.0054	tpy
	CO	0.026	0.0089	tpy
	PM	0.0026	0.018	tpy
	PM_{10}	0.0026	0.018	tpy
	$PM_{2.5}$	0.0026	0.018	tpy
	CO_2	136	524	MT/yr
	CH_4	0.0055	0.021	MT/yr
	N_2O	0.0011	0.0043	MT/yr
	CO_2e	137	526	MT/yr

Notes:

1. VOC, NO_x, CO and PM emission factors are from generator spec sheets. PM_{10} was conservatively assumed equal to PM emissions. The 778 HP diesel generators are CARB Family Name FCPXL18.1HTG and the 65.7 HP diesel generators are CARB Family Name FSZXL02.2PXB.

2. SO_x emission factors based on MDAQMD guidance and are equivalent to the diesel fuel sulfur content California regulatory standard of 15 ppm.
3. GHG emission factors are from 40 CFR Part 98, Subpart C Tables C-1 and C-2.
4. ROG and VOC assumed to be interchangeable terminologies.
5. CO_2 equivalent (CO_2e) emissions calculated based on CO_2, N_2O, and CH_4 emissions and the corresponding global warming potentials (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR). Diesel generators are expected to use renewable diesel fuel, consistent with other offroad equipment, but have conservatively been assumed to use conventional diesel in this inventory, and thus resulting CO_2 emissions are characterized as non-biogenic.

References:

Code of Federal Regulations. Title 40 Chapter I Subchapter C Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

MDAQMD. 2015. Default Emission Factors for Internal Combustion Engines. http://mdaqmd.ca.gov/home/showdocument?id=722

Abbreviations:

CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
g - gram
GHG - greenhouse gas
GWP - global warming potential
HP - horsepower
hr - hour
kg - kilogram
kW - kilowatt
lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
MMBtu - million British thermal units
MRR - Mandatory Reporting Rule
MT - metric ton
NO_x - nitrogen oxides
N_2O - nitrous oxide
PM - particulate matter
ROG - reactive organic gas
SO_x - sulfur oxides
tpy - tons per year
VOC - volatile organic compound
yr - year

2022 Mine Plan of Operations: Table O-26
Diesel Generators
Toxic Air Contaminants and Hazardous Air Pollutants
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Emergency Generators #1 through #4[1]	Diesel Water Well Generators #1 and #2[1]	Units
Quantity		4	2	--
Maximum Engine Rating		778	65.7	HP
		580	49	kW
Generator Power		455	36	kW
Fuel Type		Diesel	Diesel	--
Fuel Consumption		33.4	2.93	gal/hr
Load		100%	100%	--
Maximum Daily Hours		1	24	hrs
Annual Hours		100	8,760	hrs
Emission Factors	1,3-Butadiene	2.2E-04	2.2E-04	lb/gal
	Acenaphthene	2.0E-05	2.0E-05	lb/gal
	Acenaphthylene	1.5E-05	1.5E-05	lb/gal
	Acetaldehyde	7.8E-04	7.8E-04	lb/gal
	Acrolein	3.4E-05	3.4E-05	lb/gal
	Ammonia	0.0054		lb/gal
	Anthracene	6.7E-06	6.7E-06	lb/gal
	Arsenic	7.8E-06	7.8E-06	lb/gal
	Benzene	1.9E-04	1.9E-04	lb/gal
	Benzaldehyde	1.4E-05	1.4E-05	lb/gal
	Benzo(a)anthracene	8.5E-08	2.3E-07	lb/gal
	Benzo(a)pyrene	1.8E-08	1.3E-08	lb/gal
	Benzo(b)fluoranthene	1.5E-07	6.8E-09	lb/gal
	Benzo(g,h,i)perylene	6.7E-06	6.7E-06	lb/gal
	Benzo(k)fluoranthene	1.5E-08	1.1E-08	lb/gal
	Cadmium	1.5E-06	1.5E-06	lb/gal
	Chlorobenzene	2.0E-07	2.0E-07	lb/gal
	Chromium (hexavalent)	2.0E-07	2.0E-07	lb/gal
	Chromium (total)	3.2E-06	3.2E-06	lb/gal
	Chrysene	6.7E-06	6.7E-06	lb/gal
	Copper	4.1E-06	4.1E-06	lb/gal
	Dibenz(a,h)anthracene	2.4E-08	4.0E-08	lb/gal
	DPM[2]	3.8E-04	6.9E-04	lb/gal
	Ethyl benzene	1.1E-05	1.1E-05	lb/gal
	Fluoranthene	6.7E-06	6.7E-06	lb/gal
	Fluorene	4.3E-05	4.3E-05	lb/gal
	Formaldehyde	0.0017	0.0017	lb/gal
	Hexane	2.7E-05	2.7E-05	lb/gal
	Hydrogen chloride	1.9E-04	1.9E-04	lb/gal
	Indeno(1,2,3-cd)pyrene	2.8E-08	2.6E-08	lb/gal
	Lead	8.3E-06	8.3E-06	lb/gal
	Manganese	3.1E-06	3.1E-06	lb/gal
	Mercury	2.3E-06	2.3E-06	lb/gal
	Naphthalene	2.0E-05	2.0E-05	lb/gal
	Nickel	3.9E-06	3.9E-06	lb/gal
	PAH	5.6E-05	5.6E-05	lb/gal
	Phenanthrene	8.7E-05	8.7E-05	lb/gal
	Propylene	4.7E-04	4.7E-04	lb/gal
	Pyrene	1.5E-05	1.5E-05	lb/gal
	Selenium	9.8E-06	9.8E-06	lb/gal
	Toluene	1.1E-04	1.1E-04	lb/gal
	Xylenes	4.2E-05	4.2E-05	lb/gal
	Zinc	2.2E-05	2.2E-05	lb/gal

Parameter		Emergency Generators #1 through #4[1]	Diesel Water Well Generators #1 and #2[1]	Units
Maximum Annual Emissions	1,3-Butadiene	2.9	11	lb/yr
	Acenaphthene	0.27	1.0	lb/yr
	Acenaphthylene	0.20	0.75	lb/yr
	Acetaldehyde	10	40	lb/yr
	Acrolein	0.45	1.7	lb/yr
	Ammonia	72		lb/yr
	Anthracene	0.090	0.34	lb/yr
	Arsenic	0.10	0.40	lb/yr
	Benzene	2.5	9.6	lb/yr
	Benzaldehyde	0.18	0.69	lb/yr
	Benzo(a)anthracene	0.0011	0.012	lb/yr
	Benzo(a)pyrene	2.4E-04	6.6E-04	lb/yr
	Benzo(b)fluoranthene	0.0020	3.5E-04	lb/yr
	Benzo(g,h,i)perylene	0.090	0.34	lb/yr
	Benzo(k)fluoranthene	2.0E-04	5.4E-04	lb/yr
	Cadmium	0.020	0.077	lb/yr
	Chromium (hexavalent)	0.0027	0.010	lb/yr
	Chromium (total)	0.043	0.16	lb/yr
	Chrysene	0.090	0.34	lb/yr
	Copper	0.055	0.21	lb/yr
	Dibenz(a,h)anthracene	3.2E-04	0.0020	lb/yr
	DPM	5.1	36	lb/yr
	Ethyl benzene	0.15	0.56	lb/yr
	Fluoranthene	0.090	0.34	lb/yr
	Fluorene	0.58	2.2	lb/yr
	Formaldehyde	23	89	lb/yr
	Hexane	0.36	1.4	lb/yr
	Hydrogen chloride	2.5	9.6	lb/yr
	Indeno(1,2,3-cd)pyrene	3.8E-04	0.0013	lb/yr
	Lead	0.11	0.43	lb/yr
	Manganese	0.041	0.16	lb/yr
	Mercury	0.031	0.12	lb/yr
	Naphthalene	0.26	1.0	lb/yr
	Nickel	0.052	0.20	lb/yr
	PAH	0.75	2.9	lb/yr
	Phenanthrene	1.2	4.5	lb/yr
	Propylene	6.2	24	lb/yr
	Pyrene	0.20	0.75	lb/yr
	Selenium	0.13	0.50	lb/yr
	Toluene	1.4	5.4	lb/yr
	Xylenes	0.57	2.2	lb/yr
	Zinc	0.30	1.1	lb/yr

Notes:

1. TAC and HAP emission factors for Emergency Generators #1 through #4 are based on default MDAQMD guidance for diesel generators with SCR rated higher than 600 HP and the emission factors for Water Well Generators #1 and #2 are based on default MDAQMD guidance for uncontrolled diesel generators rated less than 600 HP. These emission factors are likely conservative since the diesel generators have Tier 4 engines which have VOC and PM controls that would similarly reduce organic and inorganic TAC emissions.
2. Diesel PM emissions are assumed to be equal to PM10 emissions, presented in Table O-25.

References:

MDAQMD. 2015. Default Emission Factors for Internal Combustion Engines. http://mdaqmd.ca.gov/home/showdocument?id=722

Abbreviations:

DPM - diesel particulate matter
gal - gallon
HAP - hazardous air pollutant
HP - horsepower
hr - hour
kW - kilowatt
lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
SCR - selective catalytic reduction
TAC - toxic air contaminant
yr - year

2022 Mine Plan of Operations: Table O-27
Gasoline Dispensing Facility Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter	Daily Throughput (gal/day)	Annual Throughput (gal/yr)
Throughput[1]	274	100,000
Control[2]	Phase I and II	

Pollutant	Emission Factor[3] (lb/1000 gal)	Daily Emissions (lb/day)	Annual Emissions (tpy)
TOG	1.5	0.42	0.076
Benzene	0.0080	0.0022	4.0E-04
Ethyl benzene	0.0066	0.0018	3.3E-04
n-Hexane	0.028	0.0076	0.0014
Naphthalene	7.4E-04	2.0E-04	3.7E-05
Propylene (propene)	4.0E-05	1.1E-05	2.0E-06
Toluene	0.036	0.0098	0.0018
Xylene	0.032	0.0088	0.0016

Notes:

1. Annual gasoline throughput provided by Castle Mountain Venture and is a conservative overestimate compared to actual projected usage. Daily gasoline throughput is based on annual throughput and 365 days/yr of operation.
2. MDAQMD default pre-EVR emission factors for aboveground storage tank gasoline dispensing from CARB/CAPCOA guidance since the guidance does not include post-EVR emission factors.

References:

CARB/CAPCOA. 2022. Gasoline Service Industry Risk Assessment Technical Guidance. February 18. https://www.mdaqmd.ca.gov/home/showpublisheddocument/9310/637850250462300000

Abbreviations:

CARB - California Air Resources Board
CAPCOA - California Air Pollution Control Officers Association
gal - gallons
HAP - hazardous air pollutant
lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
TAC - toxic air contaminant
TOG - total organic gas
tpy- tons per year
yr - year

2022 Mine Plan of Operations: Table O-28a
Storage Tank Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Quantity	Tank Volume[1] (gallons)	Annual Tank Throughput[1] (gal/yr)	Breathing Losses[2,3,4] (lb/yr)	Working Losses[2,3,4] (lb/yr)	Daily VOC Emissions (lb/day)	Annual VOC Emissions (tpy)
Off-road Diesel Storage Tanks	3	20,000	4,369,443	0.0054	72	0.59	0.11
Stationary Equipment Diesel Storage Tank	1	10,000	64,694	0.0031	3.5	0.0096	0.0017
GDF Clear Diesel Storage Tank	1	3,000	30,000	2.6E-04	1.0	0.0028	5.1E-04
LNG Storage Tanks[5]	8	20,000	11,354,292			2.0	0.36
					Total	**2.6**	**0.47**

Source Name	Quantity	Tank Volume[2] (gallons)	Annual Tank Throughput[2] (gal/yr)	Breathing Losses (lb/yr)	Working Losses (lb/yr)	Daily HCl Emissions (lb/day)	Annual HCl Emissions (tpy)
Hydrochloric Acid Storage Tank	1	4,993	608,333	155	628	2.1	0.39

Notes:

1. Tank parameters and annual tank throughput based on guidance from Castle Mountain Venture.
2. Emissions calculated according to the methodology presented in AP-42, Section 7.1. Breathing and working losses presented here represent losses from a single tank in lb/yr, calculated based on the USEPA AP-42 methodology. These losses are converted to daily and annual emissions based on the equipment quantity. Thus, it is conservatively assumed (if there are multiple tanks) that each tank has the same throughput.
3. Meteorological data from AP-42, Table 7.1-7 for Las Vegas, NV is used.
4. Paint solar absorptance from AP-42, Table 7.1-6.
5. The LNG storage tanks will be designed to minimize or eliminate boil-off conditions. This will be managed by balancing fuel storage with the rate of use by the turbines, such that the fuel in tanks will be kept fresh to eliminate any pressure discharges. Potential fugitive GHG emissions from equipment leaks are conservatively quantified in **Table 28b**. VOC emissions are estimated based on the methane emissions in **Table 28b** by applying the average ratio of ethane to methane in LNG (based on LNG stream compositions as presented in API 2015). Other VOC constituents (propane, butane, etc.) are expected to be minimal.

References:

API. 2015. Liquefied Natural Gas (LNG) Operations: Consistent Methodology for Estimating Greenhouse Gas Emissions. May. Available online at: https://www.api.org/-/media/Files/EHS/climate-change/api-lng-ghg-emissions-guidelines-05-2015.pdf.
USEPA. 2020. AP-42, Section 7.1, Organic Liquid Storage Tanks. June. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/ch07s01.pdf.

Abbreviations:

gal - gallons
GHG - greenhouse gas
HCl - hydrochloric acid
lb - pounds
LNG - liquefied natural gas
tpy - tons per year
USEPA - United States Environmental Protection Agency
VOC - volatile organic compound
yr- year

2022 Mine Plan of Operations: Table O-28b
GHG Emissions from LNG Storage
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fugitive Leak Emissions

Component	Component Count[1]	Total Leaking Time[2] (hr/yr)	CH_4 Emission Factor[3] (scf/hr/component)	Annual Fugitive Leak CH_4 Emissions[4] (scf/yr)	Annual Fugitive Leak CH_4 Emissions[5] (MT/yr)	Annual Fugitive Leak CO_2e Emissions[6] (MT/yr)
Valve	32	2,190	1.19	83,395	1.6	40
Pump Seal	0	2,190	4.00	0	0	0
Connector	32	2,190	0.34	23,827	0.46	11
Other	32	2,190	1.77	124,042	2.4	60
			Total	231,264	4.4	111

Notes:

1. Component count estimates provided by the LNG supplier. Pumps, and therefore pump seals, are not expected to be used.
2. Conservatively assumes fugitive leaks occur over one quarter of the year.
3. Fugitive leak CH_4 emission factors are from Appendix A, Table 5 of the California Mandatory Reporting Regulation (MRR).
4. Fugitive leak CH_4 emissions are calculated based on component counts, total leaking time, and CH_4 emission factors.
5. Methane mass emissions based on density of methane as specified in Section 95153(t) of the California MRR, and methane volume emissions.
6. CO_2 equivalent (CO_2e) emissions calculated based on CH_4 emissions and the corresponding global warming potential (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California MRR.

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CH_4 - methane
CO_2e - carbon dioxide equivalents
GHG - greenhouse gas
GWP - global warming potential
hr - hour
LNG - liquefied natural gas
MRR - Mandatory Reporting Regulation
MT - metric ton
scf - standard cubic feet
yr - year

2022 Mine Plan of Operations: Table O-29
GHG Emissions from Electricity Usage
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Historical Electricity Intensity

Provider	Annual Electricity Data	2021	2022	2023	Average[1]	Units
Nevada Energy	CO_2e Intensity Factor per Total Energy Delivered[2]	763	772	754	763	lb CO_2e/MWh delivered
	% of Total Energy From Nevada RPS-Eligible Renewables[3]	31%	36%	40%	35%	-
	CO_2e Intensity Factor per Total Non-RPS-Eligible Energy[4]	1,101	1,200	1,250	1,184	lb CO_2e/MWh delivered
Southern California Edison	CO_2e Intensity Factor per Total Energy Delivered[5]	452	444	374	423	lb CO_2e/MWh delivered
	% of Total Energy From California RPS-Eligible Renewables[5]	36%	36%	41%	38%	-
	CO_2e Intensity Factor per Total Non-RPS-Eligible Energy[4]	704	696	632	677	lb CO_2e/MWh delivered

Estimated Intensity Factor for Total Grid Energy Delivered

Provider	Model Year	2021	2022	2023	Average[1]	Units
Nevada Energy	2027 RPS (42%)[7]	638	696	725	687	lb CO_2e/MWh delivered
Southern California Edison	2027 RPS (52%)[8]	338	334	303	325	lb CO_2e/MWh delivered

Electricity Use Rates[9]

	Running Load (MW)	Annual (MWh/yr)
On-site Facilities - Nevada Energy (NVE)	10	87,600
Off-site Facilities (Water Sourcing) - Southern California Edison (SCE)	1.3	11,511
Total Emissions	**11.3**	**99,111**

Electricity Emissions[10]

	CO_2e Emissions (MT/yr)
On-site Facilities	27,280
Off-site Facilities (Water Sourcing)	1,697
Total Emissions	**28,977**

Notes:

1. Average uses data from years 2021-2023.
2. Total CO_2e intensity factors for Nevada Energy are from 2021-2023 NV Energy Sustainability Reports.

3. Percentage of energy from Nevada RPS-Eligible Renewables for Nevada Energy are from the Nevada Governor's Office of Energy's 2022 and 2024 Status of Energy Reports.
4. The emissions metric presented here is calculated based on the total CO_2e intensity factor divided by the percent of energy delivered from non-RPS-eligible renewable sources. This CO_2e intensity factor includes both fossil fuel and carbon-free sources of energy, such as largescale hydro and nuclear.
5. The intensity factor for total energy delivered is estimated by multiplying the percentage of energy delivered from non-RPS-eligible renewable energy by the CO_2e emissions per total non-RPS-eligible renewable energy metric calculated above.
6. Total CO_2e intensity factors and percentage of energy from RPS-Eligible Renewables for SCE are from the 2021-2023 Edison International Sustainability Reports.
7. Nevada Energy RPS value for 2027 based on scheduled renewable energy rate increases as outlined in https://puc.nv.gov/Renewable_Energy/Portfolio_Standard/.
8. Southern California Edison RPS value for 2027 based on requirement in Senate Bill 100 as outlined in https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/rps/rps-compliance-rules-and-process/60-percent-rps-procurement-rules.
9. Running loads provided by Castle Mountain Venture. An electricity load of 20 MW is anticipated on an annual/regular basis. On-site power generation will account for 10 MW of the on-site electricity load, with the remaining on-site load from grid power. Annual electricity use rates calculated assuming 8,760 hours per year of facility operation.
10. Emissions calculated based on intensity factor and electricity use rate.

References:

California Public Utilities Commission. 60% RPS Procurement Rules. Available online at: https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/rps/rps-compliance-rules-and-process/60-percent-rps-procurement-rules

Edison International. 2021 Sustainability Report. Available online at: https://www.edison.com/_gallery/get_file/?file_id=634a11c88ed7df0e03e0e410&file_ext=.pdf&page_id=

Edison International. 2022 Sustainability Report. Available online at: https://www.edison.com/_gallery/get_file/?file_id=6477e962b3aed34e0382ae64&file_ext=.pdf&page_id=

Edison International. 2023 Sustainability Report. Available online at: https://www.edison.com/_gallery/get_file/?file_id=6657b3b63d6332eaafbcc867&file_ext=.pdf&page_id=

NV Energy. 2021 NV Energy Sustainability Report. Available online at: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/cleanenergy/sustainability/2021-sustainability-nvenergy.pdf

NV Energy. 2022 NV Energy Sustainability Report. Available online at: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/cleanenergy/sustainability/2022-sustainability-nvenergy.pdf

NV Energy. 2023 NV Energy Sustainability Report. Available online at: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/cleanenergy/sustainability/2023-sustainability-nvenergy.pdf

Nevada Governor's Office of Energy. 2023. 2022 Status of Energy Report. January. Available online at: https://energy.nv.gov/uploadedFiles/energynvgov/content/Media/2022_status_of_energy_final.pdf.

Nevada Governor's Office of Energy. 2024. 2024 Status of Energy Report. January. Available online at: https://energy.nv.gov/uploadedFiles/energynvgov/content/Home/Features/2024%20Status%20of%20Energy%20Report_Final.pdf

State of Nevada Public Utilities Commission. Renewable Portfolio Standard. Available online at: https://puc.nv.gov/Renewable_Energy/Portfolio_Standard/

Abbreviations:

CO_2e - carbon dioxide equivalents
lb - pounds
MT - metric tons
MW - megawatts
MWh - megawatt hours
RPS - renewable portfolio standard
SCE - Southern California Edison
yr - year

2022 Mine Plan of Operations: Table O-30
GHG Emissions from Solid Waste Generation
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Solid Waste Generation Rate[1]

Waste Type	Solid Waste Generation Rate (lb/employee/day)	Number of Employees	Annual Solid Waste Generation (tpy)
Organic	8.93	423	689

Solid Waste Landfill Gas (LFG) Treatment Types[2]

Landfill, No Gas Capture	Landfill, Capture Gas Flare
100%	0%

Solid Waste Landfill Gas Emission Factors[3]

Description	CO_2 Emissions (ton/ton waste)	CH_4 Emissions (ton/ton waste)
No LFG Collection	0.097	0.032

Solid Waste GHG Emissions[4]

Waste Type	CO_2 Emissions (MT/yr)	CH_4 Emissions (MT/yr)	CO_2e Emissions (MT/yr)
Organic	60	20	555

Notes:

1. Waste generation rate based on industrial waste generation rate per employee from City of Los Angeles CEQA Thresholds Guide and number of employees at the facility.
2. Solid Waste Landfill Gas Treatment Types from Appendices C and G of the CalEEMod® User's Guide, with the exception that "Landfill, No Gas Capture" was conservatively set to 100%.
3. Solid Waste Landfill Gas Emission Factors from Table G-37 of CalEEMod® User's Guide, Appendix G.
4. CO_2 equivalent (CO_2e) emissions calculated based on CO_2 and CH_4 emissions and the corresponding global warming potentials (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

California Air Pollution Control Officers Association (CAPCOA). 2022. User's Guide of CalEEMod® Version 2022.1. May. Available online at: https://www.caleemod.com/user-guide

City of Los Angeles. 2006. L.A. CEQA Thresholds Guide: Your Resource for Preparing CEQA Analyses in Los Angeles. Available online at: https://planning.lacity.org/eir/CrossroadsHwd/deir/files/references/A07.pdf

Code of Federal Regulations. Title 40 Chapter I Subchapter C Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CalEEMod® - California Emissions Estimator Model
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
GWP - global warming potential
lb - pounds
LFG - Landfill Gas
MRR - Mandatory Reporting Regulation
MT - metric ton
tpy - tons per year
yr - year

2022 Mine Plan of Operations: Table O-31
GHG Emissions from Wastewater Treatment
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Water Use Rates[1]

End Use	Average Demand (gpm)	Annual Average Demand (MMgal/yr)
Ancillary Facilities/Offices	22	12

Wastewater Treatment Direct Emission Factors[2]

Wastewater Treatment Type	CO_2 Biogenic (ton/gal)	CO_2 Non-Biogenic (ton/gal)	CH_4 (ton/gal)	N_2O (ton/gal)
Septic	0	0	2.5E-07	8.52E-10

Wastewater Treatment Direct Emissions[3]

End Use	Total Direct Emissions (MT CO_2e/yr)
Ancillary Facilities/Offices	68

Notes:

1. Water use rates provided by Castle Mountain Venture. Annual water use rates calculated assuming continuous operation of water pumps (24/7). Emissions are only expected from the wastewater treatment of potable water. Potable water will be supplied from onsite wells and thus emissions associated with pumping and supplying water to ancillary facilities/offices are assumed to be captured in the well generator emissions.
2. Wastewater Treatment Direct Emission Factors from Table G-35 of Appendix G of the CalEEMod® User's Guide. All wastewater is assumed to be treated with an on-site septic system.
3. CO_2 equivalent (CO_2e) emissions calculated based on CO_2, N_2O, and CH_4 emissions and the corresponding global warming potentials (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

California Air Pollution Control Officers Association (CAPCOA). 2022. User's Guide of CalEEMod® Version 2022.1. April. Available online at: https://www.caleemod.com/user-guide

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CalEEMod® - California Emissions Estimator Model
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
gal - gallon
gpm - gallons per minute
GWP - global warming potential
MMgal - million gallons
MRR - Mandatory Reporting Regulation
MT - metric ton
N_2O - nitrous oxide
yr - year

2022 Mine Plan of Operations: Table O-32
On-site Power Generation Emissions from Natural Gas Turbines
Criteria Air Pollutants and Greenhouse Gases
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Value	Units
Fuel Type		Natural Gas	--
Total Capacity		10.4	MW
Total Fuel Throughput		2,571	MMBTU/day
		938,371	MMBTU/yr
Load		100%	--
Daily hours		24	hrs
Annual Hours		8,760	hrs
Vendor or Default Emission Factors[1,2,3,4]	ROG/VOC	0.009	lb/MMBtu
	NO_x	0.033	lb/MMBtu
	SO_x	0.0006	lb/MMBtu
	CO	0.090	lb/MMBtu
	PM	0.0066	lb/MMBtu
	PM_{10}	0.0066	lb/MMBtu
	$PM_{2.5}$	0.0066	lb/MMBtu
	CO_2	53	kg/MMBtu
	CH_4	1.0	g/MMBtu
	N_2O	0.10	g/MMBtu
Maximum Daily Emissions	ROG/VOC	23	lb/day
	NO_x	85	lb/day
	SO_x	1.5	lb/day
	CO	231	lb/day
	PM	17	lb/day
	PM_{10}	17	lb/day
	$PM_{2.5}$	17	lb/day
Maximum Annual Emissions[5]	ROG/VOC	4.2	tpy
	NO_x	16	tpy
	SO_x	0.28	tpy
	CO	42	tpy
	PM	3.1	tpy
	PM_{10}	3.1	tpy
	$PM_{2.5}$	3.1	tpy
	CO_2	49,790	MT/yr
	CH_4	0.47	MT/yr
	N_2O	0.047	MT/yr
	CO_2e	49,816	MT/yr

Notes:

1. With the exception of ROG/VOC, NO_x, and CO, CAP emission factors are based on SCAQMD combustion default emission factors, dated December 2024, for the "Natural Gas/Micro Turbine" category (https://www.aqmd.gov/docs/default-source/planning/annual-emission-reporting/combustion-default-emission-factors-2024.pdf?sfvrsn=9c358361_9) and a higher heating value (HHV) of 1020 Btu/scf consistent with the California Mandatory Reporting Regulation (MRR). The current proposed turbine configuration would consist of microturbines, packaged into 1 MW units, which each consisting of five 200 kW engine bays. In this table these units are simply referred to as "turbines".
2. The ROG/VOC, NO_x, and CO emission factors are based on manufacturer's specification sheets for the mictroturbines which list exhaust concentrations of 7 ppmv (as CH_4 equivalent), 9 ppmvd, and 40 ppmvd at 15% O_2, and are converted to lb/MMBTU using the dry F-factor method for natural gas.
3. ROG and VOC assumed to be interchangeable terminologies.
4. CO_2, CH_4, and N_2O emission factors based on USEPA emission factors for greenhouse gas inventories for natural gas combustion in stationary equipment from 40 CFR Part 98, Tables C-1 and C-2.
5. CO_2 equivalent emissions calculated based on CO_2, N_2O, and CH_4 emissions and the corresponding GWP from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

Code of Federal Regulations. Title 40 Chapter I Subchapter C Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

SCAQMD Combustion Default Emission Factors. December 2024. Available online here: https://www.aqmd.gov/docs/default-source/planning/annual-emission-reporting/combustion-default-emission-factors-2024.pdf?sfvrsn=9c358361_9

United States Environmental Protection Agency (USEPA). Method 19: Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates. Available online at: https://www.epa.gov/sites/production/files/2017-08/documents/method_19.pdf

USEPA. 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

BACT - Best Available Control Technology
Btu - British thermal units
CAP - criteria air pollutant
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
g - gram
GHG - greenhouse gas
GWP - global warming potential
HHV - high heating value
hr - hour
kg - kilogram
lb - pounds
MMBtu - million British thermal units
MRR - Mandatory Reporting Regulation
MT - metric ton
MW - megawatt
MWh - megawatt-hour
NO_x - nitrogen oxides
N_2O - nitrous oxide
PM - particulate matter
ROG - reactive organic gas
SCAQMD - South Coast Air Quality Management District
scf - standard cubic feet
SO_x - sulfur oxides
tpy - tons per year
VOC - volatile organic compound
yr - year

2022 Mine Plan of Operations: Table O-33
On-site Power Generation Emissions from Natural Gas Turbines
Toxic Air Contaminants and Hazardous Air Pollutants
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Value	Units
Fuel Type		Natural Gas	--
Total Capacity		10.4	MW
Total Fuel Throughput		2,571	MMBTU/day
		938,371	MMBTU/yr
Load		100%	--
Daily hours		24	hrs
Annual Hours		8,760	hrs
Emission Factors[1,2]	1,3-Butadiene	1.2E-07	lb/MMBtu
	2-Chloronaphthalene	2.7E-10	lb/MMBtu
	2-Methylnaphthalene	5.2E-09	lb/MMBtu
	Acenaphthene	1.9E-08	lb/MMBtu
	Acenaphthylene	1.4E-08	lb/MMBtu
	Acetaldehyde	1.3E-04	lb/MMBtu
	Acrolein	1.9E-05	lb/MMBtu
	Ammonia	0.0031	lb/MMBtu
	Anthracene	3.3E-08	lb/MMBtu
	Benzene	1.3E-05	lb/MMBtu
	Benzo(a)anthracene	2.2E-08	lb/MMBtu
	Benzo(a)pyrene	1.4E-08	lb/MMBtu
	Benzo(b)fluoranthene	1.1E-08	lb/MMBtu
	Benzo(e)pyrene	5.3E-10	lb/MMBtu
	Benzo(g,h,i)perylene	1.3E-08	lb/MMBtu
	Benzo(k)fluoranthene	1.1E-08	lb/MMBtu
	Chrysene	2.5E-08	lb/MMBtu
	Dibenz(a,h)anthracene	2.3E-08	lb/MMBtu
	Ethylbenzene	1.8E-05	lb/MMBtu
	Fluoranthene	4.2E-08	lb/MMBtu
	Fluorene	5.7E-08	lb/MMBtu
	Formaldehyde	9.0E-04	lb/MMBtu
	Hexane	2.5E-04	lb/MMBtu
	Indeno(1,2,3-c,d)pyrene	2.3E-08	lb/MMBtu
	Naphthalene	1.6E-06	lb/MMBtu
	Perylene	6.9E-10	lb/MMBtu
	Phenanthrene	3.1E-07	lb/MMBtu
	Propylene	7.6E-04	lb/MMBtu
	Propylene Oxide	4.7E-05	lb/MMBtu
	Pyrene	2.7E-08	lb/MMBtu
	Toluene	7.0E-05	lb/MMBtu
	Xylene (total)	2.6E-05	lb/MMBtu

Parameter		Value	Units
Maximum Annual Emissions	1,3-Butadiene	0.12	lb/yr
	2-Chloronaphthalene	2.5E-04	lb/yr
	2-Methylnaphthalene	0.0049	lb/yr
	Acenaphthene	0.017	lb/yr
	Acenaphthylene	0.014	lb/yr
	Acetaldehyde	126	lb/yr
	Acrolein	17	lb/yr
	Ammonia	2,944	lb/yr
	Anthracene	0.031	lb/yr
	Benzene	12	lb/yr
	Benzo(a)anthracene	0.021	lb/yr
	Benzo(a)pyrene	0.013	lb/yr
	Benzo(b)fluoranthene	0.010	lb/yr
	Benzo(e)pyrene	5.0E-04	lb/yr
	Benzo(g,h,i)perylene	0.013	lb/yr
	Benzo(k)fluoranthene	0.010	lb/yr
	Chrysene	0.023	lb/yr
	Dibenz(a,h)anthracene	0.022	lb/yr
	Ethylbenzene	16	lb/yr
	Fluoranthene	0.040	lb/yr
	Fluorene	0.053	lb/yr
	Formaldehyde	844	lb/yr
	Hexane	238	lb/yr
	Indeno(1,2,3-c,d)pyrene	0.022	lb/yr
	Naphthalene	1.5	lb/yr
	Perylene	6.4E-04	lb/yr
	Phenanthrene	0.29	lb/yr
	Propylene	709	lb/yr
	Propylene Oxide	44	lb/yr
	Pyrene	0.025	lb/yr
	Toluene	65	lb/yr
	Xylene (total)	24	lb/yr

Notes:

1. With the exception of ammonia, emission factors for turbines are from CATEF emission factors for natural gas turbines with no control and a HHV of 1020 Btu/scf. The CATEF mean value was chosen for each air toxic.
2. The ammonia emission factor for turbines is based on the SCAQMD default emission factor for natural gas turbines and microturbines of all sizes without SNCR or SCR.

References:

CATEF emission factors: https://ww3.arb.ca.gov/ei/catef/catef.csv

SCAQMD. Combustion Default Emission Factors (revised December 2024). https://www.aqmd.gov/docs/default-source/planning/annual-emission-reporting/combustion-default-emission-factors-2024.pdf?sfvrsn=9c358361_9.

Abbreviations:

Btu - British thermal units
CATEF - California Air Toxics Emission Factor database
HHV - high heating value
hr - hour
lb - pounds
MMBtu - million British thermal units
MW - megawatt
MWh - megawatt-hour
SCAQMD - South Coast Air Quality Management District
scf - standard cubic feet
SCR - selective catalytic reduction
SNCR - selective non-catalytic reduction
yr - year

OPERATIONAL EMISSIONS INVENTORY: APPROVED OPERATIONS, DETAILED TABLES

Approved Operations: Table OA-1
Criteria Air Pollutant and Greenhouse Gas Emissions Summary
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Type[1]	Maximum Daily Emissions (lb/day)						Annual Emissions (tpy)						Annual GHG Emissions (MT/yr)	
	PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	VOC	Biogenic	Non-biogenic
Material Transfers (fugitive)	53	8.0					8.6	1.3						
Material Transfers (stationary)	5.8	1.5					0.74	0.18						
Crushing	2.8	0.53					0.34	0.064						
Screening	8.4	1.3					1.0	0.15						
Diesel Generators[2]	0.15	0.15	16	0.058	0.56	0.99	0.020	0.020	2.9	0.0068	0.034	0.17		663
Power Generation (Diesel Generators)	1.8	1.8	18	1.0	18	3.9	0.34	0.34	3.4	0.18	3.4	0.72		17,979
On-site Unpaved Road Mobile Equipment (fugitive dust)	594	59					48	4.8						
Other On-site Off-Road Mobile Equipment (fugitive dust)	30	9.1					1.9	0.58						
On-site Mobile Equipment (exhaust)	14	14	1,035	2.6	1,358	78	1.6	1.6	131	0.28	145	8.4	24,411	692
Off-site Mobile Equipment (fugitive dust)	77	8.0					7.2	0.74						
Off-site Mobile Equipment (exhaust)	2.5	1.2	24	0.25	5.7	0.44	0.12	0.054	1.1	0.012	0.70	0.043		1,206
Disturbed Operational Areas	3.2	0.48					0.077	0.012						
Stockpile Wind Erosion	15	5.9					2.7	1.1						
Blasting and Blast Hole Drilling	41	2.4	160	0.028	651		4.3	0.25	24	0.0043	99			2,520
Gasoline Dispensing Facility						0.20						0.037		
Fuel Storage Tanks						0.18						0.032		
Electricity Usage														9,433
Solid Waste													17	140
Wastewater														19
Total Emissions	**848**	**113**	**1,254**	**3.9**	**2,033**	**83**	**77**	**11**	**163**	**0.48**	**249**	**9.4**	**24,428**	**32,652**

Notes:

1. Detailed emission calculations are presented in Tables OA-3 through OA-33.
2. Diesel generators are expected to use renewable diesel fuel, consistent with other offroad equipment, but have conservatively been assumed to use conventional diesel in this inventory, and thus resulting CO_2 emissions are characterized as non-biogenic.

Abbreviations:

CO - carbon monoxide
GHG - greenhouse gas
lb - pounds
MT - metric tons
NO_x - nitrogen oxides
PM - particulate matter
SO_x - sulfur oxides
tpy - tons per day
VOC - volatile organic gases
yr - year

Approved Operations: Table OA-2
Toxic Air Contaminant and Hazardous Air Pollutant Emissions Summary, On-Site Sources
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

TAC	CAS Number	Annual Emissions[1] (lb/yr)																	
		Refinery	Acid Tank Evaporation	Heap Leach Pad and Various Process Tanks	Material Transfers	Crushing	Screening	Power Generation (Diesel Generators)[2]	Diesel Generators (Emergency/ Supporting)[2]	Stockpile Erosion	On-Site Unpaved Road Mobile Equipment Fugitive Dust	On-Site Unpaved Road Mobile Equipment Exhaust[2]	Other On-Site Off-Road Mobile Equipment Fugitive Dust	Other On-Site Off-Road Mobile Equipment Exhaust[2]	Disturbed Operational Area	Blasting and Blast Hole Drilling	Gasoline Dispensing Facility	Storage Tanks	Total
1,2,4-Trimethylbenzene	95636											0.068		89					89
1,3-Butadiene	106990							382	14			0.039		32					427
2,2,4-Trimethylpentane	540841											0.088		50					50
Acenaphthene	83329							36	1.3										37
Acenaphthylene	208968							26	0.95										27
Acetaldehyde	75070							1375	51			0.29		1,228					2,654
Acrolein	107028							60	2.2			0.0070							62
Aluminum	7429905				1,048	39	116			308	3,876	4.6E-04	216	0.56	8.7	490			6,103
Ammonia	7664417							9,462	72							259			9,794
Ammonium	14798039										4.0								4.0
Anthracene	120127							12	0.43										12
Antimony	7440360				0.32	0.012	0.035			0.093	1.2	9.3E-05	0.065	0.11	0.0026	0.15			1.9
Arsenic	7440382				0.93	0.034	0.10	14	0.50	0.27	5.5	1.3E-05	0.19	0.016	0.0077	0.43			22
Barium	7440393				3.5	0.13	0.39			1.0	58		0.72		0.029	1.6			65
Benzene	71432							327	12			0.21		334			0.38		674
Benzaldehyde	100527							24	0.87										24.6
Benzo(a)anthracene	56553							0.15	0.013										0.16
Benzo(a)pyrene	50328							0.031	9.0E-04										0.032
Benzo(b)fluoranthene	205992							0.27	0.0024										0.27
Benzo(g,h,i)perylene	191242							12	0.43										12
Benzo(k)fluoranthene	207089							0.026	7.4E-04										0.027
Beryllium	7440417				0.092	0.0034	0.010			0.027			0.019		7.7E-04	0.043			0.20
Bromine	7726956										6.5	2.0E-04		0.057					6.5
Cadmium	7440439				0.0031	1.2E-04	3.5E-04	2.6	0.097	9.2E-04	1.2	1.0E-04	0.0006	0.13	2.6E-05	0.0015			4.1
Chlorine	7782505											0.022		1.1					1.1
Chromium (hexavalent)	18540299							0.35	0.013										0.36
Chromium (total)	7440473				1.7	0.063	0.19	5.6	0.21	0.50	12	1.8E-04	0.35	0.038	0.014	0.79			22
Chrysene	218019							12	0.43										12
Cobalt	7440484										8.0	1.8E-04		0.035					8.0
Copper	7440508				0.26	0.0096	0.028	7.2	0.27	0.076	21	2.2E-04	0.053	0.079	0.0022	0.12			29
Crotonaldehyde	4170303											0.0051							0.0051
Cumene	98828											0.0027		3.3					3.3
Cyclohexane	110827											0.019		5.0					5.0
Dibenz(a,h)anthracene	53703							0.042	0.0024										0.044
Diesel PM	9901							672	41			2,328		842					3,883
Ethanol	64175											7.5E-04		1.7					1.7
Ethyl Benzene	100414							19	0.71			0.070		52			0.32		72
Ethylene	74851											0.87		2,402					2,403
Fluoranthene	206440							12	0.43										12
Fluorene	86737							76	2.8										79
Formaldehyde	50000							3030	112			0.65		2,457					5,599
n-Hexane	110543							47	1.7			0.057		27			1.3		77
Hydrogen Chloride	7647010		3.7					327	12									364	707
Hydrogen Cyanide[3]	74908			4,655												169			4,824
Indeno(1,2,3-c,d)pyrene	193395							0.050	0.0017										0.052
Isoprene	78795											0.0055							0.0055
Lead	7439921				0.54	0.020	0.060	15	0.54	0.16	4.7	1.1E-04	0.11	0.13	0.0045	0.25			21
Manganese	7439965				3.9	0.14	0.43	5.4	0.20	1.1	74	2.5E-04	0.80	0.13	0.032	1.8			88
Mercury	7439976	4.3			0.019	7.2E-04	0.0021	4.0	0.15	0.0057	1.6	7.8E-05	0.0040	0.095	1.6E-04	0.0090			10
Methanol	67561											0.028		5.0					5.0
Methyl Ethyl Ketone	78933											0.056		247					247
Methyl Tert-Butyl Ether	1634044											0.073							0.073
Naphthalene	91203							35	1.3			0.0083		15			0.035		51
Nickel	7440020				0.085	0.0032	0.0094	6.8	0.25	0.025	3.5	2.0E-04	0.017	0.060	7.1E-04	0.040			11
n-Pentane	109660											0.092		30					30
Phenanthrene	85018							152	5.6										158
Phosphorus	7723140				3.5	0.13	0.39			1.0	43	3.3E-04	0.72	0.40	0.029	1.6			51
Phosphorus pentoxide	1314563				9.2	0.34	1.0			2.7			1.9		0.077	4.3			20
Propionaldehyde	123386											0.040		162					162
Propylene	115071							820	30			0.28		434			0.0019		1,285
Pyrene	129000							26	0.95										27
Selenium	7782492				0.018	6.9E-04	0.0020	17	0.63	0.0054	0.19	2.6E-05	0.0038	0.032	1.5E-04	0.0086			18
Silica	14808607				14,353	534	1,584			4,215			2,961		120	6,713			30,479
Silver	7440224				0.035	0.0013	0.0039			0.010	0.70	7.3E-05	0.0073	0.089	2.9E-04	0.016			0.87
Styrene	100425											0.0072		10					10
Thallium	7440280				0.029	0.0011	0.0032			0.0084			0.0059		2.4E-04	0.013			0.061
Toluene	108883							185	6.8			0.32		246			1.7		439
Vanadium	7440622				0.29	0.011	0.033			0.087	16	7.5E-05	0.061	0.092	0.0025	0.14			17

TAC	CAS Number	Annual Emissions[1] (lb/yr)																	
		Refinery	Acid Tank Evaporation	Heap Leach Pad and Various Process Tanks	Material Transfers	Crushing	Screening	Power Generation (Diesel Generators)[2]	Diesel Generators (Emergency/ Supporting)[2]	Stockpile Erosion	On-Site Unpaved Road Mobile Equipment Fugitive Dust	On-Site Unpaved Road Mobile Equipment Exhaust[2]	Other On-Site Off-Road Mobile Equipment Fugitive Dust	Other On-Site Off-Road Mobile Equipment Exhaust[2]	Disturbed Operational Area	Blasting and Blast Hole Drilling	Gasoline Dispensing Facility	Storage Tanks	Total
Xylenes	1330207							74	2.7			0.27		175			1.5		254
Zinc	7440666				1.5	0.058	0.17	39	1.4	0.45	18	0.0013	0.32	1.4	0.013	0.72			64

Notes:

1. Detailed emission calculations are presented in Tables OA-3 through OA-33. TAC and HAP emissions are quantified for on-site emission sources only.
2. For sources of diesel exhaust (e.g. generators, mobile equipment), both diesel particulate matter (Diesel PM) and speciated TAC and HAP emissions are presented, though Diesel PM is considered a surrogate for all diesel exhaust.
3. Hydrogen cyanide emissions from heap leaching operations and cyanide containing tanks are highly dependent on the characterization of the heap leach pad, solution pH, and temperatures. Conservative estimates of potential operating conditions have been utilized here.

Abbreviations:

HAP - Hazardous Air Pollutant
lb - pounds
PM - particulate matter
SCR - Selective Catalytic Reduction
TAC - Toxic Air Contaminant
yr - year

Approved Operations: Table OA-3
Material Transfer Emissions
Criteria Air Pollutants
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Description[1]	Source Area	Material Profile	Material Moisture Content[2] (%)	Process Rates[3]		Emission Factor[4,5,6,7] (lb/ton)		Add-On Control Method[8]	Control Efficiency[9,10]	Controlled Emissions			
				Daily (tpd)	Annual (tpy)					Daily (lb/day)		Annual (tpy)	
						PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Ore to Haul Trucks	Pits	Ore	3.0	25,781	6,250,000	0.0013	2.0E-04	Pit Enclosure	75%	8.5	1.3	1.0	0.16
Overburden to Haul Trucks	Pits	Overburden	5.0	44,658	16,300,000	6.4E-04	9.7E-05	Pit Enclosure	75%	7.2	1.1	1.3	0.20
Haul Trucks to Overburden Area	Overburden Area	Overburden	5.0	44,658	16,300,000	6.4E-04	9.7E-05	--	0%	29	4.3	5.2	0.79
Haul Trucks to Interim Ore Stockpile	Interim Ore Stockpile	Ore	3.0	6,445	1,562,500	0.0013	2.0E-04	--	0%	8.5	1.3	1.0	0.16
Haul Truck to Dump Hopper	Primary Crushing	Ore	3.0	25,781	6,250,000	4.6E-05	1.3E-05	Enclosure + Watering	0%	1.2	0.34	0.14	0.041
Dump Hopper to Feeder	Primary Crushing	Ore	3.0	25,781	6,250,000	4.6E-05	1.3E-05	Enclosure + Watering	0%	1.2	0.34	0.14	0.041
Feeder to Vibrating Grizzly	Primary Crushing	Ore	3.0	25,781	6,250,000	4.6E-05	1.3E-05	Enclosure + Watering	0%	1.2	0.34	0.14	0.041
Vibrating Grizzly to Primary Crusher Discharge Conveyor	Primary Crushing	Ore	3.0	21,391	5,185,799	4.6E-05	1.3E-05	Enclosure + Watering	0%	1.0	0.28	0.12	0.034
Crushed Ore Stockpile Reclaim Feeders to Secondary Screen Feed Conveyors	Secondary/Tertiary Crushing and Screening	Ore	3.0	25,781	6,250,000	0.0011	1.7E-04	Secondary/Tertiary Screening Dust Scrubber	99.5%	0.14	0.021	0.017	0.0026
Tertiary Screen Oversize Transfer Conveyor to Tertiary Crushing Feed Conveyor	Secondary/Tertiary Crushing and Screening	Ore	3.0	16,102	3,903,524	0.0011	1.7E-04	Secondary/Tertiary Crushing Dust Scrubber	99.5%	0.089	0.013	0.011	0.0016
Tertiary Crushing Feed Conveyor to Tertiary Crusher Surge Bin	Secondary/Tertiary Crushing and Screening	Ore	3.0	16,093	3,901,343	0.0011	1.7E-04	Secondary/Tertiary Crushing Dust Scrubber	99.5%	0.089	0.013	0.011	0.0016
Tertiary Crusher Discharge Conveyor to Stockpile Feed Conveyor	Product Stockpile	Ore	3.0	16,093	3,901,343	0.0011	1.7E-04	Secondary/Tertiary Crushing Dust Scrubber	99.5%	0.089	0.013	0.011	0.0016
Gravity Concentrate Storage Tank to Truck	Fine Ore Storage and Gravity Circuit	Ore	10	0.90	218	2.4E-04	3.7E-05	--	0%	2.2E-04	3.3E-05	2.7E-05	4.0E-06
Truck to Concentrate Feed Storage Cone	Fine Ore Storage and Gravity Circuit	Ore	10	0.90	218	2.4E-04	3.7E-05	--	0%	2.2E-04	3.3E-05	2.7E-05	4.0E-06
Stockpile Discharge Conveyor to Agglomeration Feed Bin	Agglomeration and Stacking	Ore	2.6	20,780	5,037,509	0.0016	2.4E-04	Agglomerator Feed Bin Vent	99.5%	0.17	0.025	0.020	0.0031
Truck to Cement Storage Silo	Cement	Cement	0.5	86	31,250	0.47	0.071	Cement Silo Bin Vent	99.5%	0.20	0.030	0.037	0.0056
Cement Silo Feeder to Agglomerator Feed Bin	Cement	Cement	0.5	86	31,250	0.0028	4.2E-04	--	0%	0.24	0.036	0.044	0.0066
Truck to Pebble Lime Silo	Heap Leach Pebble Lime	Lime	0.5	43	15,625	0.47	0.071	Pebble Lime Silo Bin Vent	99.5%	0.10	0.015	0.018	0.0028
Pebble Lime Silo Feeder to Agglomerator Feed Bin	Heap Leach Pebble Lime	Lime	0.5	43	15,625	0.0028	4.2E-04	--	0%	0.12	0.018	0.022	0.0033
Carbon Handling Crane to Carbon Feed Tank	Carbon Regeneration	Carbon	0.5	0.016	6.0	0.016	0.0024	--	0%	2.7E-04	4.0E-05	4.8E-05	7.3E-06
									Total Emissions	**59**	**9.5**	**9.3**	**1.5**

Notes:

1. Material handling sources with high moisture contents will have negligible emissions. Therefore, emissions from these sources were not quantified in this table.
2. Material moisture contents were provided by Castle Mountain Venture.
3. Equipment specific information provided by Castle Mountain Venture.
4. Emission factors for primary crushing system material transfer points with watering controls are based on controlled conveyor transfer point emission factors from AP-42, Section 11.19.2, Table 11.19.2-2, consistent with NDEP guidance for the mining industry.
5. Emission factors for all other material transfer points within the crusher system are based on uncontrolled conveyor transfer point emission factors from AP-42, Section 11.19.2, Table 11.19.2-2, consistent with NDEP Guidance. AP-42, Section 11.19.2, Table 11.19.2-2 does not include an uncontrolled conveyor transfer point emission factor for $PM_{2.5}$ so the emission factor was estimated using the uncontrolled conveyor transfer point emission factor for PM_{10} and a multiplier of 0.053/0.35 based on AP-42, Chapter 13.2.4, consistent with NDEP guidance for the mining industry.

6. PM_{10} emission factors for pebble lime and cement material handling points were based on silo loading and unloading emission factors from AP-42, Section 11.12 and a multiplier of 0.053/0.35 for $PM_{2.5}$ based on AP-42, Chapter 13.2.4, consistent with NDEP guidance for the mining industry.
7. Emission factors for material transfer points that are not within the crusher system or associated with pebble lime and cement material handling were estimated using MDAQMD's "most complex" Material Handling Operations methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 PM_{10} and $PM_{2.5}$ multipliers (AP-42 Section 13.2.4, "Aerodynamic Particle Size Multiplier (k) for Equation 1" table) at the time of inventory preparation. A windspeed of 8.7 mph was used consistent with the annual average site-specific meteorological measurements for the period of January 2021 through December 2021.
8. Additional or revised controls may be evaluated at the time of engineering design.
9. A control efficiency of 75% is applied consistent with MDAQMD guidance for "complete coverage by windscreens (on the windward side)", assuming that the pit in which loading activities take place will effectively act as a windscreen and reduce particulate matter emissions. The dust scrubber and bin vent control efficiencies will be confirmed with vendor guarantees upon equipment design.
10. Material transfer points will be controlled with watering and enclosures, but the watering control is already accounted for in the controlled emission factor utilized so no additional control efficiency is included here.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768
NDEP. 2017. Guidance on Emission Factors for the Mining Industry. Available online at: https://ndep.nv.gov/uploads/air-permitting-docs/ndep-mining-emissions-guidance.pdf. May 31.
USEPA. 2004. AP-42, Section 11.19.2. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s1902.pdf. August.
USEPA. 2006. AP-42, Section 13.2.4. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/13.2.4_aggregate_handling_and_storage_piles.pdf. November.
USEPA. 2012. AP-42, Section 11.12. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s12.pdf. January.

Abbreviations:

lb - pound
MDAQMD - Mojave Desert Air Quality Management District
NDEP - Nevada Division of Environmental Protection
PM - particulate matter
tpd - tons per day
tpy - tons per year
USEPA - United States Environmental Protection Agency

Approved Operations: Table OA-4
Refinery Mercury Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Equipment	Source Area	Concentrate Throughput[1]		Mercury Concentration[2] (lb/ton)	Mercury Emissions	
		Daily (tpd)	Annual (tpy)		Daily (lb/day)	Annual (tpy)
Kiln Abatement, EQ Abatement, and Retort Carbon Bed	Refinery	0.015	5.4	0.8	0.012	0.0021

Notes:

1. Equipment specific information was provided by Castle Mountain Venture. Equipment is assumed to operate 24 hours per day and 365 days per year.
2. Mercury concentration of retort concentrate was assumed to be 0.8 lb/ton based on NESHAP Subpart EEEEEEE limit for new carbon processes with mercury retorts.

References:

USEPA. 2011. NESHAP for Gold Mine Ore Processing and Production (40 CFR Part 63 Subpart EEEEEEE). Available online at: https://www.govinfo.gov/content/pkg/FR-2011-02-17/pdf/2011-2608.pdf#page=2. February.

Abbreviations:

lb - pounds
NESHAP - National Emission Standards for Hazardous Air Pollutants
tpd - tons per day
tpy - tons per year

Approved Operations: Table OA-5a
Acid Tank Evaporative Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source	Source Area	Exposed Surface Area[1] (ft^2)	Liquid Molecular Weight (g/mol)	Annual Average Wind Speed[2] (m/s)	Percent HCl[3] (liquid wt%)	Liquid Vapor Pressure at Given Temperature[3] (mmHg)	Liquid Temperature[4] (K)	HCl Emissions[5]	
								Daily (lb/day)	Annual (tpy)
Acid Mix Tank	Refinery	8.6	36	3.9	5	7.6E-04	291	0.0036	6.5E-04
Acid Wash Tank	Refinery	16	36	3.9	5	7.6E-04	291	0.0066	0.0012

Notes:

1. Surface area was estimated from tank diameters provided by Castle Mountain Venture assuming a completely open topped cylindrical vertical tank, a highly conservative assumption, as these tanks are expected to be closed top tanks with vents.
2. For outdoor sources, a windspeed of 3.9 m/s was used consistent with the annual average site-specific meteorological measurements between January 2021 and December 2021.
3. Liquid vapor pressure were calculated using vapor pressure profiles from Perry et al. 1997, and conservatively rounding up the expected liquid temperature to the next highest value in the vapor pressure profile (20 C) and the next highest liquid weight percent (6%).
4. For outdoor sources, the liquid temperature was conservatively assumed to be equivalent to the annual average temperature (291 degrees K) from on-site meteorological measurements between January 2021 and December 2021.
5. Evaporative emissions were calculated using USEPA Risk Management Program guidance for evaporative losses from a defined surface area.

References:

Perry, Robert H et al. 1997. Perry's Chemical Engineers' Handbook. 7th Edition. Table 2-10. Partial Pressures of HCl over Aqueous Solutions of HCl.
USEPA. 2009. Risk Management Program for Offsite Consequence Analysis. Appendix D: D-1. Available online at: https://www.epa.gov/sites/production/files/2017-05/documents/oca-apds.pdf

Abbreviations:

ft^2 - square feet
g/mol - grams per mole
K - degrees Kelvin
lb - pounds
m/s - meters per second
mmHg - millimeters of mercury
tpy - tons per year
USEPA - United States Environmental Protection Agency
wt% - weight percent

Approved Operations: Table OA-5b
Heap Leach and Process Tank HCN Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Area[1] (acres)	pH[2]	NaCN Concentration[3] (lb/ton)	Free Cyanide Concentration[4] (g/m^3)	Temperature[5] (deg C)	Gas Phase Mass Transfer Coefficient[6] (m/s)	Flux[7] (g/m^2-s)	Flux Chamber Adjustment for Area (F_a)	Flux Chamber Adjustment for Wind Speed (F_w)[8]	F_a*F_w	Annual HCN Emissions[9] (lb/yr)
Active Pad, Wet Surface	33	10	0.40	106	17	7.0E-06		0.42	1.2	0.51	3,171
Active Pad, Dry Surface	104						7.9E-08	0.42	1.2	0.51	1,184
Inactive Pad	104						2.0E-08	0.42	1.2	0.51	294
Various Process Tanks	0.33	10	0.06	16	17	9.3E-06		0.42	1.2	0.51	6.3

Notes:

1. The Heap Leach Pad area was assumed to have up to 33 acres of wet active area, with the remaining area split between dry active area and inactive area. The surface area for the various process tanks at the facility was conservatively assumed to be 1 acre.
2. Average pH based on expected operating levels.
3. NaCN concentrations are based on expected operating levels, including a conservative buffer.
4. Free cyanide concentrations are calculated based on NaCN concentrations.
5. Average temperature based on hourly site-specific meteorological data for the period of January 2021 through December 2021.
6. Gas phase mass transfer coefficient values based on source category and EPA flux box results (EPA 2010).
7. Flux values based on source category and EPA flux box results (EPA 2010).
8. Annual mean wind speed based on site-specific meteorological data for the period of January 2021 through December 2021.
9. Gas phase mass transfer coefficients are used when the source area is wet and has a measurable pH level. Flux values are used for the dry active pad and inactive pad sources.

References:

Quality Assurance Project Plan, Comprehensive Air Emissions Testing for Hydrogen Cyanide *at Three Nevada Gold Mines Sites Using the USEPA Surface Isolation Flux Chamber Technology, Revision 2* (November 18, 2009). EPA-HQ-OAR-2010-0239-0163_attachment 5.

Evaluation of Air Emissions of Hydrogen Cyanide from Fugitive Sources at Nevada Gold Mines Using the USEPA Surface Insolation Flux Chamber Technology: Cortez, Gold Quarry & Round Mountain Mines. April 2010. Prepared by Dr. C.E. Schmidt and Tom Card. EPA-HQ-OAR-2010-0239-0163

USEPA. HCN Flux Box Results. 2010. EPA-HQ-OAR-2010-0239-0403. Available online at: https://downloads.regulations.gov/EPA-HQ-OAR-2010-0239-0403/content.pdf.

Abbreviations:

deg C = degrees Celsius
g = grams
lb = pound
m = meters
m^3 = cubic meters
s = seconds
yr = year

Approved Operations: Table OA-6
Crushing Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Source Area	Process Rates[1]		Emission Factor[2,3,4] (lb/ton)		Add-On Control Method	Control Efficiency[5,6]	Controlled Emissions			
		Daily (tpd)	Annual (tpy)					Daily (lb/day)		Annual (tpy)	
				PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Rock Breaker	Primary Crushing	258	62,500	8.0E-05	8.0E-05	Watering	0%	0.021	0.021	0.0025	0.0025
Primary Crusher and transfers in and out	Primary Crushing	4,390	1,064,201	5.4E-04	1.0E-04	Watering + Enclosure	0%	2.4	0.44	0.29	0.053
Secondary Crushers (2) and transfers in and out	Secondary/Tertiary Crushing	20,186	4,893,580	0.0024	3.6E-04	Secondary/Tertiary Crushing Dust Scrubber	99.5%	0.24	0.037	0.029	0.0044
Tertiary Crusher and transfers in and out	Secondary/Tertiary Crushing	16,084	3,899,163	0.0024	3.6E-04	Secondary/Tertiary Crushing Dust Scrubber	99.5%	0.19	0.029	0.023	0.0035
							Total Emissions	**2.8**	**0.53**	**0.34**	**0.064**

Notes:

1. Equipment specific information was provided by Castle Mountain Venture.
2. Emissions factors for the rock breaker are from AP-42, Section 11.19.2 for "Wet Drilling - Unfractured Stone". AP-42, Section 11.19.2 (Crushed Stone Processing and Pulverized Mineral Processing) defines wet material as material containing >1.5% water. $PM_{2.5}$ is conservatively assumed to be equal to PM_{10}.
3. Emission factors for the primary crusher were based on controlled tertiary crushing emission factors from AP-42, Section 11.19.2, Table 11.19.2-2. Tertiary crushing controlled emission factors were conservatively applied to the primary crusher units based on data availability, and per NDEP guidance.
4. Emission factors for the secondary and tertiary crushers were based on uncontrolled tertiary crushing emission factors from AP-42, Section 11.19.2, Table 11.19.2-2. Tertiary crushing emission factors were conservatively applied to the primary and secondary crusher units based on data availability, and per NDEP guidance. AP-42, Section 11.19.2, Table 11.19.2-2 does not include an uncontrolled tertiary crushing emission factor for $PM_{2.5}$ so the emission factor was estimated using the uncontrolled tertiary crushing emission factor for PM_{10} and a multiplier of 0.053/0.35 based on AP-42, Chapter 13.2.4, consistent with NDEP guidance for the mining industry.
5. The rock breaker will be controlled with watering, but this control is already accounted for in the wet drilling emission factor utilized so 0% control efficiency is listed here. The primary crusher will be controlled with watering and enclosure. The watering control is already accounted for in the controlled emission factor utilized, so no additional control efficiency is listed .
6. The dust scrubber control efficiencies will be confirmed with vendor guarantees upon equipment design.

References:

NDEP. 2017. Guidance on Emission Factors for the Mining Industry. Available online at: https://ndep.nv.gov/uploads/air-permitting-docs/ndep-mining-emissions-guidance.pdf. May 31.

USEPA. 2004. AP-42, Section 11.19.2 (Crushed Stone Processing and Pulverized Mineral Processing). Available online at: https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s1902.pdf

USEPA. 2006. AP-42, Section 13.2.4. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/13.2.4_aggregate_handling_and_storage_piles.pdf. November.

Abbreviations:

lb - pounds
NDEP - Nevada Division of Environmental Protection
PM - particulate matter
tpd - tons per day
tpy - tons per year
USEPA - United States Environmental Protection Agency

Approved Operations: Table OA-7
Screening Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Source Area	Process Rates[1]		Emission Factor[2] (lb/ton)		Add-On Control Method	Control Efficiency[3]	Controlled Emissions			
		Daily (tpd)	Annual (tpy)					Daily (lb/day)		Annual (tpy)	
				PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Secondary Screens (2) and transfers in and out	Secondary/Tertiary Screening	25,781	6,250,000	0.0087	0.0013	Secondary/Tertiary Screening Dust Scrubber	99.5%	1.1	0.17	0.14	0.021
Tertiary Screen and transfers in and out	Secondary/Tertiary Screening	20,186	4,893,580	0.072	0.011	Secondary/Tertiary Screening Dust Scrubber	99.5%	7.3	1.1	0.88	0.13
							Total Emissions	**8.4**	**1.3**	**1.0**	**0.15**

Notes:

1. Equipment specific information was provided by Castle Mountain Venture.
2. Emission factors for the secondary and tertiary screens were based on uncontrolled screening (secondary screens) and uncontrolled fines screening (tertiary screens) emission factors from AP-42, Section 11.19.2, Table 11.19.2-2. AP-42, Section 11.19.2, Table 11.19.2-2 does not include an uncontrolled screening or fines screening emission factors for $PM_{2.5}$ so these emission factors were estimated using the uncontrolled screening and fines screening emission factors for PM_{10} and a multiplier of 0.053/0.35 based on AP-42, Chapter 13.2.4, consistent with NDEP guidance for the mining industry.
3. The dust scrubber control efficiencies will be confirmed with vendor guarantees upon equipment design.

References:

NDEP. 2017. Guidance on Emission Factors for the Mining Industry. Available online at: https://ndep.nv.gov/uploads/air-permitting-docs/ndep-mining-emissions-guidance.pdf. May 31.

USEPA. 2004. AP-42, Section 11.19.2 (Crushed Stone Processing and Pulverized Mineral Processing). Available online at: https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s1902.pdf

USEPA. 2006. AP-42, Section 13.2.4. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/13.2.4_aggregate_handling_and_storage_piles.pdf.

Abbreviations:

lb - pounds
NDEP - Nevada Division of Environmental Protection
PM - particulate matter
tpd - tons per day
tpy - tons per year
USEPA - United States Environmental Protection Agency

Approved Operations: Table OA-8
On-site Mobile Fugitive Dust Emissions
Unpaved Road Travel
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Equipment Quantity[1]	Equipment Description	Average Vehicle Weight[2] (tons)	Unpaved Surface Silt Content (%)[3]	Emission Factor (lb/VMT)[4]		Maximum Equipment Hours[5]		Total Miles Traveled[6]		Control Efficiency (%)[7]	Number of Days with >0.01 Inches Precipitation[8] (days/yr)	Controlled Emissions			
													Daily (lb/day)		Annual (tpy)	
					PM_{10}	$PM_{2.5}$	Daily	Annual	Daily	Annually			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Haul Trucks	6	Caterpillar 793F	296	5	5.4	0.54	18	--	871	318,052	95%	31	235	23	39	3.9
Water Truck	1	Caterpillar 785G WTR MEGA	208	5	4.6	0.46	18	1,683	180	16,828	95%	31	41	4.1	1.8	0.18
Haul Truck	1	Caterpillar 773G	83	5	3.0	0.30	18	3,155	180	31,553	95%	31	27	2.7	2.2	0.22
Articulated Truck	1	Caterpillar 740GC	55.7	5	2.5	0.25	18	526	180	5,259	95%	31	23	2.3	0.31	0.031
Fuel and Lube Truck	1	Caterpillar 777 Mega System	132	5	3.7	0.37	18	1,262	180	12,621	95%	31	34	3.4	1.1	0.11
Tractor and Low Bed	1	--	160	5	4.1	0.41	18	210	180	2,104	95%	31	37	3.7	0.20	0.020
Flatbed Hiab Truck	1	--	10	5	1.2	0.12	18	736	180	7,362	95%	31	11	1.1	0.20	0.020
Mechanics Truck	1	8100 National	36.5	5	2.1	0.21	18	526	180	5,259	95%	31	19	1.9	0.25	0.025
Welding Truck	1	--	13.0	5	1.3	0.13	18	631	180	6,311	95%	31	12	1.2	0.19	0.019
Staff Pickup Trucks	10	--	1.0	5	0.42	0.042	24	8,414	240	84,140	95%	31	50	5.0	0.80	0.080
Pit Services Pickup	6	--	1.0	5	0.42	0.042	24	8,835	240	88,347	95%	31	30	3.0	0.84	0.084
Staff Pickup Trucks (Crewcab)	3	--	1.0	5	0.42	0.042	24	2,524	240	25,242	95%	31	15	1.5	0.24	0.024
Pit Services Pickup (Crewcab)	3	--	1.0	5	0.42	0.042	24	2,524	240	25,242	95%	31	15	1.5	0.24	0.024
Shovel Crew Flat Deck	1	--	7.5	5	1.0	0.10	18	421	180	4,207	95%	31	9.3	0.93	0.099	0.0099
Shovel Crew Hiab	1	--	10	5	1.2	0.12	18	526	180	5,259	95%	31	11	1.1	0.14	0.014
Surface Crew Hiab	1	--	10	5	1.2	0.12	18	526	180	5,259	95%	31	11	1.1	0.14	0.014
Mine Rescue Vehicle	1	--	11.8	5	1.3	0.13	18	526	180	5,259	95%	31	11	1.1	0.15	0.015
Fuel Delivery Trucks	--	--	16.5	5	1.5	0.15	3	--	5.4	1,404	95%	31	0.40	0.040	0.047	0.0047
Product Delivery Trucks	--	--	16.5	5	1.5	0.15	1	--	3.8	99	95%	31	0.28	0.028	0.0033	3.3E-04
Contractor Trucks	--	--	16.5	5	1.5	0.15	2	--	8	2,573	95%	31	0.56	0.056	0.086	0.0086
Other Delivery Trucks	--	--	16.5	5	1.5	0.15	5	--	19	5,145	95%	31	1.4	0.14	0.17	0.017
Reagent Delivery Trucks	--	--	16.5	5	1.5	0.15	7	--	27	1,379	95%	31	2.0	0.20	0.046	0.0046
												Total Emissions	**594**	**59**	**48**	**4.8**

Notes:

1. Equipment counts provided by Castle Mountain Venture.
2. With the exception of Delivery Trucks, average weights are from Table 16-3 of Technical Report on the Castle Mountain Project Feasibility Study (March 2021) or based on equipment model specifications. Delivery truck weights assume heavy heavy-duty trucks (HHDT).
3. A roadway surface silt content of 5% was used, consistent with data provided by Castle Mountain Venture.
4. Fugitive dust emission factors calculated following MDAQMD's "most complex" Unpaved Roads methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 correlations for industrial roads (Equation 1a, Table 13.2.2-2, AP-42 Section 13.2.2) at the time of inventory preparation.
5. Maximum daily hours assumed to be 24 hours per day per piece of equipment for equipment with non-zero vehicle miles traveled except for the Fuel, Propane, Product, and Reagent Delivery Trucks. Delivery Trucks are assumed to make a maximum of one round-trip per hour, so the maximum daily hours are set equal to the number of daily trips presented in Table OA-13b. Maximum annual hours provided by Castle Mountain Venture. Maximum annual hours are not presented for Caterpillar 793F Haul Trucks and Delivery Trucks as this information is not required for the calculation of vehicle miles traveled (VMT) or emissions.
6. Annual VMT for Caterpillar 793F Haul Trucks was provided by Castle Mountain Venture and daily VMT was set equal to annual VMT divided by 365 days per year. Annual VMT for Fuel, Propane, Product, and Reagent Delivery Trucks is shown in Table OA-13b and daily VMT was calculated assuming 365 days per year and the days per year shown in Table OA-13b. Annual and daily VMT for all other equipment was estimated based on hours of operation and a vehicle speed of 10 mph.
7. A control efficiency of 95% was used consistent with assumptions for watering, graveling surface, treatment with chemical stabilizers, and speed control from the 1997 Castle Mountain Mine Expansion Project EIS/EIR, and the understanding that chemical suppressants will be applied to all unpaved roadways.
8. Consistent with the AP-42 Section 13.2.2 unpaved roads methodology for industrial sites, Ramboll applied a precipitation reduction based on the number of days with greater than 0.01 inches precipitation per year based on site-specific meteorological measurements between January 2021 and December 2021.

References:

Bureau of Land Management. 1997. Castle Mountain Mine Expansion Project Final Environmental Impact Statement/Environmental Impact Report. October.

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

USEPA. 2006. AP-42, Section 13.2.2, Unpaved Roads. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0202.pdf. November.

Abbreviations:

HHDT - heavy heavy-duty truck
lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
mph - miles per hour
PM - particulate matter
tpy - tons per year
USEPA - United States Environmental Protection Agency
VMT - vehicle miles traveled
yr - year

Approved Operations: Table OA-9
On-site Mobile Fugitive Dust Emissions
Dozing/Scraping/Grading and Similar Activity
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Equipment Quantity[1]	Equipment Description	Maximum Equipment Hours[1]		Control Efficiency[2] (%)	Emission Factor[3,4] (lb/hr)		Controlled Emissions			
								Daily (lb/day)		Annual (tpy)	
			Daily	Annual		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Production Blasthole Drill	1	Epiroc Pit Viper 235	18	5,610	98%	0.10	0.032	1.9	0.57	0.29	0.089
Wall Control Drill	1	Epiroc - SmartROC D65	18	3,726	98%	0.10	0.032	1.9	0.57	0.19	0.059
Hydraulic Shovel	1	Caterpillar 6060 FS	18	4,588	98%	0.10	0.032	1.9	0.57	0.24	0.072
Wheel Loader	1	Caterpillar 994K	18	3,197	98%	0.10	0.032	1.9	0.57	0.17	0.050
Track Dozer	2	Caterpillar D10T2	18	7,888	98%	0.10	0.032	3.7	1.1	0.41	0.12
Wheel Dozer	1	Caterpillar 844K	18	2,945	98%	0.10	0.032	1.9	0.57	0.15	0.046
Grader	1	Caterpillar 16MG	18	4,417	98%	0.10	0.032	1.9	0.57	0.23	0.070
Wheel Loader	1	Caterpillar 988KXE	18	1,262	98%	0.10	0.032	1.9	0.57	0.065	0.020
Excavator	1	Caterpillar 390D L	18	421	98%	0.10	0.032	1.9	0.57	0.022	0.0066
Tire Manipulator	1	Caterpillar 988K CWS TM30P	18	316	98%	0.10	0.032	1.9	0.57	0.016	0.0050
Vibratory Compactor	1	Caterpillar CS64	18	316	98%	0.10	0.032	1.9	0.57	0.016	0.0050
Backhoe	1	Caterpillar 440	18	526	98%	0.10	0.032	1.9	0.57	0.027	0.0083
Rough Terrain Forklift	1	Hyster 700	18	526	98%	0.10	0.032	1.9	0.57	0.027	0.0083
Shop Forklift	1	Taylor-360M Forklift	18	526	98%	0.10	0.032	1.9	0.57	0.027	0.0083
Hydraulic Hammer	1	TB-XC Hydraulic Breaker	18	526	98%	0.10	0.032	1.9	0.57	0.027	0.0083
							Total Emissions	**30**	**9.1**	**1.9**	**0.58**

Notes:

1. Equipment specific information provided by Castle Mountain Venture.
2. Control efficiencies were calculated consistent with MDAQMD guidance for Dust Entrainment from Unpaved Roads as shown in Table OA-18.
3. Fugitive dust emission factors for off-road equipment were calculated using Mojave Desert Air Quality Management District (MDAQMD) Bulldozing, Scraping and Grading of Materials "most complex" methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries document.
4. Emission factors are based on a material moisture content of 2% and a silt content of 5%, consistent with data provided by Castle Mountain Venture.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

Abbreviations:

lb - pounds
hr - hour
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
tpy - tons per year

Approved Operations: Table OA-10
On-site Mobile Vehicles
Exhaust Emission Factors
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Make/Model	Equipment Quantity[1]	Engine Size[1] (hp)	Equipment Tier[2]	OFFROAD2017 Equipment Type[3]	Load Factor[3]	Operating Hours[1]		Emission Factors (g/bhp-hr)[4]					
							(hr/yr)	(hr/day)	NO_x	SO_x	CO	ROG	PM_{10}	$PM_{2.5}$
Production Blasthole Drill	Epiroc Pit Viper 235	1	860	Tier 4 Final	Bore/Drill Rigs	0.50	5,610	18	2.6	0.0049	2.6	0.15	0.030	0.030
Wall Control Drill	Epiroc - SmartROC D65	1	540	Tier 4 Final	Bore/Drill Rigs	0.50	3,726	18	0.30	0.0049	2.6	0.15	0.015	0.015
Hydraulic Shovel	Caterpillar 6060 FS	1	2,996	Tier 4 Final	Other Construction Equipment	0.42	4,588	18	2.6	0.0049	2.6	0.15	0.030	0.030
Wheel Loader	Caterpillar 994K	1	1,739	Tier 4 Final	Rubber Tired Loaders	0.36	3,197	18	2.6	0.0049	2.6	0.15	0.030	0.030
Haul Trucks	Caterpillar 793F	6	2,650	Tier 4 Final	Off-Highway Trucks	0.38	32,217	18	2.6	0.0049	2.6	0.15	0.030	0.030
Track Dozer	Caterpillar D10T2	2	600	Tier 4 Final	Other Construction Equipment	0.42	7,888	18	0.30	0.0049	2.6	0.15	0.015	0.015
Wheel Dozer	Caterpillar 844K	1	620	Tier 4 Final	Rubber Tired Dozers	0.40	2,945	18	0.30	0.0049	2.6	0.15	0.015	0.015
Grader	Caterpillar 16MG	1	290	Tier 4 Final	Graders	0.41	4,417	18	0.30	0.0049	2.6	0.15	0.015	0.015
Water Truck	Caterpillar 785G WTR MEGA	1	1,450	Tier 4 Final	Off-Highway Trucks	0.38	1,683	18	2.6	0.0049	2.6	0.15	0.030	0.030
Wheel Loader	Caterpillar 988KXE	1	541	Tier 4 Final	Rubber Tired Loaders	0.36	1,262	18	0.30	0.0049	2.6	0.15	0.015	0.015
Haul Truck	Caterpillar 773G	1	825	Tier 4 Final	Off-Highway Trucks	0.38	3,155	18	2.6	0.0049	2.6	0.15	0.030	0.030
Excavator	Caterpillar 390D L	1	524	Tier 4 Final	Excavators	0.38	421	18	0.30	0.0049	2.6	0.15	0.015	0.015
Tire Manipulator	Caterpillar 988K CWS TM30P	1	541	Tier 4 Final	Other Construction Equipment	0.42	316	18	0.30	0.0049	2.6	0.15	0.015	0.015
Vibratory Compactor	Caterpillar CS64	1	130	Tier 4 Final	Other Construction Equipment	0.42	316	18	0.30	0.0049	3.7	0.15	0.015	0.015
Backhoe	Caterpillar 440	1	105	Tier 4 Final	Tractors/Loaders/Backhoes	0.37	526	18	0.30	0.0049	3.7	0.15	0.015	0.015
Articulated Truck	Caterpillar 740GC	1	450	Tier 4 Final	Off-Highway Trucks	0.38	526	18	0.30	0.0049	2.6	0.15	0.015	0.015
Fuel and Lube Truck	Caterpillar 777 Mega System	1	1,025	Tier 4 Final	Off-Highway Trucks	0.38	1,262	18	2.6	0.0049	2.6	0.15	0.030	0.030
Tractor and Low Bed	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	210	18	0.30	0.0049	2.6	0.15	0.015	0.015
Flatbed Hiab Truck	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	736	18	0.30	0.0049	2.6	0.15	0.015	0.015
Rough Terrain Forklift	Hyster 700	1	260	Tier 4 Final	Rough Terrain Forklifts	0.40	526	18	0.30	0.0049	2.6	0.15	0.015	0.015
Shop Forklift	Taylor-360M Forklift	1	173	Tier 4 Final	Forklifts	0.20	526	18	0.30	0.0049	3.7	0.15	0.015	0.015
Mechanics Truck	8100 National	1	330	Tier 4 Final	Off-Highway Trucks	0.38	526	18	0.30	0.0049	2.6	0.15	0.015	0.015
Welding Truck	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	631	18	0.30	0.0049	2.6	0.15	0.015	0.015
Shovel Crew Flat Deck	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	421	18	0.30	0.0049	2.6	0.15	0.015	0.015
Shovel Crew Hiab	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	526	18	0.30	0.0049	2.6	0.15	0.015	0.015
Surface Crew Hiab	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	526	18	0.30	0.0049	2.6	0.15	0.015	0.015
Lighting Tower	Amida	2	11	Tier 4 Final	Other Construction Equipment	0.42	3,155	18	5.3	0.0049	6.0	0.30	0.30	0.30
Hydraulic Hammer	TB-XC Hydraulic Breaker	1	172	Tier 4 Final	Other Construction Equipment	0.42	526	18	0.30	0.0049	3.7	0.15	0.015	0.015
Mine Rescue Vehicle	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	526	18	0.30	0.0049	2.6	0.15	0.015	0.015

Notes:

1. Equipment specific information provided by Castle Mountain Venture with the following exceptions: horsepower for Tractor and Low Bed, Flatbed Hiab Truck, Welding Truck, Shovel Crew Flat Deck, Shovel Crew Hiab, Surface Crew Hiab, and Hydraulic Hammer were obtained from EMFAC2021 in offroad emissions mode for MDAQMD in Calendar Year 2025.
2. All off-road equipment used at the facility will be Tier 4 Final.
3. Average equipment load factors were based on the CARB OFFROAD2017 Emission Factor Workbook (CARB 2017).
4. PM, CO, NO_x and VOC engine emission factors were based on CARB Tier 4 Final diesel engine standards. Emission factors for ROG were converted from NMHC Tier standards using USEPA hydrocarbon conversion factors (USEPA 2010). When applicable, the NMHC/NO_x combined Tier standard was split into NMHC and NO_x per BAAQMD guidance (assumed 5% NMHC, 95% NO_x). Emission factors for SO_x from diesel fuel are calculated from the California standard for diesel fuel of 15 ppm (http://www.arb.ca.gov/fuels/diesel/081404dslregs.pdf). Emission factor calculations assume a diesel fuel density of 7.1 lb/gal, heating value of 19,300 BTU/lb, BSFC of 7,000 BTU/hp-hr (USEPA 1996), and that all sulfur is converted to SO_2.

References:

BAAQMD. 2004. CARB Emission Factors for CI Diesel Engines - Percent HC in Relation to NMHC + NO_x.

CARB. Table 1: ARB and USEPA Off-Road Compression-Ignition (Diesel) Engine Standards. www.arb.ca.gov/msprog/ordiesel/documents/Off-Road_Diesel_Stds.xls.

CARB. 2017. 2017 Off-road Diesel Emission Factors. Available online at: https://ww2.arb.ca.gov/sites/default/files/2022-05/Off-road_CI_engine_standards_chart_04212022.pdf.

CARB 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250

USEPA. 2010. Conversion Factors for Hydrocarbon Emission Components, NR-002d. EPA-420-R-10-015. July. Available online at: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10081RP.pdf.

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
BSFC - brake-specific fuel consumption
BTU - British thermal units
CARB - California Air Resources Board
CO - carbon monoxide
EMFAC2021 - California Air Resources Board EMission FACtor model
g/bhp-hr - grams per brake horsepower-hour
gal - gallon
hp - horsepower
hr - hour
lb - pound
MDAQMD - Mojave Desert Air Quality Management District
NMHC - non-methane hydrocarbons
NO_x - nitrogen oxides
PM - particulate matter
ppm - parts per million
ROG - reactive organic gases
SO_x - sulfur oxides
USEPA - United States Environmental Protection Agency

Approved Operations: Table OA-11
On-site Mobile Vehicles
CAP Exhaust Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Daily Emissions[1] (lb/day)						Annual Emissions[1] (tpy)					
	NO_x	SO_x	CO	ROG	PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	ROG	PM_{10}	$PM_{2.5}$
Production Blasthole Drill	44	0.084	44	2.6	0.51	0.51	6.9	0.013	6.9	0.40	0.080	0.080
Wall Control Drill	3.2	0.053	28	1.6	0.16	0.16	0.33	0.0055	2.9	0.17	0.017	0.017
Hydraulic Shovel	130	0.25	130	7.5	1.5	1.5	17	0.031	17	0.95	0.19	0.19
Wheel Loader	65	0.12	65	3.7	0.75	0.75	5.7	0.011	5.7	0.33	0.066	0.066
Haul Trucks	623	1.2	623	36	7.2	7.2	93	0.18	93	5.4	1.1	1.1
Track Dozer	6.0	0.099	52	3.0	0.30	0.30	0.66	0.011	5.7	0.33	0.033	0.033
Wheel Dozer	3.0	0.049	26	1.5	0.15	0.15	0.24	0.0040	2.1	0.12	0.012	0.012
Grader	1.4	0.023	12	0.71	0.071	0.071	0.17	0.0029	1.5	0.087	0.0087	0.0087
Water Truck	57	0.11	57	3.3	0.66	0.66	2.7	0.0050	2.7	0.15	0.031	0.031
Wheel Loader	2.3	0.038	20	1.2	0.12	0.12	0.081	0.0013	0.70	0.041	0.004	0.004
Haul Truck	32	0.061	32	1.9	0.37	0.37	2.8	0.0054	2.8	0.16	0.033	0.033
Excavator	2.4	0.039	21	1.2	0.12	0.12	0.028	4.6E-04	0.24	0.014	0.0014	0.0014
Tire Manipulator	2.7	0.044	23	1.4	0.14	0.14	0.024	3.9E-04	0.21	0.012	0.0012	0.0012
Vibratory Compactor	0.65	0.011	8.0	0.32	0.033	0.033	0.0057	9.4E-05	0.070	0.0028	2.8E-04	2.8E-04
Backhoe	0.46	0.0076	5.7	0.23	0.023	0.023	0.0068	1.1E-04	0.083	0.0034	3.4E-04	3.4E-04
Articulated Truck	2.0	0.033	18	1.0	0.10	0.10	0.030	4.9E-04	0.26	0.015	0.0015	0.0015
Fuel and Lube Truck	40	0.076	40	2.3	0.46	0.46	1.4	0.0027	1.4	0.081	0.016	0.016
Tractor and Low Bed	1.8	0.030	16	0.91	0.092	0.092	0.011	1.8E-04	0.093	0.0053	5.3E-04	5.3E-04
Flatbed Hiab Truck	1.8	0.030	16	0.91	0.092	0.092	0.037	6.2E-04	0.32	0.019	0.0019	0.0019
Rough Terrain Forklift	1.2	0.020	11	0.62	0.062	0.062	0.018	3.0E-04	0.16	0.0090	9.0E-04	9.0E-04
Shop Forklift	0.41	0.0068	5.1	0.21	0.021	0.021	0.0060	9.9E-05	0.074	0.0030	3.0E-04	3.0E-04
Mechanics Truck	1.5	0.025	13	0.75	0.075	0.075	0.022	3.6E-04	0.19	0.011	0.0011	0.0011
Welding Truck	1.8	0.030	16	0.91	0.092	0.092	0.032	5.3E-04	0.28	0.016	0.0016	0.0016
Shovel Crew Flat Deck	1.8	0.030	16	0.91	0.092	0.092	0.021	3.5E-04	0.19	0.011	0.0011	0.0011
Shovel Crew Hiab	1.8	0.030	16	0.91	0.092	0.092	0.027	4.4E-04	0.23	0.013	0.0013	0.0013
Surface Crew Hiab	1.8	0.030	16	0.91	0.092	0.092	0.027	4.4E-04	0.23	0.013	0.0013	0.0013
Lighting Tower	1.9	0.0018	2.1	0.11	0.11	0.11	0.083	7.7E-05	0.094	0.0047	0.0047	0.0047
Hydraulic Hammer	0.86	0.014	11	0.43	0.043	0.043	0.013	2.1E-04	0.16	0.0063	0.0006	0.0006
Mine Rescue Vehicle	1.8	0.030	16	0.91	0.092	0.092	0.027	4.4E-04	0.23	0.013	0.0013	0.0013
Total Emissions	**1,034**	**2.6**	**1,357**	**78**	**14**	**14**	**131**	**0.27**	**145**	**8.4**	**1.6**	**1.6**

Notes:

[1.] Emissions based on parameters and emission factors presented in Table OA-10.

Abbreviations:

CO - carbon monoxide
lb - pounds
NO_x - nitrogen oxides
PM - particulate matter
ROG - reactive organic gases
SO_x - sulfur oxides
tpy - tons per year

Approved Operations: Table OA-12
On-site Mobile Vehicles
GHG Exhaust Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Annual Fuel Usage[1] (gal/yr)	Emission Factors (kg/gal)[2,3]			Annual Emissions[4,5] (MT/yr)				
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Biogenic CO_2e	Non-biogenic CO_2e
Production Blasthole Drill	157,088	10.21	9.4E-04	8.7E-04	1,603	0.15	0.14	1,603	44
Wall Control Drill	63,347	10.21	9.4E-04	8.7E-04	647	0.060	0.055	647	18
Hydraulic Shovel	389,963	10.21	9.4E-04	8.7E-04	3,980	0.37	0.34	3,980	110
Wheel Loader	121,469	10.21	9.4E-04	8.7E-04	1,240	0.11	0.11	1,240	34
Haul Trucks	1,214,284	10.21	9.4E-04	8.7E-04	12,394	1.1	1.1	12,394	343
Track Dozer	149,875	10.21	9.4E-04	8.7E-04	1,530	0.14	0.13	1,530	42
Wheel Dozer	47,118	10.21	9.4E-04	8.7E-04	481	0.044	0.041	481	13
Grader	35,339	10.21	9.4E-04	8.7E-04	361	0.033	0.031	361	10
Water Truck	40,387	10.21	9.4E-04	8.7E-04	412	0.038	0.035	412	11
Wheel Loader	15,145	10.21	9.4E-04	8.7E-04	155	0.014	0.013	155	4.3
Haul Truck	37,863	10.21	9.4E-04	8.7E-04	386	0.036	0.03	386	11
Excavator	5,048	10.21	9.4E-04	8.7E-04	52	0.0047	0.0044	52	1.4
Tire Manipulator	3,471	10.21	9.4E-04	8.7E-04	35	0.0033	0.0030	35	0.98
Vibratory Compactor	2,209	10.21	9.4E-04	8.7E-04	23	0.0021	0.0019	23	0.62
Backhoe	2,629	10.21	9.4E-04	8.7E-04	27	0.0025	0.0023	27	0.74
Articulated Truck	2,104	10.21	9.4E-04	8.7E-04	21	0.0020	0.0018	21	0.59
Fuel and Lube Truck	15,145	10.21	9.4E-04	8.7E-04	155	0.014	0.013	155	4.3
Tractor and Low Bed	631	10.21	9.4E-04	8.7E-04	6.4	5.9E-04	5.5E-04	6.4	0.18
Flatbed Hiab Truck	2,209	10.21	9.4E-04	8.7E-04	23	0.0021	0.0019	23	0.62
Rough Terrain Forklift	1,578	10.21	9.4E-04	8.7E-04	16	0.0015	0.0014	16	0.45
Shop Forklift	1,052	10.21	9.4E-04	8.7E-04	11	9.9E-04	9.2E-04	11	0.30
Mechanics Truck	1,578	10.21	9.4E-04	8.7E-04	16	0.0015	0.0014	16	0.45
Welding Truck	1,893	10.21	9.4E-04	8.7E-04	19	0.0018	0.0016	19	0.54
Staff Pickup Trucks	25,242	10.21	9.4E-04	8.7E-04	258	0.024	0.022	258	7.1
Pit Services Pickup	26,504	10.21	9.4E-04	8.7E-04	271	0.025	0.023	271	7.5
Staff Pickup Trucks (Crewcab)	7,573	10.21	9.4E-04	8.7E-04	77	0.0071	0.0066	77	2.1
Pit Services Pickup (Crewcab)	7,573	10.21	9.4E-04	8.7E-04	77	0.0071	0.0066	77	2.1
Shovel Crew Flat Deck	1,262	10.21	9.4E-04	8.7E-04	13	0.0012	0.0011	13	0.36
Shovel Crew Hiab	2,104	10.21	9.4E-04	8.7E-04	21	0.0020	0.0018	21	0.59
Surface Crew Hiab	2,104	10.21	9.4E-04	8.7E-04	21	0.0020	0.0018	21	0.59
Lighting Tower	6,311	10.21	9.4E-04	8.7E-04	64	0.0059	0.0055	64	1.8
Mine Rescue Vehicle	1,578	10.21	9.4E-04	8.7E-04	16	0.0015	0.0014	16	0.45
Total Emissions					**24,411**	**2.2**	**2.1**	**24,411**	**676**

Notes:

1. Annual fuel usage was provided by Castle Mountain Venture.
2. CO_2 emission factor is from 40 CFR Part 98, Subpart C, Table C-1.
3. CH_4 and N_2O emission factors are from the EPA Center for Corporate Climate Leadership (2022, April 1) Emission Factors for Greenhouse Gas Inventories, Table 5 (available at https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf) which are calculated from the USEPA Inventory of U.S. Greenhouse Gas Emission and Sinks: 1990-2019.
4. Annual CO_2e emissions were calculated using global warming potentials (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).
5. CO_2 emissions are assumed to be 100% biogenic based on the assumption of the use of 100% renewable diesel fuel in off-road equipment, consistent with regulatory requirements under the CARB In-Use Off-Road Diesel-Fueled Fleets Regulation and CMV commitments.

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

CARB. 2022. In-Use Off-Road Diesel-Fueled Fleets regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/off-roaddiesel/appa-1.pdf

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

USEPA. 2021. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019. Available at: https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-annexes.pdf

Abbreviations:

CARB - California Air Resources Board
CH_4 - methane
CMV - Castle Mountain Venture
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
gal - gallons
GHG - greenhouse gas
GWP - global warming potential
kg - kilograms
MRR - Mandatory Reporting Regulation
MT - metric tons
N_2O - nitrous oxide
USEPA - United States Environmental Protection Agency
yr - year

Approved Operations: Table OA-13a
Off-site On-Road Mobile Vehicles
Trip Rates
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type[1]	Trip Type	Trip Rate (RT/day)	Trip Length (miles/RT)	Annual Activity (days/yr)	Annual Trips (RT/yr)	Daily VMT (miles/day)	Annual VMT (miles/yr)
Employee Vehicles[2]	Employee Vehicles - Full Commute	9	170	200	1,800	1,530	306,000
	Employee Vehicles - To/From Vans/Buses	46	12	365	16,790	552	201,480
Vans/Buses[3]	Vans/Buses	2	170	365	730	340	124,100
Fuel Delivery Trucks[4]	Fuel Delivery Trucks	3	206	260	780	618	160,680
Product Delivery Trucks[6]	Product Delivery Trucks (gold to market)	1	836	26	26	836	21,736
Contractor Trucks[7]	Blasting Contractor Trucks	1	206	312	312	206	64,272
	Maintenance Contractor Trucks	1	206	365	365	206	75,190
Other Delivery Trucks[7]	Other Delivery Trucks (Warehouse to Coyote)	3	52	208	624	156	32,448
	Other Delivery Trucks (Las Vegas Origin)	2	206	365	730	412	150,380
Reagent Delivery Trucks[7]	Reagent Delivery Trucks (Antiscalant)	1	1,442	5	5	1,442	7,210
	Reagent Delivery Trucks (Carbon)	1	1,024	2	2	1,024	2,048
	Reagent Delivery Trucks (Caustic Soda)	1	578	26	26	578	15,028
	Reagent Delivery Trucks (Flocculant, Anionic)	1	574	12	12	574	6,888
	Reagent Delivery Trucks (Fluxes)	1	574	6	6	574	3,444
	Reagent Delivery Trucks (Pebble Lime)	1	206	260	260	206	53,560
	Reagent Delivery Trucks (Sodium Cyanide)	1	1,118	52	52	1,118	58,136

Notes:

1. Fleet mixes are defined in Table OA-14a.
2. Employee vehicle trip rates were based on the number of employees working at the facility and were provided by Castle Mountain Venture. Each employee was assumed to make one roundtrip per day, to and from the Project site. Employee activity was assumed to occur 365 days per year. A portion of the employees were assumed to commute the full distance between home and the facility in their personal vehicles. The remainder of the employees were assumed to commute an average of 12 miles roundtrip between home and the van/bus pickup locations in their personal vehicles. Potential van/bus pick up locations may include Las Vegas, NV, Henderson, NV, and Bullhead City/Laughlin, NV.
3. Van/bus trip rates were calculated based on the number of van/bus commuters and an assumption of 35 passengers/vehicle. An average roundtrip distance between the Henderson, NV, Bullhead City/Laughlin, NV, and Las Vegas, NV bus/van locations and the facility was assumed.
4. Annual trip rates for Fuel Delivery calculated based on daily average trip rates provided by Castle Mountain Venture and 260 days per year of activity. Daily trip rates were conservatively rounded up to the nearest whole number. Trip lengths assume all fuel would be delivered from Las Vegas, NV.
5. Daily and annual trip rates assume one Product Delivery trip every other week. Trip length was provided by Castle Mountain Venture.
6. Daily trip rates, trip lengths, and annual activity for Contractors, Other Delivery Trucks, and Reagent Delivery Trucks were provided by Castle Mountain Venture.

Abbreviations:

RT - roundtrips
VMT - vehicle miles traveled
yr - year

Approved Operations: Table OA-13b
On-site On-Road Mobile Vehicles
Trip Rates
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type[1]	Trip Type	Trip Rate (RT/day)	Trip Length (miles/RT)	Annual Activity (days/yr)	Annual Trips[1] (RT/yr)	Annual VMT[2] (miles/yr)
On-site Pickup Trucks	Staff Pickup Trucks			365		84,140
	Pit Services Pickup			365		88,347
	Staff Pickup Trucks (Crewcab)			365		25,242
	Pit Services Pickup (Crewcab)			365		25,242
Fuel Delivery Trucks	Fuel Delivery Trucks	3	1.8	260	780	1,404
Product Delivery Trucks	Product Delivery Trucks (gold to market)	1	3.8	26	26	99
Contractor Trucks	Blasting Contractor Trucks	1	3.8	312	312	1,186
	Maintenance Contractor Trucks	1	3.8	365	365	1,387
Other Delivery Trucks	Other Delivery Trucks (Warehouse to Coyote)	3	3.8	208	624	2,371
	Other Delivery Trucks (Las Vegas Origin)	2	3.8	365	730	2,774
Reagent Delivery Trucks	Reagent Delivery Trucks (Antiscalant)	1	3.8	5	5	19
	Reagent Delivery Trucks (Carbon)	1	3.8	2	2	7.6
	Reagent Delivery Trucks (Caustic Soda)	1	3.8	26	26	99
	Reagent Delivery Trucks (Flocculant, Anionic)	1	3.8	12	12	46
	Reagent Delivery Trucks (Fluxes)	1	3.8	6	6	23
	Reagent Delivery Trucks (Pebble Lime)	1	3.8	260	260	988
	Reagent Delivery Trucks (Sodium Cyanide)	1	3.8	52	52	198

Notes:

1. Fleet mixes are defined in Table OA-14b. Diesel MDVs (on-site pickup trucks fleet) only generate emissions on a per mile basis, therefore annual trip rates are not presented in this table. On-site pickup trucks are assumed to operate 365 days per year. Delivery truck trips originate off-site and the emissions generated on a per trip basis are already accounted for in the off-site mobile calculations (Tables OA-13a, OA-14a, OA-15a, OA-16a, and OA-17a. Trip rate data for delivery trucks is still presented, however, as part of the calculation of annual VMT.
2. Annual VMT for the on-site pickup trucks is calculated in Table OA-8. Delivery trucks to the site will travel a short distance on-site in addition to the off-site activity presented in Table OA-13a. Total annual onsite VMT was calculated based on the on-site mileage per trip (provided by Castle Mountain Venture) and the annual trip rates shown in Table OA-13a.

Abbreviations:

MDV - medium-duty truck
RT - roundtrips
VMT - vehicle miles traveled
yr - year

Approved Operations: Table OA-14a
Off-site On-Road Mobile Vehicles
Fleet Mix Distribution
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type	Vehicle Type	Percentage of Fleet Mix[1]	Percent by Fuel Type[1]				
			Gas	Diesel	Renewable Natural Gas	Electric	Plug-in Hybrid
Employee Vehicles	LDA	55.2%	89.5%	0%	0%	6.9%	3.4%
	LDT1	3.9%	99.0%	0.008%	0%	0.52%	0.45%
	LDT2	24.0%	97.3%	0.35%	0%	0.96%	1.4%
	MCY	0.39%	100%	0%	0%	0%	0%
	MDV	16.6%	95.8%	1.5%	0%	1.5%	1.2%
Vans/Buses	LHDT1	78.5%	100%	0%	0%	0%	0%
	LHDT2	21.5%	100%	0%	0%	0%	0%
Fuel Delivery Trucks	HHDT	100%	0%	100%	0%	0%	0%
Product Delivery, Contractor, Other Delivery, and Reagent Delivery Trucks	MHDT	6.9%	0%	100%	0%	0%	0%
	HHDT	93.1%	0%	100%	0%	0%	0%

Notes:

1. Fleet mixes and percentages by fuel type are calculated based on EMFAC2021 v1.0.2 vehicle miles traveled projections for MDAQMD with the exception of Vans which are assumed to be exclusively gasoline-fueled and Delivery Trucks which are assumed to be exclusively diesel-fueled. EMFAC2021 v1.0.2 was run in Emission Rates mode for calendar year 2027 in the annual season.

References:

California Air Resources Board (ARB) 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250

Abbreviations:

EMFAC2021 - California Air Resources Board EMission FACtor model
HHDT - heavy-heavy-duty truck
LDA - passenger car
LDT - light-duty truck
LHDT - light-heavy-duty truck
MCY - motorcycle
MDAQMD - Mojave Desert Air Quality Management District
MDV - medium-duty truck
MHDT - medium-heavy-duty truck

Approved Operations: Table OA-14b
On-site On-Road Mobile Vehicles
Fleet Mix Distribution
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type	Vehicle Type	Percentage of Fleet Mix[1]	Percent by Fuel Type[1]				
			Gas	Diesel	Renewable Natural Gas	Electric	Plug-in Hybrid
On-site Pickup Trucks	MDV	100%	50%	50%	0%	0%	0%
Fuel Delivery Trucks	HHDT	100%	0%	100%	0%	0%	0%
Product Delivery, Contractor, Other Delivery, and Reagent Delivery Trucks	MHDT	6.9%	0%	100%	0%	0%	0%
	HHDT	93.1%	0%	100%	0%	0%	0%

Notes:

1. On-site Pickup Trucks are assumed to be 50% gasoline-fueled and 50% diesel-fueled. Delivery Trucks are assumed to be 100% diesel-fueled. EMFAC2021 v1.0.2 was run in Emission Rates mode for MDAQMD for calendar year 2027 in the annual season.

References:

California Air Resources Board (ARB) 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250

Abbreviations:

EMFAC2021 - California Air Resources Board EMission FACtor model
HHDT - heavy heavy-duty truck
MDAQMD - Mojave Desert Air Quality Management District
MDV - medium-duty truck
MHDT - medium heavy-duty truck

Approved Operations: Table OA-15a
Off-site On-Road Mobile Vehicles
Exhaust and Brake Wear/Tire Wear Emission Factors
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Scenario		Emission Factor Units	Mobile Emission Factors[1]									
			CAPs						GHGs[2]			
Year	Fleet Type		ROG	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x	CO_2	CH_4	N_2O	CO_2e
2027	Employee Vehicles	g/mile	0.014	0.056	0.015	0.0050	0.76	0.0029	294	0.0031	0.0054	296
		g/trip	1.1	0.26	0.0019	0.0018	3.0	7.2E-04	73	0.069	0.032	84
	Vans/Buses	g/mile	0.023	0.17	0.090	0.031	1.2	0.0061	615	0.0047	0.0095	618
		g/trip	0.77	0.61	3.2E-04	3.0E-04	3.4	3.3E-04	34	0.040	0.049	49
	Fuel Delivery Trucks	g/mile	0.012	1.4	0.14	0.067	0.034	0.014	1,450	5.6E-04	0.23	1,518
		g/trip	0.48	7.7	0.0021	0.0020	7.0	0.0098	1,030	0.022	0.16	1,079
	Product Delivery, Contractor, Other Delivery, and Reagent Delivery Trucks	g/mile	0.012	1.3	0.14	0.064	0.035	0.013	1,423	5.6E-04	0.22	1,490
		g/trip	0.44	7.4	0.0020	0.0019	6.6	0.0092	969	0.021	0.15	1,015

Notes:

1. Emission factors were estimated using EMFAC2021 for MDAQMD. EMFAC2021 was run in Emission Rates mode for calendar year 2027 in the annual season. The following processes have units of g/trip: DIURN, HOTSOAK, RESTLOSS, STREX, and IDLEX. The following processes have units of g/mile: PMBW, PMTW, RUNEX, and RUNLOSS. Processes with units of g/vehicle/day were converted to g/trip using the population and trip rate values given in the EMFAC2021 run.
2. Annual CO_2e emissions were calculated using GWP values from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

CARB 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CAP - Criteria Air Pollutant
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
DIURN - diurnal evaporative hydrocarbon emissions
EMFAC2021 - California Air Resources Board EMission FACtor model
g - grams
GHG - greenhouse gas
GWP - global warming potential
HOTSOAK - hot soak evaporative hydrocarbon emissions
IDLEX - idle exhaust emissions
MDAQMD - Mojave Desert Air Quality Management District
MRR - Mandatory Reporting Regulation
N_2O - nitrous oxide
NO_x - nitrogen oxides
PM - particulate matter
PMBW - brake wear particulate matter emissions
PMTW - tire wear particulate matter emissions
RESTLOSS - resting evaporative losses
ROG - reactive organic gases
RUNEX - running exhaust emissions
RUNLOSS - running loss evaporative hydrocarbon emissions
STREX - start exhaust tailpipe emissions
SO_x - sulfur oxides
USEPA - United States Environmental Protection Agency

Approved Operations: Table OA-15b
On-site On-Road Mobile Vehicles
Exhaust and Brake Wear/Tire Wear Emission Factors
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Scenario		Emission Factor Units	Mobile Emission Factors[1]									
			CAPs						GHGs[2]			
Year	Fleet Type		ROG	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x	CO_2	CH_4	N_2O	CO_2e
2027	On-site Pickup Trucks	g/mile	0.015	0.11	0.019	0.0084	0.59	0.0040				
		g/trip	0.70	0.20	0.0010	9.6E-04	1.9	5.1E-04				
	Fuel Delivery Trucks	g/mile	0.012	1.4	0.14	0.067	0.034	0.014	1,450	5.6E-04	0.23	1,518
	Product Delivery, Contractor, Other Delivery, and Reagent Delivery Trucks	g/mile	0.012	1.3	0.14	0.064	0.035	0.013	1,423	5.6E-04	0.22	1,490

Notes:

1. Emission factors were estimated using EMFAC2021 for MDAQMD. EMFAC2021 was run in Emission Rates mode for calendar year 2027 in the annual season. The following processes have units of g/mile: PMBW, PMTW, RUNEX, and RUNLOSS. For the Delivery Truck fleets, the g/trip emission factors are not presented because these trips originate off-site and the emissions generated on a per trip basis are already accounted for in Tables OA-13a, OA-14a, OA-15a, OA-16a, and OA-17a.
2. GHG emissions for the On-site Pickup Trucks are based on fuel consumption rates and are calculated in Table OA-12. Annual CO2e emissions for the Delivery Truck fleets are calculated using GWP values from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

California Air Resources Board (CARB) 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CAP - Criteria Air Pollutant
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
EMFAC2021 - California Air Resources Board EMission FACtor model
g - grams
GHG - greenhouse gas
GWP - global warming potential
MDAQMD - Mojave Desert Air Quality Management District
MRR - Mandatory Reporting Rule
N_2O - nitrous oxide
NO_x - nitrogen oxides
PM - particulate matter
PMBW - brake wear particulate matter emissions
PMTW - tire wear particulate matter emissions
ROG - reactive organic gases
RUNEX - running exhaust emissions
RUNLOSS - running loss evaporative hydrocarbon emissions
SO_x - sulfur oxides
USEPA - United States Environmental Protection Agency

Approved Operations: Table OA-16a
Off-site On-Road Mobile Vehicles
Exhaust and Brake Wear/Tire Wear Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Daily Emission Rates[1]

Year	Fleet Type	Emissions from Mobile Sources					
		ROG[2]	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x
		(lb/day)					
2027	Employee Vehicles	0.19	0.29	0.068	0.023	3.8	0.013
	Vans/Buses	0.021	0.13	0.068	0.024	0.93	0.0046
	Fuel Delivery Trucks	0.020	1.9	0.19	0.091	0.093	0.019
	Product Delivery Trucks	0.023	2.5	0.25	0.12	0.079	0.025
	Contractor Trucks	0.013	1.2	0.12	0.058	0.061	0.012
	Other Delivery Trucks	0.020	1.8	0.17	0.080	0.12	0.017
	Reagent Delivery Trucks	0.15	16	1.7	0.78	0.53	0.16
Total Emissions		**0.44**	**24**	**2.5**	**1.2**	**5.7**	**0.25**

Annual Emission Rates[1]

Year	Fleet Type	Emissions from Mobile Sources									
		ROG[2]	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x	CO_2	CH_4	N_2O	Non-biogenic CO_2e
		(tons/yr)						(MT/yr)			
2027	Employee Vehicles	0.029	0.037	0.0083	0.0029	0.49	0.0016	150	0.0028	0.0034	152
	Vans/Buses	0.0038	0.023	0.012	0.0043	0.17	8.3E-04	76	6.1E-04	0.0012	77
	Fuel Delivery Trucks	0.0025	0.25	0.025	0.012	0.012	0.0024	234	1.1E-04	0.037	245
	Product Delivery Trucks	3.0E-04	0.032	0.0033	0.0015	0.0010	3.2E-04	31	1.3E-05	0.0049	32
	Contractor Trucks	0.0022	0.21	0.021	0.0098	0.010	0.0021	199	9.1E-05	0.031	208
	Other Delivery Trucks	0.0031	0.28	0.027	0.013	0.017	0.0027	261	1.3E-04	0.041	274
	Reagent Delivery Trucks	0.0021	0.22	0.022	0.010	0.0083	0.0022	209	8.9E-05	0.033	218
Total Emissions		**0.043**	**1.1**	**0.12**	**0.054**	**0.70**	**0.012**	**1,161**	**0.0039**	**0.15**	**1,206**

Notes:

1. Trip generation rates and emission factors used in emissions calculations are shown in Tables OA-13a and OA-15a, respectively.
2. ROG is assumed to equal VOC.

Abbreviations:

CO - carbon monoxide
CO_2e - carbon dioxide equivalents
lb - pound
MT - metric ton(s)
NO_x - nitrogen oxides
PM - particulate matter
ROG - reactive organic gases
SO_x - sulfur oxides
VOC - volatile organic compounds
yr - year

Approved Operations: Table OA-16b
On-site On-Road Mobile Vehicles
Exhaust and Brake Wear/Tire Wear Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Daily Emission Rates[1]

Year	Fleet Type	Emissions from Mobile Sources					
		ROG[2]	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x
		(lb/day)					
2027	On-site Pickup Trucks	0.020	0.15	0.025	0.011	0.80	0.0054
	Fuel Delivery Trucks	1.4E-04	0.017	0.0017	7.9E-04	4.1E-04	1.6E-04
	Product Delivery Trucks	1.0E-04	0.011	0.0011	5.4E-04	2.9E-04	1.1E-04
	Contractor Trucks	2.0E-04	0.022	0.0023	0.0011	5.9E-04	2.3E-04
	Other Delivery Trucks	5.0E-04	0.056	0.0057	0.0027	0.0015	5.6E-04
	Reagent Delivery Trucks	7.0E-04	0.078	0.0080	0.0038	0.0021	7.9E-04
Total Emissions		**0.021**	**0.33**	**0.044**	**0.020**	**0.80**	**0.0073**

Annual Emission Rates[1]

Year	Fleet Type	Emissions from Mobile Sources									
		ROG[2]	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x	CO_2	CH_4	N_2O	Non-biogenic CO_2e
		(tpy)						(MT/yr)			
2027	On-site Pickup Trucks	0.0036	0.027	0.0046	0.0021	0.15	9.9E-04	0	0	0	0
	Fuel Delivery Trucks	1.9E-05	0.0021	2.2E-04	1.0E-04	5.3E-05	2.1E-05	2.0	7.8E-07	3.2E-04	2.1
	Product Delivery Trucks	1.3E-06	1.5E-04	1.5E-05	7.0E-06	3.8E-06	1.5E-06	0.14	5.5E-08	2.2E-05	0.15
	Contractor Trucks	3.4E-05	0.0038	3.9E-04	1.8E-04	9.9E-05	3.8E-05	3.7	1.4E-06	5.8E-04	3.8
	Other Delivery Trucks	6.8E-05	0.0076	7.7E-04	3.6E-04	2.0E-04	7.6E-05	7.3	2.9E-06	0.0012	7.7
	Reagent Delivery Trucks	1.8E-05	0.0020	0.00021	9.7E-05	5.3E-05	2.0E-05	2.0	7.7E-07	3.1E-04	2.1
Total Emissions		**0.0037**	**0.043**	**0.0062**	**0.0028**	**0.15**	**0.0012**	**15**	**5.9E-06**	**0.0024**	**16**

Notes:

1. Trip generation rates, VMT, and emission factors used in emissions calculations are shown in Tables OA-13b and OA-15b, respectively. GHG emissions from on site pickup trucks are calculated based on fuel consumption and are presented in Table OA-12.
2. ROG is assumed to equal VOC.

Abbreviations:

CO - carbon monoxide
CO_2e - carbon dioxide equivalent
lb - pound
MT - metric ton
NO_x - nitrogen oxides
PM - particulate matter
ROG - reactive organic gases
SO_x - sulfur oxides
VMT - vehicle miles traveled
VOC - volatile organic compound
tpy - tons per year
yr - year

Approved Operations: Table OA-17a
Off-site On-Road Mobile Vehicles
Fugitive Dust Emissions - Paved Roads
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Entrained Roadway Dust Constants for San Bernardino County (MDAQMD)		
Roadway Category	**Silt Loading[1] (g/m^2)**	**Travel Fraction[1]**
Freeway	0.015	52%
Major	0.08	32%
Collector	0.08	9.0%
Local	0.84	7.0%
Weighted Silt Loading Factor	**0.099**	**100%**

Road Dust Equation[2]
E = k*(sL)^0.91 * (W)^1.02 * (1-P/4N)

Parameter[2]	**Value**
E = annual average emission factor in the same units as k	[calculated]
k = particle size multiplier for particle size range and units of interest	
PM_{10} (lb/VMT)	0.0022
$PM_{2.5}$ (lb/VMT)	3.3E-04
sL = road surface silt loading (grams per square meter) (g/m^2)	0.099
W = average weight (tons) of all the vehicles traveling the road	2.4
P = number of "wet" days with at least 0.01 inches of precipitation during averaging period[3]	45
N number of days in the averaging period	365

Vehicle Miles Traveled[4]

Fleet Type	**Miles/Day**	**Miles/Year**
Employee Vehicles	1,758	442,680
Vans/Buses	268	97,820
Fuel Delivery Trucks	510	132,600
Product Delivery Trucks	800	20,800
Contractor Trucks	340	115,090
Other Delivery Trucks	388	134,084
Reagent Delivery Trucks	5,264	133,246

Parameter[5]	**Fugitive PM_{10}**	**Fugitive $PM_{2.5}$**	**Units**
Emission Factor	6.4E-04	9.6E-05	lb/VMT

Fleet Type	**Daily Emissions (lb/day)**		**Annual Emissions (tpy)**	
	PM_{10}	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Employee Vehicles	1.1	0.17	0.14	0.021
Vans/Buses	0.17	0.026	0.031	0.0047
Fuel Delivery Trucks	0.33	0.049	0.042	0.0063
Product Delivery Trucks	0.51	0.077	0.0066	9.9E-04
Contractor Trucks	0.22	0.033	0.037	0.0055
Other Delivery Trucks	0.25	0.037	0.043	0.0064
Reagent Delivery Trucks	3.4	0.50	0.042	0.0064
Total Emissions	**5.9**	**0.89**	**0.34**	**0.051**

Notes:

1. Travel fraction by roadway category and silt loading are from the ARB's March 2021 update to Entrained Road Travel Emission Inventory Source Methodology, Tables 2 and 4, respectively.
2. The road dust equation for paved roads is from the ARB's March 2021 update to Entrained Road Travel Emission Inventory Source Methodology.
3. The number of "wet" days for San Bernardino County (MDAQMD) from Table 5 of the ARB's March 2021 update to Entrained Road Travel Emission Inventory Source Methodology.

4. Vehicle miles traveled from OA-13a account for the fact that the last 18 miles to and from Castle Mountain Mine are unpaved. Fugitive dust emissions associated with the unpaved portion of vehicle miles traveled are presented in Table OA-17b.
5. $PM_{2.5}$ is assumed to be 15% of PM_{10} based on paved road dust sampling in California (ARB Speciation Profile #471), which is a more representative fraction than provided in the older AP-42 fugitive dust methodology as discussed in ARB 2021 (page 36).

References:

California Air Resources Board. 2021. Miscellaneous Process Methodology 7.9, Entrained Road Travel, Paved Road Dust. March. Available online at: https://ww3.arb.ca.gov/ei/areasrc/fullpdf/2021_paved_roads_7_9.pdf

USEPA. 2011. AP 42. Compilation of Air Pollutant Emission Factors, Volume 1. Fifth Edition. Chapter 13.2.1, Paved Roads. Available online at: http://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0201.pdf.

Abbreviations:

ARB - California Air Resources Board
g - gram(s)
lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
m^2 - square meter
PM - particulate matter
tpy - tons per year
USEPA - United States Environmental Protection Agency
VMT - vehicle miles traveled

Approved Operations: Table OA-17b
Off-site On-Road Mobile Vehicles
Fugitive Dust Emissions - Unpaved Roads
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type	Daily Unpaved Road VMT Traveled (miles/day)[1]	Annual Unpaved Road VMT Traveled (miles/yr)[1]	Mean Vehicle Weight (tons)[2]	Emission Factor (lb/VMT)[3]		Control Efficiency (%)[4]	Number of Days with >0.01 Inches Precipitation[5] (day/yr)	Controlled Emissions			
								Daily (lb/day)		Annual (tpy)	
				PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Employee Vehicles	324	64,800	2.4	0.62	0.062	95%	30	9.2	0.92	0.92	0.092
Vans/Buses	72	26,280	15	1.4	0.14	95%	30	4.7	0.47	0.85	0.085
Fuel Delivery Trucks	108	28,080	30	1.9	0.19	95%	30	9.5	0.95	1.2	0.12
Product Delivery Trucks	36	936	30	1.9	0.19	95%	30	3.2	0.32	0.041	0.0041
Contractor Trucks	72	24,372	30	1.9	0.19	95%	30	6.4	0.64	1.1	0.11
Other Delivery Trucks	180	48,744	30	1.9	0.19	95%	30	16	1.6	2.2	0.22
Reagent Delivery Trucks	252	13,068	30	1.9	0.19	95%	30	22	2.2	0.58	0.058
							Total Emissions	**71**	**7.1**	**6.8**	**0.68**

Notes:

1. Vehicle miles traveled are from Table OA-13a and account for the fact that the last 18 miles to and from Castle Mountain Mine are unpaved. Fugitive dust emissions associated with the paved portion of vehicle miles traveled are presented in Table OA-17a.
2. Mean vehicle weights estimated based on typical vehicle weights for each vehicle type as shown in Table OA-14a.
3. Emission factors for fugitive dust were calculated following MDAQMD's "most complex" Unpaved Roads methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 correlations for industrial roads (Equation 1a, Table 13.2.2-2, AP-42 Section 13.2.2) at the time of inventory preparation. A surface silt loading content of 5% was provided by Castle Mountain Venture.
4. A control efficiency of 95% used consistent with assumptions from the 1997 Castle Mountain Mine Expansion Project EIS/EIR, and the understanding that chemical suppressants will be applied to all unpaved roadways.
5. Consistent with the AP-42 Section 13.2.2 unpaved roads methodology for industrial sites, Ramboll applied a precipitation reduction based on the number of days with greater than 0.01 inches precipitation per year based on guidance in AP-42 Section 13.2.2, Figure 13.2.2-1.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

USEPA. 2006. AP-42, Section 13.2.2, Unpaved Roads. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0202.pdf. November.

Abbreviations:

lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
tpy - tons per year
USEPA - United States Environmental Protection Agency
VMT - vehicle miles traveled
yr - year

Approved Operations: Table OA-18
Watering Assumptions for Disturbed Operational Areas
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter	Value	Data Source
Average Hourly Traffic Rate	3 vehicles/hr	Only loaders and water trucks would disturb ore areas (haul trucks travel exclusively on roads). Per Castle Mountain Venture, a maximum of two loaders plus a water truck per hour is expected.
Time Between Water Applications	1 hours	Per Castle Mountain Venture, watering occurs approximately once per hour.
Average Annual Class A Pan Evaporation	75 inches	MDAQMD Mineral Guidance, conservative default
Water Application Intensity	0.11 gallons/yd^2	MDAQMD Mineral Guidance, conservative default
Control Efficiency	98 %	MDAQMD Mineral Guidance, Pg. 26

Notes:

1. Watering control efficiencies calculated consistent with MDAQMD guidance for Dust Entrainment from Unpaved Roads.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

Abbreviations:

hr - hour
MDAQMD - Mojave Desert Air Quality Management District
yd^2 - square yard

Approved Operations: Table OA-19
Disturbed Operational Area Emissions
Wind Erosion
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Daily Disturbed Surface Area[1] (acres)		Control Efficiency[2] (%)	Daily Emissions[3,4,5] (lb/day)		Annual Emissions[3,4,5] (tpy)	
	Average	Maximum		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Disturbed Areas	0.77	0.77	98%	3.2	0.48	0.077	0.012
Total Emissions				**3.2**	**0.48**	**0.077**	**0.012**

Notes:

1. Average and maximum daily disturbed surface area based on information provided by Castle Mountain Venture.
2. Control efficiency accounts for watering of disturbed areas. The watering control efficiency was calculated consistent with MDAQMD guidance for Dust Entrainment from Unpaved Roads as shown in Table OA-18.
3. Windblown dust from disturbed areas assumed to be a "limited" reservoir consistent with MDAQMD definitions due to the significant crusting that occurs on the mine ore and overburden areas.
4. Emissions estimated using MDAQMD's "most complex" Wind Erosion from Unpaved Operational Areas and Roads methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest $PM_{2.5}$ aerodynamic factor from AP-42 (Table 13.2.5-1 in AP-42 Section 13.2.5). Threshold friction velocity selected from the MDAQMD guidance based on an area use of "disturbed desert".
5. The maximum daily windspeeds required for input into the MDAQMD equation were assumed to be the "fastest mile" windspeed from each day (consistent with AP-42 Section 13.2.5 guidance, which the MDAQMD equation is based on). The fastest mile wind speeds were calculated using hourly site-specific meteorological data from January 2021 through December 2021 by scaling up the maximum hourly average wind speed to a fastest mile windspeed using the equation:

$$u+ = 1.52u/1.2$$

Where: u+ = fastest mile wind speed, and u = hourly mean wind speed. This empirical relationship is based on a conversion of the hourly average wind speed to a 3-second gust wind speed with the coefficient 1.52 (Dregger 2005), then a conversion of the 3-second gust windspeed to a fastest mile of wind with the coefficient 1/1.2 (Fouad and Calvert 2002).

References:

Dregger. 2005. The Wind Investigator: How to Approximate Wind Velocities at Roof Level. October.

Fouad and Calvert. 2002. Wind Load Provisions in the 2001 Supports Specification. November.

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

USEPA. 2006. AP-42, Section 13.2.5, Industrial Wind Erosion. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0205.pdf. November.

Abbreviations:

lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
USEPA - United States Environmental Protection Agency
tpy - tons per year

Approved Operations: Table OA-20
Stockpile Wind Erosion Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Storage Pile Area[1] (acres)	Storage Pile Silt Loading[2] (%)	Percentage of Year Stockpile Operates[3] (%)	Percentage of Time with Wind Speed > 12 mph[4] (%)	Number of Days with >0.01 Inches Precipitation[5] (day/yr)	Daily Water Application Rate[6] (gal/acre)	Watering Control Efficiency[7] (%)	Daily PM_{10} Emissions[8] (lb/day)	Daily $PM_{2.5}$ Emissions[8] (lb/day)	Annual PM_{10} Emissions[8] (tpy)	Annual $PM_{2.5}$ Emissions[8] (tpy)
Interim Ore Stockpile	6.2	15	25	24	31	2,130	50	15	5.9	2.7	1.1

Notes:

1. Storage pile area based on information provided by Castle Mountain Venture.
2. Storage pile silt loading of 15% was used, consistent with the default value for "blend ore and dirt" in MDAQMD guidance for Wind Erosion from Stockpiles.
3. Ore stockpile will operate during crushing stoppages, assumed to be 25% of the year based on crushing circuit design availability.
4. Percentage of time with wind speed greater than 12 mph based on hourly site-specific meteorological data for the period of January 2021 through December 2021.
5. Number of days with greater than 0.01 inches precipitation per year based on site-specific meteorological data for the period of January 2021 through December 2021.
6. Daily water application rate based on MDAQMD default watering intensity of 0.11 gal/yd^2 for unpaved road control, assuming water is applied 4 times per day to the Ore Stockpile.
7. Control efficiency for watering based on MDAQMD guidance for Wind Erosion from Stockpiles and daily water application rate.
8. Fugitive dust emissions calculated consistent with the most complex method from MDAQMD guidance for Wind Erosion from Stockpiles.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

Abbreviations:

gal = gallon
lb = pound
MDAQMD = Mojave Desert Air Quality Management District
mph = miles per hour
$PM_{2.5}$ = particulate matter less than 2.5 microns in diameter
PM_{10} = particulate matter less than 10 microns in diameter
tpy = tons per year

Approved Operations: Table OA-21
Fugitive Blast Hole Drilling Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Maximum Blast Holes[1]		Emission Factor[2] (lb/hole)		Control Efficiency[3] (%)	Maximum Daily Emissions (lb/day)		Annual Emissions (tpy)	
	Annual (holes/yr)	Daily (holes/day)	PM_{10}	$PM_{2.5}$		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Blast Hole Drilling	24,748	80	0.68	0.039	75%	14	0.78	2.1	0.12

Notes:

1. Facility specific information provided by Castle Mountain Venture. Quantity of blast holes includes ROM Ore, Waste Rock, Trim/Buffer drilling and conservatively includes Pre-shear. Maximum daily holes blasted assumes 6 days/week.
2. Emission factors are calculated using MDAQMD's "most complex" Blast Hole Drilling methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 PM2.5 multiplier (AP-42 Section 11.9, Table 11.9-1) at the time of inventory preparation.
3. A control efficiency of 75% is applied consistent with MDAQMD guidance for "complete coverage by windscreens (on the windward side)", assuming that the pit in which blasting activities take place will effectively act as a windscreen and reduce particulate matter

References:

USEPA. 1998. AP-42, Section 11.9, Western Surface Coal Mining. Available online at: https://www3.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf. October.

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

Abbreviations:

lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
tpy - tons per year
USEPA - United States Environmental Protection Agency
yr - year

Approved Operations: Table OA-22
Fugitive Dust Entrainment from Blasting Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Maximum Blast Holes[1]		Maximum Blasts[1]		Horizontal Area Shifted per Blast (sf)	Emission Factor[2] (lb/blast)		Control Efficiency[3] (%)	Maximum Daily Emissions (lb/day)		Annual Emissions (tpy)	
	Annual (holes/yr)	Daily (holes/day)	Annual (blasts/yr)	Daily (blasts/day)		PM_{10}	$PM_{2.5}$		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
ROM Ore	4,450	31	72	1	32,798	43	2.5	75%	11	0.62	0.39	0.022
Waste Rock	13,256	31	214	1	43,375	66	3.8	75%	16	0.95	1.8	0.10
Trim/Buffer	1,524	0	25	0	20,991	22	1.3	75%	0	0	0.069	0.0040
								Total Emissions	**27**	**1.6**	**2.2**	**0.13**

Notes:

1. Facility specific information provided by Castle Mountain Venture. Pre-shear blasting is not shown here as it does not significantly shift material. Daily maximum blast holes were calculated using the total annual quantity of ROM Ore, Waste Rock, and Trim/Buffer blast holes and 312 days per year of operations, resulting in a lower maximum daily blast holes compared to Table OA-21 due to the exclusion of the Pre-shear quantity. Although daily activity may correspond to any of the blast types, a typical blast with an even split between ROM Ore and Waste rock holes was assumed. The number of blasts was calculated assuming 220 holes/blast.
2. Emission factors are calculated based on MDAQMD's "most complex" Dust Entrainment from Blasting methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 correlations (AP-42, Chapter 11.9, Table 11.9-1) including corrections to typographical errors included in the 1995 version.
3. A control efficiency of 75% is applied consistent with MDAQMD guidance for "complete coverage by windscreens (on the windward side)", assuming that the pit in which blasting activities take place will effectively act as a windscreen and reduce particulate matter emissions.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

USEPA. 1998. AP-42, Section 11.9, Western Surface Coal Mining. Available online at: https://www3.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf. October.

Abbreviations:

lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
sf - square feet
tpy - tons per year
USEPA - United States Environmental Protection Agency
yr - year

Approved Operations: Table OA-23
Emissions from Blasting Explosives
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Blasting Explosives					Units
Explosive Type[1]		ANFO	TNT	PETN	RDX	Total	--
Amount of Explosive Detonated[1]		2,877	6	1.7	1.7		tpy
		9	0.020	0.005	0.005		tons/day
Emission Factors[2,3]	CO	67	796	297	196		lb/ton
	NO_x	17					lb/ton
	SO_2	0.0030					lb/ton
	Ammonia		29	2.5	44		lb/ton
	HCN		27				lb/ton
	CO_2	0.189					ton/ton
	CH_4		14.3				lb/ton
Maximum Daily Emissions	CO	632	16	1.6	1.1	651	lb/day
	NO_x	160				160	lb/day
	SO_2	0.028				0.028	lb/day
	Ammonia		0.58	0.014	0.24	0.84	lb/day
	HCN		0.54			0.54	lb/day
Maximum Annual Emissions	CO	96	2.5	0.25	0.16	99	tpy
	NO_x	24				24	tpy
	SO_2	0.0043				0.0043	tpy
	Ammonia		0.091	0.0021	0.037	0.13	tpy
	HCN		0.084			0.084	tpy
	CO_2	493				493	MT/yr
	CH_4		81			81	MT/yr

Notes:

1. Explosive type and amount of explosive detonated per year was provided by Castle Mountain Venture. The amount of explosive detonated per day was calculated using the maximum daily blast holes from Table OA-22 and the maximum quantity of explosive per blast hole provided by Castle Mountain Venture.
2. Emission factors for all species other than SO_2 and CO_2 are based on AP-42, Section 13.3, Table 13.3.
3. Emission factor for SO_2 is based on diesel fuel sulfur content limit of 15 ppm and the assumption that the amount of diesel fuel is equal to 5% of the amount of ANFO.
4. Emission factor for CO_2 is based on guidance from The Mining Association of Canada.

References:

The Mining Association of Canada. 2014. Toward Sustainable Mining: Energy and GHG Emissions Management Reference Guide. June. Available online at: https://mining.ca/wp-content/uploads/dlm_uploads/2021/06/EnergyandGreenhouseGasEmissionsManagementReferenceGuide2014.

USEPA. 1980. AP-42, Section 13.3, Explosives Detonation. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s03.pdf. February.

Abbreviations:

ANFO - ammonium nitrate fuel oil
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
HCN - hydrogen cyanide
lb - pounds
MT - metric tons
NO_x - nitrogen oxides
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive
SO_2 - sulfur dioxide
TNT - trinitrotoluene
tpy - tons per year
USEPA - United States Environmental Protection Agency
yr - year

Approved Operations: Table OA-24a
Toxic Air Contaminant and Hazardous Air Pollutant Emissions (On-Site Dust Emissions from Fugitive and Stationary Points)
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source		Material Transfer		Crushing	Screening	Stockpile Erosion	Haul Road Fugitive Dust	Off-Road Fugitive Dust	Disturbed Operational Area	Blast Hole Drilling	Blasting Fugitive Dust Entrainment	Total
Material Profile[1,2]		Ore	Overburden	Ore	Ore	Ore	Desert Dust	Ore/ Overburden	Ore/ Overburden	Ore/ Overburden	Ore/ Overburden	
Annual PM_{10} Emissions (lb/yr)		5,343	13,082	685	2,034	5,411	96,782	3,801	154	4,182	4,435	
Annual Emissions (lb/yr)	Aluminum	304	744	39	116	308	3,876	216	8.7	238	252	**6,102**
	Ammonium						4.0					**4.0**
	Antimony	0.092	0.23	0.012	0.035	0.093	1.2	0.065	0.0026	0.072	0.076	**1.8**
	Arsenic	0.27	0.66	0.034	0.10	0.27	5.5	0.19	0.0077	0.21	0.22	**7.5**
	Barium	1.0	2.5	0.13	0.39	1.0	58	0.72	0.029	0.79	0.84	**65**
	Beryllium	0.027	0.065	0.0034	0.010	0.027		0.019	7.7E-04	0.021	0.022	**0.20**
	Bromine						6.5					**6.5**
	Cadmium	9.1E-04	0.0022	1.2E-04	3.5E-04	9.2E-04	1.2	6.5E-04	2.6E-05	7.1E-04	7.5E-04	**1.2**
	Chromium (total)	0.49	1.2	0.063	0.19	0.50	12	0.35	0.014	0.38	0.41	**16**
	Cobalt						8.0					**8.0**
	Copper	0.075	0.18	0.0096	0.028	0.076	21	0.053	0.0022	0.059	0.062	**21**
	Lead	0.16	0.39	0.020	0.060	0.16	4.7	0.11	0.0045	0.12	0.13	**5.8**
	Manganese	1.1	2.7	0.14	0.43	1.1	74	0.80	0.032	0.88	0.93	**82**
	Mercury	0.0056	0.014	7.2E-04	0.0021	0.0057	1.6	0.0040	1.6E-04	0.0044	0.0047	**1.6**
	Nickel	0.025	0.060	0.0032	0.0094	0.025	3.5	0.017	7.1E-04	0.019	0.020	**3.7**
	Phosphorus	1.0	2.5	0.13	0.39	1.0	43	0.72	0.029	0.79	0.84	**51**
	Phosphorus pentoxide	2.7	6.5	0.34	1.0	2.7		1.9	0.077	2.1	2.2	**20**
	Selenium	0.0053	0.013	6.9E-04	0.0020	0.0054	0.19	0.0038	1.5E-04	0.0042	0.0044	**0.23**
	Silica	4,162	10,191	534	1,584	4,215		2,961	120	3,258	3,455	**30,479**
	Silver	0.010	0.025	0.0013	0.0039	0.010	0.70	0.0073	2.9E-04	0.0080	0.0085	**0.78**
	Thallium	0.0083	0.020	0.0011	0.0032	0.0084		0.0059	2.4E-04	0.0065	0.0069	**0.061**
	Vanadium	0.085	0.21	0.011	0.033	0.087	16	0.061	0.0025	0.067	0.071	**17**
	Zinc	0.45	1.1	0.058	0.17	0.45	18	0.32	0.013	0.35	0.37	**22**

Notes:

1. Ramboll applied the maximum of material hazardous air pollutant (HAP) and toxic air contaminant (TAC) profiles from two Castle Mountain samples to all Ore and Overburden fugitive material handling PM_{10} emissions. Emission factors for desert soils from MDAQMD. Silver content of sludge was provided by Castle Mountain Venture.
2. Material composition data, and subsequent emission estimates, are subject to future refined testing of ore and overburden materials.

Reference:

Mojave Desert Air Quality Management District (MDAQMD). 2005. *Default Emission Factors for Desert Soils.*

Abbreviations:

lb - pounds
HAP - hazardous air pollutant
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
TAC - toxic air contaminant
yr - year

Approved Operations: Table OA-24b
Toxic Air Contaminant and Hazardous Air Pollutant Emissions (On-Site Mobile Exhaust)
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source		PM_{10} Weight Fractions[1,3]		VOC Weight Fractions[2,4]		Mobile Diesel Equipment Exhaust		Mobile Gasoline Equipment Exhaust	Total
Material Profile		Mobile Source Diesel Combustion	Mobile Source Gasoline Combustion	Mobile Source Diesel Combustion	Mobile Source Gasoline Combustion	Onroad	Offroad	Onroad	
Annual PM_{10} Emissions[5] (lb/yr)						2.6	3,170	0.30	
Annual VOC Emissions[6] (lb/yr)						3.6	16,703	3.9	
Annual Emissions (lb/yr)	1,2,4-Trimethylbenzene			0.0053	0.013	0.019	89	0.049	**89**
	1,3-Butadiene			0.0019	0.0083	0.0068	32	0.032	**32**
	2,2,4-Trimethylpentane			0.0030	0.020	0.011	50	0.078	**50**
	Acetaldehyde			0.074	0.0075	0.26	1,228	0.029	**1,228**
	Acrolein				0.0018			0.0070	**0.0070**
	Aluminum	1.8E-04				4.6E-04	0.56		**0.56**
	Antimony	3.6E-05				9.3E-05	0.11		**0.11**
	Arsenic	5.0E-06				1.3E-05	0.016		**0.016**
	Benzene			0.020	0.034	0.072	334	0.13	**334**
	Bromine	1.8E-05	5.0E-04			4.7E-05	0.057	1.5E-04	**0.057**
	Cadmium	4.0E-05				1.0E-04	0.13		**0.13**
	Chlorine	3.4E-04	0.070			8.9E-04	1.1	0.021	**1.1**
	Chromium (total)	1.2E-05	5.0E-04			3.1E-05	0.038	1.5E-04	**0.038**
	Cobalt	1.1E-05	5.0E-04			2.9E-05	0.035	1.5E-04	**0.035**
	Copper	2.5E-05	5.0E-04			6.5E-05	0.079	1.5E-04	**0.079**
	Crotonaldehyde				0.0013			0.0051	**0.0051**
	Cumene			2.0E-04	5.0E-04	7.2E-04	3.3	0.0020	**3.3**
	Cyclohexane			3.0E-04	0.0045	0.0011	5.0	0.018	**5.0**
	Ethanol			1.0E-04	1.0E-04	3.6E-04	1.7	3.9E-04	**1.7**
	Ethyl Benzene			0.0031	0.015	0.011	52	0.059	**52**
	Ethylene			0.14	0.089	0.52	2,402	0.35	**2,403**
	Formaldehyde			0.15	0.031	0.53	2,457	0.12	**2,458**
	Hexane			0.0016	0.013	0.0058	27	0.051	**27**
	Isoprene				0.0014			0.0055	**0.0055**
	Lead	4.2E-05				1.1E-04	0.13		**0.13**
	Manganese	4.0E-05	5.0E-04			1.0E-04	0.13	1.5E-04	**0.13**
	Mercury	3.0E-05				7.8E-05	0.095		**0.095**
	Methanol			3.0E-04	0.0070	0.0011	5.0	0.027	**5.0**
	Methyl Ethyl Ketone			0.015	6.0E-04	0.053	247	0.0023	**247**
	Methyl Tert-Butyl Ether				0.019			0.073	**0.073**
	Naphthalene			9.0E-04	0.0013	0.0032	15	0.0051	**15**
	Nickel	1.9E-05	5.0E-04			4.9E-05	0.060	1.5E-04	**0.060**
	n-Pentane			0.0018	0.022	0.0065	30	0.085	**30**
	Phosphorus	1.3E-04				3.3E-04	0.40		**0.40**
	Propionaldehyde			0.0097	0.0013	0.035	162	0.0051	**162**
	Propylene			0.026	0.049	0.094	434	0.19	**435**
	Selenium	1.0E-05				2.6E-05	0.032		**0.032**
	Silver	2.8E-05				7.3E-05	0.089		**0.09**
	Styrene			6.0E-04	0.0013	0.0022	10	0.0051	**10.0**
	Toluene			0.015	0.068	0.053	246	0.26	**246**
	Vanadium	2.9E-05				7.5E-05	0.092		**0.092**
	m-Xylene			0.0061	0.045	0.022	102	0.17	**102**
	o-Xylene			0.0034	0.016	0.012	57	0.060	**57**
	p-Xylene			0.0010		0.0036	17		**17**
	Zinc	4.4E-04	5.0E-04			0.0011	1.4	1.5E-04	**1.4**

Notes:

1. Diesel combustion PM weight fractions are based on ARB particulate matter chemical profile 425 from ARB speciation profiles. Profile selection based on ARB reference numbers for PM profiles.
2. Gasoline combustion PM weight fractions are based on ARB particulate matter chemical profile 399 from ARB speciation profiles. Profile selection based on ARB reference numbers for PM profiles.
3. Diesel combustion VOC weight fractions are based on ARB organic chemical profile 818 from ARB speciation profiles. Profile selection based on ARB reference numbers for VOC profiles.
4. Gasoline combustion VOC weight fractions are based on ARB organic chemical profile 401 from ARB speciation profiles. Profile selection based on ARB reference numbers for VOC profiles.
5. PM_{10} emissions for each source category are based on emissions from Table OA-11 and Table OA-16b. PM_{10} emissions from onroad mobile sources represent exhaust emissions only and are split by diesel and gasoline fuel sources for purposes of applying corresponding chemical profiles.
6. VOC emissions for each source category are based on emissions from Table OA-11 and Table OA-16b. VOC emissions from onroad mobile sources are split by diesel and gasoline fuel sources for purposes of applying corresponding chemical profiles.

Reference:

California Air Resources Board (ARB). *Speciation Profiles Used in CARB Modeling.* Available at: https://ww2.arb.ca.gov/speciation-profiles-used-carb-modeling

California Air Resources Board (ARB). Particulate Matter chemical speciation profiles for source categories. Available at: https://ww2.arb.ca.gov/sites/default/files/2025-05/pmchemprofile29apr25.xlsx

California Air Resources Board (ARB). Particulate Matter reference number for particulate matter profiles. Available at: https://ww2.arb.ca.gov/sites/default/files/2025-05/pmprof_ref29apr25.xlsx

California Air Resources Board (ARB). VOC chemical speciation profiles for source categories. Available at: https://ww2.arb.ca.gov/sites/default/files/2024-10/orgprofile20sep24.xlsx

California Air Resources Board (ARB). VOC reference number for VOC profiles. Available at :https://ww2.arb.ca.gov/sites/default/files/2024-

Abbreviations:

ARB - California Air Resources Board
lb - pounds
HAP - hazardous air pollutant
PM - particulate matter
TAC - toxic air contaminant
yr - year

Approved Operations: Table OA-25
Diesel Generators
Criteria Air Pollutants and Greenhouse Gases
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Emergency Generators #1 through #4	Diesel Water Well Generators #1 and #2	Units
Quantity		4	2	--
Maximum Engine Rating		778	65.7	HP
		580	49	KW
Generator Power		455	36	kW
Fuel Type		Diesel	Diesel	--
Fuel Consumption		33.4	2.93	gallons/hr
Load		100%	100%	--
Maximum Daily Hours		1	24	hrs
Annual Hours		100	8,760	hrs
Emission Factors[1,2,3,4]	ROG/VOC	0.021	0.17	g/kW-hr
	NO_x	0.10	3.0	g/kW-hr
	SO_x	0.0055	0.0057	g/kW-hr
	CO	0.10	0.0094	g/kW-hr
	PM	0.010	0.019	g/kW-hr
	PM_{10}	0.010	0.019	g/kW-hr
	$PM_{2.5}$	0.010	0.019	g/kW-hr
	CO_2	73.96	73.96	kg/MMBtu
	CH_4	0.0030	0.0030	kg/MMBtu
	N_2O	6.0E-04	6.0E-04	kg/MMBtu
Maximum Daily Emissions[5]	ROG/VOC	0.11	0.89	lb/day
	NO_x	0.51	16	lb/day
	SO_x	0.028	0.030	lb/day
	CO	0.51	0.049	lb/day
	PM	0.051	0.097	lb/day
	PM_{10}	0.051	0.097	lb/day
	$PM_{2.5}$	0.051	0.097	lb/day
	CO_2	1.4	1.4	MT/day
	CH_4	5.5E-05	5.8E-05	MT/day
	N_2O	1.1E-05	1.2E-05	MT/day
	CO_2e	1.4	1.4	MT/day
Maximum Annual Emissions[5]	ROG/VOC	0.0055	0.16	tpy
	NO_x	0.026	2.9	tpy
	SO_x	0.0014	0.0054	tpy
	CO	0.026	0.0089	tpy
	PM	0.0026	0.018	tpy
	PM_{10}	0.0026	0.018	tpy
	$PM_{2.5}$	0.0026	0.018	tpy
	CO_2	136	524	MT/yr
	CH_4	0.0055	0.021	MT/yr
	N_2O	0.0011	0.0043	MT/yr
	CO_2e	137	526	MT/yr

Notes:

1. VOC, NO_x, CO and PM emission factors are from generator spec sheets. PM_{10} was conservatively assumed equal to PM emissions. The 778 HP diesel generators are CARB Family Name FCPXL18.1HTG and the 65.7 HP diesel generators are CARB Family Name FSZXL02.2PXB.

2. SO_x emission factors based on MDAQMD guidance and are equivalent to the diesel fuel sulfur content California regulatory standard of 15 ppm.
3. GHG emission factors are from 40 CFR Part 98, Subpart C Tables C-1 and C-2.
4. ROG and VOC assumed to be interchangeable terminologies.
5. CO_2 equivalent (CO_2e) emissions calculated based on CO_2, N_2O, and CH_4 emissions and the corresponding global warming potentials (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR). Diesel generators are expected to use renewable diesel fuel, consistent with other offroad equipment, but have conservatively been assumed to use conventional diesel in this inventory, and thus resulting CO_2 emissions are characterized as non-biogenic.

References:

Code of Federal Regulations. Title 40 Chapter I Subchapter C Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

MDAQMD. 2015. Default Emission Factors for Internal Combustion Engines. http://mdaqmd.ca.gov/home/showdocument?id=722

Abbreviations:

CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
g - gram
GHG - greenhouse gas
GWP - global warming potential
HP - horsepower
hr - hour
kg - kilogram
kW - kilowatt
lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
MMBtu - million British thermal units
MRR - Mandatory Reporting Rule
MT - metric ton
NO_x - nitrogen oxides
N_2O - nitrous oxide
PM - particulate matter
ROG - reactive organic gas
SO_x - sulfur oxides
tpy - tons per year
VOC - volatile organic compound
yr - year

Approved Operations: Table OA-26
Diesel Generators
Toxic Air Contaminants and Hazardous Air Pollutants
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Emergency Generators #1 through #4[1]	Diesel Water Well Generators #1 and #2[1]	Units
Quantity		4	2	--
Maximum Engine Rating		778	65.7	HP
		580	49	kW
Generator Power		455	36	kW
Fuel Type		Diesel	Diesel	--
Fuel Consumption		33.4	2.93	gal/hr
Load		100%	100%	--
Maximum Daily Hours		1	24	hrs
Annual Hours		100	8,760	hrs
Emission Factors	1,3-Butadiene	2.2E-04	2.2E-04	lb/gal
	Acenaphthene	2.0E-05	2.0E-05	lb/gal
	Acenaphthylene	1.5E-05	1.5E-05	lb/gal
	Acetaldehyde	7.8E-04	7.8E-04	lb/gal
	Acrolein	3.4E-05	3.4E-05	lb/gal
	Ammonia	0.0054		lb/gal
	Anthracene	6.7E-06	6.7E-06	lb/gal
	Arsenic	7.8E-06	7.8E-06	lb/gal
	Benzene	1.9E-04	1.9E-04	lb/gal
	Benzaldehyde	1.4E-05	1.4E-05	lb/gal
	Benzo(a)anthracene	8.5E-08	2.3E-07	lb/gal
	Benzo(a)pyrene	1.8E-08	1.3E-08	lb/gal
	Benzo(b)fluoranthene	1.5E-07	6.8E-09	lb/gal
	Benzo(g,h,i)perylene	6.7E-06	6.7E-06	lb/gal
	Benzo(k)fluoranthene	1.5E-08	1.1E-08	lb/gal
	Cadmium	1.5E-06	1.5E-06	lb/gal
	Chlorobenzene	2.0E-07	2.0E-07	lb/gal
	Chromium (hexavalent)	2.0E-07	2.0E-07	lb/gal
	Chromium (total)	3.2E-06	3.2E-06	lb/gal
	Chrysene	6.7E-06	6.7E-06	lb/gal
	Copper	4.1E-06	4.1E-06	lb/gal
	Dibenz(a,h)anthracene	2.4E-08	4.0E-08	lb/gal
	DPM[2]	3.8E-04	6.9E-04	lb/gal
	Ethyl benzene	1.1E-05	1.1E-05	lb/gal
	Fluoranthene	6.7E-06	6.7E-06	lb/gal
	Fluorene	4.3E-05	4.3E-05	lb/gal
	Formaldehyde	0.0017	0.0017	lb/gal
	Hexane	2.7E-05	2.7E-05	lb/gal
	Hydrogen chloride	1.9E-04	1.9E-04	lb/gal
	Indeno(1,2,3-cd)pyrene	2.8E-08	2.6E-08	lb/gal
	Lead	8.3E-06	8.3E-06	lb/gal
	Manganese	3.1E-06	3.1E-06	lb/gal
	Mercury	2.3E-06	2.3E-06	lb/gal
	Naphthalene	2.0E-05	2.0E-05	lb/gal
	Nickel	3.9E-06	3.9E-06	lb/gal
	PAH	5.6E-05	5.6E-05	lb/gal
	Phenanthrene	8.7E-05	8.7E-05	lb/gal
	Propylene	4.7E-04	4.7E-04	lb/gal
	Pyrene	1.5E-05	1.5E-05	lb/gal
	Selenium	9.8E-06	9.8E-06	lb/gal
	Toluene	1.1E-04	1.1E-04	lb/gal
	Xylenes	4.2E-05	4.2E-05	lb/gal
	Zinc	2.2E-05	2.2E-05	lb/gal

Parameter		Emergency Generators #1 through #4[1]	Diesel Water Well Generators #1 and #2[1]	Units
Maximum Annual Emissions	1,3-Butadiene	2.9	11	lb/yr
	Acenaphthene	0.27	1.0	lb/yr
	Acenaphthylene	0.20	0.75	lb/yr
	Acetaldehyde	10	40	lb/yr
	Acrolein	0.45	1.7	lb/yr
	Ammonia	72		lb/yr
	Anthracene	0.090	0.34	lb/yr
	Arsenic	0.10	0.40	lb/yr
	Benzene	2.5	9.6	lb/yr
	Benzaldehyde	0.18	0.69	lb/yr
	Benzo(a)anthracene	0.0011	0.012	lb/yr
	Benzo(a)pyrene	2.4E-04	6.6E-04	lb/yr
	Benzo(b)fluoranthene	0.0020	3.5E-04	lb/yr
	Benzo(g,h,i)perylene	0.090	0.34	lb/yr
	Benzo(k)fluoranthene	2.0E-04	5.4E-04	lb/yr
	Cadmium	0.020	0.077	lb/yr
	Chromium (hexavalent)	0.0027	0.010	lb/yr
	Chromium (total)	0.043	0.16	lb/yr
	Chrysene	0.090	0.34	lb/yr
	Copper	0.055	0.21	lb/yr
	Dibenz(a,h)anthracene	3.2E-04	0.0020	lb/yr
	DPM	5.1	36	lb/yr
	Ethyl benzene	0.15	0.56	lb/yr
	Fluoranthene	0.090	0.34	lb/yr
	Fluorene	0.58	2.2	lb/yr
	Formaldehyde	23	89	lb/yr
	Hexane	0.36	1.4	lb/yr
	Hydrogen chloride	2.5	9.6	lb/yr
	Indeno(1,2,3-cd)pyrene	3.8E-04	0.0013	lb/yr
	Lead	0.11	0.43	lb/yr
	Manganese	0.041	0.16	lb/yr
	Mercury	0.031	0.12	lb/yr
	Naphthalene	0.26	1.0	lb/yr
	Nickel	0.052	0.20	lb/yr
	PAH	0.75	2.9	lb/yr
	Phenanthrene	1.2	4.5	lb/yr
	Propylene	6.2	24	lb/yr
	Pyrene	0.20	0.75	lb/yr
	Selenium	0.13	0.50	lb/yr
	Toluene	1.4	5.4	lb/yr
	Xylenes	0.57	2.2	lb/yr
	Zinc	0.30	1.1	lb/yr

Notes:

1. TAC and HAP emission factors for Emergency Generators #1 through #4 are based on default MDAQMD guidance for diesel generators with SCR rated higher than 600 HP and the emission factors for Water Well Generators #1 and #2 are based on default MDAQMD guidance for uncontrolled diesel generators rated less than 600 HP. These emission factors are likely conservative since the diesel generators have Tier 4 engines which have VOC and PM controls that would similarly reduce organic and inorganic TAC emissions.
2. Diesel PM emissions are assumed to be equal to PM10 emissions, presented in Table OA-25.

References:

MDAQMD. 2015. Default Emission Factors for Internal Combustion Engines. http://mdaqmd.ca.gov/home/showdocument?id=722

Abbreviations:

DPM - diesel particulate matter
gal - gallon
HAP - hazardous air pollutant
HP - horsepower
hr - hour
kW - kilowatt
lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
SCR - selective catalytic reduction
TAC - toxic air contaminant
yr - year

Approved Operations: Table OA-27
Gasoline Dispensing Facility Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter	Daily Throughput (gal/day)	Annual Throughput (gal/yr)
Throughput[1]	132	48,000
Control[2]	Phase I and II	

Pollutant	Emission Factor[3] (lb/1000 gal)	Daily Emissions (lb/day)	Annual Emissions (tpy)
TOG	1.5	0.20	0.037
Benzene	0.0080	0.0011	1.9E-04
Ethyl benzene	0.0066	8.7E-04	1.6E-04
n-Hexane	0.028	0.0037	6.7E-04
Naphthalene	7.4E-04	9.7E-05	1.8E-05
Propylene (propene)	4.0E-05	5.3E-06	9.6E-07
Toluene	0.036	0.0047	8.6E-04
Xylene	0.032	0.0042	7.7E-04

Notes:

1. Annual gasoline throughput provided by Castle Mountain Venture and is a conservative overestimate compared to actual projected usage. Daily gasoline throughput is based on annual throughput and 365 days/yr of operation.
2. MDAQMD default pre-EVR emission factors for aboveground storage tank gasoline dispensing from CARB/CAPCOA guidance since the guidance does not include post-EVR emission factors.

References:

CARB/CAPCOA. 2022. Gasoline Service Industry Risk Assessment Technical Guidance. February 18. https://www.mdaqmd.ca.gov/home/showpublisheddocument/9310/637850250462300000

Abbreviations:

CARB - California Air Resources Board
CAPCOA - California Air Pollution Control Officers Association
gal - gallons
HAP - hazardous air pollutant
lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
TAC - toxic air contaminant
TOG - total organic gas
tpy- tons per year
yr - year

Approved Operations: Table OA-28
Storage Tank Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Quantity	Tank Volume[2] (gallons)	Annual Tank Throughput[2] (gal/yr)	Breathing Losses[3] (lb/yr)	Working Losses[3] (lb/yr)	Daily VOC Emissions (lb/day)	Annual VOC Emissions (tpy)
Off-road Diesel Storage Tanks	3	20,000	1,234,373	0.0054	20	0.17	0.030
Stationary Equipment Diesel Storage Tank	1	10,000	64,694	0.0031	3.5	0.0096	0.0017
GDF Clear Diesel Storage Tank	1	3,000	10,000	2.6E-04	0.34	9.4E-04	1.7E-04

Source Name	Quantity	Tank Volume[2] (gallons)	Annual Tank Throughput[2] (gal/yr)	Breathing Losses (lb/yr)	Working Losses (lb/yr)	Daily HCl Emissions (lb/day)	Annual HCl Emissions (tpy)
Hydrochloric Acid Storage Tank	1	4,993	202,778	155	209	1.0	0.18

Notes:

1. Emissions calculated according to the methodology presented in AP-42, Section 7.1.
2. Tank parameters and annual tank throughput based on guidance from Castle Mountain Venture.
3. Breathing and working losses presented here represent losses from a single tank in lb/yr, calculated based on the USEPA AP-42 methodology. These losses are converted to daily and annual emissions based on the equipment quantity. Thus, it is conservatively assumed (if there are multiple tanks) that each tank has the same throughput.
4. Meteorological data from AP-42, Table 7.1-7 for Las Vegas, NV is used.
5. Paint solar absorptance from AP-42, Table 7.1-6.

References:

USEPA. 2020. AP-42, Section 7.1, Organic Liquid Storage Tanks. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/ch07s01.pdf. June.

Abbreviations:

gal - gallons
HCl - hydrochloric acid
lb - pounds
tpy - tons per year
USEPA - United States Environmental Protection Agency
VOC - volatile organic compound
yr- year

Approved Operations: Table OA-29
GHG Emissions from Electricity Usage
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Historical Electricity Intensity

Provider	Annual Electricity Data	2021	2022	2023	Average[1]	Units
Nevada Energy	CO_2e Intensity Factor per Total Energy Delivered[2]	763	772	754	763	lb CO_2e/MWh delivered
	% of Total Energy From Nevada RPS-Eligible Renewables[3]	31%	36%	40%	35%	-
	CO_2e Intensity Factor per Total Non-RPS-Eligible Energy[4]	1,101	1,200	1,250	1,184	lb CO_2e/MWh delivered
Southern California Edison	CO_2e Intensity Factor per Total Energy Delivered[5]	452	444	374	423	lb CO_2e/MWh delivered
	% of Total Energy From California RPS-Eligible Renewables[5]	36%	36%	41%	38%	-
	CO_2e Intensity Factor per Total Non-RPS-Eligible Energy[4]	704	696	632	677	lb CO_2e/MWh delivered

Estimated Intensity Factor for Total Grid Energy Delivered

Provider	Model Year	2021	2022	2023	Average[1]	Units
Nevada Energy	2027 RPS (42%)[7]	638	696	725	687	lb CO_2e/MWh delivered
Southern California Edison	2027 RPS (52%)[8]	338	334	303	325	lb CO_2e/MWh delivered

Electricity Use Rates[9]

	Running Load (MW)	Annual (MWh/yr)
On-site Facilities - Nevada Energy (NVE)	3.3	28,516
Off-site Facilities (Water Sourcing) - Southern California Edison (SCE)	0.43	3,747
Total Emissions	**3.7**	**32,263**

Electricity Emissions[10]

	CO_2e Emissions (MT/yr)
On-site Facilities	8,880
Off-site Facilities (Water Sourcing)	552
Total Emissions	**9,433**

Notes:

1. Average uses data from years 2021-2023.
2. Total CO_2e intensity factors for Nevada Energy are from 2021-2023 NV Energy Sustainability Reports.

3. Percentage of energy from Nevada RPS-Eligible Renewables for Nevada Energy are from the Nevada Governor's Office of Energy's 2022 and 2024 Status of Energy Reports.
4. The emissions metric presented here is calculated based on the total CO_2e intensity factor divided by the percent of energy delivered from non-RPS-eligible renewable sources. This CO_2e intensity factor includes both fossil fuel and carbon-free sources of energy, such as largescale hydro and nuclear.
5. The intensity factor for total energy delivered is estimated by multiplying the percentage of energy delivered from non-RPS-eligible renewable energy by the CO_2e emissions per total non-RPS-eligible renewable energy metric calculated above.
6. Total CO_2e intensity factors and percentage of energy from RPS-Eligible Renewables for SCE are from the 2021-2023 Edison International Sustainability Reports.
7. Nevada Energy RPS value for 2027 based on scheduled renewable energy rate increases as outlined in https://puc.nv.gov/Renewable_Energy/Portfolio_Standard/.
8. Southern California Edison RPS value for 2027 based on requirement in Senate Bill 100 as outlined in https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/rps/rps-compliance-rules-and-process/60-percent-rps-procurement-rules.
9. Running loads provided by Castle Mountain Venture. An electricity load of 20 MW is anticipated on an annual/regular basis. On-site power generation will account for 10 MW of the on-site electricity load, with the remaining on-site load from grid power. Annual electricity use rates calculated assuming 8,760 hours per year of facility operation.
10. Emissions calculated based on intensity factor and electricity use rate.

References:

California Public Utilities Commission. 60% RPS Procurement Rules. Available online at: https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/rps/rps-compliance-rules-and-process/60-percent-rps-procurement-rules

Edison International. 2021 Sustainability Report. Available online at: https://www.edison.com/_gallery/get_file/?file_id=634a11c88ed7df0e03e0e410&file_ext=.pdf&page_id=

Edison International. 2022 Sustainability Report. Available online at: https://www.edison.com/_gallery/get_file/?file_id=6477e962b3aed34e0382ae64&file_ext=.pdf&page_id=

Edison International. 2023 Sustainability Report. Available online at: https://www.edison.com/_gallery/get_file/?file_id=6657b3b63d6332eaafbcc867&file_ext=.pdf&page_id=

NV Energy. 2021 NV Energy Sustainability Report. Available online at: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/cleanenergy/sustainability/2021-sustainability-nvenergy.pdf

NV Energy. 2022 NV Energy Sustainability Report. Available online at: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/cleanenergy/sustainability/2022-sustainability-nvenergy.pdf

NV Energy. 2023 NV Energy Sustainability Report. Available online at: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/cleanenergy/sustainability/2023-sustainability-nvenergy.pdf

Nevada Governor's Office of Energy. 2023. 2022 Status of Energy Report. January. Available online at: https://energy.nv.gov/uploadedFiles/energynvgov/content/Media/2022_status_of_energy_final.pdf.

Nevada Governor's Office of Energy. 2024. 2024 Status of Energy Report. January. Available online at: https://energy.nv.gov/uploadedFiles/energynvgov/content/Home/Features/2024%20Status%20of%20Energy%20Report_Final.pdf

State of Nevada Public Utilities Commission. Renewable Portfolio Standard. Available online at: https://puc.nv.gov/Renewable_Energy/Portfolio_Standard/

Abbreviations:

CO_2e - carbon dioxide equivalents
lb - pounds
MT - metric tons
MW - megawatts
MWh - megawatt hours
RPS - renewable portfolio standard
SCE - Southern California Edison
yr - year

Approved Operations: Table OA-30
GHG Emissions from Solid Waste Generation
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Solid Waste Generation Rate[1]

Waste Type	Solid Waste Generation Rate (lb/employee/day)	Number of Employees	Annual Solid Waste Generation (tpy)
Organic	8.93	120	196

Solid Waste Landfill Gas (LFG) Treatment Types[2]

Landfill, No Gas Capture	Landfill, Capture Gas Flare
100%	0%

Solid Waste Landfill Gas Emission Factors[3]

Description	CO_2 Emissions (ton/ton waste)	CH_4 Emissions (ton/ton waste)
No LFG Collection	0.097	0.032

Solid Waste GHG Emissions[4]

Waste Type	CO_2 Emissions (MT/yr)	CH_4 Emissions (MT/yr)	CO_2e Emissions (MT/yr)
Organic	17	5.6	157

Notes:

1. Waste generation rate based on industrial waste generation rate per employee from City of Los Angeles CEQA Thresholds Guide and number of employees at the facility.
2. Solid Waste Landfill Gas Treatment Types from Appendices C and G of the CalEEMod® User's Guide, with the exception that "Landfill, No Gas Capture" was conservatively set to 100%.
3. Solid Waste Landfill Gas Emission Factors from Table G-37 of CalEEMod® User's Guide, Appendix G.
4. CO_2 equivalent (CO_2e) emissions calculated based on CO_2 and CH_4 emissions and the corresponding global warming potentials (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

California Air Pollution Control Officers Association (CAPCOA). 2022. User's Guide of CalEEMod® Version 2022.1. May. Available online at: https://www.caleemod.com/user-guide

City of Los Angeles. 2006. L.A. CEQA Thresholds Guide: Your Resource for Preparing CEQA Analyses in Los Angeles. Available online at: https://planning.lacity.org/eir/CrossroadsHwd/deir/files/references/A07.pdf

Code of Federal Regulations. Title 40 Chapter I Subchapter C Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CalEEMod® - California Emissions Estimator Model
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
GWP - global warming potential
lb - pounds
LFG - Landfill Gas
MRR - Mandatory Reporting Regulation
MT - metric ton
tpy - tons per year
yr - year

Approved Operations: Table OA-31
GHG Emissions from Wastewater Treatment
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Water Use Rates[1]

End Use	Average Demand (gpm)	Annual Average Demand (MMgal/yr)
Ancillary Facilities/Offices	6.2	3.3

Wastewater Treatment Direct Emission Factors[2]

Wastewater Treatment Type	CO_2 Biogenic (ton/gal)	CO_2 Non-Biogenic (ton/gal)	CH_4 (ton/gal)	N_2O (ton/gal)
Septic	0	0	2.5E-07	8.52E-10

Wastewater Treatment Direct Emissions[3]

End Use	Total Direct Emissions (MT CO_2e/yr)
Ancillary Facilities/Offices	19

Notes:

1. Water use rates provided by Castle Mountain Venture. Annual water use rates calculated assuming continuous operation of water pumps (24/7). Emissions are only expected from the wastewater treatment of potable water. Potable water will be supplied from onsite wells and thus emissions associated with pumping and supplying water to ancillary facilities/offices are assumed to be captured in the well generator emissions.
2. Wastewater Treatment Direct Emission Factors from Table G-35 of Appendix G of the CalEEMod® User's Guide. All wastewater is assumed to be treated with an on-site septic system.
3. CO_2 equivalent (CO_2e) emissions calculated based on CO_2, N_2O, and CH_4 emissions and the corresponding global warming potentials (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

California Air Pollution Control Officers Association (CAPCOA). 2022. User's Guide of CalEEMod® Version 2022.1. April. Available online at: https://www.caleemod.com/user-guide

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CalEEMod® - California Emissions Estimator Model
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
gal - gallon
gpm - gallons per minute
GWP - global warming potential
MMgal - million gallons
MRR - Mandatory Reporting Regulation
MT - metric ton
N_2O - nitrous oxide
yr - year

Approved Operations: Table OA-32
On-site Power Generation Emissions from Diesel Generators
Criteria Air Pollutants and Greenhouse Gases
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Diesel Generators	Units
Fuel Type		Diesel	--
Total Power Generation		3.5	MW
Load Factor		100%	--
Daily hours		24	hrs
Annual Hours		8,760	hrs
Total Fuel Throughput		1,755,504	gallons/yr
Emission Factors[1,2,3]	ROG/VOC	0.021	g/kW-hr
	NO_x	0.10	g/kW-hr
	SO_x	0.0055	g/kW-hr
	CO	0.10	g/kW-hr
	PM	0.010	g/kW-hr
	PM_{10}	0.010	g/kW-hr
	$PM_{2.5}$	0.010	g/kW-hr
	CO_2	73.96	kg/MMBtu
	CH_4	0.0030	kg/MMBtu
	N_2O	6.0E-04	kg/MMBtu
Daily Emissions[5,6]	ROG/VOC	3.9	lb/day
	NO_x	18	lb/day
	SO_x	1.0	lb/day
	CO	18	lb/day
	PM	1.8	lb/day
	PM_{10}	1.8	lb/day
	$PM_{2.5}$ (total)	1.8	lb/day
	$PM_{2.5}$ (condensable)	0.25	lb/day
	$PM_{2.5}$ (non-condensable)	1.6	lb/day
	CO_2	49	MT/day
	CH_4	0.0020	MT/day
	N_2O	4.0E-04	MT/day
	CO_2e	49	MT/day
Maximum Annual Emissions[6,7]	ROG/VOC	0.72	tpy
	NO_x	3.4	tpy
	SO_x	0.18	tpy
	CO	3.4	tpy
	PM	0.34	tpy
	PM_{10}	0.34	tpy
	$PM_{2.5}$ (total)	0.34	tpy
	$PM_{2.5}$ (condensable)	0.046	tpy
	$PM_{2.5}$ (non-condensable)	0.29	tpy
	CO_2	17,918	MT/yr
	CH_4	0.73	MT/yr
	N_2O	0.15	MT/yr
	CO_2e	17,979	MT/yr

Notes:

1. VOC, NO_x, CO and PM emission factors are from generator spec sheets for 778 HP diesel generators (CARB Family Name FCPXL18.1HTG). PM_{10} and $PM_{2.5}$ were conservatively assumed equal to PM emissions.
2. SO_2 emission factors based on MDAQMD guidance as found online here: http://mdaqmd.ca.gov/home/showdocument?id=722, and are equivalent to the diesel fuel sulfur content California regulatory standard of 15 ppm.
3. ROG and VOC assumed to be interchangeable terminologies.
4. GHG emission factors are from 40 CFR Part 98, Subpart C Tables C-1 and C-2.
5. Daily emissions are based on 24 hours per day of operation at the specified load for each generator.
6. CO_2 equivalent (CO_2e) emissions calculated based on CO_2, N_2O, and CH_4 emissions and the corresponding GWP from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR). Diesel generators are expected to use renewable diesel fuel, consistent with other offroad equipment, but have conservatively been assumed to use conventional diesel in this inventory, and thus resulting CO_2 emissions are characterized as non-biogenic.
7. Annual emissions are based on 8,760 hours of operation per year at 100% load.

References:

Code of Federal Regulations. Title 40 Chapter I Subchapter C Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CAP - criteria air pollutant
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
g - gram
GHG - greenhouse gas
GWP - global warming potential
hr - hour
hp - horsepower
IPCC - Intergovernmental Panel on Climate Change
kg - kilogram
kW - kilowatt
lb - pounds
MDAQMD - Mojave Desert Air Quality Management I
MMBtu - million British thermal units
MRR - Mandatory Reporting Regulation
MT - metric ton
MW - megawatt
NO_x - nitrogen oxides
N_2O - nitrous oxide
PM - particulate matter
ROG - reactive organic gas
SO_x - sulfur oxides
tpy - tons per year
VOC - volatile organic compound
yr - year
MMBtu - million British thermal units

Approved Operations: Table OA-33
On-site Power Generation Emissions from Diesel Generators
Toxic Air Contaminants and Hazardous Air Pollutants
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Generators	Units
Fuel Type		Diesel	--
Total Power Generation		3.5	MW
Load Factor		100%	--
Maximum Daily Hours of Operation		24	hrs
Maximum Annual Hours of Operation		8,760	hrs
Total Fuel Throughput		1,755,504	gal/yr
Emission Factors	1,3-Butadiene	2.2E-04	lb/gal
	Acenaphthene	2.0E-05	lb/gal
	Acenaphthylene	1.5E-05	lb/gal
	Acetaldehyde	7.8E-04	lb/gal
	Acrolein	3.4E-05	lb/gal
	Ammonia	0.0054	lb/gal
	Anthracene	6.7E-06	lb/gal
	Arsenic	7.8E-06	lb/gal
	Benzene	1.9E-04	lb/gal
	Benzaldehyde	1.4E-05	lb/gal
	Benzo(a)anthracene	8.5E-08	lb/gal
	Benzo(a)pyrene	1.8E-08	lb/gal
	Benzo(b)fluoranthene	1.5E-07	lb/gal
	Benzo(g,h,i)perylene	6.7E-06	lb/gal
	Benzo(k)fluoranthene	1.5E-08	lb/gal
	Cadmium	1.5E-06	lb/gal
	Chlorobenzene	2.0E-07	lb/gal
	Chromium (hexavalent)	2.0E-07	lb/gal
	Chromium (total)	3.2E-06	lb/gal
	Chrysene	6.7E-06	lb/gal
	Copper	4.1E-06	lb/gal
	Dibenz(a,h)anthracene	2.4E-08	lb/gal
	DPM[2]	3.8E-04	lb/gal
	Ethyl benzene	1.1E-05	lb/gal
	Fluoranthene	6.7E-06	lb/gal
	Fluorene	4.3E-05	lb/gal
	Formaldehyde	0.0017	lb/gal
	Hexane	2.7E-05	lb/gal
	Hydrogen chloride	1.9E-04	lb/gal
	Indeno(1,2,3-cd)pyrene	2.8E-08	lb/gal
	Lead	8.3E-06	lb/gal
	Manganese	3.1E-06	lb/gal
	Mercury	2.3E-06	lb/gal
	Naphthalene	2.0E-05	lb/gal
	Nickel	3.9E-06	lb/gal
	PAH	5.6E-05	lb/gal
	Phenanthrene	8.7E-05	lb/gal
	Propylene	4.7E-04	lb/gal
	Pyrene	1.5E-05	lb/gal
	Selenium	9.8E-06	lb/gal
	Toluene	1.1E-04	lb/gal
	Xylenes	4.2E-05	lb/gal
	Zinc	2.2E-05	lb/gal

Annual Emissions	1,3-Butadiene	382	lb/yr
	Acenaphthene	36	lb/yr
	Acenaphthylene	26	lb/yr
	Acetaldehyde	1,375	lb/yr
	Acrolein	60	lb/yr
	Ammonia	9,462	lb/yr
	Anthracene	12	lb/yr
	Arsenic	14	lb/yr
	Benzene	327	lb/yr
	Benzaldehyde	24	lb/yr
	Benzo(a)anthracene	0.15	lb/yr
	Benzo(a)pyrene	0.031	lb/yr
	Benzo(b)fluoranthene	0.27	lb/yr
	Benzo(g,h,i)perylene	12	lb/yr
	Benzo(k)fluoranthene	0.026	lb/yr
	Cadmium	2.6	lb/yr
	Chlorobenzene	0.35	lb/yr
	Chromium (hexavalent)	0.35	lb/yr
	Chromium (total)	5.6	lb/yr
	Chrysene	12	lb/yr
	Copper	7.2	lb/yr
	Dibenz(a,h)anthracene	0.042	lb/yr
	DPM	672	lb/yr
	Ethyl benzene	19	lb/yr
	Fluoranthene	12	lb/yr
	Fluorene	76	lb/yr
	Formaldehyde	3,030	lb/yr
	Hexane	47	lb/yr
	Hydrogen chloride	327	lb/yr
	Indeno(1,2,3-cd)pyrene	0.050	lb/yr
	Lead	15	lb/yr
	Manganese	5.4	lb/yr
	Mercury	4.0	lb/yr
	Naphthalene	35	lb/yr
	Nickel	6.8	lb/yr
	PAH	98	lb/yr
	Phenanthrene	152	lb/yr
	Propylene	820	lb/yr
	Pyrene	26	lb/yr
	Selenium	17	lb/yr
	Toluene	185	lb/yr
	Xylenes	74	lb/yr
	Zinc	39	lb/yr

Notes:

1. TAC and HAP emission factors for the diesel generators are based on default MDAQMD guidance for diesel generators with SCR rated higher than 600 HP. These emission factors are likely conservative since the diesel generators have Tier 4 engines which have VOC and PM controls that would similary reduce organic and inorganic TAC emissions.
2. Diesel PM emissions are assumed to be equal to PM_{10} emissions, presented in Table OA-32.

References:

MDAQMD. 2015. Default Emission Factors for Internal Combustion Engines. http://mdaqmd.ca.gov/home/showdocument?id=722

Abbreviations:

DPM - diesel particulate matter
gal - gallon
HAP - hazardous air pollutant
hr - hour
lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
MW - megawatt
PM - particulate matter
SCR - selective catalytic reduction
TAC - toxic air contaminant
yr - year

CONSTRUCTION EMISSIONS INVENTORY, SUMMARY TABLES

Table C-1
Construction Emissions Summary
CAP Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Type	Sub-Type	Maximum Daily Emissions[1] (lb/day)						Year 1 Emissions[1,2] (tpy)						Year 2 Emissions[1,2] (tpy)					
		PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	VOC
Commuting/ Vendor Travel	Vehicles to Facility (single-axle vehicles)	125	13	3.8	0.13	20	0.74	15	1.6	0.50	0.017	2.6	0.10	7.5	0.78	0.25	0.0083	1.3	0.048
	Vehicles to Facility (double-axle vehicles)	16	1.7	2.5	0.023	0.18	0.028	1.9	0.20	0.32	0.0030	0.024	0.0037	0.93	0.10	0.16	0.0015	0.012	0.0018
	Vanpool to Facility	29	3.1	0.80	0.026	5.5	0.15	3.5	0.37	0.10	0.0033	0.71	0.019	1.7	0.18	0.052	0.0017	0.36	0.010
	Commuters to Vanpool	4.0	0.65	1.4	0.042	18	2.6	0.52	0.084	0.19	0.0054	2.3	0.34	0.26	0.042	0.093	0.0027	1.1	0.17
Construction Equipment	Dozers	68	24	87	0.15	79	4.9	8.9	3.1	11	0.020	10	0.64	4.4	1.6	5.7	0.010	5.2	0.32
	Loader	9.0	3.0	6.8	0.012	6.2	0.38	1.2	0.39	0.88	0.0015	0.80	0.049	0.59	0.20	0.44	7.6E-04	0.40	0.025
	Motor Grader	18	5.9	11	0.020	10	0.64	2.3	0.77	1.5	0.0025	1.3	0.083	1.2	0.38	0.74	0.0013	0.67	0.041
	Scraper	64	24	114	0.20	104	6.4	8.3	3.1	15	0.026	14	0.84	4.2	1.5	7.4	0.013	6.8	0.42
	Aerial Lifts	4.2	4.2	74	0.069	52	4.2	0.55	0.55	9.7	0.0090	6.7	0.55	0.27	0.27	4.8	0.0045	3.4	0.27
	Water Trucks	66	8.7	43	0.075	39	2.4	7.9	1.1	5.6	0.010	5.1	0.32	4.0	0.53	2.8	0.0048	2.6	0.16
	Maintenance Fuel/Lube	22	2.9	14	0.025	13	0.81	2.7	0.36	1.9	0.0032	1.7	0.11	1.3	0.18	0.94	0.0016	0.85	0.053
	Skid Steer	18	5.7	6.8	0.0063	4.7	0.38	2.3	0.74	0.88	8.2E-04	0.61	0.050	1.2	0.37	0.44	4.1E-04	0.31	0.025
	Cranes	1.1	1.1	20	0.035	18	1.1	0.14	0.14	2.6	0.0045	2.4	0.15	0.069	0.069	1.3	0.0023	1.2	0.074
	Telehandler	0.89	0.89	9.9	0.015	11	0.56	0.12	0.12	1.3	0.0019	1.4	0.072	0.058	0.058	0.64	0.0010	0.71	0.036
Disturbed Areas	Construction Disturbed Areas	1.8	0.72	--	--	--	--	0.33	0.13	--	--	--	--	0.16	0.065	--	--	--	--
	Totals	**447**	**99**	**396**	**0.82**	**382**	**25**	**56**	**13**	**52**	**0.11**	**50**	**3.3**	**28**	**6.3**	**26**	**0.053**	**25**	**1.7**

Notes:

1. Details of the construction CAP emission calculations are presented in Table C-3 through Table C-5, Table C-7 through Table C-11, and Table C-13 through Table C-15.
2. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027).

Abbreviations:

CAP - criteria air pollutant
CO - carbon monoxide
lb - pound
NO_x - nitrogen oxides
PM - particulate matter
SO_x - sulfur oxides
tpy - ton per year
VOC - volatile organic compounds

Table C-2
Construction Emissions Summary
GHG Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Type	Sub-Type	Year 1 GHG Emissions[1,2] (MT/yr)					Year 2 GHG Emissions[1,2] (MT/yr)				
		CO_2	CH_4	N_2O	Biogenic CO_2e	Non-biogenic CO_2e	CO_2	CH_4	N_2O	Biogenic CO_2e	Non-biogenic CO_2e
Commuting/ Vendor Travel	Vehicles to Facility (single-axle vehicles)	1,556	0.011	0.14		1,598	778	0.0054	0.070		799
	Vehicles to Facility (double-axle vehicles)	287	1.5E-04	0.045		300	143	7.7E-05	0.023		150
	Vanpool to Facility	307	0.0028	0.0054		308	153	0.0014	0.0027		154
	Commuters to Vanpool	497	0.024	0.018		503	249	0.012	0.0088		252
Construction Equipment	Dozers	1,876	0.17	0.16	1,876	52	938	0.086	0.080	938	26
	Loader	146	0.013	0.012	146	4.0	73	0.0067	0.0062	73	2.0
	Motor Grader	244	0.022	0.021	244	6.8	122	0.011	0.010	122	3.4
	Scraper	2,462	0.23	0.21	2,462	68	1,231	0.11	0.10	1,231	34
	Aerial Lifts	861	0.079	0.073	861	24	430	0.040	0.037	430	11.9
	Water Trucks	930	0.086	0.079	930	26	465	0.043	0.040	465	13
	Maintenance Fuel/Lube	311	0.029	0.026	311	8.6	155	0.014	0.013	155	4.3
	Skid Steer	78	0.0072	0.0067	78	2.2	39	0.0036	0.0033	39	1.1
	Cranes	436	0.040	0.037	436	12	218	0.020	0.019	218	6.0
	Telehandler	182	0.017	0.016	182	5.1	91	0.0084	0.0078	91	2.5
Totals		**10,172**	**0.73**	**0.85**	**7,526**	**2,918**	**5,086**	**0.37**	**0.42**	**3,763**	**1,459**

Notes:

1. Details of the construction GHG emission calculations are presented in Table C-6 and Table C-12.
2. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027).

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
GHG - greenhouse gas
MT - metric ton
N_2O - nitrous oxide
yr - year

CONSTRUCTION EMISSIONS INVENTORY, DETAILED TABLES

Table C-3
Fugitive Dust Emissions from Bulldozing, Scraping and Grading Activity
Offroad Construction Equipment
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Equipment Type[1]	Equipment Details	Quantity[2]	Operating Days per Year[2,3]		Operating Hours per Day[2]	Operating Hours per Year[3]		Control Efficiency[4] (%)	Emission Factors[5,6] (lb/hr)		Daily Emissions (lb/day)		Year 1 Emissions[3] (tpy)		Year 2 Emissions[3] (tpy)	
			Year 1	Year 2		Year 1	Year 2		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Dozers	D6	4	260	130	8	8,320	4,160	83%	0.72	0.22	23	7.1	3.0	0.92	1.5	0.46
	D9	5	260	130	8	10,400	5,200	83%	0.72	0.22	29	8.8	3.8	1.1	1.9	0.57
	D10	2	260	130	8	4,160	2,080	83%	0.72	0.22	12	3.5	1.5	0.46	0.75	0.23
Loader	Cat 950	3	260	130	4	3,120	1,560	83%	0.72	0.22	8.7	2.7	1.1	0.34	0.56	0.17
Motor-Grader	Cat 140M	3	260	130	8	6,240	3,120	83%	0.72	0.22	17	5.3	2.3	0.69	1.1	0.34
Scraper	Cat 657	10	260	130	8	20,800	10,400	83%	0.72	0.22	58	18	7.5	2.3	3.8	1.1
Other	Skid Steer	4	260	130	6	6,240	3,120	83%	0.72	0.22	17	5.3	2.3	0.69	1.1	0.34
										Total	**165**	**50**	**21**	**6.6**	**11**	**3.3**

Notes:

1. Fugitive Dust from Single-axle Equipment, Double-axle Equipment, and Vanpools are calculated on a per VMT basis as shown in Table C-4.
2. Equipment quantity, operating hours per day, and operating days per year provided by Castle Mountain Venture.
3. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027).
4. Control efficiency calculated based on MDAQMD guidance for Dust Entrainment from Unpaved Roads as presented in Table C-4.
5. Bulldozing, Scraping, and Grading Emission Factors are derived from the Mojave Desert Air Quality Management District's Emissions Inventory Guidance for Mineral Handling and Processing Industries, using the "Most Complex" method.
6. A roadway moisture content of 2% and a surface silt content of 5% were used, consistent with data provided by Castle Mountain Venture.

Abbreviations:

TSP - total suspended particles
VMT - vehicle miles traveled
PM - particulate matter
lb- pounds
hr - hour

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance Mineral Handling and Processing Industries. Available online at: https://www.mdaqmd.ca.gov/home/showdocument?id=768

Table C-4
Fugitive Dust Emissions from Offroad Trucks
Unpaved Roads
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Equipment Type[1]	Equipment Details	Quantity[1]	Average Vehicle Weight[2] (tons)	Emission Factors[3,4] (lb/VMT)		Operating Days per Year[1,5]		Daily Maximum Hours[1]	Daily Total Miles Traveled[6] (VMT/day)	Annual Total Miles Traveled[6] (VMT/yr)		Control Efficiency[7] (%)	Number of Days with >0.01 Inches Precipitation[8] (days/yr)	Maximum Daily Emissions (lb/day)		Year 1 Emissions[5] (tpy)		Year 2 Emissions[5] (tpy)	
				PM_{10}	$PM_{2.5}$	Year 1	Year 2			Year 1	Year 2			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Water Truck	Cat 740 WW (8k)	3	38	2.1	0.21	260	130	8	360	93,600	46,800	95%	31	38	3.8	4.6	0.46	2.3	0.23
	2500 Gallon Trucks	2	38	2.1	0.21	260	130	8	240	62,400	31,200	95%	31	26	2.6	3.1	0.31	1.5	0.15
Maintenance Fuel/Lube	--	5	30	1.9	0.19	260	130	3	225	58,500	29,250	95%	31	22	2.2	2.6	0.26	1.3	0.13
													Total	**86**	**8.6**	**10**	**1.0**	**5.1**	**0.51**

Notes:

1. Equipment quantity, operating hours per day, and operating days per year provided by Castle Mountain Venture.
2. Vehicle weights estimated based off of typical equipment for the types of equipment listed.
3. A roadway surface silt content of 5% was used, consistent with data provided by Castle Mountain Venture.
4. Fugitive dust emission factors calculated following MDAQMD's "most complex" Unpaved Roads methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 correlations for industrial roads (Equation 1a, Table 13.2.2-2, AP-42 Section 13.2.2) at the time of inventory preparation.
5. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027).
6. VMT calculated based on hours of operation and number of pieces of equipment assuming an average speed of 15 mph.
7. A control efficiency of 95% was used consistent with assumptions for watering, graveling surface, treatment with chemical stabilizers, and speed control from the 1997 Castle Mountain Mine Expansion Project EIS/EIR, and the understanding that chemical suppressants will be applied to all unpaved roadways.
8. Consistent with the AP-42 Section 13.2.2 unpaved roads methodology for industrial sites, Ramboll applied a precipitation reduction based on the number of days with greater than 0.01 inches precipitation per year based on site-specific meteorological measurements between January 2021 and December 2021.

Abbreviations:

lb- pounds
PM - particulate matter
tpy - tons per year
VMT - vehicle miles traveled
yr - year

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance Mineral Handling and Processing Industries. Available online at: https://www.mdaqmd.ca.gov/home/showdocument?id=768
USEPA. 2006. AP-42, Section 13.2.2, Unpaved Roads. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0202.pdf. November.

Table C-5
Offroad Equipment
Exhaust CAP Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Equipment Type	Equipment Details	Quantity[1]	Engine Tier Level[2]	Engine[3] (hp)	Equipment Load Factor[4]	Fuel Type	Operating Days per Year[1,5]		Operating Hours per Day[1]	Emission Factors[6] (g/hp-hr)						Daily Emissions (lb/day)						Year 1 Emissions[5] (tpy)						Year 2 Emissions[5] (tpy)					
							Year 1	Year 2		NO_x	SO_x	CO	ROG	PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$
Dozers	D6	4	Tier 3	215	0.40	Renewable Diesel	260	130	8	2.9	0.0049	2.6	0.16	0.15	0.15	17	0.030	16	0.97	0.91	0.91	2.2	0.0039	2.1	0.13	0.12	0.12	1.1	0.0019	1.0	0.063	0.059	0.059
	D9	5	Tier 3	452	0.40	Renewable Diesel	260	130	8	2.9	0.0049	2.6	0.16	0.15	0.15	45	0.079	41	2.6	2.4	2.4	5.9	0.010	5.4	0.33	0.31	0.31	3.0	0.0051	2.7	0.17	0.16	0.16
	D10	2	Tier 3	602	0.40	Renewable Diesel	260	130	8	2.9	0.0049	2.6	0.16	0.15	0.15	24	0.042	22	1.4	1.3	1.3	3.1	0.0054	2.9	0.18	0.17	0.17	1.6	0.0027	1.4	0.089	0.083	0.083
Loader	Cat 950	3	Tier 3	249	0.36	Renewable Diesel	260	130	4	2.9	0.0049	2.6	0.16	0.15	0.15	6.8	0.012	6.2	0.38	0.36	0.36	0.88	0.0015	0.80	0.049	0.046	0.046	0.44	7.6E-04	0.40	0.025	0.023	0.023
Motor-Grader	Cat 140M	3	Tier 3	183	0.41	Renewable Diesel	260	130	8	2.9	0.0049	2.6	0.16	0.15	0.15	11	0.020	10	0.64	0.60	0.60	1.5	0.0025	1.3	0.083	0.077	0.077	0.74	0.0013	0.67	0.041	0.039	0.039
Scraper	Cat 657	10	Tier 3	473	0.48	Renewable Diesel	260	130	8	2.9	0.0049	2.6	0.16	0.15	0.15	114	0.20	104	6.4	6.0	6.0	15	0.026	14	0.84	0.78	0.78	7.4	0.013	6.8	0.42	0.39	0.39
Aerial Lifts	Boom Lifts	15	Tier 2	63	0.42	Renewable Diesel	260	130	8	5.3	0.0049	3.7	0.30	0.30	0.30	37	0.035	26	2.1	2.1	2.1	4.8	0.0045	3.4	0.27	0.27	0.27	2.4	0.0022	1.7	0.14	0.14	0.14
	Scissor Lifts	15	Tier 2	63	0.42	Renewable Diesel	260	130	8	5.3	0.0049	3.7	0.30	0.30	0.30	37	0.035	26	2.1	2.1	2.1	4.8	0.0045	3.4	0.27	0.27	0.27	2.4	0.0022	1.7	0.14	0.14	0.14
Water Truck	Cat 740 WW (8k)	3	Tier 3	484	0.38	Renewable Diesel	260	130	8	2.9	0.0049	2.6	0.16	0.15	0.15	28	0.048	25	1.6	1.5	1.5	3.6	0.0062	3.3	0.20	0.19	0.19	1.8	0.0031	1.6	0.10	0.095	0.095
	2500 Gallon Trucks	2	Tier 3	402	0.38	Renewable Diesel	260	130	8	2.9	0.0049	2.6	0.16	0.15	0.15	15	0.027	14	0.86	0.81	0.81	2.0	0.0035	1.8	0.11	0.11	0.11	1.0	0.0017	0.91	0.056	0.053	0.053
Maintenance Fuel/Lube	--	5	Tier 3	402	0.38	Renewable Diesel	260	130	3	2.9	0.0049	2.6	0.16	0.15	0.15	14	0.025	13	0.81	0.76	0.76	1.9	0.0032	1.7	0.11	0.10	0.10	0.94	0.0016	0.85	0.053	0.049	0.049
Other	Skid Steer	4	Tier 2	65	0.37	Renewable Diesel	260	130	6	5.3	0.0049	3.7	0.30	0.30	0.30	6.8	0.0063	4.7	0.38	0.38	0.38	0.88	8.2E-04	0.61	0.050	0.050	0.050	0.44	4.1E-04	0.31	0.025	0.025	0.025
	Cranes	6	Tier 3	231	0.29	Renewable Diesel	260	130	8	2.9	0.0049	2.6	0.16	0.15	0.15	20	0.035	18	1.1	1.1	1.1	2.6	0.0045	2.4	0.15	0.14	0.14	1.3	0.0023	1.2	0.074	0.069	0.069
	Telehandler	6	Tier 3	89	0.42	Renewable Diesel	260	130	6	3.3	0.0049	3.7	0.19	0.30	0.30	9.9	0.015	11	0.56	0.89	0.89	1.3	0.0019	1.4	0.072	0.12	0.12	0.64	0.0010	0.71	0.036	0.058	0.058
															Total	**388**	**0.60**	**338**	**22**	**21**	**21**	**50**	**0.078**	**44**	**2.8**	**2.7**	**2.7**	**25**	**0.039**	**22**	**1.4**	**1.4**	**1.4**

Notes:

1. Equipment quantity, operating hours per day, and operating days per year provided by Castle Mountain Venture.
2. All off-road equipment used during construction was conservatively assumed to be Tier 3. Tier 2 standards were conservatively assumed for equipment less than 75 hp because Tier 3 standards do not exist for equipment under 75 hp.
3. Equipment specific horsepower ratings were utilized where equipment model numbers were provided by Castle Mountain Venture. In the absence of equipment model numbers, engine horsepower rating were estimated based on default values in Appendix D of the CalEEMod® User's Guide (CAPCOA 2022).
4. Load factors for off-road equipment were selected from default values from OFFROAD2017 as provided in Appendix G of the CalEEMod® User's Guide (CAPCOA 2022).
5. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027).
6. PM, CO, NO_x, and VOC engine emission factors based on ARB Tier 3 diesel engine standards. Emission factors for ROG and NO_x were converted from NMHC values provided in the Tier standards using EPA hydrocarbon conversion factors. When applicable, the NMHC/NO_x combined Tier standard was split into NMHC and NO_x per BAAQMD guidance (assumed 5% NMHC, 95% NO_x). Emission factors for SO_x from diesel fuel are calculated from the California standard for diesel fuel of 15 ppm (http://www.arb.ca.gov/fuels/diesel/081404dslregs.pdf). Emission factor calculations assume a diesel fuel density of 7.1 lb/gal, heating value of 19,300 BTU/lb, BSFC of 7,000 BTU/hp-hr (USEPA 1996), and that all sulfur is converted to SO_2.

Abbreviations:

CO - carbon monoxide
g - gram
hp - horsepower
hr - hour
lb - pound
NMHC - non-methane hydrocarbons
NO_x - nitrogen oxides
PM - particulate matter
ROG - reactive organic gases
SO_x - sulfur oxides
tpy - ton per year
VOC - volatile organic compounds
yr - year

References:

Bay Area Air Quality Management District (BAAQMD). 2004. CARB Emission Factors for CI Diesel Engines - Percent HC in Relation to NMHC + NOx.

California Air Pollution Control Officers Association (CAPCOA). 2022. User's Guide of CalEEMod® Version 2022.1. April. Available online at: https://www.caleemod.com/user-guide

California Air Resources Board (CARB). CARB and United States Environmental Protection Agency (USEPA) Off-Road Compression-Ignition (Diesel) Engine Standards. Available online at: https://ww2.arb.ca.gov/sites/default/files/2020-03/Tier_Color_Chart_Off_Road_Diesel_Stds_R.pdf

CARB. Off-Road Diesel New Engine Emissions Standards. Available online at: https://ww3.arb.ca.gov/msei/ordiesel/ordieselstandards.xlsx

CARB. In-Use Off-Road Diesel-Fueled Fleets regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/off-roaddiesel/appa-1.pdf

CARB. 2022. Renewable Diesel Joint Statement. Available online at: https://ww2.arb.ca.gov/our-work/programs/alternative-diesel-fuels/biodiesel-renewable-diesel

CARB. 2017. 2017 Off-road Diesel Emission Factors. Available online at: https://ww2.arb.ca.gov/sites/default/files/2022-05/Off-road_CI_engine_standards_chart_04212022.pdf.

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

USEPA. 2010. Conversion Factors for Hydrocarbon Emission Components, NR-002d. EPA-420-R-10-015. July. Available online at:

USEPA. 1996. AP-42 Chapter 3.4 Large Stationary Diesel And Stationary Dual-fuel Engines. Available at: https://www.epa.gov/sites/default/files/2020-10/documents/c03s04.pdf

Table C-6
Offroad Equipment
Exhaust GHG Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Equipment Type	Equipment Details	Quantity[1]	Engine[2] (hp)	Load Factor[3]	Fuel Type	Operating Hours per Year[1,4]		Annual Fuel Usage[5] (gal/yr)		Emission Factors[6] (kg/gal)			Year 1 Emissions[4] (MT/yr)					Year 2 Emissions[4] (MT/yr)				
						Year 1	Year 2	Year 1	Year 2	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Biogenic CO_2e[7,8]	Non-biogenic CO_2e[7,8]	CO_2	CH_4	N_2O	Biogenic CO_2e[7,8]	Non-biogenic CO_2e[7,8]
Dozers	D6	4	215	0.40	Renewable Diesel	2,080	1,040	36,551	18,276	10.21	9.4E-04	8.7E-04	373	0.034	0.032	373	10	187	0.017	0.016	187	5.2
	D9	5	452	0.40	Renewable Diesel	2,080	1,040	96,054	48,027	10.21	9.4E-04	8.7E-04	980	0.090	0.084	980	27	490	0.045	0.042	490	14
	D10	2	602	0.40	Renewable Diesel	2,080	1,040	51,172	25,586	10.21	9.4E-04	8.7E-04	522	0.048	0.045	522	14	261	0.024	0.022	261	7.2
Loader	Cat 950	3	249	0.36	Renewable Diesel	1,040	520	14,287	7,143	10.21	9.4E-04	8.7E-04	146	0.013	0.012	146	4.0	73	0.0067	0.0062	73	2.0
Motor-Grader	Cat 140M	3	183	0.41	Renewable Diesel	2,080	1,040	23,917	11,958	10.21	9.4E-04	8.7E-04	244	0.022	0.021	244	6.8	122	0.011	0.010	122	3.4
Scraper	Cat 657	10	473	0.48	Renewable Diesel	2,080	1,040	241,239	120,620	10.21	9.4E-04	8.7E-04	2,462	0.23	0.21	2,462	68	1,231	0.11	0.10	1,231	34
Aerial Lifts	Boom Lifts	15	63	0.42	Renewable Diesel	2,080	1,040	42,172	21,086	10.21	9.4E-04	8.7E-04	430	0.040	0.037	430	12	215	0.020	0.018	215	6.0
	Scissor Lifts	15	63	0.42	Renewable Diesel	2,080	1,040	42,172	21,086	10.21	9.4E-04	8.7E-04	430	0.040	0.037	430	12	215	0.020	0.018	215	6.0
Water Truck	Cat 740 WW (8k)	3	484	0.38	Renewable Diesel	2,080	1,040	58,627	29,313	10.21	9.4E-04	8.7E-04	598	0.055	0.051	598	17	299	0.028	0.026	299	8.3
	2500 Gallon Trucks	2	402	0.38	Renewable Diesel	2,080	1,040	32,463	16,231	10.21	9.4E-04	8.7E-04	331	0.031	0.028	331	9.2	166	0.015	0.014	166	4.6
Maintenance Fuel/Lube	--	5	402	0.38	Renewable Diesel	780	390	30,434	15,217	10.21	9.4E-04	8.7E-04	311	0.029	0.026	311	8.6	155	0.014	0.013	155	4.3
Other	Skid Steer	4	65	0.37	Renewable Diesel	1,560	780	7,666	3,833	10.21	9.4E-04	8.7E-04	78	0.007	0.0067	78	2.2	39	0.0036	0.0033	39	1.1
	Cranes	6	231	0.29	Renewable Diesel	2,080	1,040	42,708	21,354	10.21	9.4E-04	8.7E-04	436	0.040	0.037	436	12	218	0.020	0.019	218	6.0
	Telehandler	6	89	0.42	Renewable Diesel	1,560	780	17,873	8,937	10.21	9.4E-04	8.7E-04	182	0.017	0.016	182	5.1	91	0.008	0.0078	91	2.5
												Total	**7,526**	**0.69**	**0.64**	**7,526**	**208**	**3,763**	**0.35**	**0.32**	**3,763**	**104**

Notes:

1. Equipment quantity and operating hours per year provided by Castle Mountain Venture.
2. Engine horsepower estimated based off of typical equipment for the types of equipment listed.
3. Load factors for off-road equipment were selected from default values from OFFROAD2017 as provided in Appendix G of the CalEEMod® User's Guide (CAPCOA 2022).
4. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027).
5. Fuel usage is calculated by taking the horsepower-hours for each piece of equipment (calculated as horsepower * usage hours * load factor) and multiplying it by the gallons of diesel consumption per horsepower-hour consistent with USEPA AP-42 diesel fuel data in Table 3.4.1, which cites an average brake-specific fuel consumption (BSFC) of 7,000 BTU/hp-hr, a heating value of 19,300 BTU/lb, and density of 7.1 lb/gal. Consistent with ARB guidelines, renewable diesel is treated the same as conventional diesel (CARB 2022).
6. CO_2 emission factor is from 40 CFR Part 98, Subpart C, Table C-1. CH_4 and N_2O emission factors are from the EPA Center for Corporate Climate Leadership (2022, April 1) Emission Factors for Greenhouse Gas Inventories, Table 5 (available at https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf) which are calculated from the USEPA Inventory of U.S. Greenhouse Gas Emission and Sinks: 1990-2019.
7. CO_2 emissions are assumed to be 100% biogenic based on the assumption of the use of 100% renewable diesel fuel in off-road equipment, consistent with regulatory requirements under the CARB In-Use Off-Road Diesel-Fueled Fleets Regulatior and CMV commitments.
8. CO_2 equivalent emissions calculated based on CO_2, N_2O, and CH_4 emissions and the corresponding GWP from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
gal - gallon
GHG - greenhouse gas
GWP - global warming potential
hp - horsepower
kg - kilogram
MRR - Mandatory Reporting Regulation
MT - metric ton
N_2O - nitrous oxide
yr - year

References:

California Air Pollution Control Officers Association (CAPCOA). 2022. User's Guide of CalEEMod® Version 2022.1. April. Available online at: https://www.caleemod.com/user-guide
California Air Resources Board (CARB). 2022. In-Use Off-Road Diesel-Fueled Fleets regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/off-roaddiesel/appa-1.pdf
CARB. 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf
CARB. 2022. Renewable Diesel Joint Statement. Available online at: https://ww2.arb.ca.gov/our-work/programs/alternative-diesel-fuels/biodiesel-renewable-diesel
Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1
United States Environmental Protection Agency (USEPA). 2021. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019. Available at: https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-annexes.pdf
USEPA. 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and
USEPA. 1996. AP-42 Chapter 3.4 Large Stationary Diesel And Stationary Dual-fuel Engines. Available at: https://www.epa.gov/sites/default/files/2020-10/documents/c03s04.pdf

Table C-7
Watering Assumptions for Disturbed Construction Areas
Construction Vehicles
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter[1]	Value	Units	Data Source
Average Hourly Traffic Rate	21	vehicles/hr	It is assumed that only 25% of total operating equipment would operate over the same area in a given hour. Given the total operating equipment amounts to 83 vehicles, it is expected that 21 vehicles will operate per hour.
Time Between Water Applications	1	hours	Per Castle Mountain Venture, watering occurs approximately once per hour.
Average Annual Class A Pan Evaporation	75	inches	MDAQMD Mineral Guidance, conservative default, Pg. 26
Water Application Intensity	0.11	gallons/yd^2	MDAQMD Mineral Guidance, conservative default, Pg. 26
Control Efficiency	83	%	MDAQMD Mineral Guidance, Pg. 26

Notes:

1. Watering control efficiencies calculated consistent with MDAQMD guidance for Dust Entrainment from Unpaved Roads.

Abbreviations:

hr - hour
yd^2 - square yard

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance Mineral Handling and Processing Industries. Available online at: https://www.mdaqmd.ca.gov/home/showdocument?id=768

Table C-8
Construction Mobile Vehicle Fleet Mix
On-road Vehicles
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Mix Assumption[1]	Vehicle Type	Percentage of Fleet Mix[2]		% by Fuel Type[2] Year 1[3]					% by Fuel Type[2] Year 2[3]				
		2026	2027	Gas	Diesel	Natural Gas	Electric	Plug-in Hybrid	Gas	Diesel	Natural Gas	Electric	Plug-in Hybrid
Commuters to Vanpool	LDA	55.3%	55.2%	90%	0.20%	0%	6.3%	3.3%	89%	0.18%	0%	6.9%	3.4%
	LDT1	4.0%	3.9%	99%	0.017%	0%	0.40%	0.34%	99%	0.0083%	0%	0.52%	0.45%
	LDT2	23.7%	24.0%	98%	0.34%	0%	0.82%	1.2%	97%	0.35%	0%	0.96%	1.4%
	MCY	0.4%	0.4%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
	MDV	16.7%	16.6%	96%	1.6%	0%	1.3%	1.1%	96%	1.5%	0%	1.5%	1.2%
Vehicles to Facility (single-axle vehicles)	MDV	100%	100%	50%	50%	0%	0%	0%	50%	50%	0%	0%	0%
Vehicles to Facility (double-axle vehicles)	HHDT	100%	100%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%
Vanpool to Facility	LHDT1	78.5%	78.4%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
	LHDT2	21.5%	21.6%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%

Notes:

1. The following types of trips are expected to occur during construction: commuters to vanpool pick-up, vanpooling trips (vanpool to Facility), and single and double axle vehicle trips in support of construction work.
2. Fleet mixes and percentages by fuel type are calculated based on EMFAC2021 v1.0.1 vehicle miles traveled projections for MDAQMD. EMFAC2021 v1.0.1 was run in Emission Rates mode for calendar years 2026 and 2027 in the annual season.
3. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027).

Abbreviations:

EMFAC2021 - California Air Resources Board EMission FACtor model

References:

California Air Resources Board (ARB) 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory

Table C-9
On-road Mobile Vehicles
Exhaust Emission Factors
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Scenario		Emission Factor Units	Mobile Emission Factors[2,3]									
			CAPs						GHGs			
Year[1]	Fleet		ROG	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x	CO_2	CH_4	N_2O	CO_2e[4]
Year 1	Commuters to Vanpool	g/mile	0.015	0.062	0.015	0.0051	0.81	0.0030	306	0.0033	0.0058	308
		g/trip	1.1	0.28	0.0020	0.0018	3.2	7.5E-04	76	0.073	0.033	87
	Vehicles to Facility (single-axle vehicles)	g/mile	0.016	0.12	0.019	0.0089	0.63	0.0042	431	0.0025	0.038	442
		g/trip	0.73	0.21	0.0011	0.0010	2.0	5.3E-04	53	0.051	0.021	61
	Vehicles to Facility (double-axle vehicles)	g/mile	0.012	1.4	0.14	0.066	0.037	0.014	1,478	5.7E-04	0.23	1,548
		g/trip	0.48	8.1	0.0021	0.0020	7.0	0.010	1,051	0.022	0.17	1,101
	Vanpool to Facility	g/mile	0.026	0.19	0.090	0.031	1.3	0.0062	630	0.0053	0.010	633
		g/trip	0.80	0.63	3.4E-04	3.2E-04	3.4	3.3E-04	34	0.041	0.050	50
Year 2	Commuters to Vanpool	g/mile	0.014	0.056	0.015	0.0050	0.76	0.0030	300	0.0031	0.0054	302
		g/trip	1.1	0.26	0.0019	0.0018	3.0	7.3E-04	74	0.069	0.032	85
	Vehicles to Facility (single-axle vehicles)	g/mile	0.015	0.11	0.019	0.0084	0.59	0.0041	426	0.0022	0.038	437
		g/trip	0.70	0.20	0.0010	9.6E-04	1.9	5.1E-04	52	0.047	0.020	59
	Vehicles to Facility (double-axle vehicles)	g/mile	0.012	1.4	0.14	0.067	0.034	0.014	1,450	5.6E-04	0.23	1,518
		g/trip	0.48	8.1	0.0021	0.0020	7.0	0.0098	1,030	0.022	0.16	1,079
	Vanpool to Facility	g/mile	0.023	0.17	0.090	0.031	1.2	0.0061	615	0.0047	0.0095	618
		g/trip	0.77	0.61	3.2E-04	3.0E-04	3.4	3.3E-04	34	0.040	0.049	49

Notes:

1. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027).
2. Emission factors were estimated using EMFAC2021 for MDAQMD. EMFAC2021 was run in Emission Rates mode for calendar year 2026 and 2027 in the annual season. The following processes have units of g/trip: DIRUN, HOTSOAK, RESTLOSS, STREX, and IDLEX. The following processes have units of g/mile: PMBW, PMTW, RUNEX, and RUNLOSS. Processes with units of g/vehicle/day were converted to g/trip using the population and trip rate values given in the EMFAC2021 run.
3. Emission factors from EMFAC with units of g/vehicle/day were converted to g/trip by scaling by the ratio of the total number of vehicles divided by the total number of trips for each vehicle class, fuel type, and year.
4. CO_2 equivalent emissions calculated based on CO_2, N_2O, and CH_4 emissions and the corresponding GWP from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

Abbreviations:

CAP - Criteria Air Pollutant
CH_4 - methane
CO - carbon monoxide
MRR - Mandatory Reporting Regulation
N_2O - nitrous oxide
NO_x - nitrogen oxides

CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
DIURN - diurnal evaporative hydrocarbon emissions
EMFAC2017 - California Air Resources Board EMission FACtor model
g - grams
GHG - greenhouse gas
HOTSOAK - hot soak evaporative hydrocarbon emissions
IDLEX - idle exhaust emissions
mi - mile
PM - particulate matter
PMBW - break wear particulate matter emissions
PMTW - tire wear particulate matter emissions
RESTLOSS - resting evaporative losses
ROG - reactive organic gases
RUNEX - running exhaust emissions
RUNLOSS - running loss evaporative hydrocarbon emissions
STREX - start exhaust tailpipe emissions
SO_x - sulfur oxides

References:

CARB. 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

CARB 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Table C-10
On-road Mobile Vehicles
Trip Rates
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type[1]	One-Way Trip Rate[2] (trips/day)	One-Way Trip Length[2] (VMT/trip)	Annual Activity[3] (days/yr)		Annual Trips (trips/yr)		Annual VMT[4] (VMT/yr)	
			Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Commuters to Vanpool	1,000	6	260	130	260,000	130,000	1,560,000	780,000
Vehicles to Facility (single-axle vehicles)	150	85	260	130	39,000	19,500	3,607,500	1,803,750
Vehicles to Facility (double-axle vehicles)	8	85	260	130	2,080	1,040	192,400	96,200
Vanpool to Facility	22	85	260	130	5,720	2,860	486,200	243,100

Notes:

1. Fleet mixes are defined in Table C-8.
2. Employee vehicle trip rates are based on the number of employees working at the facility during construction and were provided by Castle Mountain Venture. Construction employees were assumed to commute an average of 12 miles roundtrip between home and the van/bus pickup locations in their personal vehicles. Potential van/bus pick up locations may include Las Vegas, NV, Henderson, NV, and Bullhead City/Laughlin, NV. Anticipated travel from single and double-axle vehicles in support of construction (e.g. vendor trips) was provided by Castle Mountain Venture.
3. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027). Employee activity was assumed to occur 260 days for Year 1 and 130 days for Year 2.
4. In addition to commuting, single-axle and double-axle vehicles are expected to be used for daily construction operations assuming 1 hour of usage per day at an average speed of 15 mph.

Abbreviations:

VMT - vehicle miles travelled
yr - year

Table C-11
On-road Mobile Vehicles
Exhaust CAP Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Daily Emission Rates[1,2,3]

Year	Trip Type	Vehicle Activity			Emissions from Mobile Sources (lb/day)					
		Vehicle Quantity	VMT (VMT/day)	Trips (Trips/day)	ROG[4]	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x
Years 1 and 2	Commuters to Vanpool	500	6,000	1,000	2.6	1.4	0.20	0.072	18	0.042
	Vehicles to Facility (single-axle vehicles)	75	13,875	150	0.74	3.8	0.60	0.27	20	0.13
	Vehicles to Facility (double-axle vehicles)	4	740	8.0	0.028	2.5	0.23	0.11	0.18	0.023
	Vanpool to Facility	11	1,870	22	0.15	0.80	0.37	0.13	5.5	0.026
Total					**3.5**	**8.5**	**1.4**	**0.58**	**43**	**0.22**

Year 1 Annual Emission Rates[1,2,3]

Year	Trip Type	Vehicle Activity			Emissions from Mobile Sources (tons/yr)					
		Vehicle Quantity	VMT (VMT/yr)	Trips (Trips/yr)	ROG[4]	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x
Year 1	Commuters to Vanpool	500	1,560,000	260,000	0.34	0.19	0.026	0.0094	2.3	0.0054
	Vehicles to Facility (single-axle vehicles)	75	3,607,500	39,000	0.10	0.50	0.077	0.036	2.6	0.017
	Vehicles to Facility (double-axle vehicles)	4	192,400	2,080	0.0037	0.32	0.030	0.014	0.024	0.0030
	Vanpool to Facility	11	486,200	5,720	0.019	0.10	0.048	0.017	0.71	0.0033
Total					**0.46**	**1.1**	**0.18**	**0.076**	**5.6**	**0.028**

Year 2 Annual Emission Rates[1,2,3]

Year	Trip Type	Vehicle Activity			Emissions from Mobile Sources (tons/yr)					
		Vehicle Quantity	VMT (VMT/yr)	Trips (Trips/yr)	ROG[4]	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x
Year 2	Commuters to Vanpool	500	780,000	130,000	0.17	0.093	0.013	0.0047	1.1	0.0027
	Vehicles to Facility (single-axle vehicles)	75	1,803,750	19,500	0.048	0.25	0.039	0.018	1.3	0.0083
	Vehicles to Facility (double-axle vehicles)	4	96,200	1,040	0.0018	0.16	0.015	0.0071	0.012	0.0015
	Vanpool to Facility	11	243,100	2,860	0.0095	0.052	0.024	0.0084	0.36	0.0017
Total					**0.23**	**0.55**	**0.091**	**0.038**	**2.8**	**0.014**

Notes:

1. Trip generation rates and emission factors used in emissions calculations are shown in Table C-10 and Table C-9, respectively.
2. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027).
3. Daily emissions calculated by averaging Year 1 annual emissions over 260 days.
4. ROG is assumed to equal VOC.

Abbreviations:

CO - carbon monoxide
lb - pound
NO_x - nitrogen oxides
PM - particulate matter
ROG - reactive organic gases
SO_x - sulfur oxides
VMT - vehicle miles traveled
VOC - volatile organic compounds
yr - year

Table C-12
On-road Mobile Vehicles
Exhaust GHG Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Year 1 Annual Emission Rates[1]

Year	Trip Type	Vehicle Quantity	Vehicle Activity[2]		Annual Emissions[2,3]			
			VMT	Trips	(MT/yr)			
			(VMT/yr)	(Trips/yr)	CO_2	CH_4	N_2O	Non-biogenic CO_2e
Year 1	Commuters to Vanpool	500	1,560,000	260,000	497	0.024	0.018	503
	Vehicles to Facility (single-axle vehicles)	75	3,607,500	39,000	1,556	0.011	0.14	1,598
	Vehicles to Facility (double-axle vehicles)	4	192,400	2,080	287	1.5E-04	0.045	300
	Vanpool to Facility	11	486,200	5,720	307	0.0028	0.0054	308
Total					**2,647**	**0.038**	**0.21**	**2,710**

Year 2 Annual Emission Rates[1]

Year	Trip Type	Vehicle Quantity	Vehicle Activity[2]		Annual Emissions[2,3]			
			VMT	Trips	(MT/yr)			
			(VMT/yr)	(Trips/yr)	CO_2	CH_4	N_2O	Non-biogenic CO_2e
Year 2	Commuters to Vanpool	500	780,000	130,000	244	0.011	0.0084	247
	Vehicles to Facility (single-axle vehicles)	75	1,803,750	19,500	769	0.0050	0.069	789
	Vehicles to Facility (double-axle vehicles)	4	96,200	1,040	141	7.7E-05	0.022	147
	Vanpool to Facility	11	243,100	2,860	150	0.0013	0.0025	150
Total					**1,303**	**0.018**	**0.10**	**1,333**

Notes:

1. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027).
2. Trip generation rates and emission factors used in emissions calculations are shown in Table C-10 and Table C-9, respectively.

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
GHG - greenhouse gas
MT - metric ton
N_2O - nitrous oxide
VMT - vehicle miles traveled
yr - year

Table C-13
Fugitive Dust Emissions from On-road Mobile Vehicles
Paved Roads
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Road Dust Equation[1]

E = k*(sL)^0.91 * (W)^1.02 * (1-P/4N)

Parameter[2]	**Value**
E = annual average emission factor in the same units as k	[calculated]
k = particle size multiplier for particle size range and units of interest	
PM_{10} (lb/VMT)	0.0022
$PM_{2.5}$ (lb/VMT)	3.3E-04
sL = road surface silt loading (grams per square meter) (g/m^2)	0.099
W = average weight (tons) of all the vehicles traveling the road	2.4
P = number of "wet" days with at least 0.01 in of precipitation during averaging period[2]	45
N number of days in the averaging period	365

Entrained Roadway Dust Constants for San Bernardino County (MDAQMD)		
Roadway Category	**Silt Loading[3] (g/m^2)**	**Travel Fraction[3]**
Freeway	0.015	52%
Major	0.08	32%
Collector	0.08	9.0%
Local	0.84	7.0%
Weighted Silt Loading Factor	**0.099**	**100%**

Paved Vehicle Miles Traveled[4]

Year 1[5]

Commuters to Vanpool	6	miles/trip	260,000	Trips/yr	1,560,000	miles/year
Vehicles to Facility (single-axle vehicles)	67	miles/trip	39,000	Trips/yr	2,613,000	miles/year
Vehicles to Facility (double-axle vehicles)	67	miles/trip	2,080	Trips/yr	139,360	miles/year
Vanpool to Facility	67	miles/trip	5,720	Trips/yr	383,240	miles/year

Year 2[5]

Commuters to Vanpool	6	miles/trip	130,000	Trips/yr	780,000	miles/year
Vehicles to Facility (single-axle vehicles)	67	miles/trip	19,500	Trips/yr	1,306,500	miles/year
Vehicles to Facility (double-axle vehicles)	67	miles/trip	1,040	Trips/yr	69,680	miles/year
Vanpool to Facility	67	miles/trip	2,860	Trips/yr	191,620	miles/year

Parameter[6]	Fugitive PM_{10}	Fugitive $PM_{2.5}$	Units
Emission Factor	6.4E-04	9.6E-05	lb/VMT

Vehicle Type	Daily Emissions[7] (lb/day)		Year 1 Emissions[5] (tpy)		Year 2 Emissions[5] (tpy)	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Commuters to Vanpool	3.8	0.57	0.50	0.075	0.25	0.037
Vehicles to Facility (single-axle vehicles)	6.4	0.96	0.83	0.12	0.42	0.062
Vehicles to Facility (double-axle vehicles)	0.34	0.051	0.044	0.0067	0.022	0.0033
Vanpool to Facility	0.94	0.14	0.12	0.018	0.061	0.0092
Total	**12**	**1.7**	**1.5**	**0.22**	**0.75**	**0.11**

Notes:

1. The road dust equation for paved roads is from the ARB's March 2021 update to Entrained Road Travel Emission Inventory Source Methodology.
2. The number of "wet" days for San Bernardino County (MDAQMD) from Table 5 of the ARB's March 2021 update to Entrained Road Travel Emission Inventory Source Methodology.
3. Travel fraction by roadway category and silt loading are from the ARB's March 2021 update to Entrained Road Travel Emission Inventory Source Methodology, Tables 2 and 4, respectively.
4. Vehicle miles traveled from Table C-10.
5. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027).
6. $PM_{2.5}$ is assumed to be 15% of PM_{10} based on paved road dust sampling in California (ARB Speciation Profile #471), which is a more representative fraction than provided in the older AP-42 fugitive dust methodology as discussed in ARB 2018 (page 10).
7. Daily emissions calculated by averaging annual emissions over 260 days.

Abbreviations:

ARB - Air Resources Board
CalEEMod® - California Emissions Estimator Model
g - gram(s)
lb - pounds
m - meter
PM - particulate matter
VMT - vehicle miles traveled

References:

California Air Resources Board. 2021. Miscellaneous Process Methodology 7.9, Entrained Road Travel, Paved Road Dust. March. Available online at: https://ww3.arb.ca.gov/ei/areasrc/fullpdf/2021_paved_roads_7_9.pdf

USEPA. 1996. AP 42. Compilation of Air Pollutant Emission Factors, Volume 1. Fifth Edition. Chapter 13.2.1, Paved Roads. Available online at: http://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0201.pdf. Accessed January 2016.

Table C-14
Fugitive Dust Emissions from On-road Mobile Vehicles
Unpaved Roads
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Equipment Description[1]	Average Vehicle Weight[2] (tons)	Daily Trips[3]	Unpaved Miles per Trip[4]	Daily Total Miles Traveled[4] (VMT/day)	Annual Total Miles Traveled[4,5] (VMT/yr)		PM_{10} EF[6,7] (lb/VMT)	$PM_{2.5}$ EF[6,7] (lb/VMT)	Control Efficiency[8] (%)	Number of Days with >0.01 Inches Precipitation[9] (day/yr)	Daily Emissions (lb/day)		Year 1 Emissions[5] (tpy)		Year 2 Emissions[5] (tpy)	
					Year 1	Year 2					PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Vehicles to Facility (single-axle vehicles)	2.4	150	18	3,825	994,500	497,250	0.62	0.062	95%	31	118	12	14	1.4	7.0	0.70
Vehicles to Facility (double-axle vehicles)	16.5	8	18	204	53,040	26,520	1.5	0.15	95%	31	15	1.5	1.8	0.18	0.89	0.089
Vanpool to Facility	15	22	18	396	102,960	51,480	1.4	0.14	95%	31	28	2.8	3.3	0.33	1.7	0.17
										Total	**161**	**16**	**19**	**1.9**	**9.6**	**0.96**

Notes:

1. The following types of trips are expected to travel on unpaved roads during construction: vanpooling trips (vanpool to Facility) and single and double axle vehicle trips in support of construction work.
2. Vehicle weights estimated based off of typical vehicle size for the types of trips listed.
3. Unpaved trip length is based on the 18 mile unpaved roadway segment to reach the Project Site from Joshua Tree Highway.
4. VMT and trip rates shown in Table C-10.
5. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027).
6. Fugitive dust emission factors calculated following MDAQMD's "most complex" Unpaved Roads methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 correlations for industrial roads (Equation 1a, Table 13.2.2-2, AP-42 Section 13.2.2) at the time of inventory preparation.
7. A roadway moisture content of 2% and a surface silt content of 5% were used, consistent with data provided by Castle Mountain Venture.
8. A control efficiency of 95% was used consistent with assumptions for watering, graveling surface, treatment with chemical stabilizers, and speed control from the 1997 Castle Mountain Mine Expansion Project EIS/EIR, and the understanding that chemical suppressants will be applied to all unpaved roadways.
9. Consistent with the AP-42 Section 13.2.2 unpaved roads methodology for industrial sites, Ramboll applied a precipitation reduction based on the number of days with greater than 0.01 inches precipitation per year based on site-specific meteorological measurements between January 2021 and December 2021.

References:

Bureau of Land Management. 1997. Castle Mountain Mine Expansion Project Final Environmental Impact Statement/Environmental Impact Report. October.

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance Mineral Handling and Processing Industries. Available online at: https://www.mdaqmd.ca.gov/home/showdocument?id=768

Table C-15
Disturbed Construction Area Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name[1]	Mean Wind Speed[2] (m/s)	Fraction of Vegetative Cover[3]	Threshold Friction Velocity[4] (m/s)	Ratio of Wind Speed to Friction Velocity[5]	Threshold Value of Wind Speed[1] (m/s)	x Value for Correction Factor Selection	Correction Factor[1]	Emission Factors[1] (ton/acre/yr)		Disturbed Surface Area (acres)[6]	Control Efficiency[7] (%)	Daily Emissions[4,5] (lb/day)		Year 1 Emissions[8] (tpy)		Year 2 Emissions[8] (tpy)	
								PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Construction Disturbed Areas	3.9	0	0.26	15.0	3.9	0.9	1.7	2.4	1.0	0.79	83%	1.8	0.72	0.33	0.13	0.16	0.065
											Totals	**1.8**	**0.72**	**0.33**	**0.13**	**0.16**	**0.065**

Notes:

1. Windblown dust from construction disturbed areas assumed to be a "unlimited" reservoir consistent with MDAQMD definitions due to the fact that significant crusting would not occur on construction areas. Emissions were estimated using the intermediate complexity Wind Erosion from Unpaved Operational Areas and Roads methodology in MDAQMD Emissions Inventory Guidance, Section VI.L.
2. Mean wind speed based on annual average site-specific meteorological measurements for the period of January 2021 through December 2021.
3. Vegetative cover fraction assumed to be zero which provides a conservative estimate of emissions from disturbed construction areas.
4. Threshold friction velocity selected from the MDAQMD guidance based on an area use of "disturbed desert".
5. Ratio of wind speed to friction velocity selected from the MDAQMD guidance based on an area use of "open space".
6. Disturbed surface area based on information provided by Castle Mountain Venture. This area represents the surface area expected to be disturbed on a daily basis for the duration of the construction period. Per MDAQMD Guidance, "actively disturbed is defined as being disturbed by man's activity at least once per day".
7. Control efficiency accounts for watering of disturbed areas and is estimated in Table C-7. Watering control efficiency is calculated consistent with MDAQMD guidance for Dust Entrainment from Unpaved Roads as shown in Table C-7.
8. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (assumed to be 2026) and 6 months of construction in Year 2 (assumed to be 2027).

Abbreviations:

lb/day - pounds per day
m/s - meters per second
PM - particulate matter
tpy - tons per year

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

CLIMATE ANALYSIS, GHG INVENTORY TABLES

Table GHG-1
Greenhouse Gas Emissions Summary by Species
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Annual CO_2 Emissions[1,2] (MT/yr)

Source Type																					
	Construction Year	**1**	**2**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	Operation Year	**--**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
	Calendar Year	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**
Diesel Generators[3]			660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660
On-site Mobile Equipment (biogenic)[4]		7,526	6,647	18,810	55,472	59,916	63,980	67,691	64,652	69,172	71,889	68,570	64,323	70,763	72,855	79,503	82,034	78,852	73,506	37,653	6,462
Off-site On-road Mobile Vehicles (biogenic)[5]			437	437	437	437	437	437	437	437	437	437	437	437	437	437	437	437	437	437	437
Off-site On-road Mobile Vehicles-(non-biogenic)[5]		2,647	3,857	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,554
On-site On-road Mobile Vehicles (biogenic)[5]			2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
On-site On-road Mobile Vehicles (non-biogenic)[5]			34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
Blasting and Blast Hole Drilling[6]			1,746	1,746	1,746	1,746	1,746	1,746	1,746	1,746	1,746	1,746	1,746	1,746	1,746	1,746	1,746	1,746	1,746	1,746	1,746
Electricity Usage[7]			28,834	28,834	28,834	24,808	24,808	24,808	24,808	24,808	24,808	24,808	24,808	24,808	24,808	24,808	24,808	24,808	24,808	24,808	24,808
Solid Waste (biogenic)[8]			60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
Wastewater[8]			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site Power Generation[8]			49,790	49,790	49,790	49,790	49,790	49,790	49,790	49,790	49,790	49,790	49,790	49,790	49,790	49,790	49,790	49,790	49,790	49,790	49,790
LNG Storage Tanks[8]			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Biogenic Subtotal		7,526	7,146	19,309	55,971	60,415	64,479	68,191	65,151	69,671	72,388	69,069	64,822	71,262	73,354	80,002	82,533	79,351	74,005	38,152	6,962
Non-biogenic Subtotal		2,647	84,921	83,618	83,618	79,593	79,593	79,593	79,593	79,593	79,593	79,593	79,593	79,593	79,593	79,593	79,593	79,593	79,593	79,593	79,593
Total		**10,172**	**92,067**	**102,928**	**139,590**	**140,008**	**144,071**	**147,783**	**144,744**	**149,264**	**151,981**	**148,662**	**144,415**	**150,854**	**152,947**	**159,595**	**162,126**	**158,944**	**153,598**	**117,744**	**86,554**

Annual CH_4 Emissions[1,2] (MT/yr)

Source Type																					
	Construction Year	**1**	**2**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	Operation Year	**--**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
	Calendar Year	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**
Diesel Generators[3]			0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027
On-site Mobile Equipment[4]		0.69	0.61	1.7	5.1	5.5	5.9	6.2	6.0	6.4	6.6	6.3	5.9	6.5	6.7	7.3	7.6	7.3	6.8	3.5	0.60
Off-site On-road Mobile Vehicles[5]		0.038	0.37	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
On-site On-road Mobile Vehicles[5]			0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017
Blasting and Blast Hole Drilling[6]			287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287
Electricity Usage[7]			2.1	2.1	2.1	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Solid Waste[8]			20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Wastewater[8]			2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
On-site Power Generation[8]			0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
LNG Storage Tanks[8]			4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
Biogenic Subtotal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non-biogenic Subtotal		0.73	317	319	322	322	322	323	322	323	323	323	322	323	323	324	324	324	323	320	317
Total		**0.73**	**317**	**319**	**322**	**322**	**322**	**323**	**322**	**323**	**323**	**323**	**322**	**323**	**323**	**324**	**324**	**324**	**323**	**320**	**317**

Annual N_2O Emissions[1,2] (MT/yr)

Source Type																					
	Construction Year	**1**	**2**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	Operation Year	**--**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
	Calendar Year	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**
Diesel Generators[3]			0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054
On-site Mobile Equipment[4]		0.64	0.57	1.6	4.7	5.1	5.5	5.8	5.5	5.9	6.1	5.8	5.5	6.0	6.2	6.8	7.0	6.7	6.3	3.2	0.55
Off-site On-road Mobile Vehicles[5]		0.21	0.50	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
On-site On-road Mobile Vehicles[5]			0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058
Blasting and Blast Hole Drilling[6]			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity Usage[7]			0.30	0.30	0.30	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Solid Waste[8]			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wastewater[8]			0.0089	0.0089	0.0089	0.0089	0.0089	0.0089	0.0089	0.0089	0.0089	0.0089	0.0089	0.0089	0.0089	0.0089	0.0089	0.0089	0.0089	0.0089	0.0089
On-site Power Generation[8]			0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
LNG Storage Tanks[8]			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Biogenic Subtotal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non-biogenic Subtotal		0.85	1.4	2.4	5.5	5.8	6.2	6.5	6.2	6.6	6.9	6.6	6.2	6.8	6.9	7.5	7.7	7.4	7.0	3.9	1.3
Total		**0.85**	**1.4**	**2.4**	**5.5**	**5.8**	**6.2**	**6.5**	**6.2**	**6.6**	**6.9**	**6.6**	**6.2**	**6.8**	**6.9**	**7.5**	**7.7**	**7.4**	**7.0**	**3.9**	**1.3**

Notes:

1. Detailed emission calculations are presented in Table GHG-2 through Table GHG-17.
2. Project construction is assumed to begin as early as year 2026 and is expected to occur over a period of 18 months. Project operations are assumed to occur as early as year 2027, and thus the first year of operation is conservatively assumed to overlap with a portion of construction. Actual construction and operational periods may be later than those presented here and overlap between construction and operation may not occur.
3. Diesel generator operational emission factors and usage do not vary by year. While diesel generators will likely utilize renewable diesel, that has conservatively not been accounted for here.
4. On-site mobile equipment operational usage varies by year, but emission factors do not vary by year.
5. Off-site and on-site on-road mobile vehicle operational emission factors vary by year but annual usage is assumed to remain constant. The GHG emissions here conservatively use 2027 EMFAC emission factors for all operational years.
6. Blasting and blast hole drilling operational activity varies by year, but emission factors do not vary by year. The maximum annual activity level was conservatively used for all operational years.
7. Electricity operational emission factors vary by year, but electricity usage is assumed to be constant.
8. Solid waste, wastewater, on-site power generation, and LNG storage tank operational GHG emission factors and throughput do not vary by year.

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
GHG - greenhouse gas
LNG - liquefied natural gas
N_2O - nitrous oxide
MT - metric tons
yr - year

Table GHG-2
Construction GHG Emissions
On-Site Mobile Equipment Exhaust Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Equipment Type	Equipment Details	Quantity[1]	Engine[2] (hp)	Load Factor[3]	Fuel Type	Operating Hours per Year[1,4]		Annual Fuel Usage[5] (gal/yr)		Emission Factors[6] (kg/gal)			Construction Year 1 Emissions[4] (MT/yr)					Construction Year 2 Emissions[4] (MT/yr)				
						Year 1	Year 2	Year 1	Year 2	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Biogenic CO_2e[7]	Non-biogenic CO_2e[7]	CO_2	CH_4	N_2O	Biogenic CO_2e[7]	Non-biogenic CO_2e[7]
Dozers	D6	4	215	0.40	Renewable Diesel	2,080	1,040	36,551	18,276	10.21	9.4E-04	8.7E-04	373	0.034	0.032	373	10	187	0.017	0.016	187	5.2
	D9	5	452	0.40	Renewable Diesel	2,080	1,040	96,054	48,027	10.21	9.4E-04	8.7E-04	980	0.090	0.084	980	27	490	0.045	0.042	490	14
	D10	2	602	0.40	Renewable Diesel	2,080	1,040	51,172	25,586	10.21	9.4E-04	8.7E-04	522	0.048	0.045	522	14	261	0.024	0.022	261	7.2
Loader	Cat 950	3	249	0.36	Renewable Diesel	1,040	520	14,287	7,143	10.21	9.4E-04	8.7E-04	146	0.013	0.012	146	4.0	73	0.0067	0.0062	73	2.0
Motor-Grader	Cat 140M	3	183	0.41	Renewable Diesel	2,080	1,040	23,917	11,958	10.21	9.4E-04	8.7E-04	244	0.022	0.021	244	6.8	122	0.011	0.010	122	3.4
Scraper	Cat 657	10	473	0.48	Renewable Diesel	2,080	1,040	241,239	120,620	10.21	9.4E-04	8.7E-04	2,462	0.23	0.21	2,462	68	1,231	0.11	0.10	1,231	34
Aerial Lifts	Boom Lifts	15	63	0.42	Renewable Diesel	2,080	1,040	42,172	21,086	10.21	9.4E-04	8.7E-04	430	0.040	0.037	430	12	215	0.020	0.018	215	6.0
	Scissor Lifts	15	63	0.42	Renewable Diesel	2,080	1,040	42,172	21,086	10.21	9.4E-04	8.7E-04	430	0.040	0.037	430	12	215	0.020	0.018	215	6.0
Water Truck	Cat 740 WW (8k)	3	484	0.38	Renewable Diesel	2,080	1,040	58,627	29,313	10.21	9.4E-04	8.7E-04	598	0.055	0.051	598	17	299	0.028	0.026	299	8.3
	2500 Gallon Trucks	2	402	0.38	Renewable Diesel	2,080	1,040	32,463	16,231	10.21	9.4E-04	8.7E-04	331	0.031	0.028	331	9.2	166	0.015	0.014	166	4.6
Maintenance Fuel/Lube	--	5	402	0.38	Renewable Diesel	780	390	30,434	15,217	10.21	9.4E-04	8.7E-04	311	0.029	0.026	311	8.6	155	0.014	0.013	155	4.3
Other	Skid Steer	4	65	0.37	Renewable Diesel	1,560	780	7,666	3,833	10.21	9.4E-04	8.7E-04	78	0.007	0.0067	78	2.2	39	0.0036	0.0033	39	1.1
	Cranes	6	231	0.29	Renewable Diesel	2,080	1,040	42,708	21,354	10.21	9.4E-04	8.7E-04	436	0.040	0.037	436	12	218	0.020	0.019	218	6.0
	Telehandler	6	89	0.42	Renewable Diesel	1,560	780	17,873	8,937	10.21	9.4E-04	8.7E-04	182	0.017	0.016	182	5.1	91	0.0084	0.0078	91	2.5

Notes:

1. Equipment quantity and operating hours per year provided by Castle Mountain Venture.
2. Engine horsepower estimated based off of typical equipment for the types of equipment listed.
3. Average equipment load factors were based on the CARB OFFROAD2017 Emission Factor Workbook (CARB 2017).
4. Construction will occur over an 18 month period, with 12 months of construction in Construction Year 1 (2026) and 6 months of construction in Construction Year 2 (2027).
5. Fuel usage is calculated by taking the horsepower-hours for each piece of equipment (calculated as horsepower * usage hours * load factor) and multiplying it by the gallons of diesel consumption per horsepower-hour consistent with USEPA AP 42 diesel fuel data in Table 3.4.1, which cites an average brake-specific fuel consumption (BSFC) of 7,000 BTU/hp-hr, a heating value of 19,300 BTU/lb, and density of 7.1 lb/gal. Consistent with ARB guidelines, renewable diesel is treated the same as conventional diesel (CARB 2022).
6. CO_2 emission factor is from 40 CFR Part 98, Subpart C, Table C-1. CH_4 and N_2O emission factors are from the EPA Center for Corporate Climate Leadership (2022, April 1) Emission Factors for Greenhouse Gas Inventories, Table 5 (available at https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf) which are calculated from the USEPA Inventory of U.S. Greenhouse Gas Emission and Sinks: 1990-2019.
7. CO_2 emissions are assumed to be 100% biogenic based on the assumption of the use of 100% renewable diesel fuel in off-road equipment, consistent with regulatory requirements under the CARB In-Use Off-Road Diesel-Fueled Fleets Regulation and CMV commitments.

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
gal - gallon
hp - horsepower
kg - kilogram
MT - metric ton
N_2O - nitrous oxide
yr - year

References:

CARB. In-Use Off-Road Diesel-Fueled Fleets regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/off-roaddiesel/appa-1.pdf
CARB. 2022. Renewable Diesel Joint Statement. Available online at: https://ww2.arb.ca.gov/our-work/programs/alternative-diesel-fuels/biodiesel-renewable-diesel
CARB. 2017. 2017 Off-road Diesel Emission Factors. Available online at: https://ww2.arb.ca.gov/sites/default/files/2022-05/Off-road_CI_engine_standards_chart_04212022.pdf.
Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1
USEPA. 2021. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019. Available at: https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-annexes.pdf
USEPA. 1996. AP-42 Chapter 3.4 Large Stationary Diesel And Stationary Dual-fuel Engines. Available at: https://www.epa.gov/sites/default/files/2020-10/documents/c03s04.pdf

Table GHG-3
Construction GHG Emissions
Off-Site Mobile Vehicle Trip Rates
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type	One-Way Trip Rate[2] (trips/day)	One-Way Trip Length[2] (VMT/trip)	Annual Activity[3] (days/yr)		Annual Trips (trips/yr)		Annual VMT[4] (VMT/yr)	
			Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Commuters to Vanpool	1,000	6	260	130	260,000	130,000	1,560,000	780,000
Vehicles to Facility (single-axle vehicles)	150	85	260	130	39,000	19,500	3,607,500	1,803,750
Vehicles to Facility (double-axle vehicles)	8	85	260	130	2,080	1,040	192,400	96,200
Vanpool to Facility	22	85	260	130	5,720	2,860	486,200	243,100

Notes:

1. Employee vehicle trip rates are based on the number of employees working at the facility during construction and were provided by Castle Mountain Venture. Construction employees were assumed to commute an average of 12 miles roundtrip between home and the van/bus pickup locations in their personal vehicles. Potential van/bus pick up locations may include Las Vegas, NV, Henderson, NV, and Bullhead City/Laughlin, NV.
2. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027). Employee activity was assumed to occur 260 days for Year 1 and 130 days for Year 2.
3. In addition to commuting, single-axle and double-axle vehicles are expected to be used for daily construction operations assuming 1 hour of usage per day at an average speed of 15 mph.

Abbreviations:

VMT - vehicle miles travelled
yr - year

Table GHG-4
Construction GHG Emissions
Off-Site Mobile Vehicle Exhaust Emission Factors
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Scenario		Emission Factor Units	Mobile GHG Emission Factors[2,3]			
Year[1]	Fleet		CO_2	CH_4	N_2O	CO_2e[4]
Year 1	Commuters to Vanpool	g/mile	306	0.0033	0.0058	308
		g/trip	76	0.073	0.033	87
	Vehicles to Facility (single-axle vehicles)	g/mile	431	0.0025	0.038	442
		g/trip	53	0.051	0.021	61
	Vehicles to Facility (double-axle vehicles)	g/mile	1,478	5.7E-04	0.23	1,548
		g/trip	1,051	0.022	0.17	1,101
	Vanpool to Facility	g/mile	630	0.0053	0.010	633
		g/trip	34	0.041	0.050	50
Year 2	Commuters to Vanpool	g/mile	300	0.0031	0.0054	302
		g/trip	74	0.069	0.032	85
	Vehicles to Facility (single-axle vehicles)	g/mile	426	0.0022	0.038	437
		g/trip	52	0.047	0.020	59
	Vehicles to Facility (double-axle vehicles)	g/mile	1,450	5.6E-04	0.23	1,518
		g/trip	1,030	0.022	0.16	1,079
	Vanpool to Facility	g/mile	615	0.0047	0.0095	618
		g/trip	34	0.040	0.049	49

Notes:

1. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027).
2. Emission factors were estimated using EMFAC2021 for MDAQMD. EMFAC2021 was run in Emission Rates mode for calendar year 2026 and 2027 in the annual season. The following processes have units of g/trip: STREX and IDLEX. The following process has units of g/mile: RUNEX.
3. Emission factors from EMFAC with units of g/vehicle/day were converted to g/trip by scaling by the ratio of the total number of vehicles divided by the total number of trips for each vehicle class, fuel type, and year.
4. Emission factors for CO_2e were estimated by multiplying the CO_2, CH_4, and N_2O emission factors by their global warming potentials from the IPCC 4th Assessment Report on Climate Change (AR4).

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
EMFAC2017 - California Air Resources Board EMission FACtor model
g - grams
GHG - greenhouse gas
IDLEX - idle exhaust emissions
IPCC - Intergovernmental Panel on Climate Change
mi - mile
N_2O - nitrous oxide
RUNEX - running exhaust emissions
STREX - start exhaust tailpipe emissions

References:

California Air Resources Board (ARB) 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory

Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007. Available at: https://www.ipcc.ch/assessment-report/ar4/

Table GHG-5
Construction GHG Emissions
Off-Site Mobile Vehicles Exhaust Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Year 1 Annual Emission Rates[1]

Year	Trip Type	Vehicle Quantity	Vehicle Activity[2]		Annual Emissions[2]			
			VMT	Trips	(MT/yr)			
			(VMT/yr)	(Trips/yr)	CO_2	CH_4	N_2O	Non-biogenic CO_2e
Year 1	Commuters to Vanpool	500	1,560,000	260,000	497	0.024	0.018	503
	Vehicles to Facility (single-axle vehicles)	75	3,607,500	39,000	1,556	0.011	0.14	1,598
	Vehicles to Facility (double-axle vehicles)	4	192,400	2,080	287	1.5E-04	0.045	300
	Vanpool to Facility	11	486,200	5,720	307	0.0028	0.0054	308
Total					**2,647**	**0.038**	**0.21**	**2,710**

Year 2 Annual Emission Rates[1]

Year	Trip Type	Vehicle Quantity	Vehicle Activity[2]		Annual Emissions[2]			
			VMT	Trips	(MT/yr)			
			(VMT/yr)	(Trips/yr)	CO_2	CH_4	N_2O	Non-biogenic CO_2e
Year 2	Commuters to Vanpool	500	780,000	130,000	244	0.011	0.0084	247
	Vehicles to Facility (single-axle vehicles)	75	1,803,750	19,500	769	0.0050	0.069	789
	Vehicles to Facility (double-axle vehicles)	4	96,200	1,040	141	7.7E-05	0.022	147
	Vanpool to Facility	11	243,100	2,860	150	0.0013	0.0025	150
Total					**1,303**	**0.018**	**0.10**	**1,333**

Notes:

1. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027).
2. Trip generation rates and emission factors used in emissions calculations are shown in Table GHG-3 and Table GHG-4, respectively.

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
GHG - greenhouse gas
MT - metric ton
N_2O - nitrous oxide
VMT - vehicle miles traveled
yr - year

Table GHG-6
2022 Mine Plan of Operations: Operational GHG Emissions
On-site Mobile Vehicle Annual Fuel Usage
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Annual Fuel Usage[1] (gal/yr)																		
	Operation Year 1	Operation Year 2	Operation Year 3	Operation Year 4	Operation Year 5	Operation Year 6	Operation Year 7	Operation Year 8	Operation Year 9	Operation Year 10	Operation Year 11	Operation Year 12	Operation Year 13	Operation Year 14	Operation Year 15	Operation Year 16	Operation Year 17	Operation Year 18	Operation Year 19
Production Blasthole Drill	0	118,691	444,209	329,406	301,351	371,726	327,747	372,574	429,258	424,844	403,894	448,356	511,382	556,062	381,071	448,513	318,009	63,331	9,397
Wall Control Drill	0	49,878	127,737	120,976	112,739	134,754	149,222	169,831	196,211	177,002	153,383	166,793	195,530	224,235	162,745	162,594	165,646	95,597	26,090
Hydraulic Shovel	0	173,208	969,389	957,553	956,753	1,039,765	956,477	1,046,602	1,162,800	1,133,889	1,143,463	1,373,186	1,329,215	1,380,394	1,348,859	1,228,316	944,425	363,040	57,160
Wheel Loader	0	67,786	379,377	374,745	374,432	323,875	297,931	326,005	362,199	353,194	356,176	427,732	414,035	429,977	420,154	382,606	294,177	113,083	17,805
Haul Trucks	282,590	697,936	1,937,239	2,510,674	2,946,180	3,185,025	3,025,952	3,285,218	3,315,914	3,052,257	2,668,194	2,939,966	3,155,586	3,772,502	4,298,331	4,077,398	4,142,707	2,000,790	349,578
Track Dozer	0	212,211	530,528	530,528	530,528	530,528	530,528	530,528	530,528	530,528	530,528	530,528	530,528	424,422	424,422	424,422	424,422	212,211	34,884
Wheel Dozer	0	83,395	166,790	166,790	166,790	166,790	166,790	166,790	166,790	166,790	166,790	166,790	166,790	166,790	166,790	166,790	166,790	166,790	27,418
Grader	0	62,546	125,093	125,093	125,093	125,093	125,093	125,093	125,093	125,093	125,093	125,093	125,093	125,093	125,093	125,093	125,093	125,093	20,563
Water Truck	0	71,482	142,963	142,963	142,963	142,963	142,963	142,963	142,963	142,963	142,963	142,963	142,963	142,963	142,963	142,963	142,963	71,482	11,750
Wheel Loader	0	26,806	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	8,813
Haul Truck	0	67,014	134,028	134,028	134,028	134,028	134,028	134,028	134,028	134,028	134,028	134,028	89,352	89,352	89,352	89,352	0	0	0
Excavator	0	8,935	17,870	17,870	17,870	17,870	17,870	17,870	17,870	17,870	17,870	17,870	17,870	17,870	17,870	17,870	17,870	17,870	2,938
Tire Manipulator	0	6,143	12,286	12,286	12,286	12,286	12,286	12,286	12,286	12,286	12,286	12,286	12,286	12,286	12,286	12,286	12,286	12,286	2,020
Vibratory Compactor	0	3,909	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	1,285
Backhoe	0	4,654	9,308	9,308	9,308	9,308	9,308	9,308	9,308	9,308	9,308	9,308	9,308	9,308	9,308	9,308	9,308	9,308	1,530
Articulated Truck	0	3,723	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	1,224
Fuel and Lube Truck	0	26,806	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	53,611	8,813
Tractor and Low Bed	0	1,117	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	2,234	367
Flatbed Hiab Truck	0	3,909	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	7,818	1,285
Rough Terrain Forklift	0	2,792	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	918
Shop Forklift	0	1,862	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	3,723	612
Mechanics Truck	0	2,792	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	918
Welding Truck	0	3,351	6,701	6,701	6,701	6,701	6,701	6,701	6,701	6,701	6,701	6,701	6,701	6,701	6,701	6,701	6,701	6,701	1,102
Staff Pickup Trucks	0	44,676	89,352	89,352	89,352	89,352	89,352	89,352	89,352	89,352	89,352	89,352	89,352	89,352	89,352	89,352	89,352	89,352	14,688
Pit Services Pickup	0	46,910	93,820	93,820	93,820	93,820	93,820	93,820	93,820	93,820	93,820	93,820	93,820	93,820	93,820	93,820	93,820	93,820	15,422
Staff Pickup Trucks (Crewcab)	0	13,403	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	4,406
Pit Services Pickup (Crewcab)	0	13,403	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	26,806	4,406
Shovel Crew Flat Deck	0	2,234	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	4,468	734
Shovel Crew Hiab	0	3,723	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	1,224
Surface Crew Hiab	0	3,723	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	7,446	1,224
Lighting Tower	0	11,169	22,338	22,338	22,338	22,338	22,338	22,338	22,338	22,338	22,338	22,338	22,338	22,338	22,338	22,338	22,338	22,338	3,672
Mine Rescue Vehicle	0	2,792	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	5,585	918

Notes:

[1] Annual fuel usage was provided by Castle Mountain Venture. Operational Year 1 is assumed to only transport backfill material.

Abbreviations:

gal - gallons

yr - year

Table GHG-7a
2022 Mine Plan of Operations: Operational GHG Emissions
On-site Mobile Vehicle Exhaust CO_2 Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	CO_2 Emission Factors (kg/gal)[1]	Annual Biogenic CO_2 Emissions[2,3] (MT/yr)																		
		Operation Year 1	Operation Year 2	Operation Year 3	Operation Year 4	Operation Year 5	Operation Year 6	Operation Year 7	Operation Year 8	Operation Year 9	Operation Year 10	Operation Year 11	Operation Year 12	Operation Year 13	Operation Year 14	Operation Year 15	Operation Year 16	Operation Year 17	Operation Year 18	Operation Year 19
Production Blasthole Drill	10.21	0	1,211	4,534	3,362	3,076	3,794	3,345	3,803	4,381	4,336	4,122	4,576	5,219	5,675	3,889	4,578	3,246	646	96
Wall Control Drill	10.21	0	509	1,304	1,235	1,151	1,375	1,523	1,733	2,003	1,807	1,566	1,702	1,996	2,289	1,661	1,660	1,691	976	266
Hydraulic Shovel	10.21	0	1,768	9,894	9,773	9,765	10,612	9,762	10,682	11,868	11,573	11,671	14,015	13,567	14,089	13,767	12,537	9,639	3,705	583
Wheel Loader	10.21	0	692	3,872	3,825	3,822	3,306	3,041	3,327	3,697	3,605	3,635	4,366	4,226	4,389	4,288	3,905	3,003	1,154	182
Haul Trucks	10.21	2,884	7,123	19,772	25,625	30,070	32,508	30,884	33,531	33,844	31,153	27,233	30,007	32,207	38,504	43,871	41,616	42,282	20,421	3,568
Track Dozer	10.21	0	2,166	5,415	5,415	5,415	5,415	5,415	5,415	5,415	5,415	5,415	5,415	5,415	4,332	4,332	4,332	4,332	2,166	356
Wheel Dozer	10.21	0	851	1,702	1,702	1,702	1,702	1,702	1,702	1,702	1,702	1,702	1,702	1,702	1,702	1,702	1,702	1,702	1,702	280
Grader	10.21	0	638	1,277	1,277	1,277	1,277	1,277	1,277	1,277	1,277	1,277	1,277	1,277	1,277	1,277	1,277	1,277	1,277	210
Water Truck	10.21	0	730	1,459	1,459	1,459	1,459	1,459	1,459	1,459	1,459	1,459	1,459	1,459	1,459	1,459	1,459	1,459	730	120
Wheel Loader	10.21	0	274	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	90
Haul Truck	10.21	0	684	1,368	1,368	1,368	1,368	1,368	1,368	1,368	1,368	1,368	1,368	912	912	912	912	0	0	0
Excavator	10.21	0	91	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	30
Tire Manipulator	10.21	0	63	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	21
Vibratory Compactor	10.21	0	40	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	13
Backhoe	10.21	0	47	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	16
Articulated Truck	10.21	0	38	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	12
Fuel and Lube Truck	10.21	0	274	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	90
Tractor and Low Bed	10.21	0	11	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	3.7
Flatbed Hiab Truck	10.21	0	40	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	13
Rough Terrain Forklift	10.21	0	28	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	9.4
Shop Forklift	10.21	0	19	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	6.2
Mechanics Truck	10.21	0	28	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	9.4
Welding Truck	10.21	0	34	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	11
Staff Pickup Trucks	10.21	0	456	912	912	912	912	912	912	912	912	912	912	912	912	912	912	912	912	150
Pit Services Pickup	10.21	0	479	958	958	958	958	958	958	958	958	958	958	958	958	958	958	958	958	157
Staff Pickup Trucks (Crewcab)	10.21	0	137	274	274	274	274	274	274	274	274	274	274	274	274	274	274	274	274	45
Pit Services Pickup (Crewcab)	10.21	0	137	274	274	274	274	274	274	274	274	274	274	274	274	274	274	274	274	45
Shovel Crew Flat Deck	10.21	0	23	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	7.5
Shovel Crew Hiab	10.21	0	38	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	12
Surface Crew Hiab	10.21	0	38	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	12
Lighting Tower	10.21	0	114	228	228	228	228	228	228	228	228	228	228	228	228	228	228	228	228	37
Mine Rescue Vehicle	10.21	0	28	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	9.4

Notes:

1. CO_2 emission factor is from 40 CFR Part 98, Subpart C, Table C-1.
2. Annual fuel usage was provided by Castle Mountain Venture.
3. CO_2 emissions are assumed to be 100% biogenic based on the assumption of the use of 100% renewable diesel fuel in off-road equipment, consistent with regulatory requirements under the CARB In-Use Off-Road Diesel-Fueled Fleets Regulation and CMV commitments.

References:

CARB. In-Use Off-Road Diesel-Fueled Fleets regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/off-roaddiesel/appa-1.pdf

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

Abbreviations:

CARB - California Air Resources Board
CMV - Castle Mountain Venture
CO_2 - carbon dioxide
gal - gallons
GHG - greenhouse gas
kg - kilograms
MT - metric tons
USEPA - United States Environmental Protection Agency
yr - year

Table GHG-7b
2022 Mine Plan of Operations: Operational GHG Emissions
On-site Mobile Vehicle Exhaust CH_4 Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	CH_4 Emission Factors (kg/gal)[1]	Annual CH_4 Emissions[2] (MT/yr)																		
		Operation Year 1	Operation Year 2	Operation Year 3	Operation Year 4	Operation Year 5	Operation Year 6	Operation Year 7	Operation Year 8	Operation Year 9	Operation Year 10	Operation Year 11	Operation Year 12	Operation Year 13	Operation Year 14	Operation Year 15	Operation Year 16	Operation Year 17	Operation Year 18	Operation Year 19
Production Blasthole Drill	9.4E-04	0	0.11	0.42	0.31	0.28	0.35	0.31	0.35	0.40	0.40	0.38	0.42	0.48	0.52	0.36	0.42	0.30	0.060	0.0088
Wall Control Drill	9.4E-04	0	0.047	0.12	0.11	0.11	0.13	0.14	0.16	0.18	0.17	0.14	0.16	0.18	0.21	0.15	0.15	0.16	0.090	0.025
Hydraulic Shovel	9.4E-04	0	0.16	0.91	0.90	0.90	0.98	0.90	0.98	1.1	1.1	1.1	1.3	1.2	1.3	1.3	1.2	0.89	0.34	0.054
Wheel Loader	9.4E-04	0	0.064	0.36	0.35	0.35	0.30	0.28	0.31	0.34	0.33	0.33	0.40	0.39	0.40	0.39	0.36	0.28	0.11	0.017
Haul Trucks	9.4E-04	0.27	0.66	1.8	2.4	2.8	3.0	2.8	3.1	3.1	2.9	2.5	2.8	3.0	3.5	4.0	3.8	3.9	1.9	0.33
Track Dozer	9.4E-04	0	0.20	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.40	0.40	0.40	0.40	0.20	0.033
Wheel Dozer	9.4E-04	0	0.078	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.026
Grader	9.4E-04	0	0.059	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.019
Water Truck	9.4E-04	0	0.067	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.067	0.011
Wheel Loader	9.4E-04	0	0.025	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.0083
Haul Truck	9.4E-04	0	0.063	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.084	0.084	0.084	0.084	0	0	0
Excavator	9.4E-04	0	0.0084	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.0028
Tire Manipulator	9.4E-04	0	0.0058	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.002
Vibratory Compactor	9.4E-04	0	0.0037	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0012
Backhoe	9.4E-04	0	0.0044	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0014
Articulated Truck	9.4E-04	0	0.0035	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0012
Fuel and Lube Truck	9.4E-04	0	0.0252	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.0083
Tractor and Low Bed	9.4E-04	0	0.0010	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	3.5E-04
Flatbed Hiab Truck	9.4E-04	0	0.0037	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0012
Rough Terrain Forklift	9.4E-04	0	0.0026	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	8.6E-04
Shop Forklift	9.4E-04	0	0.0017	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	5.8E-04
Mechanics Truck	9.4E-04	0	0.0026	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	8.6E-04
Welding Truck	9.4E-04	0	0.0031	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0010
Staff Pickup Trucks	9.4E-04	0	0.042	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.014
Pit Services Pickup	9.4E-04	0	0.044	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.014
Staff Pickup Trucks (Crewcab)	9.4E-04	0	0.013	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.0041
Pit Services Pickup (Crewcab)	9.4E-04	0	0.013	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.0041
Shovel Crew Flat Deck	9.4E-04	0	0.0021	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0007
Shovel Crew Hiab	9.4E-04	0	0.0035	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0012
Surface Crew Hiab	9.4E-04	0	0.0035	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0012
Lighting Tower	9.4E-04	0	0.010	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.0035
Mine Rescue Vehicle	9.4E-04	0	0.0026	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	8.6E-04

Notes:

1. CH_4 emission factors are from the EPA Center for Corporate Climate Leadership (2022, April 1) Emission Factors for Greenhouse Gas Inventories, Table 5 (available at https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf) which are calculated from the USEPA Inventory of U.S. Greenhouse Gas Emission and Sinks: 1990-2019.
2. Annual fuel usage was provided by Castle Mountain Venture and is presented in Table GHG-6.

References:

USEPA. 2021. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019. Available at: https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-annexes.pdf

Abbreviations:

CARB - California Air Resources Board
CH_4 - methane
CMV - Castle Mountain Venture
gal - gallons
GHG - greenhouse gas
kg - kilograms
MT - metric tons
USEPA - United States Environmental Protection Agency
yr - year

Table GHG-7c
2022 Mine Plan of Operations: Operational GHG Emissions
On-site Mobile Vehicle Exhaust N_2O Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	N_2O Emission Factors (kg/gal)[1]	Annual N_2O Emissions[2] (MT/yr)																		
		Operation Year 1	Operation Year 2	Operation Year 3	Operation Year 4	Operation Year 5	Operation Year 6	Operation Year 7	Operation Year 8	Operation Year 9	Operation Year 10	Operation Year 11	Operation Year 12	Operation Year 13	Operation Year 14	Operation Year 15	Operation Year 16	Operation Year 17	Operation Year 18	Operation Year 19
Production Blasthole Drill	8.7E-04	0	0.10	0.39	0.29	0.26	0.32	0.29	0.32	0.37	0.37	0.35	0.39	0.44	0.48	0.33	0.39	0.28	0.055	0.0082
Wall Control Drill	8.7E-04	0	0.043	0.11	0.11	0.098	0.12	0.13	0.15	0.17	0.15	0.13	0.15	0.17	0.20	0.14	0.14	0.14	0.083	0.023
Hydraulic Shovel	8.7E-04	0	0.15	0.84	0.83	0.83	0.90	0.83	0.91	1.0	0.99	0.99	1.2	1.2	1.2	1.2	1.1	0.82	0.32	0.050
Wheel Loader	8.7E-04	0	0.059	0.33	0.33	0.33	0.28	0.26	0.28	0.32	0.31	0.31	0.37	0.36	0.37	0.37	0.33	0.26	0.098	0.015
Haul Trucks	8.7E-04	0.25	0.61	1.7	2.2	2.6	2.8	2.6	2.9	2.9	2.7	2.3	2.6	2.7	3.3	3.7	3.5	3.6	1.7	0.30
Track Dozer	8.7E-04	0	0.18	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.37	0.37	0.37	0.37	0.18	0.030
Wheel Dozer	8.7E-04	0	0.073	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.024
Grader	8.7E-04	0	0.054	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.018
Water Truck	8.7E-04	0	0.062	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.062	0.010
Wheel Loader	8.7E-04	0	0.023	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.05	0.047	0.0077
Haul Truck	8.7E-04	0	0.058	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.078	0.078	0.078	0.078	0	0	0
Excavator	8.7E-04	0	0.0078	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.0026
Tire Manipulator	8.7E-04	0	0.0053	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.0018
Vibratory Compactor	8.7E-04	0	0.0034	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0011
Backhoe	8.7E-04	0	0.0040	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0013
Articulated Truck	8.7E-04	0	0.0032	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0011
Fuel and Lube Truck	8.7E-04	0	0.023	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.0077
Tractor and Low Bed	8.7E-04	0	9.7E-04	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	3.2E-04
Flatbed Hiab Truck	8.7E-04	0	0.0034	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0011
Rough Terrain Forklift	8.7E-04	0	0.0024	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	8.0E-04
Shop Forklift	8.7E-04	0	0.0016	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	5.3E-04
Mechanics Truck	8.7E-04	0	0.0024	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	8.0E-04
Welding Truck	8.7E-04	0	0.0029	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	9.6E-04
Staff Pickup Trucks	8.7E-04	0	0.039	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.013
Pit Services Pickup	8.7E-04	0	0.041	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.013
Staff Pickup Trucks (Crewcab)	8.7E-04	0	0.012	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.0038
Pit Services Pickup (Crewcab)	8.7E-04	0	0.012	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.0038
Shovel Crew Flat Deck	8.7E-04	0	0.0019	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	6.4E-04
Shovel Crew Hiab	8.7E-04	0	0.0032	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0011
Surface Crew Hiab	8.7E-04	0	0.0032	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0011
Lighting Tower	8.7E-04	0	0.0097	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.0032
Mine Rescue Vehicle	8.7E-04	0	0.0024	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	8.0E-04

Notes:

1. N_2O emission factors are from the EPA Center for Corporate Climate Leadership (2022, April 1) Emission Factors for Greenhouse Gas Inventories, Table 5 (available at https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf) which are calculated from the USEPA Inventory of U.S. Greenhouse Gas Emission and Sinks: 1990-2019.
2. Annual fuel usage was provided by Castle Mountain Venture and is presented in Table GHG-6.

References:

USEPA. 2021. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019. Available at: https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-annexes.pdf

Abbreviations:

CARB - California Air Resources Board
CMV - Castle Mountain Venture
gal - gallons
GHG - greenhouse gas
kg - kilograms
MT - metric tons
N_2O - nitrous oxide
USEPA - United States Environmental Protection Agency
yr - year

Table GHG-8a
2022 Mine Plan of Operations: Operational GHG Emissions
Off-site On-Road Mobile Vehicles
Trip Rates
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type	Trip Type	Trip Length (miles/RT)	Annual Trips (RT/yr)	Annual VMT (miles/yr)
Employee Vehicles[1]	Employee Vehicles - Full Commute	170	6,000	1,020,000
	Employee Vehicles - To/From Vans/Buses	12	58,400	700,800
Vans/Buses[2]	Vans/Buses	170	1,825	310,250
Fuel Delivery Trucks[3]	Fuel Delivery Trucks	206	1,040	214,240
LNG Delivery Trucks[4]	LNG Delivery Trucks	368	1,095	402,960
Product Delivery Trucks[5]	Product Delivery Trucks (gold to market)	836	26	21,736
Contractor Trucks[6]	Blasting Contractor Trucks	206	312	64,272
	Maintenance Contractor Trucks	206	730	150,380
Other Delivery Trucks[6]	Other Delivery Trucks (Warehouse to Coyote)	52	1,872	97,344
	Other Delivery Trucks (Las Vegas Origin)	206	1,825	375,950
Reagent Delivery Trucks[6]	Reagent Delivery Trucks (Antiscalant)	1,442	5	7,210
	Reagent Delivery Trucks (Carbon)	1,024	2	2,048
	Reagent Delivery Trucks (Caustic Soda)	578	26	15,028
	Reagent Delivery Trucks (Flocculant, Anionic)	574	12	6,888
	Reagent Delivery Trucks (Fluxes)	574	6	3,444
	Reagent Delivery Trucks (Pebble Lime)	206	780	160,680
	Reagent Delivery Trucks (Sodium Cyanide)	1,118	156	174,408

Notes:

1. Employee vehicle trip rates were based on the number of employees working at the facility and were provided by Castle Mountain Venture. Each employee was assumed to make one roundtrip per day, to and from the Project site. Employee activity was assumed to occur 365 days per year. A portion of the employees were assumed to commute the full distance between home and the facility in their personal vehicles. The remainder of the employees were assumed to commute an average of 12 miles roundtrip between home and the van/bus pickup locations in their personal vehicles. Potential van/bus pick up locations may include Las Vegas, NV, Henderson, NV, and Bullhead City/Laughlin, NV.
2. Van/bus trip rates were calculated based on the number of van/bus commuters and an assumption of 35 passengers/vehicle. An average roundtrip distance between the Henderson, NV, Bullhead City/Laughlin, NV, and Las Vegas, NV bus/van locations and the facility was assumed.
3. Annual trip rates for Fuel Delivery calculated based on daily average trip rates provided by Castle Mountain Venture and 260 days per year of activity. Daily trip rates were conservatively rounded up to the nearest whole number. Trip lengths assume all fuel would be delivered from Las Vegas, NV.
4. Annual trip rates for LNG Delivery calculated based on daily average trip rates provided by Castle Mountain Venture and 365 days per year of activity. Trip length was provided by Castle Mountain Venture based on expected supplier.
5. Annual trip rates assume one Product Delivery trip every other week. Trip length was provided by Castle Mountain Venture.
6. Trip rates, trip lengths, and annual activity for Contractors, Other Delivery Trucks, and Reagent Delivery Trucks were provided by Castle Mountain Venture.

Abbreviations:

RT - roundtrips
VMT - vehicle miles traveled
yr - year

Table GHG-8b
2022 Mine Plan of Operations: Operational GHG Emissions
On-site On-Road Mobile Vehicles
Trip Rates
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type	Trip Type	Trip Length (miles/RT)	Annual Trips (RT/yr)	Annual VMT (miles/yr)
Fuel Delivery Trucks[1]	Fuel Delivery Trucks	1.8	1,040	1,872
LNG Delivery Trucks[2]	LNG Delivery Trucks	1.8	1,095	1,971
Product Delivery Trucks[3]	Product Delivery Trucks (gold to market)	3.8	26	99
Contractor Trucks[4]	Blasting Contractor Trucks	3.8	312	1,186
	Maintenance Contractor Trucks	3.8	730	2,774
Other Delivery Trucks[4]	Other Delivery Trucks (Warehouse to Coyote)	3.8	1,872	7,114
	Other Delivery Trucks (Las Vegas Origin)	3.8	1,825	6,935
Reagent Delivery Trucks[4]	Reagent Delivery Trucks (Antiscalant)	3.8	5	19
	Reagent Delivery Trucks (Carbon)	3.8	2	7.6
	Reagent Delivery Trucks (Caustic Soda)	3.8	26	99
	Reagent Delivery Trucks (Flocculant, Anionic)	3.8	12	46
	Reagent Delivery Trucks (Fluxes)	3.8	6	23
	Reagent Delivery Trucks (Pebble Lime)	3.8	780	2,964
	Reagent Delivery Trucks (Sodium Cyanide)	3.8	156	593

Notes:

1. Annual trip rates for Fuel Delivery calculated based on daily average trip rates provided by Castle Mountain Venture and 260 days per year of activity. Daily trip rates were conservatively rounded up to the nearest whole number. Trip lengths assume all fuel would be delivered from Las Vegas, NV.
2. Annual trip rates for LNG Delivery calculated based on daily average trip rates provided by Castle Mountain Venture and 365 days per year of activity. Trip length was provided by Castle Mountain Venture based on expected supplier.
3. Annual trip rates assume one Product Delivery trip every other week. Trip length was provided by Castle Mountain Venture.
4. Trip rates, trip lengths, and annual activity for Contractor Trucks, Other Delivery Trucks, and Reagent Delivery Trucks were provided by Castle Mountain Venture.

Abbreviations:

RT - roundtrips
VMT - vehicle miles traveled
yr - year

Table GHG-9a
2022 Mine Plan of Operations: Operational GHG Emissions
Off-site On-Road Mobile Vehicles
Exhaust Emission Factors
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type	Emission Factor Units	Mobile Emission Factors[1]			
		CO_2	CH_4	N_2O	CO_2e[2]
Employee Vehicles	g/mile	294	0.0031	0.0054	296
	g/trip	73	0.069	0.032	84
Vans	g/mile	615	0.0047	0.0095	618
	g/trip	34	0.040	0.049	49
Fuel Delivery Trucks	g/mile	1,450	5.6E-04	0.23	1,518
	g/trip	1,030	0.022	0.16	1,079
LNG Delivery Trucks	g/mile	1,080	0.83	0.22	1,167
	g/trip	1,149	4.0	0.23	1,320
Product Delivery, Contractor, Other Delivery, and Reagent Delivery Trucks	g/mile	1,423	5.6E-04	0.22	1,490
	g/trip	969	0.021	0.15	1,015

Notes:

1. Emission factors were estimated using EMFAC2021 for MDAQMD. EMFAC2021 was run in Emission Rates mode for calendar year 2027 in the annual season. The following processes have units of g/trip: STREX and IDLEX. The following process has units of g/mile: RUNEX. Processes with units of g/vehicle/day were converted to g/trip using the population and trip rate values given in the EMFAC2021 run.
2. Annual CO_2e emissions were calculated using GWP values from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (ARB) 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
EMFAC2021 - California Air Resources Board EMission FACtor model
g - grams
GHG - greenhouse gas
GWP - global warming potential
IDLEX - idle exhaust emissions
MDAQMD - Mojave Desert Air Quality Management District
N_2O - nitrous oxide
RUNEX - running exhaust emissions
STREX - start exhaust tailpipe emissions

Table GHG-9b
2022 Mine Plan of Operations: Operational GHG Emissions
On-site On-Road Mobile Vehicles
Exhaust Emission Factors
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type	Emission Factor Units	Mobile Emission Factors[1]			
		CO_2	CH_4	N_2O	CO_2e[2]
Fuel Delivery Trucks	g/mile	1,450	5.6E-04	0.23	1,518
LNG Delivery Trucks	g/mile	1,080	0.83	0.22	1,167
Product Delivery, Contractor, Other Delivery, and Reagent Delivery Trucks	g/mile	1,423	5.6E-04	0.22	1,490

Notes:

1. Emission factors were estimated using EMFAC2021 for MDAQMD. EMFAC2021 was run in Emission Rates mode for calendar year 2027 in the annual season. The following process has units of g/mile: RUNEX. For the Delivery Truck fleets, the g/trip emission factors are not presented because these trips originate off-site and the emissions generated on a per trip basis are already accounted for in **Tables GHG-8a, GHG-9a, and GHG-10a**.
2. Annual CO_2e emissions were calculated using GWP values from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

California Air Resources Board (CARB) 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
EMFAC2021 - California Air Resources Board EMission FACtor model
g - grams
GHG - greenhouse gas
GWP - global warming potential
MDAQMD - Mojave Desert Air Quality Management District
N_2O - nitrous oxide
RUNEX - running exhaust emissions

Table GHG-10a
2022 Mine Plan of Operations: Operational GHG Emissions
Off-Site On-Road Mobile Vehicles
Exhaust Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type	Annual Emissions (MT/yr)				
	CO_2	CH_4	N_2O	Biogenic CO_2e	Non-biogenic CO_2e
Employee Vehicles	510	0.010	0.011	0	514
Vans	191	0.0015	0.0030	0	192
Fuel Delivery Trucks	312	1.4E-04	0.049	0	326
LNG Delivery Trucks[2]	437	0.34	0.089	437	35
Product Delivery Trucks	31	1.3E-05	0.0049	0	32
Contractor Trucks	306	1.4E-04	0.048	0	321
Other Delivery Trucks	677	3.4E-04	0.11	0	709
Reagent Delivery Trucks	527	2.3E-04	0.083	0	552
Total	**2,991**	**0.35**	**0.40**	**437**	**2,681**

Notes:

1. Trip generation rates and emission factors used in emissions calculations are shown in **Tables GHG-8a and GHG-9a**, respectively.
2. LNG Delivery Trucks will be fueled exclusively by renewable compressed natural gas. Therefore, the associated CO_2 emissions are treated as biogenic.

Abbreviations:

CO_2e - carbon dioxide equivalents

lb - pound

MT - metric tons

yr - year

Table GHG-10b
2022 Mine Plan of Operations: Operational GHG Emissions
On-Site On-Road Mobile Vehicles
Exhaust Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type	Annual Emissions (MT/yr)[1]				
	CO_2	**CH_4**	**N_2O**	**Biogenic CO_2e**	**Non-biogenic CO_2e**
Fuel Delivery Trucks	2.7	1.0E-06	4.3E-04	0	2.8
LNG Delivery Trucks[2]	2.1	0.0016	4.3E-04	2.1	0.17
Product Delivery Trucks	0.14	5.5E-08	2.2E-05	0	0.15
Contractor Trucks	5.6	2.2E-06	8.9E-04	0	5.9
Other Delivery Trucks	20	7.8E-06	0.0031	0	21
Reagent Delivery Trucks	5.3	2.1E-06	8.4E-04	0	5.6
Total	**36**	**0.0017**	**0.0058**	**2.1**	**36**

Notes:

1. Trip generation rates and emission factors used in emissions calculations are shown in **Tables GHG-8b and GHG-9b**, respectively.
2. LNG Delivery Trucks will be fueled exclusively by renewable compressed natural gas. Therefore, the associated CO_2 emissions are treated as biogenic.

Abbreviations:

CO_2e - carbon dioxide equivalents

lb - pound

MT - metric tons

yr - year

Table GHG-11
2022 Mine Plan of Operations: Operational GHG Emissions
Blasting Explosives Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter	**Blasting Explosives**		**Units**
Explosive Type[1]	ANFO	TNT	--
Amount of Explosive Detonated[1]	10,184	22	tpy
CO_2 Emission Factor[2]	0.189		ton/ton
Maximum Annual CO_2 Emissions	1,746		MT/yr
CH_4 Emission Factor[3]		14.3	lb/ton
Maximum Annual CH_4 Emissions		287	MT/yr
Total CO_2e Emissions	**8,921**		**MT/yr**

Notes:

1. Explosive type and amount of explosive detonated per year was provided by Castle Mountain Venture.
2. Emission factor for CO_2 is based on guidance from The Mining Association of Canada.
3. Emission factor for CH_4 is based on AP-42, Section 13.3, Table 13.3.

References:

The Mining Association of Canada. 2014. Toward Sustainable Mining: Energy and GHG Emissions Management Reference Guide. June. Available online at: https://mining.ca/wp-content/uploads/dlm_uploads/2021/06/EnergyandGreenhouseGasEmissionsManagementReferenceGuide2014.pdf.

USEPA. 1980. AP-42, Section 13.3, Explosives Detonation. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s03.pdf. February.

Abbreviations:

ANFO - ammonium nitrate fuel oil
CH_4 - methane
CO_2 - carbon dioxide
MT - metric tons
TNT - trinitrotoluene
tpy - tons per year
USEPA - United States Environmental Protection Agency

Table GHG-12
2022 Mine Plan of Operations: Operational GHG Emissions
Diesel Generator Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Emergency Generators #1 through #4	Diesel Water Well Generators #1 and #2	Units
Quantity		4	2	--
Maximum Engine Rating		778	65.7	HP
		580	49	KW
Generator Power		455	36	kW
Fuel Type		Diesel	Diesel	--
Fuel Consumption		33.4	2.93	gallons/hr
Load		100%	100%	--
Maximum Daily Hours		1	24	hrs
Annual Hours		100	8,760	hrs
Emission Factors[1]	CO_2	73.96	73.96	kg/MMBtu
	CH_4	0.0030	0.0030	kg/MMBtu
	N_2O	6.0E-04	6.0E-04	kg/MMBtu
Maximum Annual Emissions[2]	CO_2	136	524	MT/yr
	CH_4	0.0055	0.021	MT/yr
	N_2O	0.0011	0.0043	MT/yr
	CO_2e	137	526	MT/yr

Notes:

1. GHG emission factors are from 40 CFR Part 98, Subpart C Tables C-1 and C-2.
2. CO_2 equivalent (CO_2e) emissions calculated based on CO_2, N_2O, and CH_4 emissions and the corresponding GWP from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

Code of Federal Regulations. Title 40 Chapter I Subchapter A Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98/subpart-A

Code of Federal Regulations. Title 40 Chapter I Subchapter C Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

USEPA. 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
GHG - greenhouse gas
GWP - global warming potential
HP - horsepower
hr - hour
kg - kilogram
kW - kilowatt
MDAQMD - Mojave Desert Air Quality Management District
MMBtu - million British thermal units
MRR - Mandatory Reporting Regulation
MT - metric ton
yr - year

Table GHG-13
2022 Mine Plan of Operations: Operational GHG Emissions
Electricity Usage Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Historical Electricity Intensity

Provider	Annual Electricity Data	2021	2022	2023	Average[1]	Units
Nevada Energy (NVE)	CO_2e Intensity Factor per Total Energy Delivered[2]	763	772	754	763	lb CO_2e/MWh delivered
	CH_4 Intensity Factor per Total Energy Delivered[3]	0.057	0.055	0.048	0.053	lb CH_4/MWh delivered
	N_2O Intensity Factor per Total Energy Delivered[3]	0.008	0.008	0.007	0.0077	lb N_2O/MWh delivered
	CO_2 Intensity Factor per Total Energy Delivered[4]	759	768	751	759	lb CO_2/MWh delivered
	% of Total Energy From RPS-Eligible Renewables[5]	31%	36%	40%	35%	-
	CH_4 Intensity Factor per Total Non-RPS-Eligible Energy[6]	0.0823	0.086	0.080	0.082	lb CH_4/MWh delivered
	N_2O Intensity Factor per Total Non-RPS-Eligible Energy[6]	0.012	0.012	0.012	0.0119	lb N_2O/MWh delivered
	CO_2 Intensity Factor per Total Non-RPS-Eligible Energy[6]	1,095	1,194	1,245	1,178	lb CO_2/MWh delivered
Southern California Edison (SCE)	CO_2e Intensity Factor per Total Energy Delivered[7]	452	444	374	423	lb CO_2e/MWh delivered
	CH_4 Intensity Factor per Total Energy Delivered[3]	0.057	0.055	0.048	0.053	lb CH_4/MWh delivered
	N_2O Intensity Factor per Total Energy Delivered[3]	0.008	0.008	0.007	0.0077	lb N_2O/MWh delivered
	CO_2 Intensity Factor per Total Energy Delivered[4]	448	440	371	420	lb CO_2/MWh delivered
	% of Total Energy From RPS-Eligible Renewables[7]	36%	36%	41%	38%	-
	CH_4 Intensity Factor per Total Non-RPS-Eligible Energy[5]	0.0888	0.086	0.081	0.085	lb CH_4/MWh delivered
	N_2O Intensity Factor per Total Non-RPS-Eligible Energy[5]	0.012	0.013	0.012	0.012	lb N_2O/MWh delivered
	CO_2 Intensity Factor per Total Non-RPS-Eligible Energy[5]	698	690	626	671	lb CO_2/MWh delivered

Estimated Intensity Factor for Total Grid Energy Delivered[8]

Provider	Model Year	CO_2 Intensity Factor[1] (lb/MWh delivered)	CH_4 Intensity Factor[1] (lb/MWh delivered)	N_2O Intensity Factor[1] (lb/MWh delivered)
Nevada Energy (NVE)[9]	2027-2029 RPS (42%)	683	0.048	0.0069
	2030+ RPS (50%)	589	0.041	0.0059
Southern California Edison (SCE)[10]	2027-2029 RPS (52%)	322	0.041	0.0059
	2030+ RPS (60%)	269	0.034	0.0049

Electricity Use Rates[11]

Source	Running Load (MW)	Annual (MWh/yr)
On-site Facilities - Nevada Energy (NVE)	10.0	87,600
Off-site Facilities (Water Sourcing) - Southern California Edison (SCE)	1.3	11,511
Total	**11.3**	**99,111**

Electricity Emissions[12]

Source	CO_2 Emissions (MT/yr)		CH_4 Emissions (MT/yr)		N_2O Emissions (MT/yr)	
	2027-2029	2030+	2027-2029	2030+	2027-2029	2030+
On-site Facilities - Nevada Energy (NVE)	27,151	23,406	1.9	1.6	0.27	0.24
Off-site Facilities (Water Sourcing) - Southern California Edison (SCE)	1,683	1,402	0.21	0.18	0.031	0.026
Total	**28,834**	**24,808**	**2.1**	**1.8**	**0.30**	**0.26**

Notes:

1. Uses average of data from years 2021-2023.
2. CO_2e intensity factors for Nevada Energy are from 2021-2023 Nevada Energy ESG Sustainability Reports.
3. CH_4 and N_2O intensity factors are from eGRID2021, eGRID2022, and eGRID2023 data for the Western Electricity Coordinating Council (WECC) region.
4. CO_2 intensity factors are back calculated based on CO_2e intensity factors from the energy provider, CH_4 and N_2O intensity factors from eGRID, and global warming potentials (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).
5. Percentage of energy from RPS-Eligible Renewables for Nevada Energy are from the Nevada Governor's Office of Energy's 2022 Status of Energy Report.
6. The emissions metrics presented here are calculated based on the intensity factors divided by the percent of energy delivered from non-RPS-eligible renewable sources. These intensity factors includes both fossil fuel and carbon-free sources of energy, such as large-scale hydro and nuclear.
7. Total CO_2e intensity factors and percentage of energy from RPS-Eligible Renewables for SCE are from the 2021-2023 Edison International Sustainability Reports.
8. The intensity factors for total energy delivered are estimated by multiplying the percentage of energy delivered from non-RPS-eligible renewable energy by the GHG emissions per total non-RPS-eligible renewable energy metric calculated above.
9. RPS values for Nevada Energy are based on scheduled renewable energy rate increases as outlined in https://puc.nv.gov/Renewable_Energy/Portfolio_Standard/.
10. RPS values for Southern California Edison are based on requirement in Senate Bill 100 as outlined in https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/rps/rps-compliance-rules-and-process/60-percent-rps-procurement-rules.
11. Running loads provided by Castle Mountain Venture. An electricity load of 20 MW is anticipated on an annual/regular basis. On-site power generation will account for 10 MW of the on-site electricity load, with the remaining on-site load from grid power. Annual electricity use rates calculated assuming 8,760 hours per year of facility
12. Emissions calculated based on intensity factor and electricity use rate.

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

California Public Utilities Commission. 60% RPS Procurement Rules. Available online at: https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/rps/rps-compliance-rules-and-process/60-percent-rps-procurement-rules

Edison International. 2021 Sustainability Report. Available online at: https://www.edison.com/_gallery/get_file/?file_id=634a11c88ed7df0e03e0e410&file_ext=.pdf&page_id=

Edison International. 2022 Sustainability Report. Available online at: https://www.edison.com/_gallery/get_file/?file_id=6477e962b3aed34e0382ae64&file_ext=.pdf&page_id=

Edison International. 2023 Sustainability Report. Available online at: https://www.edison.com/_gallery/get_file/?file_id=6657b3b63d6332eaafbcc867&file_ext=.pdf&page_id=

NV Energy. 2021 NV Energy Sustainability Report. Available online at: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/cleanenergy/sustainability/2021-sustainability-nvenergy.pdf

NV Energy. 2022 NV Energy Sustainability Report. Available online at: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/cleanenergy/sustainability/2022-sustainability-nvenergy.pdf

NV Energy. 2023 NV Energy Sustainability Report. Available online at: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/cleanenergy/sustainability/2023-sustainability-nvenergy.pdf

EPA. 2023. eGRID2021 Data File. Available online at: https://www.epa.gov/system/files/documents/2023-01/eGRID2021_data.xlsx

EPA. 2024. eGRID2022 Data File. Available online at: https://www.epa.gov/system/files/documents/2024-01/egrid2022_data.xlsx

EPA. 2025. eGRID2023 Data File. Available online at: https://www.epa.gov/system/files/documents/2025-06/egrid2023_data_rev2.xlsx

Nevada Governor's Office of Energy. 2023. 2022 Status of Energy Report. January. Available online at: https://energy.nv.gov/uploadedFiles/energynvgov/content/Media/2022_status_of_energy_final.pdf.

Nevada Governor's Office of Energy. 2024. 2024 Status of Energy Report. January. Available online at: https://energy.nv.gov/uploadedFiles/energynvgov/content/Home/Features/2024%20Status%20of%20Energy%20Report_Final.pdf

State of Nevada Public Utilities Commission. Renewable Portfolio Standard. Available online at: https://puc.nv.gov/Renewable_Energy/Portfolio_Standard/

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CH_4 - methane

CO_2e - carbon dioxide

GWP - global warming potential

lb - pounds

MRR - Mandatory Reporting Regulation

MT - metric tons

MW - megawatts

MWh - megawatt hours

N_2O - nitrous oxide

NVE - Nevada Energy

RPS - renewable portfolio standard

SCE - Southern California Edison

yr - year

Table GHG-14
2022 Mine Plan of Operations: Operational GHG Emissions
Solid Waste Generation Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Solid Waste Generation Rate[1]

Waste Type	Solid Waste Generation Rate (lb/employee/day)	Number of Employees	Annual Solid Waste Generation (tpy)
Organic	8.93	423	689

Solid Waste Landfill Gas (LFG) Treatment Types[2]

Landfill, No Gas Capture	Landfill, Capture Gas Flare
100%	0%

Solid Waste Landfill Gas Emission Factors[3]

Description	CO_2 Emissions (ton/ton waste)	CH_4 Emissions (ton/ton waste)
No LFG Collection	0.097	0.032

Solid Waste GHG Emissions[4]

Waste Type	CO_2 Emissions (MT/yr)	CH_4 Emissions (MT/yr)	CO_2e Emissions (MT/yr)
Organic	60	20	555

Notes:

1. Waste generation rate based on industrial waste generation rate per employee from City of Los Angeles CEQA Thresholds Guide and number of employees at the facility.
2. Solid Waste Landfill Gas Treatment Types from Appendices C and G of the CalEEMod® User's Guide, with the exception that "Landfill, No Gas Capture" was conservatively set to 100%.
3. Solid Waste Landfill Gas Emission Factors from Table G-37 of CalEEMod® User's Guide, Appendix G.
4. CO_2e emissions calculated using a global warming potential of 1 for CO_2 and 25 for CH_4.

References:

California Air Pollution Control Officers Association (CAPCOA). 2022. User's Guide of CalEEMod® Version 2022.1. May. Available online at: https://www.caleemod.com/user-guide

City of Los Angeles. 2006. L.A. CEQA Thresholds Guide: Your Resource for Preparing CEQA Analyses in Los Angeles. Available online at: https://planning.lacity.org/eir/CrossroadsHwd/deir/files/references/A07.pdf

Abbreviations:

CalEEMod® - California Emissions Estimator Model
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
lb - pounds
LFG - landfill gas
MT - metric ton
tpy - tons per year
yr - year

Table GHG-15
2022 Mine Plan of Operations: Operational GHG Emissions
Wastewater Treatment Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Water Use Rates[1]

End Use	Average Demand (gpm)	Annual Average Demand (MMgal/yr)
Ancillary Facilities/Offices	22	12

Wastewater Treatment Direct Emission Factors[2]

Wastewater Treatment Type	CO_2 Biogenic (ton/gal)	CO_2 Non-Biogenic (ton/gal)	CH_4 (ton/gal)	N_2O (ton/gal)
Septic	0	0	2.5E-07	8.52E-10

Wastewater Treatment Direct Emissions[3]

End Use	Direct CH_4 Emissions (MT/yr)	Direct N_2O Emissions (MT/yr)	Total Direct Emissions (MT CO_2e/yr)
Ancillary Facilities/Offices	2.6	0.0089	68

Notes:

1. Water use rates provided by Castle Mountain Venture. Annual water use rates calculated assuming continuous operation of water pumps (24/7). Emissions are only expected from the wastewater treatment of potable water. Potable water will be supplied from onsite wells and thus emissions associated with pumping and supplying water to ancillary facilities/offices are assumed to be captured in the well generator emissions.
2. Wastewater Treatment Direct Emission Factors from Table G-35 of Appendix G of the CalEEMod® User's Guide. All wastewater is assumed to be treated with an on-site septic system.
3. CO_2 equivalent (CO_2e) emissions calculated based on CO_2, N_2O, and CH_4 emissions and the corresponding global warming potentials (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Pollution Control Officers Association (CAPCOA). 2022. User's Guide of CalEEMod® Version 2022.1. April. Available online at: https://www.caleemod.com/user-guide

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

Code of Federal Regulations. Title 40 Chapter I Subchapter A Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98/subpart-A

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

USEPA. 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CalEEMod® - California Emissions Estimator Model
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
gal - gallon
gpm - gallons per minute
GWP - global warming potential
MMgal - million gallons
MT - metric ton
N_2O - nitrous oxide
yr - year

Table GHG-16
2022 Mine Plan of Operations: Operational GHG Emissions
On-site Power Generation Emissions from NG Turbines
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Value	Units
Fuel Type		LNG	--
Total Capacity		10.4	MW
Total Fuel Throughput		2,571	MMBTU/day
		938,371	MMBTU/yr
Load		100%	--
Daily hours		24	hrs
Annual Hours		8,760	hrs
Emission Factors[1]	CO_2	53	kg/MMBtu
	CH_4	1.0	g/MMBtu
	N_2O	0.10	g/MMBtu
Maximum Annual Emissions[2]	CO_2	49,790	MT/yr
	CH_4	0.47	MT/yr
	N_2O	0.047	MT/yr
	CO_2e	49,816	MT/yr

Notes:

1. GHG emission factors are based on USEPA emission factors for greenhouse gas inventories for natural gas combustion in stationary equipment from 40 CFR Part 98, Tables C-1 and C-2.
2. CO_2 equivalent emissions calculated based on CO_2, N_2O, and CH_4 emissions and the corresponding GWP from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

Abbreviations:

Btu - British thermal units
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
g - gram
GHG - greenhouse gas
GWP - global warming potential
hr - hour
kg - kilogram
MMBtu - million British thermal units
MRR - Mandatory Reporting Regulation
MT - metric ton
MW - megawatt
MWh - megawatt-hour
NG - Natural Gas
N_2O - nitrous oxide
scf - standard cubic feet
yr - year

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

Code of Federal Regulations. Title 40 Chapter I Subchapter A Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98/subpart-A

Code of Federal Regulations. Title 40 Chapter I Subchapter C Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

USEPA. 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Table GHG-17
2022 Mine Plan of Operations: Operational GHG Emissions
LNG Storage Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fugitive Leak Emissions

Component	Component Count[1]	Total Leaking Time[2] (hr/yr)	CH_4 Emission Factor[3] (scf/hr/component)	Annual Fugitive Leak CH_4 Emissions[4] (scf/yr)	Annual Fugitive Leak CH_4 Emissions[5] (MT/yr)	Annual Fugitive Leak CO_2e Emissions[6] (MT/yr)
Valve	32	2,190	1.19	83,395	1.6	40
Pump Seal	0	2,190	4.00	0	0	0
Connector	32	2,190	0.34	23,827	0.46	11
Other	32	2,190	1.77	124,042	2.4	60
			Total	231,264	4.4	111

Notes:

1. Component count estimates provided by the LNG supplier. Pumps, and therefore pump seals, are not expected to be used.
2. Conservatively assumes fugitive leaks occur over one quarter of the year.
3. Fugitive leak CH_4 emission factors are from Appendix A, Table 5 of the California Mandatory Reporting Regulation (MRR).
4. Fugitive leak CH_4 emissions are calculated based on component counts, total leaking time, and CH_4 emission factors.
5. Methane mass emissions based on density of methane as specified in Section 95153(t) of the California MRR, and methane volume emissions.
6. CO_2 equivalent (CO_2e) emissions calculated based on CH_4 emissions and the corresponding global warming potential (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California MRR.

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CH_4 - methane
CO_2e - carbon dioxide equivalents
GHG - greenhouse gas
GWP - global warming potential
hr - hour
LNG - liquefied natural gas
MRR - Mandatory Reporting Regulation
MT - metric ton
scf - standard cubic feet
yr - year

ENERGY ANALYSIS, SUMMARY AND DETAILED TABLES

2022 Mine Plan of Operations: Table E-1
Summary of Construction Energy Consumption
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source	Gasoline Usage (gal)	Conventional Diesel Usage (gal)	Renewable Diesel Usage[3] (gal)	Electricity Usage (MWh)
Off-Road Construction Equipment[1]	--	--	1,106,002	--
On-Road Construction Trips[2]	266,098	158,952	--	16,632
Total	266,098	158,952	1,106,002	16,632

Notes:

1. Off-Road fuel usage is calculated in 2022 Mine Plan of Operations: Table E-2.
2. On-Road fuel usage is calculated in 2022 Mine Plan of Operations: Table E-3.
3. All offroad equipment is assumed to use renewable diesel.

Abbreviations:

gal - gallons
MWh - Megawatt per hour

2022 Mine Plan of Operations: Table E-2
Estimated Energy Consumption by Off-Road Construction Equipment
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Equipment Type	Equipment Details	Fuel[1]	Number[2]	Horsepower[3]	kW	Load Factor[4]	Operating Hours per Year[2,5]		Fuel Usage (gal renewable diesel)[6]
							Year 1	Year 2	
Dozers	D6	Renewable Diesel	4	215	160	0.40	2,080	1,040	54,827
	D9	Renewable Diesel	5	452	337	0.40	2,080	1,040	144,081
	D10	Renewable Diesel	2	602	449	0.40	2,080	1,040	76,758
Loader	Cat 950	Renewable Diesel	3	249	186	0.36	1,040	520	21,430
Motor-Grader	Cat 140 M	Renewable Diesel	3	183	136	0.41	2,080	1,040	35,875
Scraper	Cat 657	Renewable Diesel	10	473	353	0.48	2,080	1,040	361,859
Aerial Lifts	Boom Lifts	Renewable Diesel	15	63	47	0.42	2,080	1,040	63,258
	Scissor Lifts	Renewable Diesel	15	63	47	0.42	2,080	1,040	63,258
Water Truck	Cat 740 WW (8k)	Renewable Diesel	3	484	361	0.38	2,080	1,040	87,940
	2500 Gallon Trucks	Renewable Diesel	2	402	300	0.38	2,080	1,040	48,694
Maintenance Fuel/Lube	--	Renewable Diesel	5	402	300	0.38	780	390	45,651
Other	Skid Steer	Renewable Diesel	4	65	48	0.37	1,560	780	11,499
	Cranes	Renewable Diesel	6	231	172	0.29	2,080	1,040	64,062
	Telehandler	Renewable Diesel	6	89	66	0.42	1,560	780	26,810

Notes:

1. All off-road equipment used at the facility is assumed to use renewable diesel.
2. Equipment quantity and operating hours per year provided by Castle Mountain Venture.
3. Engine horsepower estimated based off of typical equipment for the types of equipment listed.
4. Load factors for off-road equipment were selected from default values from OFFROAD2017 as provided in Appendix G of the CalEEMod® User's Guide (CAPCOA 2022).
5. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027).
6. Fuel usage is calculated by taking the horsepower-hours for each piece of equipment (calculated as horsepower * usage hours * load factor) and multiplying it by the gallons of diesel consumption per horsepower-hour consistent with USEPA AP-42 diesel fuel data in Table 3.4.1, which cites an average brake-specific fuel consumption (BSFC) of 7,000 BTU/hp-hr, a heating value of 19,300 BTU/lb, and density of 7.1 lb/gal. Consistent with ARB guidelines, renewable diesel is treated the same as conventional diesel (ARB 2022).

Abbreviations:

BTU - British Thermal Unit
CARB - California Air Resources Board
gal - gallon(s)
hp - horsepower
hr - hour
kW - kilowatt
lb - pound(s)
USEPA - United States Environmental Protection Agency

References:

ARB. 2022. Renewable Diesel Joint Statement. Available online at: https://ww2.arb.ca.gov/our-work/programs/alternative-diesel-fuels/biodiesel-renewable-diesel

California Air Pollution Control Officers Association (CAPCOA). 2022. User's Guide of CalEEMod® Version 2022.1. April. Available online at: https://www.caleemod.com/user-guide

USEPA. 1996. AP-42 Chapter 3.4 Large Stationary Diesel And Stationary Dual-fuel Engines. Available at: https://www.epa.gov/sites/default/files/2020-10/documents/c03s04.pdf

2022 Mine Plan of Operations: Table E-3
Estimated Energy Consumption by On-Road Construction Vehicles
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Project Fuel Efficiency Data by Fleet Type[1]

Scenario	Year	Fuel Efficiency[2]						VMT by Vehicle Fuel Type[3]					
		Gasoline	Diesel	Natural Gas	Electricity	Plug-in Hybrid (Gasoline)	Plug-in Hybrid (Electricity)	Gasoline	Diesel	Natural Gas	Electricity	Plug-in Hybrid (Gasoline)	Plug-in Hybrid (Electricity)
		(mi/gal)	(mi/gal)	(mi/DGE)	(mi/kWh)	(mi/gal)	(mi/kWh)	Percentage (%)					
Commuters to Vanpool	1	28	32	--	2.6	32	3.3	93%	0%	0%	4%	2%	2%
	2	29	32	--	2.6	32	3.3	93%	0%	0%	4%	2%	2%
Vehicles to Facility (single-axle vehicles)	1	20	24	--	2.6	31	3.3	50%	50%	0%	0%	0%	0%
	2	20	24	--	2.6	31	3.3	50%	50%	0%	0%	0%	0%
Vehicles to Facility (double-axle vehicles)	1	4.1	6.4	6,111	0.55	--	--	0%	100%	0%	0%	0%	0%
	2	4.2	6.5	6,180	0.55	--	--	0%	100%	0%	0%	0%	0%
Vanpool to Facility	1	14	20	--	1.8	--	--	100%	0%	0%	0%	0%	0%
	2	14	20	--	1.7	--	--	100%	0%	0%	0%	0%	0%

Fuel Consumption

Scenario	Year	Trip Rate[4] (RT/year)	Trip Length (mi/RT)	Annual VMT[5] (mi/yr)	Annual Fuel Consumption[6]					
					Gasoline	Diesel	Natural Gas	Electricity	Plug-in Hybrid (Gasoline)	Plug-in Hybrid (Electricity)
					(gallons)	(gallons)	(MMBtu)	(MWh)	(gallons)	(MWh)
Commuters to Vanpool	1	130,000	12	1,560,000	51,487	220	--	24	1,129	10,854
	2	65,000	12	780,000	25,156	105	--	13	598	5,742
Vehicles to Facility (single-axle vehicles)	1	19,500	170	3,607,500	90,477	76,205	--	--	--	--
	2	9,750	170	1,803,750	44,348	37,634	--	--	--	--
Vehicles to Facility (double-axle vehicles)	1	1,040	170	192,400	--	30,051	--	--	--	--
	2	520	170	96,200	--	14,737	--	--	--	--
Vanpool to Facility	1	2,860	170	486,200	35,561	--	--	--	--	--
	2	1,430	170	243,100	17,343	--	--	--	--	--

Annual Construction On-Road Fuel Usage		Annual Fuel Consumption					
		Gasoline	Diesel	Natural Gas	Electricity	Plug-in Hybrid (Gasoline)	Plug-in Hybrid (Electricity)
		(gallons)	(gallons)	(MMBtu)	(MWh)	(gallons)	(MWh)
Year	1	177,525	106,476	--	24	1,129	10,854
	2	86,846	52,476	--	13	598	5,742

Notes:

1. Data obtained from EMFAC2021 for MDAQMD using the following inputs: emission mode, annual time period, EMFAC2007 vehicle classes, aggregated model year, aggregated speed. Construction will occur over an 18 month period, with 12 months of construction in Year 1 (2026) and 6 months of construction in Year 2 (2027). EMFAC data uses calendar years 2026 and 2027.
2. Fuel efficiency was calculated as daily fuel consumption rate divided by daily total VMT. Fuel consumption rates and daily VMT is obtained from EMFAC2021 and summed by fuel type and year for Mojave Desert AQMD.
3. Default fleet mixes and percentages by fuel type are calculated based on EMFAC2021 v1.0.1 vehicle miles traveled projections for MDAQMD. EMFAC2021 v1.0.1 was run in Emission Rates mode for calendar years 2026 and 2027 in the annual season. Fuel consumption and VMT data by vehicle category were converted to fuel consumption and VMT data by fleet type using weighted sums.
4. Employee vehicle trip rates are based on the number of employees working at the facility during construction and were provided by Castle Mountain Venture. Construction employees were assumed to commute an average of 12 miles roundtrip between home and the van/bus pickup locations in their personal vehicles. Potential van/bus pick up locations may include Las Vegas, NV, Henderson, NV, and Bullhead City/Laughlin, NV. Anticipated travel from single and double-axle vehicles in support of construction (e.g. vendor trips) was provided by Castle Mountain Venture.
5. In addition to commuting, single-axle and double-axle vehicles are expected to be used for daily construction operations assuming 1 hour of usage per day at an average speed of 15 mph.
6. Annual energy usage rate calculated as follows: (Annual VMT) * (% of VMT attributed to fuel type) / (Fuel Efficiency).

Abbreviations:

DGE - diesel gallon equivalent
EMFAC - California Air Resources Board EMission FACtor model
gal - gallons
kWh - kilowatt-hour
MDAQMD - Mojave Desert Air Quality Management District
mi - mile(s)
MMBTU - million British Thermal Units
MWh - megawatt-hour
RT - round trip
VMT - vehicle miles traveled
yr - year

References:

California Air Resources Board (ARB) 2021. EMFAC2021. Available at: https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-modeling-tools

2022 Mine Plan of Operations: Table E-4
Summary of Operational Energy Consumption
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source	Gasoline Usage (gal/yr)	Conventional Diesel Usage (gal/yr)	Renewable Diesel Usage (gal/yr)	Natural Gas (MMBtu/yr)	Renewable Natural Gas Usage[9] (MMBtu/yr)	Electricity Usage (MWh/yr)
Off-Road Operational Equipment[1,2]	--	--	8,229,279	--	--	--
On-Road Operational Trips - Offsite[3]	78,128	175,198	--	--	8.4	12,689
On-Road Operational Trips - Onsite[4]	19,294	20,099	--	--	0.041	--
On-site GDF[5]	26,163	--	--	--	--	--
On-site Facilities[6]	--	--	--	--	--	87,600
Off-site Facilities (Water Sourcing)[6]	--	--	--	--	--	11,511
Emergency Generators[7]	--	--	13,360	--	--	--
Diesel Water Well Generators[7]	--	--	51,334	--	--	--
On-site Power Generation[8]	--	--	--	938,371	--	--
Total	**123,586**	**195,298**	**8,293,973**	**938,371**	**8.4**	**111,800**

Notes:

1. Off-Road fuel usage is calculated in 2022 Mine Plan of Operations: Table E-5.
2. Diesel used by offroad equipment is renewable diesel.
3. On-Road offsite fuel usage is calculated in 2022 Mine Plan of Operations: Table E-6.
4. On-Road onsite fuel usage is calculated in 2022 Mine Plan of Operations: Table E-7.
5. The on-site Gasoline Dispensing Facility (GDF) fuel usage is calculated in 2022 Mine Plan of Operations: Table O-27. The GDF will fuel onsite and some offsite vehicles and thus is paritally accounted for in other source rows.
6. The on-site and off-site facilities' electricity consumption are calculated in 2022 Mine Plan of Operations: Table O-29.
7. Generator fuel usage is calculated by multiplying the fuel consumption (gal/hr/gen) * the annual hours of operation (hr/yr) * the quantity (total number of gens), which are shown in 2022 Mine Plan of Operations: Table O-25.
8. The on-site power generation LNG consumption is calculated in 2022 Mine Plan of Operations: Table O-32.
9. Natural gas used by LNG delivery trucks is renewable compressed natural gas.

Abbreviations:

gal - gallons
GDF - gasoline dispensing facility
LNG - liquefied natural gas
MMBTU - million British Thermal Units
MWh - Megawatt per hour
yr - year

2022 Mine Plan of Operations: Table E-5
Estimated Energy Consumption by Off-Road Operational Equipment
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Equipment Type	Fuel[1]	Number[2]	Horsepower[2]	kW	Load Factor[3]	Operating Hours per Year[2]	Fuel Consumption (gal diesel/hr)[2]	Annual Fuel Usage (gal renewable diesel)[4]
Production Blasthole Drill	Renewable Diesel	3	860	641	0.50	19,859	28	556,062
Wall Control Drill	Renewable Diesel	2	540	403	0.50	13,190	17	224,235
Hydraulic Shovel	Renewable Diesel	3	2,996	2,234	0.42	16,240	85	1,380,394
Wheel Loader	Renewable Diesel	2	1,739	1,297	0.36	11,315	38	429,977
Haul Trucks	Renewable Diesel	20	2,650	1,976	0.38	114,040	34	4,298,331
Track Dozer	Renewable Diesel	5	600	447	0.42	27,923	19	530,528
Wheel Dozer	Renewable Diesel	2	620	462	0.40	10,424	16	166,790
Grader	Renewable Diesel	3	290	216	0.41	15,637	8.0	125,093
Water Truck	Renewable Diesel	2	1,450	1,081	0.38	5,957	24	142,963
Wheel Loader	Renewable Diesel	1	541	403	0.36	4,468	12	53,611
Haul Truck	Renewable Diesel	3	825	615	0.38	11,169	12	134,028
Excavator	Renewable Diesel	1	524	391	0.38	1,489	12	17,870
Tire Manipulator	Renewable Diesel	1	541	403	0.42	1,117	11	12,286
Vibratory Compactor	Renewable Diesel	1	130	97	0.42	1,117	7.0	7,818
Backhoe	Renewable Diesel	1	105	78	0.37	1,862	5.0	9,308
Articulated Truck	Renewable Diesel	1	450	336	0.38	1,862	4.0	7,446
Fuel and Lube Truck	Renewable Diesel	1	1,025	764	0.38	4,468	12	53,611
Tractor and Low Bed	Renewable Diesel	1	405	302	0.38	745	3.0	2,234
Flatbed Hiab Truck	Renewable Diesel	1	405	302	0.38	2,606	3.0	7,818
Rough Terrain Forklift	Renewable Diesel	1	260	194	0.40	1,862	3.0	5,585
Shop Forklift	Renewable Diesel	1	173	129	0.20	1,862	2.0	3,723
Mechanics Truck	Renewable Diesel	1	330	246	0.38	1,862	3.0	5,585
Welding Truck	Renewable Diesel	1	405	302	0.38	2,234	3.0	6,701
Shovel Crew Flat Deck	Renewable Diesel	1	405	302	0.38	1,489	3.0	4,468
Shovel Crew Hiab	Renewable Diesel	1	405	302	0.38	1,862	4.0	7,446
Surface Crew Hiab	Renewable Diesel	1	405	302	0.38	1,862	4.0	7,446
Lighting Tower	Renewable Diesel	6	11	8.0	0.42	11,169	2.0	22,338
Hydraulic Hammer	Renewable Diesel	1	172	129	0.42	1,862	0	--
Mine Rescue Vehicle	Renewable Diesel	1	405	302	0.38	1,862	3.0	5,585

Notes:

1. All off-road equipment used at the facility is assumed to use renewable diesel.
2. Equipment specific information provided by Castle Mountain Venture with the following exceptions: horsepower for Tractor and Low Bed, Flatbed Hiab Truck, Welding Truck, Shovel Crew Flat Deck, Shovel Crew Hiab, Surface Crew Hiab, and Hydraulic Hammer were obtained from EMFAC2021 in offroad emissions mode for MDAQMD in Calendar Year 2025.
3. Average equipment load factors were based on the CARB OFFROAD2017 Emission Factor Workbook (CARB 2017).
4. Fuel usage is calculated by taking the horsepower-hours for each piece of equipment (calculated as horsepower * usage hours * load factor) and multiplying it by the gallons of diesel consumption per horsepower-hour consistent with USEPA AP-42 diesel fuel data in Table 3.4.1, which cites an average brake-specific fuel consumption (BSFC) of 7,000 BTU/hp-hr, a heating value of 19,300 BTU/lb, and density of 7.1 lb/gal. Consistent with ARB guidelines,

Abbreviations:

BTU - British Thermal Unit
CARB - California Air Resources Board
EMFAC2021 - California Air Resources Board EMission FACtor model
gal - gallon(s)
hp - horsepower
hr - hour
kW - kilowatt
lb - pound(s)
MDAQMD - Mojave Desert Air Quality Management District
USEPA - United States Environmental Protection Agency

References:

ARB. 2022. Renewable Diesel Joint Statement. Available online at: https://ww2.arb.ca.gov/our-work/programs/alternative-diesel-fuels/biodiesel-renewable-diesel

CARB. 2017. 2017 Off-road Diesel Emission Factors. Available online at: https://ww2.arb.ca.gov/sites/default/files/2022-05/Off-road_CI_engine_standards_chart_04212022.pdf.

CARB 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250

USEPA. 1996. AP-42 Chapter 3.4 Large Stationary Diesel And Stationary Dual-fuel Engines. Available at: https://www.epa.gov/sites/default/files/2020-10/documents/c03s04.pdf

2022 Mine Plan of Operations: Table E-6
Estimated Energy Consumption by Offsite On-Road Operational Vehicles
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Project Fuel Efficiency Data by Fleet Type[1]

Scenario	Fuel Efficiency[2]						VMT by Vehicle Fuel Type[3]					
	Gasoline	Diesel	Natural Gas	Electricity	Plug-in Hybrid (Gasoline)	Plug-in Hybrid (Electricity)	Gasoline	Diesel	Renewable Natural Gas	Electricity	Plug-in Hybrid (Gasoline)	Plug-in Hybrid (Electricity)
	(mi/gal)	(mi/gal)	(mi/DGE)	(mi/kWh)	(mi/gal)	(mi/kWh)	Percentage (%)					
Employee Vehicles	29	32	--	3.3	32	3.3	93%	0%	0%	4%	2%	2%
Vans/Buses	14	20	--	1.7	--	--	100%	0%	0%	0%	0%	0%
Fuel Delivery Trucks	4.2	6.5	6,180	0.55	--	--	0%	100%	0%	0%	0%	0%
LNG Delivery Trucks	4.2	6.5	6,180	0.55	--	--	0%	0%	100%	0%	0%	0%
Product Delivery Trucks	5.3	6.5	6,206	0.56	--	--	0%	100%	0%	0%	0%	0%
Contractor Trucks	5.3	6.5	6,206	0.56	--	--	0%	100%	0%	0%	0%	0%
Other Delivery Trucks	5.3	6.5	6,206	0.56	--	--	0%	100%	0%	0%	0%	0%
Reagent Delivery Trucks	5.3	6.5	6,206	0.56	--	--	0%	100%	0%	0%	0%	0%

Fuel Consumption

Scenario	Trip Rate[4] (RT/year)	Trip Length (mi/RT)	Annual VMT (mi/yr)	Annual Fuel Consumption[5]					
				Gasoline	Diesel	Renewable Natural Gas	Electricity	Plug-in Hybrid (Gasoline)	Plug-in Hybrid (Electricity)
				(gallons)	(gallons)	(MMBtu)	(MWh)	(gallons)	(MWh)
Employee Vehicles - Full Commute	6,000	170	1,020,000	32,410	137	--	13	781	7,508
Employee Vehicles - To/From Vans/Buses	58,400	12	700,800	22,268	94	--	9.1	537	5,159
Vans/Buses	1,825	170	310,250	22,132	--	--	--	--	--
Fuel Delivery Trucks	1,040	206	214,240	--	32,819	--	--	--	--
LNG Delivery Trucks[6]	1,095	368	402,960	--	--	8.4	--	--	--
Product Delivery Trucks	26	836	21,736	--	3,326	--	--	--	--
Blasting Contractor Trucks	312	206	64,272	--	9,834	--	--	--	--
Maintenance Contractor Trucks	730	206	150,380	--	23,010	--	--	--	--
Other Delivery Trucks (Warehouse to Coyote)	1,872	52	97,344	--	14,895	--	--	--	--
Other Delivery Trucks (Las Vegas Origin)	1,825	206	375,950	--	57,524	--	--	--	--
Reagent Delivery Trucks (Antiscalant)	5.0	1,442	7,210	--	1,103	--	--	--	--
Reagent Delivery Trucks (Carbon)	2.0	1,024	2,048	--	313	--	--	--	--
Reagent Delivery Trucks (Caustic Soda)	26	578	15,028	--	2,299	--	--	--	--
Reagent Delivery Trucks (Flocculant, Anionic)	12	574	6,888	--	1,054	--	--	--	--
Reagent Delivery Trucks (Fluxes)	6.0	574	3,444	--	527	--	--	--	--
Reagent Delivery Trucks (Pebble Lime)	780	206	160,680	--	24,586	--	--	--	--
Reagent Delivery Trucks (Sodium Cyanide)	156	1,118	174,408	--	26,686	--	--	--	--

Annual Operational On-Road Fuel Usage	Annual Fuel Consumption					
	Gasoline	Diesel	Renewable Natural Gas	Electricity	Plug-in Hybrid (Gasoline)	Plug-in Hybrid (Electricity)
	(gallons)	(gallons)	(MMBtu)	(MWh)	(gallons)	(MWh)
	76,810	175,198	8.4	22	1,318	12,667

Notes:

1. Data obtained from EMFAC2021 for MDAQMD using the following inputs: emission mode, annual time period, EMFAC2007 vehicle classes, aggregated model year, aggregated speed. Full operations were assumed to begin in 2027. EMFAC data conservatively uses calendar year 2027 only.
2. Fuel efficiency was calculated as daily fuel consumption rate divided by daily total VMT. Fuel consumption rates and daily VMT is obtained from EMFAC2021 and summed by fuel type and year for Mojave Desert AQMD.
3. Fleet mixes are defined in 2022 Mine Plan of Operations: Table O-14a. Fuel consumption and VMT data by vehicle category were converted to fuel consumption and VMT data by fleet type using weighted
4. Trip rates and trips lengths are defined in 2022 Mine Plan of Operations: Table O-13a.
5. Annual energy usage rate calculated as follows: (Annual VMT) * (% of VMT attributed to fuel type) / (Fuel Efficiency).
6. Natural gas usage rates for LNG delivery trucks were converted from DGE to MMBTU using US Department of Energy Alternative Fuel Data Center conversion factor of 1 DGE of CNG = 128,488 Btu.

Abbreviations:

CVMT - combustion vehicle miles travelled
DGE - diesel gallon equivalent
EVMT - electric vehicle miles travelled
EMFAC2021 - California Air Resources Board EMission FACtor model
gal - gallons
kWh - kilowatt-hour
LNG - liquefied natural gas
MDAQMD - Mojave Desert Air Quality Management District
mi - mile(s)
MMBTU - million British Thermal Units
MWh - megawatt-hour
VMT - vehicle miles traveled
yr - year

References:

California Air Resources Board (ARB) 2021. EMFAC2021. Available at: https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-

2022 Mine Plan of Operations: Table E-7
Estimated Energy Consumption by Onsite On-Road Operational Vehicles
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Project Fuel Efficiency Data by Fleet Type[1]

Scenario	Fuel Efficiency[2]						VMT by Vehicle Fuel Type[3]					
	Gasoline	Diesel	Natural Gas	Electricity	Plug-in Hybrid (Gasoline)	Plug-in Hybrid (Electricity)	Gasoline	Diesel	Renewable Natural Gas	Electricity	Plug-in Hybrid (Gasoline)	Plug-in Hybrid (Electricity)
	(mi/gal)	(mi/gal)	(mi/DGE)	(mi/kWh)	(mi/gal)	(mi/kWh)	Percentage (%)					
On-site Pickup Trucks	20	24	--	3.8	31	3.3	50%	50%	0%	0%	0%	0%
Fuel Delivery Trucks	4.2	6.5	6,180	0.55	--	--	0%	100%	0%	0%	0%	0%
LNG Delivery Trucks	4.2	6.5	6,180	0.55	--	--	0%	0%	100%	0%	0%	0%
Product, Blasting Contractor, Non-Reagent, and Reagent Delivery Trucks	5.3	6.5	6,206	0.56	--	--	0%	100%	0%	0%	0%	0%

Fuel Consumption

Scenario	Trip Rate[4] (RT/year)	Trip Length (mi/RT)	Annual VMT (mi/yr)	Annual Fuel Consumption[5]					
				Gasoline	Diesel	Renewable Natural Gas	Electricity	Plug-in Hybrid (Gasoline)	Plug-in Hybrid (Electricity)
				(gallons)	(gallons)	(MMBtu)	(MWh)	(gallons)	(MWh)
Staff Pickup Trucks	--	--	297,840	7,281	6,214	--	--	--	--
Pit Services Pickup	--	--	312,732	7,645	6,525	--	--	--	--
Staff Pickup Trucks (Crewcab)	--	--	89,352	2,184	1,864	--	--	--	--
Pit Services Pickup (Crewcab)	--	--	89,352	2,184	1,864	--	--	--	--
Fuel Delivery Trucks	1,040	1.8	1,872	--	287	--	--	--	--
LNG Delivery Trucks[6]	1,095	1.8	1,971	--	--	0.041	--	--	--
Product Delivery Trucks (gold to market)	26	3.8	99	--	15	--	--	--	--
Blasting Contractor Trucks	312	3.8	1,186	--	181	--	--	--	--
Maintenance Contractor Trucks	730	3.8	2,774	--	424	--	--	--	--
Other Delivery Trucks (Warehouse to Coyote)	1,872	3.8	7,114	--	1,088	--	--	--	--
Other Delivery Trucks (Las Vegas Origin)	1,825	3.8	6,935	--	1,061	--	--	--	--
Reagent Delivery Trucks (Antiscalant)	5.0	3.8	19	--	2.9	--	--	--	--
Reagent Delivery Trucks (Carbon)	2.0	3.8	7.6	--	1.2	--	--	--	--
Reagent Delivery Trucks (Caustic Soda)	26	3.8	99	--	15	--	--	--	--
Reagent Delivery Trucks (Flocculant, Anionic)	12	3.8	46	--	7.0	--	--	--	--
Reagent Delivery Trucks (Fluxes)	6.0	3.8	23	--	3.5	--	--	--	--
Reagent Delivery Trucks (Pebble Lime)	780	3.8	2,964	--	454	--	--	--	--
Reagent Delivery Trucks (Sodium Cyanide)	156	3.8	593	--	91	--	--	--	--

Annual Operational On-Road Fuel Usage	Annual Fuel Consumption					
	Gasoline	Diesel	Renewable Natural Gas	Electricity	Plug-in Hybrid (Gasoline)	Plug-in Hybrid (Electricity)
	(gallons)	(gallons)	(MMBtu)	(MWh)	(gallons)	(MWh)
	19,294	20,099	0.041	--	--	--

Notes:

1. Data obtained from EMFAC2021 for MDAQMD using the following inputs: emission mode, annual time period, EMFAC2007 vehicle classes, aggregated model year, aggregated speed. Full operations were assumed to begin in 2027. EMFAC data conservatively uses calendar year 2027 only.
2. Fuel efficiency was calculated as daily fuel consumption rate divided by daily total VMT. Fuel consumption rates and daily VMT is obtained from EMFAC2021 and summed by fuel type and year for Mojave Desert AQMD.
3. Fleet mixes are defined in 2022 Mine Plan of Operations: Table O-14b. Fuel consumption and VMT data by vehicle category were converted to fuel consumption and VMT data by fleet type using weighted sums.
4. Trip rates and trips lengths are defined in 2022 Mine Plan of Operations: Table O-13b.
5. Annual energy usage rate calculated as follows: (Annual VMT) * (% of VMT attributed to fuel type) / (Fuel Efficiency).
6. Natural gas usage rates were converted from DGE to MMBTU using US Department of Energy Alternative Fuel Data Center conversion factor of 1 DGE of CNG = 128,488 Btu.

Abbreviations:

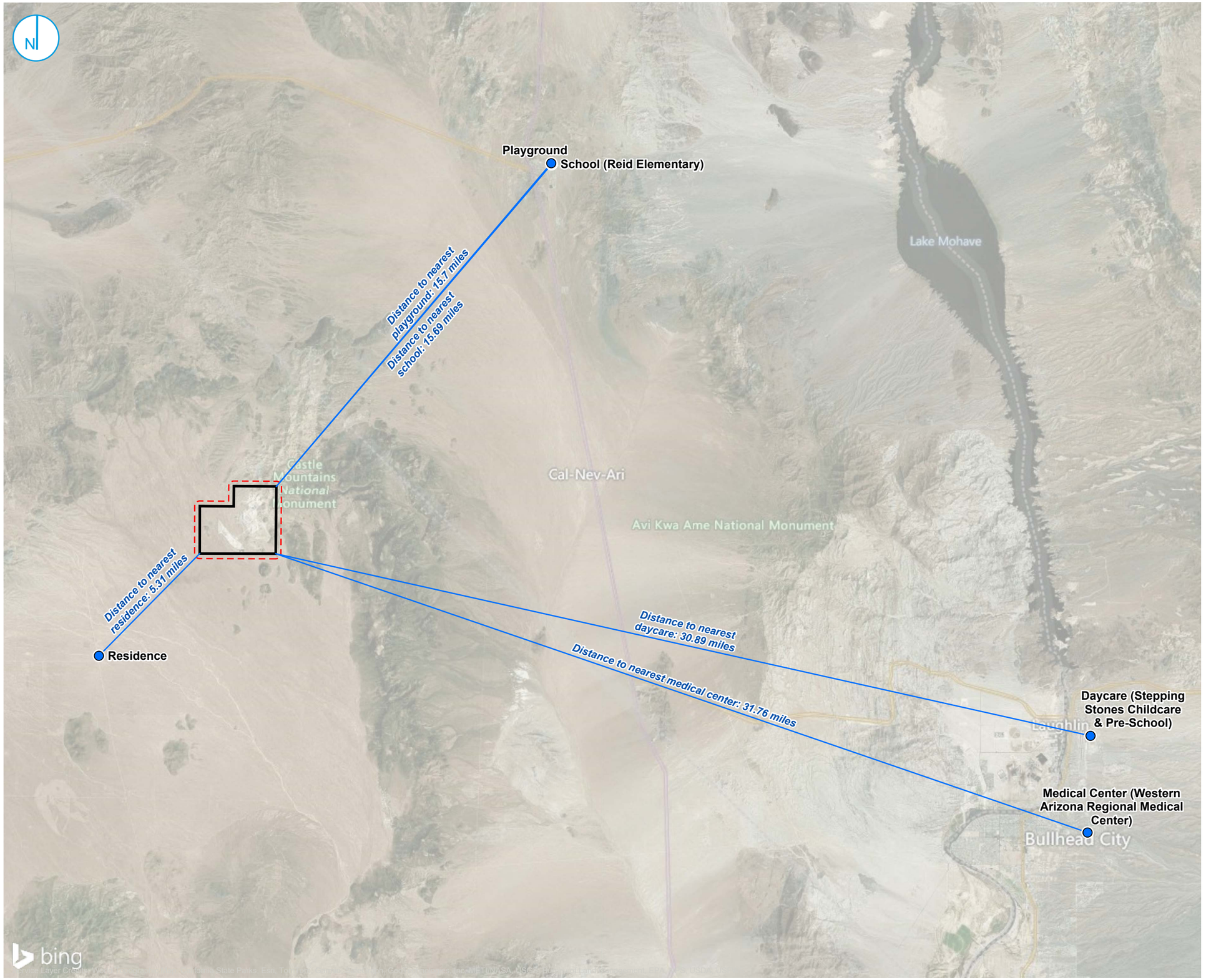
CVMT - combustion vehicle miles travelled
DGE - diesel gallon equivalent
EVMT - electric vehicle miles travelled
EMFAC2021 - California Air Resources Board EMission FACtor model
gal - gallons
kWh - kilowatt-hour
LNG - liquefied natural gas
MDAQMD - Mojave Desert Air Quality Management District
mi - mile(s)
MMBTU - million British Thermal Units
MWh - megawatt-hour
VMT - vehicle miles traveled
yr - year

References:

California Air Resources Board (ARB) 2021. EMFAC2021. Available at: https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-modeling-tools

FIGURES

PROJECT: 1690025697 | DATED: 4/18/2024 | DESIGNER: CWILLIAMSFREIER C:\Users\CWILLIAMSFREIER\Ramboll\Melody Kneale - Projects\Castle Mountain Mine\03_GIS\20240418_NearestReceptors\20240418_NearestReceptors.aprx\Figure 01 - Location of Nearest Receptors



Site Boundary
1,000 ft buffer of Site Boundary
Nearest Receptors

0 1.75 3.5 Miles



KEY MAP (not to scale)

NEAREST RECEPTORS

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

FIGURE 01

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL

ATTACHMENT A
AIR DISPERSION MODELING AND ANALYSES REPORT

Intended for
Bureau of Land Management
San Bernardino County

Prepared by
Ramboll Americas Engineering Solutions, Inc.

Date
October 2025

Revision
Rev.2.2

AIR DISPERSION MODELING AND ANALYSES REPORT FOR NEPA AND CEQA REVIEW

EQUINOX GOLD CORP – CASTLE MOUNTAIN VENTURE

CASTLE MOUNTAIN MINE PROPOSED 2022 MINE PLAN OF OPERATIONS

RAMBOLL

CONTENTS

1.	**INTRODUCTION**	**1**
2.	**PROJECT DESCRIPTION**	**2**
3.	**DISPERSION MODELING APPROACH**	**2**
3.1	Meteorological Data Processing	3
3.2	Receptor Grid and Terrain Data	3
3.3	Downwash	3
3.4	NO2 Modeling Approach	3
3.5	Secondary Ozone and PM2.5 Formation	3
3.6	Air Quality Related Values	4
3.7	Background Concentrations	5
4.	**MODELING RESULTS**	**6**
4.1	Summary of NAAQS Impact Assessment Results	6
4.2	Summary of CAAQS Impact Assessment Results	8
5.	**REFERENCES**	**11**

TABLES

Table 1: Source Categories included in Emission Source Apportionment Tables

Table 2: Q/D Calculations for the Nearest Class I Areas

Table 3: Maximum Emissions Scenario NAAQS Results

Table 4: Maximum Emissions Scenario – Assumed North Operations NAAQS Results

Table 5: Maximum Emissions Scenario – Assumed South Operations NAAQS Results

Table 6: Maximum Emissions Scenario CAAQS Results

Table 7: Maximum Emissions Scenario – Assumed North Operations CAAQS Results

Table 8: Maximum Emissions Scenario – Assumed South Operations CAAQS Results

ATTACHMENTS

Attachment 1: Air Dispersion Modeling and Analyses Protocol for NEPA and CEQA Review

Attachment 2: Annualized, Maximum Daily Project Emissions for Q/D Calculation

Attachment 3: Graphical Plots of Project Impacts for Each Modeling Scenario and Air Quality Standard

ACRONYMS AND ABBREVIATIONS

AQRV	Air Quality Related Value
BLM	Bureau of Land Management
CAAQS	California Ambient Air Quality Standards
CEQA	California Environmental Quality Act
CMM	Castle Mountain Mine
CMV	Castle Mountain Venture
CO	Carbon Monoxide
D	Distance in kilometers
EPA	U.S. Environmental Protection Agency
FLAG	Federal Land Managers' Air Quality Related Values Work Group
GEP	Good Engineering Practice
km	Kilometer
m	Meter
MERPs	Modeled Emission Rates for Precursors
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
O_3	Ozone
OLM	Ozone Limiting Method
PM_{10}	Particulate Matter Less Than or Equal to 10 Microns in Diameter
$PM_{2.5}$	Particulate Matter Less Than or Equal to 2.5 Microns in Diameter
ppb	Parts per billion
Q	Annualized emissions in tons per year
SIL	Significant Impact Level
SO_2	Sulfur Dioxide
tpy	Tons per year
U.S.	United States
USFS	United States Forest Service
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compound
$\mu g/m^3$	Microgram per Cubic Meter

1. INTRODUCTION

The Castle Mountain Mine (CMM) is an open pit gold mine located in the Mojave Desert of eastern San Bernardino County, California. Elevation ranges from 4,100 to 5,100 feet above mean sea level. The proposed 2022 Mine Plan of Operations ("2022 Plan" or "Project") is an amendment proposing changes to the authorized plan currently in effect at CMM. The 2022 Plan proposes a continuation of mining at gold mineral ore zones including extensions of approved pit boundaries and increased mining rates. The 2022 Plan does not propose to increase the current site boundary of 3,910 acres.

The United States (U.S.) Bureau of Land Management (BLM) and San Bernardino County (SBC) are serving as the lead agencies in the review of the mining extension and amendment to the Mine Plan of Operation and Reclamation Plan prepared for the Castle Mountain Mine operated by Equinox Gold through their wholly owned subsidiary – Castle Mountain Venture (CMV).

To support the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) environmental review, Ramboll, on behalf of CMM, performed air dispersion modeling and analyses of air quality impacts at and beyond the site boundary from air emissions generated during the Project. The Project is located in a federal nonattainment area (moderate classification) for PM_{10}. Thus, this modeling will also inform the General Conformity (GC) analysis for PM_{10}. The Project area is classified as attainment or unclassifiable for all other pollutants under the National Ambient Air Quality Standards (NAAQS). Under the California Ambient Air Quality Standards (CAAQS), the Project is located in a state nonattainment area for PM_{10} and ozone (O_3).

Project emissions of the following pollutants are analyzed for comparison to the applicable air quality standards: particulate matter less than or equal to 10 microns in diameter (PM_{10}), particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$), nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2). Emissions of NO_x and SO_2 are analyzed for the formation of secondary $PM_{2.5}$ and emissions of volatile organic compounds (VOCs) are also analyzed as a precursor to ozone. Finally, a screening calculation for air quality related values (AQRVs) for federal Class I areas was completed.

The Project emissions are analyzed using the Environmental Protection Agency (EPA) preferred dispersion model, AERMOD. AERMOD requires additional inputs of meteorology, terrain data, source characterization, source operating schedule, and pollutant-specific model options. The Project description, emissions inventory, and modeling inputs/approach are described in detail in the modeling protocol, which is provided as **Attachment 1.**[1] This report provides a brief overview of the Project (**Section 2**) and model inputs (**Section 3**). **Section 4** provides a detailed summary of the AERMOD results and a comparison to the applicable NAAQS and CAAQS.

[1] All references to the modeling protocol in this document refer to Attachment 1.

2. PROJECT DESCRIPTION

A detailed description of the proposed Project is provided in **Section 2 of the modeling protocol** (see **Attachment 1**). The Project includes the following general emission source categories:

- Stationary sources (e.g., baghouses, dust collectors, bin vents, material transfers, emergency generators, NG turbines, other combustion, etc.);
- Haul truck loading and unloading fugitive dust at pits and waste rock (i.e., overburden) piles;
- Offroad equipment fugitive dust and exhaust at pits and overburden piles;
- Fugitive dust at pits, overburden piles, and heap leach pad;
- Blast hole drilling fugitive dust and blasting at pits; and
- Haul roads (Northern pit complex[2], South Extension, Overburden piles, miscellaneous and delivery trucks).

Detailed information about these sources are provided in the following appendices of the modeling protocol:

- Appendix A: detailed emissions calculations;
- Appendix B: modeled source groups, emission rates, and operating schedules; and
- Appendix C: modeled source parameters.

The proposed model setup for the maximum emissions year scenario is provided in **Figure 6a of the modeling protocol**. Two other hypothetical spatial layouts were also analyzed to conservatively evaluate potential operations across the mine life. In the first scenario, all extraction is assumed to occur at the northern pit complex, and overburden material is assumed to be placed on the North Overburden Pile. Haul truck travel is therefore assumed to occur on the following haul roads: Oro Belle (east), JSLA East, JSLA West, Jumbo Ore Belle, and North Overburden. All other sources not tied to pit or overburden locations (e.g., stationary sources) were modeled at the same locations. The proposed model setup for this scenario is provided in **Figure 6b of the modeling protocol**. In the second scenario, all extraction is assumed to occur at the Southern Extension Pit, and overburden material is assumed to be placed on the South Overburden Pile. Haul truck travel is therefore assumed to occur on the following haul roads: South Extension Phase I, South Extension Phase II, and South Overburden. All other sources not tied to pit or overburden locations (e.g., stationary sources) were modeled at the same locations. The proposed model setup for this scenario is provided in **Figure 6c of the modeling protocol**. While these configurations are not reflective of specific mining years, they are intended to conservatively evaluate potential operations across multiple mining years where activity may occur in the northern or southern portions of the site.

3. DISPERSION MODELING APPROACH

The air dispersion modeling utilized the models, inputs, and methodology fully described and documented in the modeling protocol (see **Attachment 1**). This includes the model versions and guidance available at the time of the analyses, which include AERMOD version 24142, its associated processors, EPA's Guideline on Air Quality Models 40 CFR 51, Appendix W (EPA, 2024), and other applicable EPA guidance.

[2] The "Northern pit complex" is used to reference the aggregate of the JSLA, Jumbo and Oro Belle pits.

An overview of the model inputs and calculations for secondary ozone, $PM_{2.5}$ and AQRVs is provided below.

3.1 Meteorological Data Processing

The on-site 10-meter North station meteorological data was processed for the period of January 1, 2021, through December 31, 2022, using the data inputs and methodology described in the modeling protocol. The processed wind rose for this data is provided in **Figure 7 of the modeling protocol**.

3.2 Receptor Grid and Terrain Data

A nested Cartesian receptor grid was used for the dispersion modeling analysis following the spacing and extent described in the modeling protocol. The modeled receptor grid is presented in **Figure 8 of the modeling protocol**. The receptors were processed with AERMAP as described in the modeling protocol. All receptors and source locations were based on the Universal Transverse Mercator (UTM) North American Datum 1983 (NAD83), Zone 10 coordinate system.

3.3 Downwash

Downwash effects for the NG turbines were included in the dispersion modeling analysis following the approach described in the modeling protocol. Using information provided by the vendor, the Building Profile Input Program with Prime (BPIPPRM version 04274) was run for the turbine enclosures and exhaust stacks. Each enclosure was treated as a single tiered structure that housed 5 microturbines. In total, 13 structures were included in BPIPPRM as shown in **Figure 2 of the modeling protocol**. The turbine stack heights are below the Good Engineering Practice (GEP) stack height in accordance with EPA guidance.

3.4 NO2 Modeling Approach

The Tier 3 method [Ozone Limiting Method (OLM)] was used for all NO_2 analyses. This includes hourly ozone data from the Jean, Nevada station and source-specific in-stack ratios of NO_2 to NO_x for each NO_x-emitting source. The NO_2/NO_x in-stack ratios used for each source type are summarized in **Table 3 of the modeling protocol**.

3.5 Secondary Ozone and PM2.5 Formation

Secondary $PM_{2.5}$ formation from Project emissions of SO_2 and NO_x emissions were estimated using the EPA MERPs guidance discussed in the modeling protocol. The secondary $PM_{2.5}$ is added to the primary $PM_{2.5}$ impacts generated from AERMOD. The total $PM_{2.5}$, primary plus secondary, are compared to the applicable $PM_{2.5}$ air quality standards. Secondary ozone formation from onsite Project emissions of NO_x and VOC emissions were estimated using the same approach using the MERPs guidance.

Using the EPA MERPs Qlik tool[3], the nearest hypothetical source from CMM is in Las Vegas, Nevada, which is about 129 km (80 miles) away from CMM. This hypothetical source is in a similar climate zone as the Project and is considered representative of the expected environmental factors that contribute to secondary formation of ozone and secondary $PM_{2.5}$. The total onsite Project emissions and data extracted from the EPA MERPs database for the 10-meter stack for this source are provided in **Table 1** below. Use of the 10-meter stack is representative of the majority of Project emissions, which are fugitive or low-level releases. The development of Project emissions is documented in **Appendix A of the modeling protocol**.

[3] https://www.epa.gov/scram/merps-view-qlik#Modeled_Impacts

Following recent EPA guidance (EPA, 2024), the estimated Project impacts were estimated using the normalized modeling approach that does not account for the specific significant impact level (SIL) values by pollutant. The precursor-specific impacts were calculated and then added for the combined, estimated Project impacts from each precursor. As summarized in **Table 1** below, the Project estimated impacts are:

- For 8-hour ozone, the Project impacts are 0.372 ppb, which is less than the SIL value of 1.0 ppb. Therefore, the Project will have insignificant impacts on ozone.
- For 24-hour $PM_{2.5}$, the Project impacts of secondary $PM_{2.5}$ are 0.048 $\mu g/m^3$. These impacts will be added to the direct $PM_{2.5}$ impacts modeled with AERMOD for comparison to the applicable $PM_{2.5}$ standards.
- For annual $PM_{2.5}$, the Project impacts of secondary $PM_{2.5}$ are 0.005 $\mu g/m^3$. These impacts will be added to the direct $PM_{2.5}$ impacts modeled with AERMOD for comparison to the applicable $PM_{2.5}$ standards.

It is noted that the EPA-estimated secondary impacts from the MERPs database represent the maximum impacts anywhere within 50 km (31 miles) of the hypothetical source. This maximum impact is added to design value impacts of primary $PM_{2.5}$ from AERMOD, which as discussed in **Section 4**, occur at the site boundary. The addition of the secondary and primary $PM_{2.5}$ impacts, even though they are not spatially paired, provides a conservative estimate of the total $PM_{2.5}$ impacts from the Project.

Table 1. EPA MERP Modeling Results for a Hypothetical Source in Las Vegas, NV

State	County	Metric	Precursor	MERP Emissions (tpy)	Onsite Project Emissions (tpy)	MERP Impact	Estimated Project Impact by Precursor	Combined, Estimated Project Impact
Nevada	Clark Co	8-hr Ozone	NOx	1000	569	0.636 ppb	0.362 ppb	0.373 ppb
Nevada	Clark Co	8-hr Ozone	VOC	500	35	0.160 ppb	0.011 ppb	
Nevada	Clark Co	Annual $PM_{2.5}$	NOx	1000	569	0.009 $\mu g/m^3$	0.005 $\mu g/m^3$	0.005 $\mu g/m^3$
Nevada	Clark Co	Annual $PM_{2.5}$	SO_2	1000	1.3	0.012 $\mu g/m^3$	0.000 $\mu g/m^3$	
Nevada	Clark Co	Daily $PM_{2.5}$	NOx	1000	569	0.085 $\mu g/m^3$	0.048 $\mu g/m^3$	0.048 $\mu g/m^3$
Nevada	Clark Co	Daily $PM_{2.5}$	SO_2	1000	1.3	0.086 $\mu g/m^3$	0.000 $\mu g/m^3$	

3.6 Air Quality Related Values

Following the Federal Land Managers' Air Quality Related Values Work Group (FLAG) guidance for Class I areas (USFS 2010), an assessment of Project impacts on the air quality related values (AQRVs) of regional haze and acid deposition at Class I areas beyond 50 km (31 miles) is made using the Q/D screening approach. For Q/D, Q is the onsite annualized, maximum daily Project emissions of visibility-impairing pollutants, i.e., PM_{10}, SO_2, and NO_x for this Project, in tons per year, divided by the distance between the Project and the Class I area, D in km. The estimated onsite maximum daily emissions and conservatively converted annual emissions for each of the Project emission categories are provided in **Attachment 2**. The closest Class I areas to the Project are Grand Canyon National Park and Joshua Tree National Park. The Q/D calculations using the maximum daily Project emissions for the emitted visibility-impairing pollutants (PM_{10}, SO_2, and NO_x) at each of these Class I areas are provided in **Table 2**.

Table 2. Q/D Calculations for the Nearest Class I Areas

Onsite Annualized Maximum Daily Emissions (tpy)	Distance to Grand Canyon, D (km)	Distance to Joshua Tree, D (km)
NOx = 678	128	131
SO_2 = 1.5		
PM_{10} = 344		
Q = 1,004	Q/D = 8.0	Q/D = 7.8

The Q/D values for both Class I areas are less than 10; therefore, Project emissions will not have an adverse impact on AQRVs at these national parks. It is noted that the value of Q includes fugitive PM_{10} emissions, which are unlikely to travel to the Class I areas due to gravitational settling, wet and dry deposition, the low-level nature of the emissions. Therefore, this Q/D calculation should be considered a conservative estimate of the Q/D value.

3.7 Background Concentrations

Ambient background concentrations are added to the modeled impacts from the Project sources in order to compare the cumulative impacts to the applicable NAAQS and CAAQS. The ambient background concentrations and modeled Project impacts used in this comparison are both in the form (design value) of the applicable standard. The background concentrations are intended to account for sources not explicitly included in the modeling. These sources include (i) natural sources, (ii) nearby non-modeled sources, and (iii) unidentified sources of air pollution (e.g., long-range transport). The background concentrations are summarized in **Table 5 and Table 6a/6b of the modeling protocol**. The background values were conservatively assumed to be constant at the design value, except for PM_{10}, which varied monthly to account for monthly/seasonal changes in wind speed.

4. MODELING RESULTS

The model inputs and methodology described in detail in the modeling protocol (**Attachment 1**) were used to estimate Project impacts for compliance with the applicable NAAQS and CAAQS. The modeled results are in the form of the applicable air quality standard (design value) and were added to the design value of the background data. As described in **Section 3.4**, the secondary $PM_{2.5}$ impacts were also added to the primary $PM_{2.5}$ impacts from AERMOD to estimate total $PM_{2.5}$ impacts.

Graphical plots of the modeled design value of Project impacts for each air quality standard, and for each modeled scenario, are provided in **Attachment 3**. These are displayed without background or secondary $PM_{2.5}$ data added, with the exception of PM_{10}, which includes the variable monthly background. These plots depict the location of the maximum impacts and the spatial variation in modeled concentrations near the CMM site boundary for each pollutant and averaging period.

4.1 Summary of NAAQS Impact Assessment Results

The modeling results for comparison to the NAAQS are summarized below for each of the three scenarios, Maximum Emissions Scenario, Maximum Emissions Scenario – Assumed North Operations (North Scenario), and Maximum Emission Scenario – Assumed South Operations (South Scenario). As detailed below, all modeled scenarios are in compliance with the applicable NAAQS. The impacts between the three modeled scenarios differ slightly based on the different spatial locations of the emission sources between the scenarios, e.g., location of blasting, haul roads, overburden piles, etc.

The modeling results for Maximum Emissions Scenario are summarized in **Table 3**. The results demonstrate that the overall impacts from the CMM project, including background concentrations and secondary $PM_{2.5}$, are in compliance with all applicable NAAQS for this scenario. The impacts that are the highest percentage of the standard are for 1-hour NO_2. These impacts are driven by the NOx blasting emissions, which were conservatively assumed to occur each hour between 6 am to 6 pm, at the maximum hourly emissions rate. The reported 1-hour results are therefore based on the conservative model treatment that the blasting will always occur during worst-case meteorological conditions during the operating window. The results for the remaining pollutants are all less than 75% of the applicable NAAQS.

As shown in **Attachment 3**, the locations of the highest modeled concentrations (in the form of the standard) of pollutants under the Maximum Emissions Scenario are located at the Project's site boundary, with rapidly decreasing impacts away from the boundary. All pollutants, except for 1-hour SO_2 and 24-hour $PM_{2.5}$, show the highest impacts on the southern Project site boundary. The maximum impacts for 1-hour SO_2 and 24-hour $PM_{2.5}$ are observed at locations in the western and northwestern Project site boundary, respectively.

Table 3. Maximum Emissions Scenario NAAQS Results

Pollutant	Averaging Time	Rank	Impact (µg/m³)	Background (µg/m³)	Total Concentration (µg/m³)	NAAQS (µg/m³)	Percent of Standard
SO_2	1-hr	99th Percentile	0.4	11	11.4	196	6%
NO_2	1-hr	98th Percentile	101.6	64.9	166.5	188	89%

Pollutant	Averaging Time	Rank	Impact (µg/m³)	Background (µg/m³)	Total Concentration (µg/m³)	NAAQS (µg/m³)	Percent of Standard
	Annual	Maximum	5.9	6.8	12.7	100	13%
CO	1-hr	H2H	3,164	2,406	5,570	40,000	14%
	8-hr	H2H	487	1,948	2,435	10,000	24%
PM_{10}	24-hr	H2H	28.7	(included)	28.7	150	19%
$PM_{2.5}$	24-hr	98th Percentile	1.5[a]	16.6	18.1	35	52%
	Annual	Maximum	0.46[a]	4.8	5.3	9	58%

[a] Includes primary and secondary contributions.

Table 4 summarizes the modeling results for the North Operations scenario. The results demonstrate that the overall impacts from the CMM project, including background concentrations and secondary $PM_{2.5}$, are in compliance with all applicable NAAQS for this scenario. These results represent a conservative demonstration of potential North operations.

As shown in **Attachment 3** the locations of the highest modeled concentrations (in the form of the standard) of pollutants under the North Operations scenario are located at or near the north/northwestern site boundary, with rapidly decreasing impacts away from the boundary.

Table 4. Maximum Emissions Scenario – Assumed North Operations NAAQS Results

Pollutant	Averaging Time	Rank	Impact (µg/m³)	Background (µg/m³)	Total Concentration (µg/m³)	NAAQS (µg/m³)	Percent of Standard
SO_2	1-hr	99th Percentile	0.4	11	11.4	196	6%
NO_2	1-hr	98th Percentile	109.6	64.9	174.5	188	93%
	Annual	Maximum	8.0	6.8	14.8	100	15%
CO	1-hr	H2H	3,076	2,406	5,482	40,000	14%
	8-hr	H2H	491	1,948	2,439	10,000	24%
PM_{10}	24-hr	H2H	34.4	(included)	34.4	150	23%
$PM_{2.5}$	24-hr	98th Percentile	2.6[a]	16.6	19.2	35	55%
	Annual	Maximum	0.76[a]	4.8	5.6	9	62%

[a] Includes primary and secondary contributions.

Table 5 summarizes the modeling results for the South Operations scenario. The results demonstrate that the overall impacts from the CMM project, including background concentrations and secondary $PM_{2.5}$, are in compliance with all applicable NAAQS for this scenario. These results represent a conservative demonstration of potential South operations.

As shown in **Attachment 3**, the locations of the highest modeled concentrations (in the form of the standard) of pollutants under the South Operations scenario are located at the southern site boundary, with rapidly decreasing impacts away from the boundary. The only exception is 1-hour SO_2, which has the maximum impact along the western site boundary.

Table 5. Maximum Emissions Scenario – Assumed South Operations NAAQS Results

Pollutant	Averaging Time	Rank	Impact (µg/m³)	Background (µg/m³)	Total Concentration (µg/m³)	NAAQS (µg/m³)	Percent of Standard
SO_2	1-hr	99th Percentile	0.5	11	11.5	196	6%
NO_2	1-hr	98th Percentile	103.8	64.9	168.7	188	90%
	Annual	Maximum	7.5	6.8	14.3	100	14%
CO	1-hr	H2H	3,168	2,406	5,574	40,000	14%
	8-hr	H2H	493	1,948	2,441	10,000	24%
PM_{10}	24-hr	H2H	29.8	(included)	29.8	150	20%
$PM_{2.5}$	24-hr	98th Percentile	1.6[a]	16.6	18.2	35	52%
	Annual	Maximum	0.58[a]	4.8	5.4	9	60%

[a] Includes primary and secondary contributions.

4.2 Summary of CAAQS Impact Assessment Results

The modeling results for comparison to the CAAQS are summarized below for each of the three scenarios, Maximum Emissions Scenario, Maximum Emissions Scenario – Assumed North Operations (North Scenario), and Maximum Emission Scenario – Assumed South Operations (South Scenario). As detailed below, all modeled scenarios are in compliance with the applicable CAAQS. The impacts between the three modeled scenarios differ slightly based on the different spatial locations of the emission sources between the scenarios, e.g., location of blasting, haul roads, overburden piles, etc.

The modeling results for Maximum Emissions Scenario are summarized in **Table 6**. The results demonstrate that the overall impacts from the CMM project, including background concentrations and secondary $PM_{2.5}$, are in compliance with all applicable CAAQS for this scenario. The impacts for all pollutants are less than 75% of the applicable CAAQS. The impacts that are the highest percentage of the standard are for 1-hour NO_2. As noted above, these impacts are driven by the NOx blasting emissions, which were conservatively assumed to occur each hour between 6 am to 6 pm, at the maximum hourly emissions. The reported 1-hour results are therefore based on the conservative model treatment that the blasting will always occur during worst-case meteorological conditions during the operating window.

As shown in **Attachment 3**, the locations of the highest modeled concentrations (in the form of the standard) of pollutants under the Maximum Emissions Year scenario are located at the Project's southern site boundary, with rapidly decreasing impacts away from the boundary. The only exception is 24-hour SO_2, which has a maximum impact along the western site boundary.

Table 6. Maximum Emissions Scenario CAAQS Results

Pollutant	Averaging Time	Rank	Impact (µg/m³)	Background (µg/m³)	Total Concentration (µg/m³)	CAAQS (µg/m³)	Percent of Standard
SO_2	1-hr	Maximum	0.9	19.3	20.2	655	3%
	24-hr	Maximum	0.1	19.3	19.4	105	18%
NO_2	1-hr	Maximum	164.1	82	246.1	339	73%
	Annual	Maximum	5.9	6.8	12.7	57	22%
CO	1-hr	Maximum	9,011	2,635	11,646	23,000	51%
	8-hr	Maximum	1,145	1,948	3,093	10,000	31%
PM_{10}	24-hr	Maximum	29.7	(included)	29.7	50	59%
	Annual	Maximum	3.5	6.3	9.8	20	49%
$PM_{2.5}$	Annual	Maximum	0.46[a]	5.1	5.6	12	46%

[a] Includes primary and secondary contributions.

The modeling results for North Operations scenario are summarized in **Table 7**. The results demonstrate that the overall impacts from the CMM project, including background concentrations and secondary $PM_{2.5}$, are in compliance with all applicable CAAQS for this scenario. Similar to the Maximum Emissions Scenario, the impacts for all pollutants are less than 75% of the applicable CAAQS. These results represent a conservative demonstration of potential North operations.

As shown in **Attachment 3**, the locations of the highest modeled concentrations (in the form of the standard) of pollutants under the North Operations scenario are located at the Project's northern/northwestern site boundary, with rapidly decreasing impacts away from the boundary. The exceptions to this are 1-hour CO, 8-hour CO, and 1-hour SO_2 with the maximum impact occurring just over 1 km (0.62 miles) from the eastern site boundary. It is important to note that compliance with the CAAQS is based on the overall maximum impact. In the case of 1-hour standards, reporting the overall maximum concentration increases the likelihood that anomalous meteorological conditions become a controlling factor. Anomalous meteorological conditions may include AERMET-calculated surface-level mixing heights and AERMOD's documented limitations during low wind speed hours.[4]

Table 7. Maximum Emissions Scenario – Assumed North Operations CAAQS Results

Pollutant	Averaging Time	Rank	Impact (µg/m³)	Background (µg/m³)	Total Concentration (µg/m³)	CAAQS (µg/m³)	Percent of Standard
SO_2	1-hr	Maximum	0.8	19.3	20.1	655	3%
	24-hr	Maximum	0.1	19.3	19.4	105	18%
NO_2	1-hr	Maximum	142.2	82	224.2	339	66%
	Annual	Maximum	8.0	6.8	14.8	57	26%
CO	1-hr	Maximum	6,231	2,635	8,866	23,000	39%
	8-hr	Maximum	784	1,948	2,732	10,000	27%

[4] https://www.epa.gov/sites/default/files/2021-01/documents/lowwind_overview_white_paper.pdf

Pollutant	Averaging Time	Rank	Impact (µg/m³)	Background (µg/m³)	Total Concentration (µg/m³)	CAAQS (µg/m³)	Percent of Standard
PM_{10}	24-hr	Maximum	34.9	(included)	34.9	50	70%
	Annual	Maximum	5.3	6.3	11.6	20.0	58%
$PM_{2.5}$	Annual	Maximum	0.76[a]	5.1	5.9	12	49%

[a] Includes primary and secondary contributions.

The modeling results for South Operations scenario are summarized in **Table 8**. The results demonstrate that the overall impacts from the CMM project, including background concentrations and secondary $PM_{2.5}$, are in compliance with all applicable CAAQS for this scenario. Similar to the Maximum Emissions Scenario, the impacts for all pollutants are less than 75% of the applicable CAAQS.

As shown in **Attachment 3**, the locations of the highest modeled concentrations (in the form of the standard) of pollutants under the South Operations scenario are located at the Project's southern site boundary, with rapidly decreasing impacts away from the boundary. The exceptions to this are 1-hour SO_2 and 24-hour PM_{10} and with maximum impacts along the eastern site boundary, and 24-hour SO_2 with maximum impacts occurring along the western site boundary.

Table 8. Maximum Emissions Scenario – Assumed South Operations CAAQS Results

Pollutant	Averaging Time	Rank	Impact (µg/m³)	Background (µg/m³)	Total Concentration (µg/m³)	CAAQS (µg/m³)	Percent of Standard
SO2	1-hr	Maximum	1.2	19.3	20.5	655	3%
	24-hr	Maximum	0.1	19.3	19.4	105	18%
NO_2	1-hr	Maximum	167.4	82	249.4	339	74%
	Annual	Maximum	7.5	6.8	14.3	57	25%
CO	1-hr	Maximum	9,042	2,635	11,677	23,000	51%
	8-hr	Maximum	1,143	1,948	3,091	10,000	31%
PM_{10}	24-hr	Maximum	33.0	(included)	33.0	50	66%
	Annual	Maximum	4.4	6.3	10.7	20	54%
$PM_{2.5}$	Annual	Maximum	0.58[a]	5.1	5.7	12	47%

[a] Includes primary and secondary contributions.

5. REFERENCES[5]

EPA. 2024. Guideline on Air Quality Models 40 CFR 51, Appendix W (Revised, November 29, 2024). Available at: https://www.epa.gov/system/files/documents/2024-11/appendix_w-2024.pdf

EPA. 2024c. Clarification on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and PM2.5 under the PSD Permitting Program. Office of Air Quality Planning and Standards, Environmental Protection Agency. Research Triangle Park, North Carolina. April 30, 2024. Available at: https://www.epa.gov/sites/default/files/2020-09/documents/epa-454_r-19-003.pdf

USFS. 2010. Federal Land Managers' Air Quality Related Values Work Group (FLAG) Phase I Report—Revised National Park Service, U.S. Department of the Interior Natural Resource Report NPS/NRPC/NRR—2010/232. 2010. Available at: https://www.fws.gov/guidance/sites/guidance/files/documents/FLAG%20Air%20Quality%20Phase%201%20report.pdf

[5] All other references are listed in Attachment 1 (Modeling Protocol).

ATTACHMENT 1
AIR DISPERSION MODELING AND ANALYSES PROTOCOL FOR NEPA AND CEQA REVIEW

Intended for
Bureau of Land Management
San Bernadino County

Prepared by
Ramboll Americas Engineering Solutions, Inc.

Date
October 2025

Revision
Rev.2.2

AIR DISPERSION MODELING AND ANALYSES PROTOCOL FOR NEPA AND CEQA REVIEW

EQUINOX GOLD CORP – CASTLE MOUNTAIN VENTURE

CASTLE MOUNTAIN MINE PROPOSED 2022 MINE PLAN OF OPERATIONS

RAMBOLL

CONTENTS

1.	**INTRODUCTION**	**1**
2.	**PROJECT DESCRIPTION**	**2**
2.1	Process Description	2
2.2	Emissions Inventory	2
2.2.1	Project Features and Control Measures	5
2.2.2	Emissions Year	5
2.3	Proposed 2022 Plan and Approved Operations	6
2.3.1	Emission Source Apportionment	6
2.3.2	Emission Source Locations	6
3.	**DISPERSION MODELING APPROACH**	**8**
3.1	Model Selection	8
3.2	Source Parameters	8
3.2.1	Point Sources	10
3.2.2	Volume Sources	10
3.2.3	Area Sources	10
3.3	Meteorological Data Processing	10
3.3.1	Land Use Characterization	11
3.4	Receptor Grid and Terrain Data	11
3.5	NO_2 Modeling Approach	12
4.	**OTHER ANALYSES**	**14**
4.1	Ozone Ambient Impact Analysis	14
4.2	Secondary $PM_{2.5}$ Formation	14
4.3	Air Quality Related Values	14
5.	**BACKGROUND CONCENTRATIONS**	**15**
5.1	Background Concentrations	15
5.2	RFFA and RFD	19
6.	**MODELING RESULTS**	**20**
7.	**REFERENCES**	**22**

TABLES

Table 1: Source Categories included in Emission Source Apportionment Tables
Table 2: Castle Mountain Mine Key Emissions Sources and Model Characterization
Table 3: In-Stack Ratios for NOx-emitting Sources
Table 4. Comparison of Annual PM_{10} Concentrations for 2021, High Wind Periods not Removed
Table 5. Processed Background PM_{10} Concentrations from North Station for 2021
Table 6. Background Concentration Summary for Other Pollutants
Table 7. Modeling Output for NAAQS and CAAQS Compliance Demonstration

FIGURES

Figure 1: Site Boundary
Figure 2: Stationary Sources
Figure 3: Area Sources
Figure 4: Volume Sources
Figure 5: Hauling Routes
Figure 6a: Maximum Emissions Scenario
Figure 6b: Maximum Emissions Scenario – Assumed North Operations
Figure 6c: Maximum Emissions Scenario – Assumed South Operations
Figure 7: 2021 - 2022 Onsite Station Wind Rose
Figure 8: Receptor Grid
Figure 9: Onsite Station Locations

ATTACHMENTS

Attachment 1: Figure 2-2 from the July 2023 Mine Plan Amendment Submittal

APPENDICES

Appendix A: Emissions Inventory
Appendix B: Source Groups and Modeled Emission Rates
Appendix C: Modeled Source Parameters

ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
AQRV	Air Quality Related Value
AQS	Air Quality System
BLM	Bureau of Land Management
CAAQS	California Ambient Air Quality Standards
CAPCOA	California Air Pollution Control Officers Association
CARB	California Air Resources Board
CIC	Carbon in Column
CMM	Castle Mountain Mine
CMV	Castle Mountain Venture
CNG	Compressed natural gas
CO	Carbon Monoxide
D	Distance in kilometers
EI	Emissions Inventory
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ER	East Ridge Station
FLAG	Federal Land Managers' Air Quality Related Values Work Group
FLM	Federal Land Manager
GHG	Greenhouse Gas
HAP	Hazardous Air Pollutant
HCN	Hydrogen cyanide
ISR	In-Stack Ratio
km	Kilometer
LNG	Liquefied natural gas
m	Meter
MDAQMD	Mojave Desert Air Quality Management District
MERPs	Modeled Emission Rates for Precursors
mph	Miles per Hour
MW	Megawatt
N	North Station
NAAQS	National Ambient Air Quality Standards
NAD83	North American Datum of 1983

NDEP	Nevada Department of Environmental Protection
NEPA	National Environmental Policy Act
NED	National Elevation Dataset
NG	Natural gas
NLCD	National Land Cover Database
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
O_3	Ozone
OLM	Ozone Limiting Method
Pb	Lead
PBL	Planetary Boundary Layer
PM	Particulate Matter
PM_{10}	Particulate Matter Less Than or Equal To 10 Microns in Diameter
$PM_{2.5}$	Particulate Matter Less Than or Equal To 2.5 Microns in Diameter
ppb	Parts per Billion
ppm	Parts per Million
PSD	Prevention of Significant Deterioration
Q	Annualized emissions in tons per year
RFD	Reasonably Foreseeable Development
RFFA	Reasonably Foreseeable Future Actions
RPS	Renewable Portfolio Standard
SE	Southeast Station
SCAQMD	South Coast Air Quality Management District
SIL	Significant Impact Level
SO_2	Sulfur Dioxide
SW	Southwest Station
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compound
$\mu g/m^3$	Microgram per Cubic Meter

1. INTRODUCTION

The United States Bureau of Land Management (BLM) and San Bernadino County (SBC) are in the process of reviewing the Mining Extension and Amendment to the Mine Plan of Operation and Reclamation Plan prepared for the Castle Mountain Mine (CMM) operated by Equinox Gold through their wholly owned subsidiary, Castle Mountain Venture (CMV). The Castle Mountain Mine is an open pit gold mine located in the Mojave Desert of eastern San Bernardino County, California. Elevation ranges from 4,100 to 5,100 feet above mean sea level. **Figure 1** shows the site boundary. The proposed 2022 Mine Plan of Operations ("2022 Plan", or "Project") is an amendment proposing changes to the authorized plan currently in effect at CMM.[1] The 2022 Plan proposes a continuation of mining at gold mineral ore zones including extensions of pit boundaries and increased mining rates. The 2022 Plan does not propose to increase the current site boundary of 3,910 acres.

To support the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) environmental review, Ramboll, on behalf of CMM, is performing air dispersion modeling and analysis of air quality impacts at and beyond the property boundary from air emissions generated during the Project. The Project is located in a federal nonattainment area (moderate classification) for PM_{10}. Thus, this modeling will also help inform the General Conformity (GC) analysis for PM_{10}. The Project area is classified as attainment or unclassifiable for all other pollutants under the National Ambient Air Quality Standards (NAAQS). Under the California Ambient Air Quality Standards (CAAQS), the Project is located in a state nonattainment area for PM_{10} and ozone (O_3). Emissions of the following pollutants would be anticipated from the Project: particulate matter less than or equal to 10 microns in diameter (PM_{10}), particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$), nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), volatile organic compounds (VOCs), greenhouse gases (GHGs), and hazardous air pollutants (HAPs).

Dispersion modeling will be conducted for PM_{10}, $PM_{2.5}$, NO_2, CO, and SO_2 to demonstrate compliance with both the NAAQS and CAAQS. Emissions of lead (Pb) will be negligible; therefore, lead modeling will not be conducted. The Project's formation of ozone and secondary $PM_{2.5}$ will be estimated using United States Environmental Protection Agency (USEPA) approved methods that do not require modeling. This document outlines the modeling approach to be used to evaluate the impacts of the Project's air emissions on nearby receptors.

This protocol consists of seven sections:

- Section 1 provides this general introduction and high-level Project overview,
- Section 2 contains a detailed description of the Project and associated emission sources and a list of general modeling assumptions,
- Section 3 presents the methodologies and procedures proposed to be used for the dispersion modeling,
- Section 4 discusses other air quality related analyses,
- Section 5 discusses background concentrations and nearby sources,
- Section 6 outlines the proposed format for evaluating air dispersion modeling results, and
- References are listed in Section 7.

[1] This 2022 Plan amendment is a continuation of the original approved 1990 Plan and the 1998 Plan approved as Ver 2.0 of the 1990 Plan, and includes other minor plan modifications made since the original 1990 Plan including the 2018 Plan Update, approved as Ver 2.1. This 2022 Plan amendment will be referenced as Ver 2.2.

2. PROJECT DESCRIPTION

2.1 Process Description

Castle Mountain Mine is an open pit, heap leach gold mine that is proposing to process up to 19 million tons of ore annually (increased from 6.25 million tons currently) and up to 61 million tons of overburden annually (increased from 16.3 million tons currently).

Excavation of ore is achieved through drilling and blasting of ore and overburden material. Overburden is either stockpiled at designated overburdened sites or backfilled into mine pits. Ore grade material is then delivered to a crushing circuit where it is reduced in size to 1 inch or less.

Crushed ore will be gravity separated at the Comminution Plant, then routed through the agglomeration circuit where lime, binder, and moisture are added to bind the ore into larger particles. This improves leach solution mobility through the stacked ore pile. Agglomerated ore is then transferred to the heap leach pad.

At the heap leach pad, a sodium cyanide solution is distributed across the top by drip irrigation. The leach solution percolates through the crushed ore material and dissolves gold from the ore. The pregnant (gold-bearing) solution is then routed to the gold recovery (Process) plant.

Through a carbon in column circuit (CIC), gold is adsorbed by activated carbon. Resulting barren solution is recirculated to the heap leach pad, while the gold-bearing carbon is chemically treated to release, or "strip", gold. The gold-bearing strip solution is treated by electrolysis in an electrowinning cell, after which it is washed, dried, and melted in a furnace to produce an alloy of gold and silver (doré). Stripped carbon is then acid washed to remove any scale and other inorganic contaminants that might inhibit gold adsorption and thermally reactivated.

2.2 Emissions Inventory

The Project emissions inventory (EI) includes stationary, fugitive, and mobile emissions from Project operations. Emission sources may fall into the categories described below. Emission categories and methodologies presented here are subject to refinement based on further engineering design and analysis.

Stationary Sources

Stationary sources associated with operational emissions at the Project would include:

- Primary Crushing jaw crusher and material handling points
- Secondary and Tertiary Crushing, including crushers, screens, bin vents/dust scrubbers, and material handling points
- Agglomeration material handling points
- Cement and Pebble Lime storage, bin vents, and material handling points
- Carbon material handling points
- Refinery mercury emissions
- Heap leach hydrogen cyanide (HCN) emissions
- Emergency and water well generators
- Natural gas (NG) turbines for on-site electricity generation
- Fuel and chemical storage tanks, and

- Gasoline dispensing facility

Potential emissions for all stationary sources except emergency generators and NG turbines will be calculated using emission factors from the USEPA's AP-42, Fifth Edition Compilation of Air Pollutant Emission Factors[2] (USEPA 1995) and the Mojave Desert Air Quality Management District (MDAQMD) emission inventory guidance document (MDAQMD 2013).

Emergency generator emission factors for NO_x, CO, VOC, PM_{10}, and $PM_{2.5}$ will be based on Federal Tier standards and an assumed load factor of 100%. Generators will have Tier 4 final engines per information provided by CMM. Emission factors for SO_2 will be based on fuel consumption estimates provided by CMM and assume a fuel sulfur concentration of 15 parts per million (ppm).[3] GHG emissions for the emergency generators will be based on emission factors and global warming potential values from 40 CFR Part 98, Subparts A and C.

NG turbine ROG/VOC, NOx, and CO emission factors are based on manufacturer's specification sheets for the mictroturbines which list exhaust concentrations of 7 ppmv (as CH_4 equivalent), 9 ppmvd, and 40 ppmvd at 15% O2, and are converted to lb/MMBTU using the dry F-factor method for natural gas (USEPA 2017). Remaining criteria pollutant emissions (SOx, PM_{10}, $PM_{2.5}$) are based on SCAQMD combustion default emission factors, dated December 2024, for the "Natural Gas/Micro Turbine" category (SCAQMD 2024).

Potential emissions from crushers, screens, and material handling transfer points within the crusher system or associated with pebble lime and cement will be estimated using AP-42 methodologies, consistent with Nevada Department of Environmental Protection (NDEP) guidance for the mining industry (NDEP 2017), while potential emissions from all other general material handling transfer points will rely on MDAQMD guidance.

Potential emissions from the gasoline dispensing facility will be based on MDAQMD default emission factors for gasoline dispensing in the Gasoline Service Industry Risk Assessment Technical Guidance (ARB 2022b) along with daily and annual gasoline throughput provided by CMM. Storage tank potential emissions will be based on AP-42, and potential GHG emissions from LNG storage (fugitive leaks) will be based on ARB and USEPA GHG reporting guidance.

Fugitive Sources

Fugitive sources associated with Project operations would include:

- Pit material handling points
- Overburden Area material handling points
- Interim Stockpile wind erosion
- Windblown dust from areas disturbed by operational activities
- Fugitive dust from haul trucks, worker vehicles, and off-road equipment traveling on unpaved roads and surfaces
- Fugitive dust from traffic on off-site paved roads, and
- Blasting and blast hole drilling.

[2] The 5th edition of AP-42 was published in 1995. Since then, individual sections of AP-42 have been modified and added. The emissions inventory for this Project relies upon updated versions of Sections 11.9 (1998), 13.2.1 (2011). 13.2.2 (2006), 13.2.4 (2006), and 13.2.5 (2006).

[3] https://www.epa.gov/diesel-fuel-standards/diesel-fuel-standards-and-rulemakings

Potential emissions for these sources will be calculated using emission factors from the MDAQMD Mineral Emissions Inventory guidance (MDAQMD 2013) and USEPA's AP-42. Calculations will be based on data provided by CMM, application of site-specific moisture contents, default silt loading assumptions, and engineering judgement.

A control efficiency of 95% will be assumed for unpaved road fugitive dust emissions consistent with assumptions for watering, graveling surface, treatment with chemical stabilizers, and speed control from the 1997 Castle Mountain Mine Expansion Project Environmental Impact Statement (EIS)/Environmental Impact Report (EIR), and the understanding that chemical stabilizers will be applied to all unpaved roads. For off-road and disturbed operational area fugitive dust emissions a control efficiency of 98% will be used based on calculations following MDAQMD Mineral Emissions Inventory guidance (MDAQMD 2013), along with watering frequency and the average hourly traffic rate data provided by CMM. Blast hole drilling and blasting PM emissions will utilize a control efficiency of 75% consistent with MDAQMD guidance for "complete coverage by windscreens (on the windward side)", assuming that the pit in which blasting activities take place will effectively act as a windscreen and reduce particulate matter emissions.

Mobile Sources

Tailpipe emissions from mobile vehicle sources associated with Project operation would include:

- Haul trucks
- Off-road equipment;
- On-site on-road vehicles (pickup trucks)
- On-site on-road fuel, product, and reagent trucks, and
- Off-site on-road vehicles (worker commute via private vehicles and vans/buses, fuel deliveries, product deliveries, contractor trucks, reagent deliveries, and other deliveries).

Potential emissions for haul trucks and off-road equipment will be based on USEPA tiered emission limits and assume all engines will meet Tier 4 Final emission limits. Emissions for on-road vehicles and trucks will be based on emission factors from the EMFAC2021 model for MDAQMD and will conservatively utilize calendar year 2027. As Project operations are expected to commence after this date and continue through the mine life, this serves as a conservative estimate of emissions. For off-road equipment, 100% renewable diesel fuel will be used, consistent with regulatory requirements under the California Air Resources Board (CARB) In-Use Off-Road Diesel-Fueled Fleets Regulation (CARB 2022a) and CMV commitments. Liquefied natural gas (LNG) fuel delivery trucks will also be fueled by renewable compressed natural gas (CNG).

Other GHG Emissions

Other GHG emissions, including indirect sources, associated with Project operations would include:

- Electricity usage
- Solid waste generation, and
- Water delivery (associated electricity usage) and wastewater treatment.

Potential GHG emissions for electricity usage will be estimated for continuous operation of electric equipment with a running load of 10 megawatts (MW) and 1.3 MW from the Project's energy providers, Nevada Energy and Southern California Edison (SCE), respectively, and the CO_2e intensity factor for Year 2027 Renewable Portfolio Standard (RPS). Potential GHG emissions from

solid waste generation will be calculated based on the number of employees, an industrial waste generation rate per employee from the City of Los Angeles CEQA Thresholds Guide (City of Los Angeles, 2006), and solid waste landfill gas emission factors from the California Emissions Estimator Model (CalEEMod), Table 10.2 (CAPCOA, 2021). Potential GHG emissions from the off-site water distribution pump station in Nipton, California will be estimated based on the pump's size and power demand and the CO_2e intensity factor for Year 2027 RPS for Nevada Energy. Potential GHG emissions from wastewater treatment will be based on water usage rates for the Project with continuous operation of water pumps and emission factors from CalEEMod, Table 9.4 (CAPCOA, 2021), assuming all wastewater will be treated with an on-site septic system.

2.2.1 Project Features and Control Measures

Potential emissions associated with the Project will be controlled by various methods and technologies. Emissions from the operation of generators and off-road equipment will be minimized through the use of engines which meet Federal Tier 4 Final standards. Potential emissions associated with the crushers, screens, and select material transfer handling points will be either controlled with moisture, enclosure, and/or vented to baghouses and bin vents. Fugitive dust from disturbed operational areas and off-road areas with vehicular traffic will be controlled using water application on an hourly basis. Unpaved road fugitive dust emissions from the access road and primary haul roads will be controlled by applying a chemical suppressant. Onsite haul roads will also be controlled with watering. As noted above, 100% renewable diesel fuel will be used for off-road equipment, consistent with regulatory requirements under the CARB In-Use Off-Road Diesel-Fueled Fleets Regulation (CARB 2022a) and CMV commitments. As a result, CO_2 emissions from off-road equipment use will be 100% biogenic based. Blast hole drilling and blasting PM emissions will be reduced because the pit in which blasting activities take place will effectively act as a windscreen. Mercury emissions from the retort system will be controlled with carbon scrubbers.

Control methods presented here are subject to refinement based on further engineering design and analysis.

2.2.2 Emissions Year

To conservatively capture variations in year-to-year operations and to present a potential peak year of operation, maximum annual activity data will be modeled from each activity type, regardless of overlapping year. For example, maximum hauling operations and maximum equipment counts for the inventory are projected to occur in different years but will be conservatively modeled together in the inventory development. Additionally, emission factors which are dependent on operational year (e.g. on-road mobile vehicles) will conservatively utilize year 2027, while Project operations are expected to commence after this date and extend through the mine life.

Maximum annual operations will be evaluated to account for up to 19.2 million tons of ore processed and up to 60.6 million tons of overburden material mined, which include the portions of ore and overburden processing that are currently approved (6.25 million tons annually and 16.3 million tons annually, respectively).

Mining activity during the peak year will be primarily located at the South Extension Pit along the South Extension Phase I haul route and at the northern pit complex[4] along the Oro Belle (east) haul route, with a small amount of additional activity along with Jumbo Oro Belle haul route. The

[4] The "northern pit complex" is used to reference the aggregate of the JSLA, Jumbo, and Oro Belle pits.

peak year of haul truck travel will occur along the Oro Belle (east), South Extension Phase I, and South Extension Phase II haul routes. During these years, the overburden will be hauled from the mining locations and used as backfill at the northern pit complex. See Section 2.3.2 for a discussion of the emission source locations. The final modeling report will include detailed calculations and supporting methodologies used to develop the emissions inventory, see **Appendix A**. Emissions presented here are subject to refinement based on further engineering design and analysis.

2.3 Proposed 2022 Plan and Approved Operations

The emission inventories will be developed to reflect total operations under the Proposed 2022 Plan, including the portion of activity that is currently approved. Currently approved operations include emissions associated with mining and processing of materials as authorized in the 1998 Plan and recent revisions (1998 Plan Version 2.0 and Version 2.1). Ore processing is currently authorized and permitted for up to 6.25 million tons annually, and overburden mining is currently authorized for up to 16.3 million tons annually.

2.3.1 Emission Source Apportionment

Emission sources to be modeled to demonstrate compliance with the NAAQS and CAAQS include on-site stationary, fugitive, and mobile source emissions of PM_{10}, $PM_{2.5}$, NO_x, CO, and SO_2. **Table 1** shows the type of source groups presented in the emission apportionment tables. Proposed treatment of emissions, i.e., temporal variability, associated with each source are presented in **Appendix B**. A compilation of proposed source parameters is included in **Appendix C**.

Table 1: Source Categories included in Emission Source Apportionment Tables

Source Groups
Stationary Sources (baghouses, dust collectors, bin vents, material transfers, emergency generators, NG turbines, other combustion, etc.)
Haul Truck Loading and Unloading Fugitive Dust at Pits and Overburden Piles
Offroad Equipment Fugitive Dust and Exhaust at Pits and Overburden Piles
Erosion Fugitive Dust at Pits, Overburden Piles, and Heap Leach Pad
Blast Hole Drilling Fugitive Dust and Blasting at Pits
Northern pit complex Haul Roads
South Extension Pit Haul Roads
Overburden Piles Haul Roads
Miscellaneous Trucks Haul Roads
Fuel and Delivery Trucks Haul Roads

2.3.2 Emission Source Locations

Attachment 1 provides the spatial extents of the proposed maximum development areas, including the mine pit limit and the extent of the disturbed areas. These extents were used to characterize the location and size the emission sources for input into the model. **Figure 2** shows the locations of stationary sources. **Figure 3 and Figure 4** show the locations of the pits, overburden, and heap leach area and volume sources, respectively. During the peak year of

mining operation, extraction will occur at both the Northern pit complex (along the Oro Belle (east) route) and South Extension Pit, and overburden material will be placed back into the northern pit complex as backfill. **Figure 5** shows the locations of the hauling and vehicle routes. During the maximum year of haul truck travel, activity will occur on the following pit haul roads: South Extension Phase I, South Extension Phase II, Oro Belle (east), JSLA Backfill, JSLA East, and Jumbo Oro Belle. The proposed model setup for the maximum year scenario is provided in **Figure 6a**.

To conservatively evaluate additional mining years where extraction and overburden loading may occur in different areas of the mine site, the peak year of emissions will be modeled under two hypothetical scenarios of alternate source locations.

In the first hypothetical scenario, all extraction is assumed to occur at the northern pit complex, and overburden material is assumed to be placed on the North Overburden Pile. Haul truck travel is therefore assumed to occur on the following haul roads: Oro Belle (east), JSLA East, JSLA West, Jumbo Ore Belle, and North Overburden. All other sources not tied to pit or overburden locations (e.g. stationary sources) will be modeled at the same locations. While this configuration is not reflective of a specific mining year, it is intended to conservatively evaluate potential operations across multiple mining years where activity may occur in the northern portion of the site. The proposed model setup for this scenario is provided in **Figure 6b**.

In the second hypothetical scenario, all extraction is assumed to occur at the Southern Extension Pit, and overburden material is assumed to be placed on the South Overburden Pile. Haul truck travel is therefore assumed to occur on the following haul roads: South Extension Phase I, South Extension Phase II, and South Overburden. All other sources not tied to pit or overburden locations (e.g. stationary sources) will be modeled at the same locations. While this configuration is not reflective of a specific mining year, it is intended to conservatively evaluate potential operations across multiple mining years where activity may occur in the southern portion of the site. The proposed model setup for this scenario is provided in **Figure 6c**.

3. DISPERSION MODELING APPROACH

The model and methods to be used to simulate the dispersion of criteria pollutant emissions are discussed below.

3.1 Model Selection

Modeling will be conducted with the latest version of AERMOD, The American Meteorological Society/ Environmental Protection Agency Regulatory Model, (Version 24142) in accordance with USEPA's Guideline on Air Quality Models 40 CFR 51, Appendix W (Revised, November 29, 2024), herein referred to as Appendix W (USEPA 2024).

AERMOD is the preferred dispersion model recommended by USEPA (i.e., Appendix W) for source to receptor distances less than 50 kilometers (km) (31 miles). It is capable of handling complex source configurations, deposition processes, emission units subject to plume downwash, and situations where plumes interact with complex terrain.

3.2 Source Parameters

Emission sources associated with the Project will be modeled using point, volume, and area source representations. **Table 2** shows a proposed source characterization organized by source category. Source characterization may be adjusted based on further engineering design or source refinement. Proposed treatment of emissions, i.e., temporal variability, associated with each source are presented in **Appendix B**. A compilation of proposed source parameters is included in **Appendix C**.

Table 2: Castle Mountain Mine Key Emissions Sources and Model Characterization

Emissions Source Category	Source type	Assumptions
Stationary Sources (Baghouses, Dust Collectors, Bin Vents)	Point	Multiple point sources each representing exhaust emissions from baghouses, dust collectors, and bin vents associated with material transfers at different Crushing and Agglomeration Plant units. Proposed source parameters (Appendix C) are provided by CMV or based on engineering judgment.
Stationary Sources (NG Turbines)	Point	Vertical, uncapped point sources modeled with downwash. These sources are assumed to operate continuously (8,760 hours per year) and include downwash effects from their enclosures. The source parameters were provided by the vendor.
Stationary Sources (Diesel Generators)	Point	Combustion sources include four (4) emergency generators and two (2) water well generators. Emergency generator modeling will assume 100 hours per year of operation for emissions calculations, but emissions will be annualized over 8,760 hours per year for the annual modeled emission rates. Short-term pollutant scenarios (e.g.,

Emissions Source Category	Source type	Assumptions
		1-hour NO_2 and 24-hour PM_{10}) will also use the annualized emission rate, consistent with USEPA guidance for intermittent stationary sources. Source parameters were provided by CMV or based on engineering judgment.
Stationary Sources (Material Transfers)	Volume	Volume sources will be used to represent material transfers at key process areas where fugitive dust emissions do not route to a stack. Source parameters are based on information provided by CMV and calculated following USEPA guidance, best practices, and engineering judgement.
Fugitive Dust from Haul Truck Loading, Offroad Equipment, Wind Erosion, and Blast Hole Drilling	Area	Short-term (daily) and annual fugitive dust emissions will be modeled over the extent of a given activity area (pit, overburden pile, and/or heap leach pad). Haul truck loading will occur at the pits. Offroad equipment will generally be used at the pits and overburden piles, while drilling-specific offroad equipment and blast hole drilling will only occur at the pits. Wind erosion will occur at the pits, overburden piles, and heap leach pad. Source characteristics were selected based on best practices and engineering judgement.
Fugitive Dust from Overburden Unloading	Volume	Short-term (daily) and annual fugitive dust emissions will be modeled over the extent of a given overburden pile location. Source characteristics were selected based on best practices and engineering judgement.
Offroad Equipment Exhaust and Blasting	Volume	Short-term (hourly/daily) and annual emissions will be modeled over the extent of a given location (pit and/or overburden pile). Offroad equipment will generally be used at the pits and overburden piles, while drilling-specific offroad equipment and blasting explosives will only be used at the pits. Source characteristics were selected based on best practices and engineering judgement.

Emissions Source Category	Source type	Assumptions
Northern pit complex Haul Routes, South Extension Pit Haul Routes, Overburden Pile Haul Routes, Miscellaneous Truck Routes, Delivery Truck Routes	Series of Volume Sources	Source parameters will be calculated consistent with USEPA Haul Road Guidance (USEPA 2012).

3.2.1 Point Sources

Point source modeling requires an estimate of stack height, stack diameter, exit temperature, and exit velocity. Parameters will be determined based on the specific equipment types being modeled where available. Where specific equipment types and release parameters are unknown, Ramboll will use conservative stack parameters based on best practices and engineering judgement.

The NG turbines are package units that are designed with built-in enclosures. The height of the enclosures and height of the exhaust stacks are similar. In order to account for the potential downwash effects on the turbine exhaust stacks created by the enclosures, the Building Profile Input Program with Prime (BPIPPRM version 04274) will be run for the turbines and enclosures to generate input for AERMOD. Due to the small vertical and lateral footprint of the turbine enclosures, they are not expected to affect any other point sources. The location of the exhaust stacks and enclosures for the turbines are provided in **Figure 2**.

3.2.2 Volume Sources

Volume source parameters will be assigned based on the size of the initial plume or the physical dimensions of the source. The methods will follow the recommendation of the AERMOD User's Guide (USEPA 2024). Series of volumes used to simulate roadway sources will be parameterized as per recommendations in the USEPA's Haul Road Workgroup Final Report (USEPA 2012). The dimensions of the sources will depend on the physical characteristics of the roads and the sizes of the vehicles transporting the materials. The same parameters will be used for both the fugitive and exhaust emissions on these roads.

3.2.3 Area Sources

Area source parameters will be based on the footprint of each source and simulated as rectangles or polygons. Complex footprints may be assigned to multiple polygons depending on the proximity of nearby receptors to obtain more precise concentration estimates at these locations. The initial release height and vertical dimensions of each area source will follow the same guidance as used for the volume sources.

3.3 Meteorological Data Processing

The Castle Mountain Mine currently maintains and operates a 10-meter meteorological tower located on the Northern site (North station) boundary, as part of a sitewide PM_{10} and meteorological monitoring program. This meteorological tower includes standard 10-meter (m) wind data, sigma-theta, 10- and 2-meter temperature differences, and solar radiation that are designed for direct input into AERMET/AERMOD. The station also undergoes routine calibration and auditing to ensure the data is of sufficient quality and completeness for use as input into a dispersion model. Further details about station siting, quality assurance and quality control, and

data collection and validation procedures are discussed in the Ambient Air Quality and Meteorological Monitoring Quality Assurance Plan (Ramboll 2023).

The North station meteorological data will be processed using the most recent version of AERMET (version 24142). The current federal modeling guidance, Appendix W (USEPA 2024), requires at least 1-year of site-specific meteorological data for air quality modeling; therefore, the North station meteorology will be processed for the period of January 1, 2021 through December 31, 2022. The following processing inputs and options will be utilized:

- Upper-air data from Las Vegas, NV. Las Vegas is approximately 90 km (56 miles) due north of the project site and is climatologically representative of the general area.
- The stable planetary boundary layer (PBL) will be based on the Bulk Richardson scheme in AERMET. The solar radiation data will be used during the unstable PBL calculations. The sigma-theta data is passed directly to AERMOD, which precludes the use of the "adjust u*" option in AERMET/AERMOD.

All meteorological parameters during the selected two-year period meet the 90 percent data completeness criteria by quarter required by USEPA. The wind rose for the North station data is presented in **Figure 7**.

3.3.1 Land Use Characterization

Land use data surrounding the North station will be processed using AERSURFACE (Version 24142) with surface characteristics based on data from the National Land Cover Database (2016 NLCD), canopy data, and impervious surface data. The monthly surface moisture condition will be estimated by comparing monthly precipitation data collected from the North station to the 30-year climatological record (1991-2020) from Las Vegas, NV for the respective months. For each month, "wet" conditions will be selected when precipitation is in the upper 30th percentile, "dry" conditions when precipitation is in the lower 30th percentile, and "average" conditions when precipitation is in the middle 40th percentile (USEPA 2024b).

Other land-use processing options to be applied include:

- Use of 12 sectors;
- The site will be classified as arid, no snow, and non-airport;
- Default seasons assignments; and
- A monthly temporal resolution.

Using standard AERSURFACE processing, albedo and Bowen ratio values will be based on a 10 km by 10 km domain centered on the North station. Monthly surface roughness values will be calculated for twelve 30-degree sectors within 1 km of the North station.

3.4 Receptor Grid and Terrain Data

A nested Cartesian receptor grid will be used for the dispersion modeling analysis. The ambient air boundary will be defined by the Project boundary. Receptors will be placed as follows:

- 10 m resolution along the ambient air boundary
- 200 m resolution extending from the boundary to 4 km, and
- 500 m resolution from 4 km to 20 km.

Boundary or off-site receptors located within 100 feet from the center of a modeled roadway will be excluded. The proposed receptor grid is presented in **Figure 8**.

The latest version of AERMAP (Version 24142) will be used to extract terrain elevations and critical hill heights for all receptors defined in the nested receptor grid using 1/3-arc second National Elevation Data (NED).

All receptors and source locations will be based on the Universal Transverse Mercator (UTM) North American Datum 1983 (NAD83), Zone 10 coordinate system.

3.5 NO_2 Modeling Approach

Ramboll proposes to use a Tier 3 method [Ozone Limiting Method (OLM)] for all NO_2 analyses. The inputs for OLM include ambient ozone measurements and in-stack NO_2 to NO_x ratio for all NO_x-emitting sources. The hourly ozone data will be obtained from the Air Quality System (AQS) Data Mart database for the Jean station (AQS ID: 32-003-1019) for the modeled period (January 2021-December 2022). The Jean station is the closest monitoring site to the Project site (approximately 55 km (34 miles) to the north) and adequately represents ambient ozone in the area. This ozone dataset has a small percentage of missing data (96% completeness). The missing data will be filled in with data from the Trona station (AQS ID: 06-071-1234). For any remaining missing hours, missing data will be filled with data for the non-missing hours surrounding the missing hour.

In addition to ozone data, OLM requires specification of an in-stack ratio of NO_2 to NO_x for each NO_x-emitting source. The proposed NO_2/NO_x in-stack ratios for each source type are summarized in **Table 3**.

Table 3: In-Stack Ratios for NO_x-emitting Sources

Emissions Source Category	In Stack NO_2/NO_x Ratio	Source
Emergency Generators	0.10	USEPA ISR database (USEPA 2020)
NG turbines	0.50	USEPA default
On-road Light/Medium Duty Trucks and Cars	0.25	California Air Pollution Control Officers Association (CAPCOA 2011)
On-road Heavy Duty Diesel Trucks	0.11	California Air Pollution Control Officers Association (CAPCOA 2011)
Off-road Equipment	0.20	California Air Pollution Control Officers Association (CAPCOA 2011)

Emissions Source Category	In Stack NO_2/NO_x Ratio	Source
Blasting	0.036	Commonwealth Scientific and Industrial Research Organisation (CSIRO 2008)

4. OTHER ANALYSES

4.1 Ozone Ambient Impact Analysis

An ozone ambient impact analysis for the ozone NAAQS will be conducted using Modeled Emission Rates for Precursors (MERPs), consistent with USEPA's Guidance on the Development of MERPs as a Tier I Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program (USEPA 2024c). Ramboll will quantify Project emissions and estimate the secondary formation of ozone from project NO_x and VOC emissions using a nearby, representative source modeled by USEPA. The estimated ozone formation due to Project emissions will be compared to the ozone SIL value of 1.0 ppb. If the estimated ozone formation is greater than or equal to the ozone SIL, the Project impacts will be added to the ozone design value using the Jean site (AQS ID: 32-003-1019) for comparison to the NAAQS.

4.2 Secondary $PM_{2.5}$ Formation

Similar to ozone, Ramboll will estimate secondary $PM_{2.5}$ formation from Project SO_2 and NO_x emissions using the USEPA MERPS guidance (USEPA 2024c). The secondary $PM_{2.5}$ will be added to the primary $PM_{2.5}$ impacts generated from AERMOD. The total $PM_{2.5}$, primary plus secondary, will be compared to the applicable air quality standards.

It is noted that the direct $PM_{2.5}$ impacts will generally occur close to the fence line given the nature of the sources and their distances to the fence line, while secondary $PM_{2.5}$ formation from combustion sources will generally occur much farther downwind. Ramboll will evaluate the profile of the predicted primary $PM_{2.5}$ impacts and source characteristics of the SO_2 and NO_x sources since the MERPs database[5] allows for an analysis of secondary impacts by distance from source.

4.3 Air Quality Related Values

Using the Federal Land Managers' Air Quality Related Values Work Group (FLAG) guidance for Class I areas (USFS 2010), an assessment of Project impacts on the air quality related values (AQRVs) of regional haze and acid deposition will be made using the Q/D screening approach, where Q is the annualized, maximum daily Project emissions of PM_{10}, SO_2, NO_x, and sulfuric acid in tons per year, divided by the distance, D in km. If the Q/D value exceeds a value of 10, then further analyses may be required. If the Q/D value is than 10, no significant impacts to AQRVs is demonstrated.

[5] https://www.epa.gov/scram/merps-view-qlik#Modeled_Impacts_Distance

5. BACKGROUND CONCENTRATIONS

Ambient background concentrations will be added to the modeled impacts from the Project sources to establish the potential cumulative impacts for comparison to the NAAQS and CAAQS. The background concentrations are intended to account for sources not explicitly included in the modeling. These sources include (i) natural sources, (ii) nearby non-modeled sources, and (iii) unidentified sources of air pollution (e.g., long-range transport). The concentrations should be representative of regional air quality in the vicinity of the proposed facility. Review of available data indicates that there are no nearby, non-Project sources that would need to be explicitly included in the modeling. The proposed background concentrations for each criteria pollutant are based on a combination of in-situ measurements for PM_{10} and data from nearby, representative monitors for all other pollutants.

5.1 Background Concentrations

CMM is currently conducting PM_{10} monitoring at four monitoring stations: Southwest (SW), East Ridge (ER), North (N), and the Southeast (SE) station, as shown in **Figure 9**. All four stations collect continuous data for PM_{10} and meteorological parameters. Due to the remote location of the Castle Mountain site and limitations of available alternating current (AC) power, this monitoring program utilizes one Met One EBAM monitor (EBAM) configured with a PM_{10} inlet at each location. However, the ER station has a substantial solar and battery array (for site communications equipment) that can support AC power so this site was also configured with a Met One EBAM Plus, which has been given Federal Equivalency Method (FEM) designation for PM_{10} so that EBAM data can be verified and validated against PM_{10} FEM data. Additional information about station siting, quality assurance and quality control, and data collection and validation procedures are discussed in the Ambient Air Quality and Meteorological Monitoring Quality Assurance Plan (Ramboll, 2023).

The PM_{10} data collected at the North station was processed to establish a background value for use in the cumulative impact assessment. The North station is used as the basis of the PM_{10} background based on the availability of co-located and high-quality meteorological data. Review of the data indicates that high winds can frequently elevate the monitored PM_{10} concentrations at all monitoring stations, therefore, properly accounting for windblown dust is considered an important component of establishing a representative background concentration.

A comparison of 2021 annual average PM_{10} concentrations, including concentrations during high-wind period, at the onsite North station and at two offsite stations in the region is shown below in **Table 4**.

Table 4. Comparison of Annual PM_{10} Concentrations for 2021, High Wind Periods not Removed

Station	Annual Average PM_{10} Concentrations ($\mu g/m^3$)
On-site N Station	8.4
Jean, NV	20.5
Barstow, CA	30.6

To establish a representative background value, the PM_{10} data was processed to remove the effects of high winds and possible contribution of dust from existing onsite activities. As noted in

Section 2.3, the emission inventories will be modeled reflect the total operations under the Proposed 2022 Plan, including the portion of activity that is currently approved. The data processing used in the determination of 24-hour background values is not intended to meet the statutory or regulatory requirements under the Exceptional Events Rule and associated guidance (USEPA 2019). However, both USEPA guidance and MDAQMD regulations were reviewed in order to inform the proposed processing steps.

The PM_{10} data during the period of January 1, 2021 through December 31, 2021 was analyzed due to minimal onsite activity during this time period (compared to 2022 and future years). The data processing is consistent with procedures as outlined in the 2021 Annual Air Quality and Meteorology Monitoring Data Summary Report (Ramboll 2022), with the following additional steps:

- Based on the location of the N station, winds from the south (i.e., between 90 and 270 degrees) may have elevated concentrations of PM_{10} from existing activities. Therefore, winds from this sector were classified as downwind of existing activities and excluded from the analysis so as to not double-count impacts. Conversely, winds from 270 to 90 degrees were classified as upwind of existing activities. There are no other routine anthropogenic PM_{10} sources further upwind of the N station. If a day had less than 12 hours of winds from the upwind sector, then the 24-hour background value was not included in this background analysis. Designated upwind directions are shown in **Figure 9**.
- The 24-hr average PM_{10} concentrations were not included in this background analysis if there was an hour during the day with an hourly average wind speed exceeding 25 miles per hour (mph) (USEPA 2019) or 15 mph per MDAQMD's definition of high winds[6].

Using the processing steps discussed above, the monitored data were processed and the first highest 24-hour PM_{10} background concentration by month, and annually, were reported for the one-year dataset. Ramboll proposes to use maximum (1st high) background concentrations for PM_{10}, by month, and the annual average as presented in **Table 5**.

[6] MDAQMD Rule 403 Fugitive Dust Control defines "high winds" as "*When the wind speed instantaneously exceeds 40 kilometers (25 miles) per hour, or when the average wind speed is greater than 24 kilometers (15 miles) per hour. The average wind speed determination shall be on a 15-minute average at the nearest District-approved meteorological station"*.

Table 5. Processed Background PM_{10} Concentrations from North Station for 2021

Month	1st Highest 24-hour Concentration ($\mu g/m^3$)	Annual Concentration ($\mu g/m^3$)
January	2.1	--
February	3.5	--
March	7.8	--
April	14.0	--
May	13.2	--
June	20.1	--
July	16.3	--
August	11.9	--
September	16.9	--
October	7.0	--
November	3.8	--
December	4.2	--
Annual Average	--	6.3

For all other criteria pollutants, background values were obtained from existing air quality monitors in the area and are summarized in **Table 6a** for NAAQS and **Table 6b** for CAAQS. To cover all criteria pollutants, the following sites were used:

- Jean, NV is located off of Interstate 15 and is approximately 55 km (34 miles) to the north-northwest of the Project site. The Jean monitor will be used for $PM_{2.5}$ and ozone (O_3) background data.
- Trona, CA is approximately 210 km (130 miles) to the west-northwest of the Project site. The Trona monitor will be used for NO_2 background data.
- Las Vegas, NV is approximately 100 km (62 miles) north of the Project site. The Las Vegas monitor will be used for CO and SO_2 background data.

Table 6a. NAAQS Background Concentration Summary for Other Pollutants

Pollutant	Value Description	Reported Value	Monitored Value (◦g/m³ unless noted)	Monitoring Station ID	Years
$PM_{2.5}$	Annual	3-year average of arithmetic means	4.8	AQS 32-003-1019 (Jean)	2020 - 2022
$PM_{2.5}$	24-hour	3-year average of 98th percentile	16.6	AQS 32-003-1019 (Jean)	2020 - 2022
NO_2	Annual	Arithmetic mean	6.8	AQS 06-071-1234 (Trona)	Maximum of: 2020 - 2022
NO_2	1-hour	3-year average of 98th percentile	64.9	AQS 06-071-1234 (Trona)	2020 - 2022
O_3	8-hour	3-year average of 4th highest	68.7 ppb	AQS 32-003-1019 (Jean)	2020 - 2022
CO	1-hour	2nd highest	2.1 ppm	AQS 32-003-1501 (Las Vegas)	Maximum of: 2020 - 2022
CO	8-hour	2nd highest	1.7 ppm	AQS 32-003-1501 (Las Vegas)	Maximum of: 2020 - 2022
SO_2	1-hour	3-year average of 99th percentile	11.0	AQS 32-003-0540 (Las Vegas)	2020 - 2022

Table 6b. CAAQS Background Concentration Summary for Other Pollutants

Pollutant	Value Description	Reported Value	Monitored Value (◦g/m³ unless noted)	Monitoring Station ID	Years
$PM_{2.5}$	Annual	Annual arithmetic mean	5.1	AQS 32-003-1019 (Jean)	Maximum of: 2020 - 2022
NO_2	Annual	Annual arithmetic mean	6.8	AQS 06-071-1234 (Trona)	Maximum of: 2020 - 2022

Pollutant	Value Description	Reported Value	Monitored Value (◦g/m³ unless noted)	Monitoring Station ID	Years
NO_2	1-Hour	Maximum	82.0	AQS 06-071-1234 (Trona)	Maximum of: 2020 - 2022
CO	1-Hour	Maximum	2.3 ppm	AQS 32-003-1501 (Las Vegas)	Maximum of: 2020 - 2022
CO	8-Hour	Maximum	1.7 ppm	AQS 32-003-1501 (Las Vegas)	Maximum of: 2020 - 2022
SO_2	1-Hour	Maximum	19.3	AQS 32-003-0540 (Las Vegas)	Maximum of: 2020 - 2022
SO_2	24-Hour	Maximum	19.3 (set equal to 1-hour)	AQS 32-003-0540 (Las Vegas)	Maximum of: 2020 - 2022

5.2 RFFA and RFD

Ramboll will work with the BLM and stakeholders to determine if there are any relevant nearby sources, Reasonably Foreseeable Future Actions (RFFA), or Reasonably Foreseeable Development (RFD).

6. MODELING RESULTS

The model inputs described above will be used to evaluate compliance with the applicable NAAQS and CAAQS summarized in **Table 7**. For $PM_{2.5}$, secondary $PM_{2.5}$ impacts will be added to the primary modeled $PM_{2.5}$ impacts from AERMOD. The Project impacts will be added to the background concentrations summarized in **Section 5.1**. Modeling and evaluation of SO_2, PM_{10}, $PM_{2.5}$, CO, and NO_2 are consistent with the scope of modeling required for an Ambient Air Quality Standard (AAQS) analysis required under CEQA per Santa Barbara County APCD (SBCAPCD 2020) and an Ambient Air Quality Analysis (AAQA) required under CEQA per San Joaquin Valley APCD (SJVAPCD 2019).

Graphical plots of modeled concentrations for each pollutant and averaging period will be provided with the final report to show the location of the maximum concentration and how the modeled concentrations vary across the domain.

Table 7. Level of Standard and Modeling Output for NAAQS and CAAQS Compliance Demonstration

Pollutant	Averaging Period	CAAQS (µg/m³)	NAAQS (µg/m³)	Form Description	Form (Reportable Concentration)
SO_2	1-hour	655 (250 ppb)	196 (75 ppb)	CAAQS: Not to be exceeded	H1H
				NAAQS: 99th percentile of 1-hour daily maximum concentrations, multi-year average	Maximum 99th percentile of maximum daily 1-hour concentrations, multiyear average
	24-hour	105 (40 ppb)	—	CAAQS: Not to be exceeded	H1H
NO_2	1-hour	339 (180 ppb)	188 (100 ppb)	CAAQS: Not to be exceeded	H1H
				NAAQS: 98th percentile of 1-hour daily maximum concentrations, multi-year average	Maximum 98th percentile of maximum daily 1-hour concentrations, multiyear average
	Annual	57 (30 ppb)	100 (53 ppb)	CAAQS: Annual average for individual year	Maximum by year

Pollutant	Averaging Period	CAAQS (µg/m³)	NAAQS (µg/m³)	Form Description	Form (Reportable Concentration)
				NAAQS: Annual average for individual year	
CO	1-hour	23,000 (20 ppm)	40,000 (35 ppm)	CAAQS: Not to be exceeded	H1H
				NAAQS: Not to be exceeded more than once per year	H2H by year
	8-hour	10,000 (9 ppm)	10,000 (9 ppm)	CAAQS: Not to be exceeded	H1H
				NAAQS: Not to be exceeded more than once per year	H2H by year
PM_{10}	24-hour	50	150	CAAQS: Not to be exceeded	H1H
				NAAQS: Not to be exceeded more than once per year on average over 3 years	H2H by year
	Annual	20	—	CAAQS: Annual average for individual year	H1H
$PM_{2.5}$	24-hour	—	35	NAAQS: 98th percentile, multi-year average	Maximum 98th percentile, multiyear average
	Annual	12	9	CAAQS: Annual average for individual year	Maximum annual average by year
				NAAQS: Annual mean, averaged over 3 years	Maximum annual average, multiyear average

7. REFERENCES

CAPCOA. 2011. Modeling Compliance of the Federal 1-hour NO_2 NAAQS. October 27. Available at: http://www.valleyair.org/busind/pto/Tox_Resources/CAPCOANO2GuidanceDocument10-27-11.pdf

CAPCOA. 2021. User's Guide of CalEEMod Version 2020.4.0. May. Available online at: http://www.aqmd.gov/caleemod/user's-guide

CARB. 2022a. In-Use Off-Road Diesel-Fueled Fleets regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/off-roaddiesel/froa-1.pdf

CARB. 2022b. Gasoline Service Industry Risk Assessment Technical Guidance. February 18. https://www.mdaqmd.ca.gov/home/showpublisheddocument/9310/637850250462300000

City of Los Angeles. 2006. L.A. CEQA Thresholds Guide: Your Resource for Preparing CEQA Analyses in Los Angeles. Available online at: https://planning.lacity.org/eir/CrossroadsHwd/deir/files/references/A07.pdf

CSIRO. 2008. "NO_x Emissions from Blasting Operations in Open-Cut Coal Mining." *Atmospheric Environment.* (42) 34: 7874–7883.

https://www.epa.gov/sites/default/files/2019-04/documents/high_wind_dust_event_guidance.pdfhttps://www.epa.gov/scram/nitrogen-dioxidenitrogen-oxide-stack-ratio-isr-databasehttps://www.epa.gov/system/files/documents/2024-11/appendix_w-2024.pdfMDAQMD. 2013. Emissions Inventory Guidance. Mineral Handling and Processing Industries. November 4. Available at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

NDEP. 2017. Guidance on Emission Factors for the Mining Industry. May 31. Available online at: https://ndep.nv.gov/uploads/air-permitting-docs/ndep-mining-emissions-guidance.pdf

Ramboll. 2022. 2021 Annual Air Quality and Meteorology Monitoring Data Summary Report.

Ramboll. 2023. Ambient Air Quality and Meteorological Monitoring Assurance Plan.

Santa Barbara County APCD (SBCAPCD), Modeling Guidelines for Air Quality Impact Assessments. June 2020. Available online at: https://www.ourair.org/wp-content/uploads/aqia.pdf

Santa Joaquin Valley APCD (SJVAPCD), APR 1925 Policy for District Rule 2201 AAQA Modeling. March 2019. Available online at: http://www.valleyair.org/policies_per/policies/apr-1925.pdf

South Coast Air Quality Management District (SCAQMD). 2024. Combustion Default Emission Factors. December. Available online at: https://www.aqmd.gov/docs/default-source/planning/annual-emission-reporting/combustion-default-emission-factors-2024.pdf?sfvrsn=9c358361_9

United States Environmental Protection Agency (USEPA). 1995. AP-42, Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources. Available at: https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emission-factors#5thed

USEPA. 2012. Haul Road Workgroup Final Report Submission to EPA-OAQPS. March. Available at: https://www3.epa.gov/ttn/scram/reports/Haul_Road_Workgroup-Final_Report_Package-20120302.pdf

USEPA. 2017. Method 19: Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates. Available online at: https://www.epa.gov/sites/production/files/2017-08/documents/method_19.pdf

USEPA. 2019. Guidance on the Preparation of Demonstrations in Support of Request to Exclude Ambient Air Quality Data Influenced by High Wind Dust Events Under the 2016 Exceptional Events Rule. EPA-457/B-19-001. Office of Air Quality Planning and Standards, Environmental Protection Agency. Research Triangle Park, North Carolina. April. Available at: https://www.epa.gov/sites/default/files/2019-04/documents/high_wind_dust_event_guidance.pdf

USEPA. 2020. Nitrogen Dioxide/Nitrogen Oxide In-Stack Ratio (ISR) Database. NO2_ISR_database.xlsx. October 29, 2020. Available at: https://www.epa.gov/scram/nitrogen-dioxidenitrogen-oxide-stack-ratio-isr-database

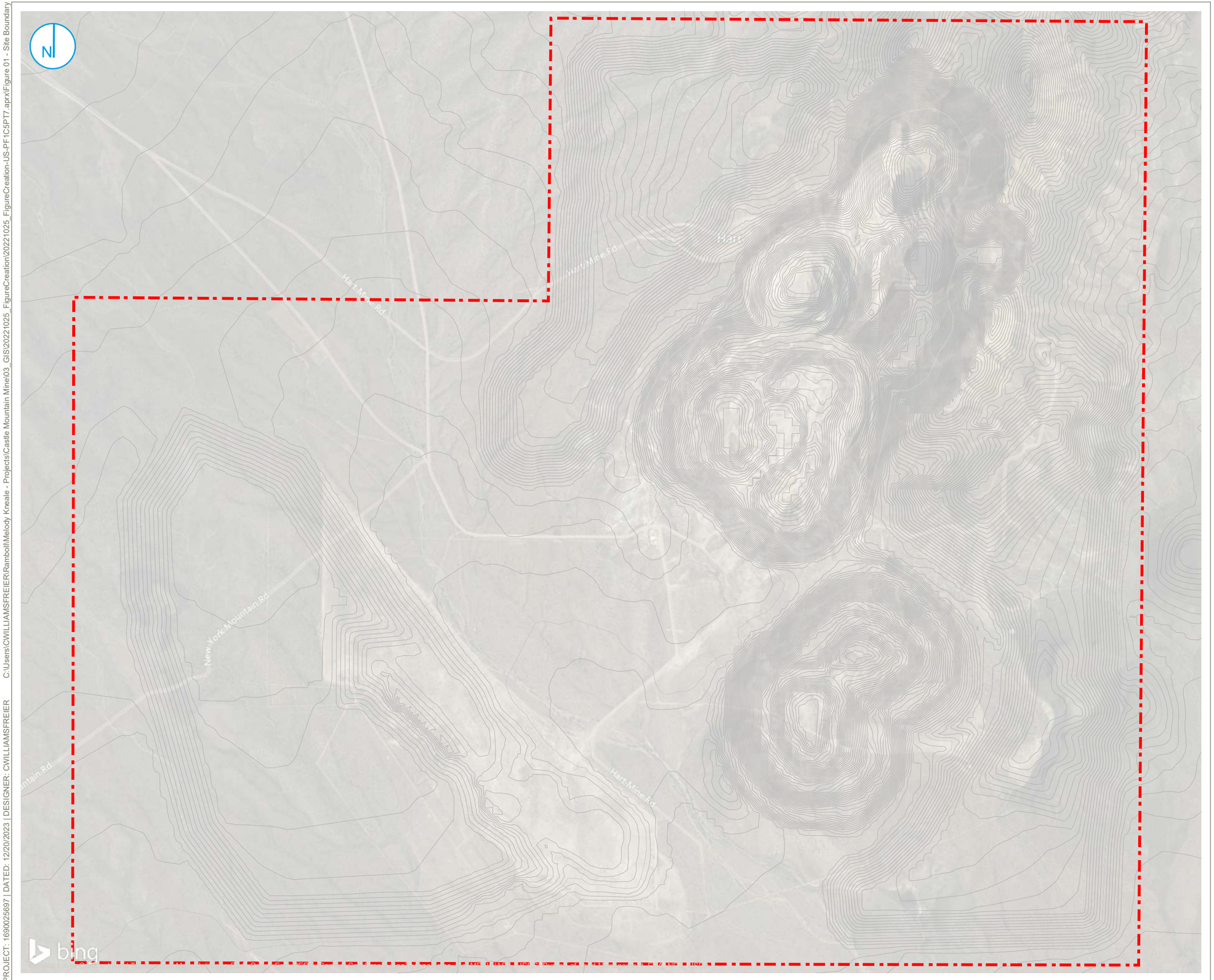
USEPA. 2024. Guideline on Air Quality Models 40 CFR 51, Appendix W (Revised, November 29, 2024). Available at: https://www.epa.gov/system/files/documents/2024-11/appendix_w-2024.pdf

USEPA. 2024a. User's Guide for the AMS/EPA Regulatory Model (AERMOD). EPA-454/B-24-007. U.S. Office of Air Quality Planning and Standards, Environmental Protection Agency. Research Triangle Park, North Carolina. November. Available at: https://gaftp.epa.gov/Air/aqmg/SCRAM/models/preferred/aermod/aermod_userguide.pdf

USEPA. 2024b. User's Guide for the AERSURFACE Tool. EPA-454/B-24-003. Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. November. Available at: https://gaftp.epa.gov/Air/aqmg/SCRAM/models/related/aersurface/aersurface_ug_v24142.pdf

USEPA. 2024c. Clarification on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and PM2.5 under the PSD Permitting Program. Office of Air Quality Planning and Standards, Environmental Protection Agency. Research Triangle Park, North Carolina. April 30, 2024. Available at: https://www.epa.gov/sites/default/files/2020-09/documents/epa-454_r-19-003.pdf

FIGURES



Site Boundary

0 650 1,300 Feet



KEY MAP (not to scale)

SITE BOUNDARY

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

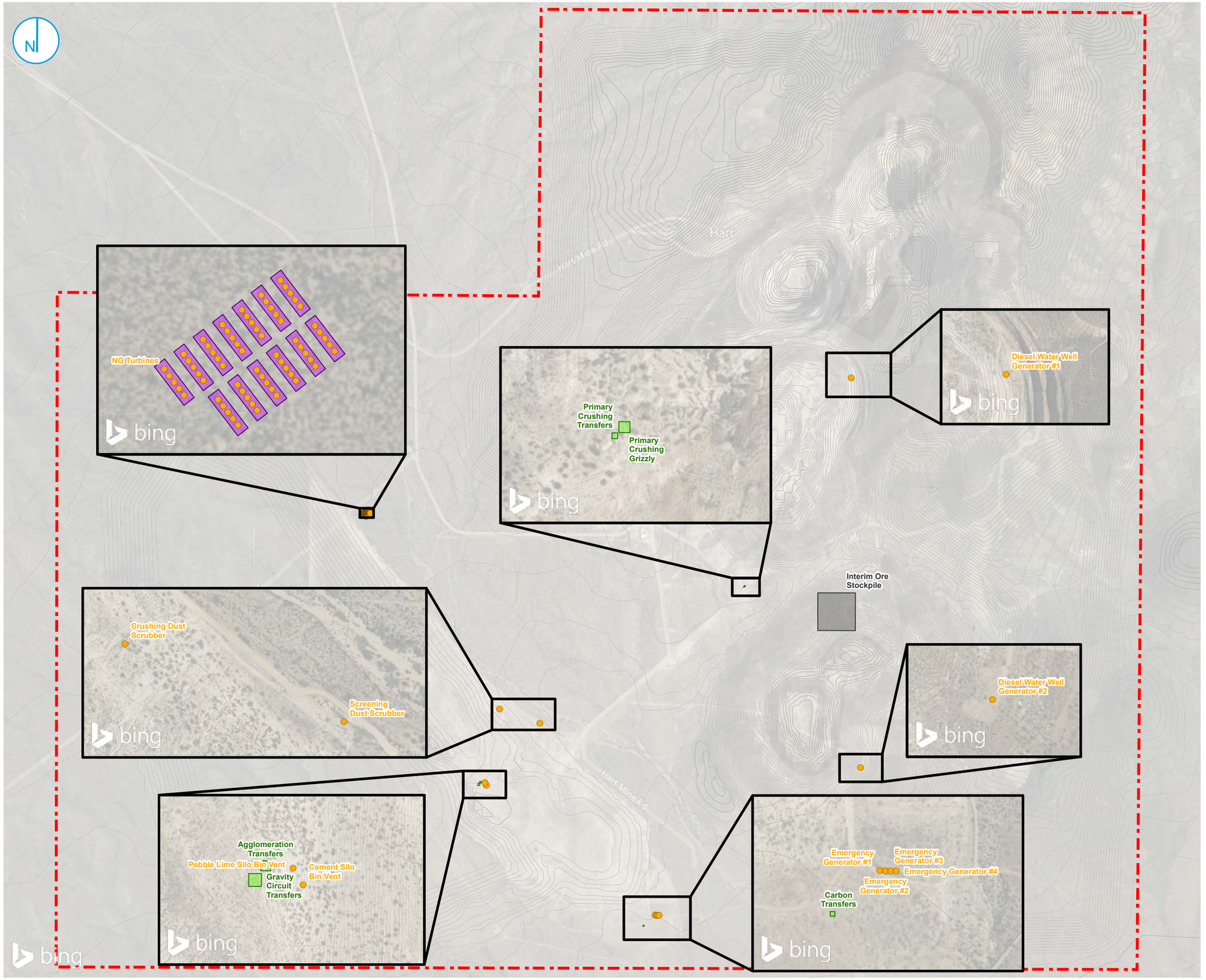
FIGURE 01

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL

PROJECT: 1690025697 | DATED: 12/20/2023 | DESIGNER: CWILLIAMSFREIER C:\Users\CWILLIAMSFREIER\Ramboll\Melody Kneale - Projects\Castle Mountain Mine\03_GIS\20221025_FigureCreation\20221025_FigureCreation-US-PF1C5PT7.aprx\Figure 01 - Site Boundary

PROJECT: 1690025697 | DATED: 8/26/2025 | DESIGNER: CWILLIAMSFREIER | C:\Users\CWILLIAMSFREIER\Ramboll\Western GIS Graphics Portal - General\Projects\Castle Mountain Mine\03_GIS\20250731_SourceUpdates\20250731_SourceUpdates.aprx\Figure 02 - Stationary Sources



Site Boundary
Point Source
Volume Sources
Area Source
Building

0 650 1,300 Feet



KEY MAP (not to scale)

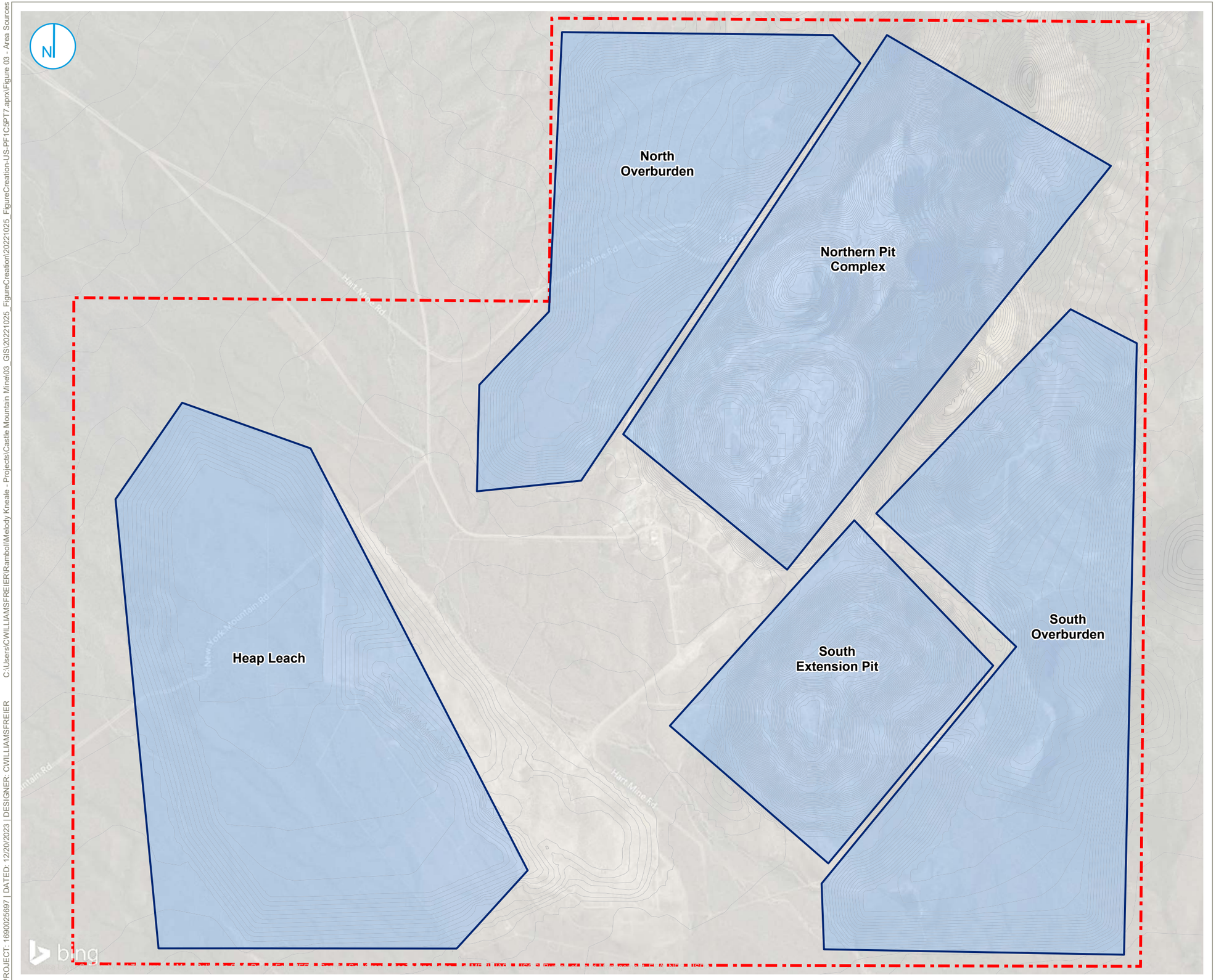
STATIONARY SOURCES

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

FIGURE 02

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary
Area Sources

Notes:
1. Northern Pit Complex and South Extension Pit extents shown were developed for air modeling purposes only.

0 650 1,300 Feet



KEY MAP (not to scale)

AREA SOURCES
PIT / OVERBURDEN / LEACH

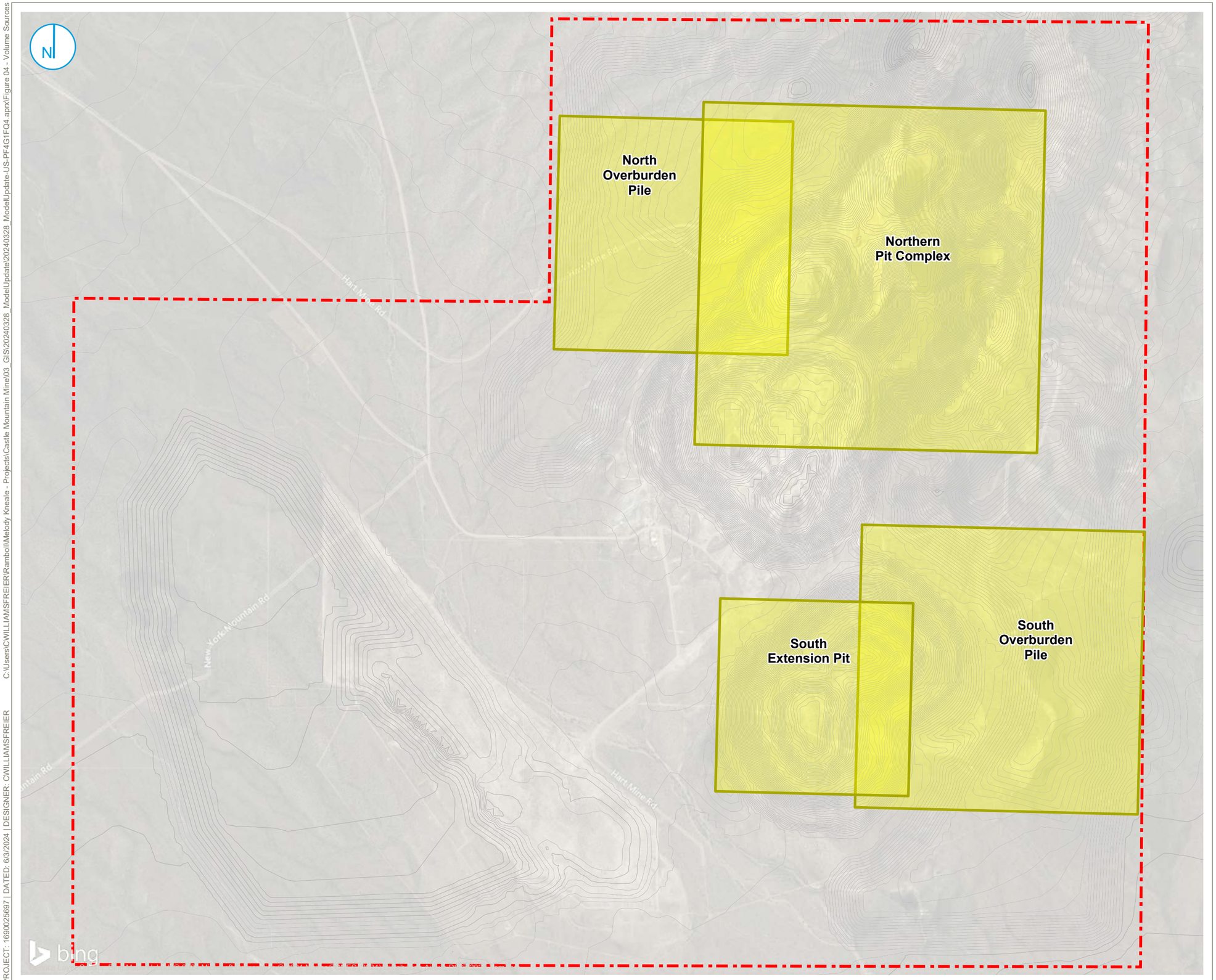
Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

FIGURE 03

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL

PROJECT: 1690025697 | DATED: 12/20/2023 | DESIGNER: CWILLIAMSFREIER | C:\Users\CWILLIAMSFREIER\Ramboll\Melody Kneale - Projects\Castle Mountain Mine\03_GIS\20221025_FigureCreation\20221025_FigureCreation-US-PF1C5PT7.aprx\Figure 03 - Area Sources



Site Boundary
Volume Sources

Notes:
1. Northern Pit Complex and South Extension Pit extents shown were developed for air modeling purposes only.

0 650 1,300 Feet



KEY MAP (not to scale)

VOLUME SOURCES
PIT/OVERBURDEN

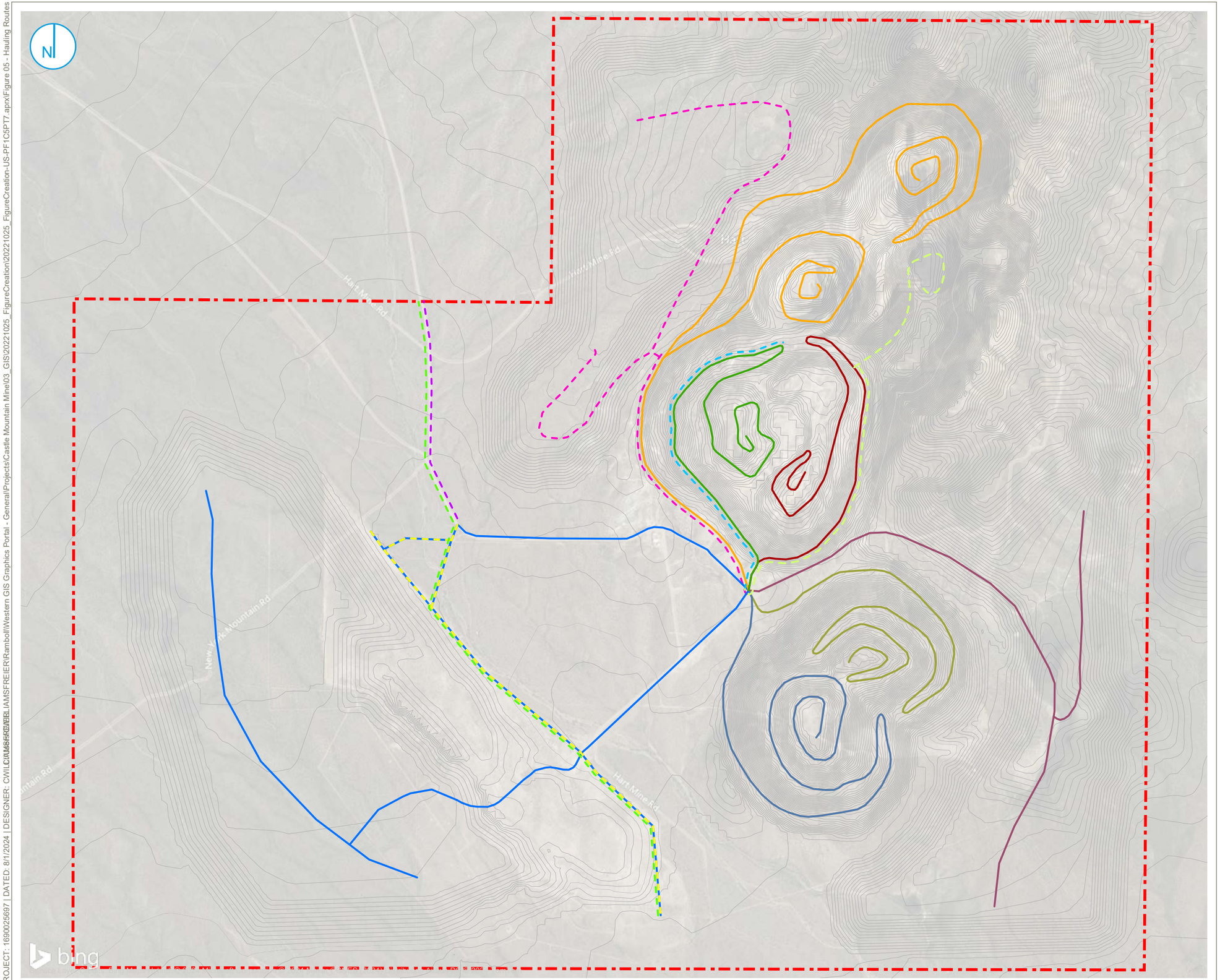
Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

FIGURE 04

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL

PROJECT: 1690025697 | DATED: 6/3/2024 | DESIGNER: CWILLIAMSFREIER C:\Users\CWILLIAMSFREIER\Ramboll\Melody Kneale - Projects\Castle Mountain Mine\03_GIS\20240328_ModelUpdate\20240328_ModelUpdate-US-PF4G1FQ4.aprx\Figure 04 - Volume Sources



Site Boundary
Oro Belle (East)
Fuel Delivery
JSLA Backfill
JSLA East
JSLA West
Jumbo Oro Belle
Miscellaneous Medium & Heavy Duty Vehicles
Miscellaneous Light Duty Vehicles
North Overburden
Reagent & Product Delivery
South Overburden
South Extension Phase 1
South Extension Phase 2

0 650 1,300 Feet



KEY MAP (not to scale)

HAULING ROUTES

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

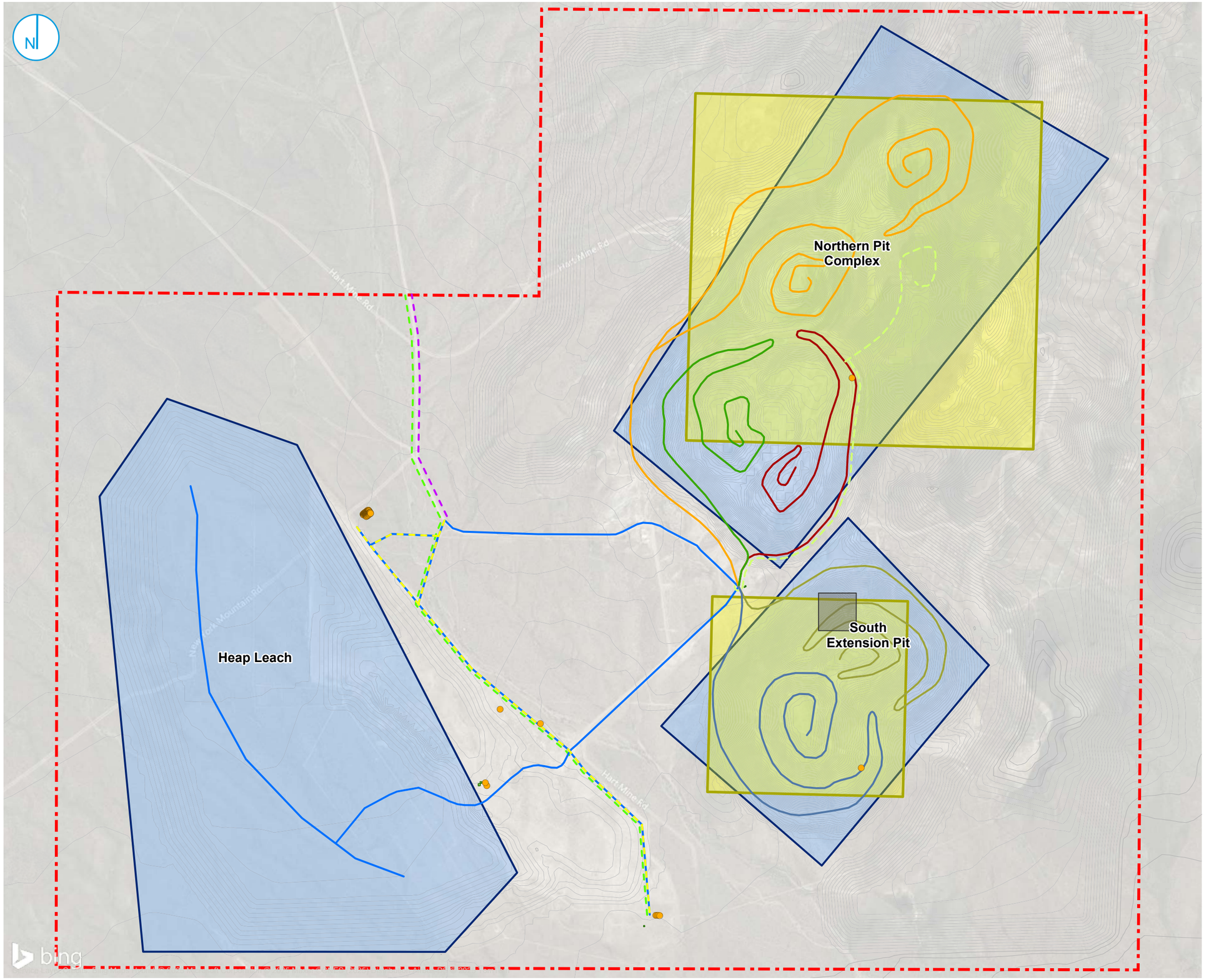
FIGURE 05

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL

PROJECT: 1690025697 | DATED: 8/1/2024 | DESIGNER: CWILLIAMSFREIER | C:\Users\CWILLIAMSFREIER\Ramboll\Western GIS Graphics Portal - General\Projects\Castle Mountain Mine\03_GIS\20221025_FigureCreation\20221025_FigureCreation-US-PF1C5PT7.aprx\Figure 05 - Hauling Routes

PROJECT: 1690025697 | DATED: 7/31/2025 | DESIGNER: CVOLLMER/TFREIER/AMSFREIER\Ramboll\Western GIS Graphics Portal - General\Projects\Castle Mountain Mine\03_GIS\20250731_SourceUpdates\20250731_SourceUpdates.aprx\Figure 06A - Maximum Emissions Scenario



- Site Boundary
- Stationary Sources (Point)
- Stationary Sources (Volume)
- Stationary Sources (Area)
- Volume Sources
- Area Sources
- Oro Belle (East)
- Fuel Delivery
- JSLA Backfill
- JSLA East
- Jumbo Oro Belle
- Miscellaneous Medium & Heavy Duty Vehicles
- Miscellaneous Light Duty Vehicles
- Reagent & Product Delivery
- South Extension Phase 1
- South Extension Phase 2

Notes:
1. Northern Pit Complex and South Extension Pit extents shown were developed for air modeling purposes only.

0 650 1,300 Feet



KEY MAP (not to scale)

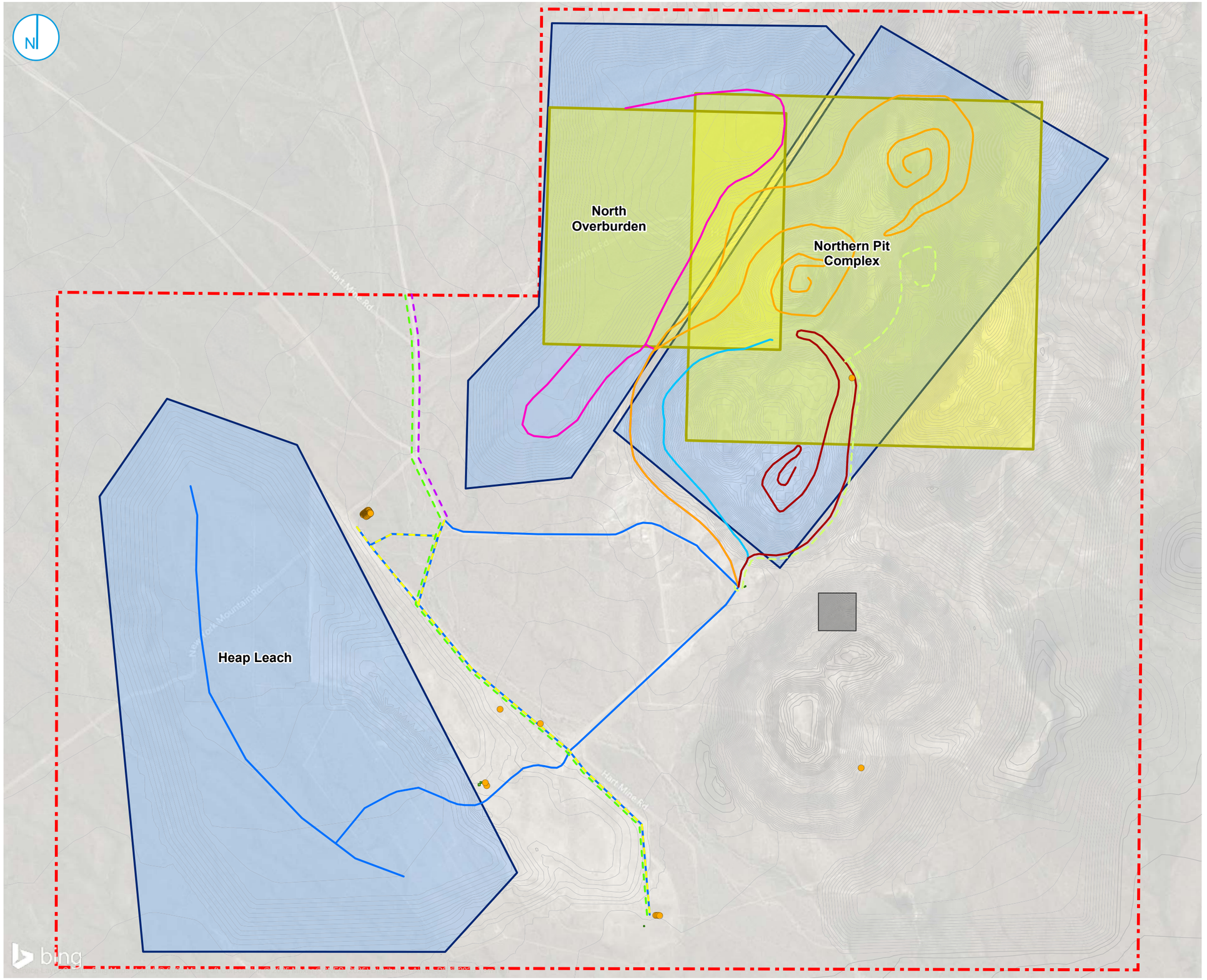
MAXIMUM EMISSIONS SCENARIO

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

FIGURE 06A

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary
Stationary Sources (Point)
Stationary Sources (Volume)
Stationary Sources (Area)
Volume Sources
Area Sources
Oro Belle (East)
Fuel Delivery
JSLA East
JSLA West
Jumbo Oro Belle
North Overburden
Miscellaneous Light Duty Vehicles
Miscellaneous Medium & Heavy Duty Vehicles
Reagent & Product Delivery

Notes:
1. Northern Pit Complex extent shown was developed for air modeling purposes only.

0 650 1,300 Feet


KEY MAP (not to scale)

MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS

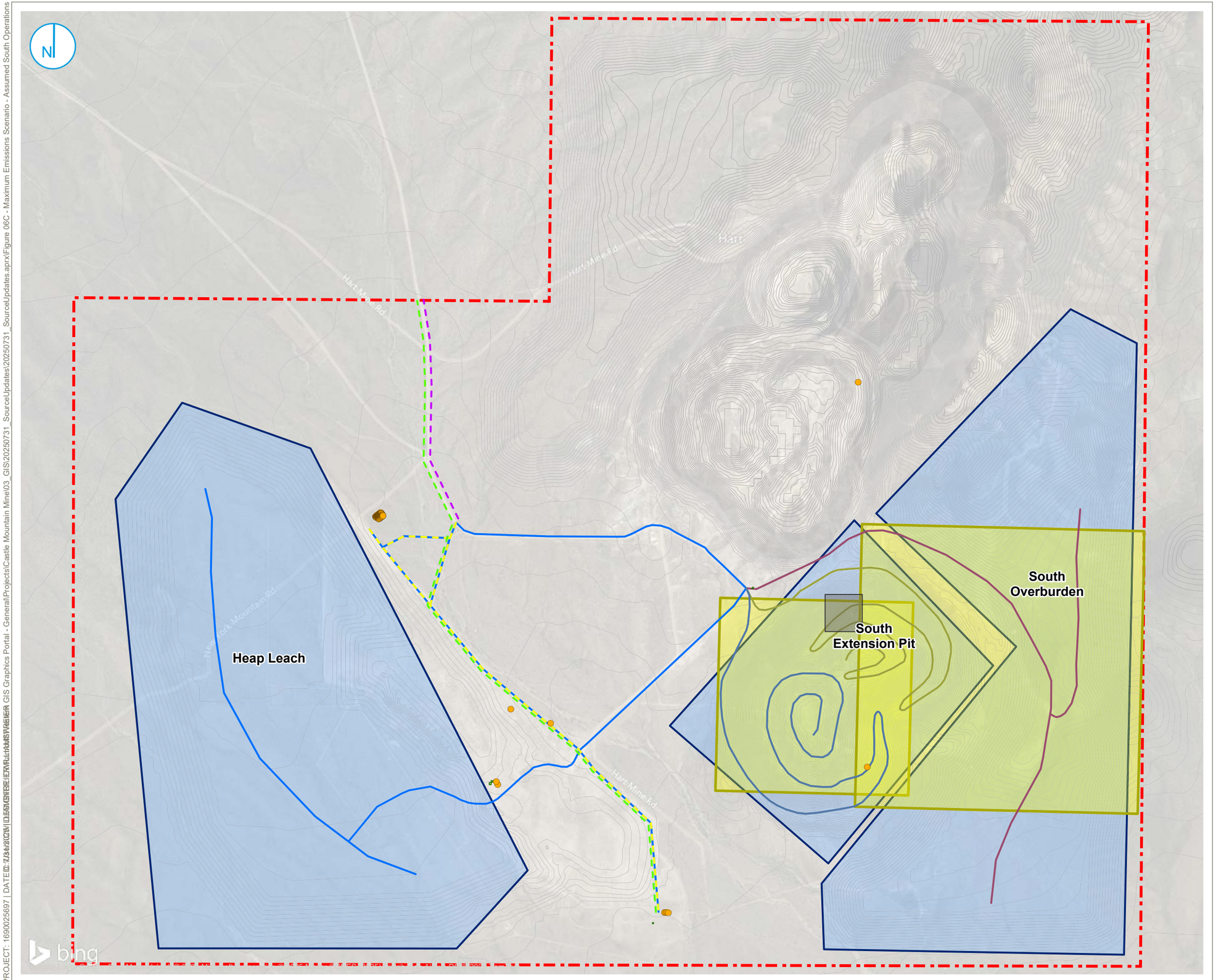
Castle Mountain Mine 2022
Plan Amendment
San Bernardino County, California

FIGURE 06B

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL

PROJECT: 1690025697 | DATE: 07/31/2025 | DESIGNED BY: MSTREETER | CREATED BY: MSTREETER | CHECKED BY: MSTREETER | APPROVED BY: MSTREETER | G:\Shared drives\GIS Graphics Portal - General\Projects\Castle Mountain Mine\03_GIS\20250731_SourceUpdates\20250731_SourceUpdates.aprx\Figure 06B - Maximum Emissions Scenario - Assumed North Operations



- Site Boundary
- Stationary Sources (Point)
- Stationary Sources (Volume)
- Stationary Sources (Area)
- Volume Sources
- Area Sources
- Fuel Delivery
- South Extension Phase 1
- South Extension Phase 2
- South Overburden
- Miscellaneous Light Duty Vehicles
- Miscellaneous Medium & Heavy Duty Vehicles
- Reagent & Product Delivery

Notes:
1. South Extension Pit extent shown was developed for air modeling purposes only.

0 650 1,300 Feet



KEY MAP (not to scale)

MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

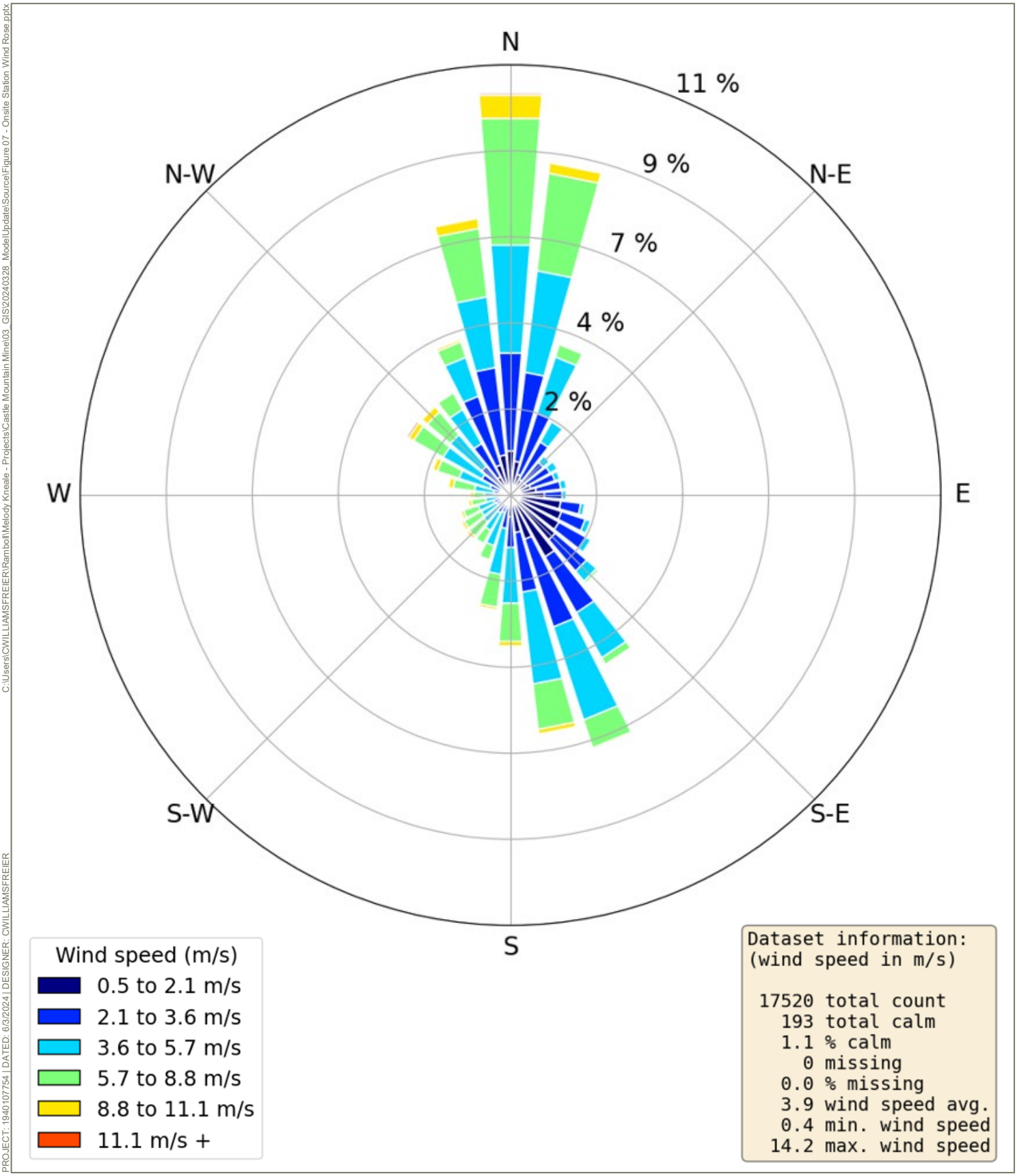
FIGURE 06C

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL

PROJECT: 1690025697 | DATE: 7/31/2025 | DESIGNED BY: [illegible] | CHECKED BY: [illegible] | ESRI GIS Graphics Portal - General\Projects\Castle Mountain Mine\03_GIS\20250731_SourceUpdates\20250731_SourceUpdates.aprx\Figure 06C - Maximum Emissions Scenario - Assumed South Operations

C:\Users\CWILLIAMSFREIER\Ramboll\Melody Kneale - Projects\Castle Mountain Mine\03_GIS\20240328_Model\Update\Source\Figure 07 - Onsite Station Wind Rose.pptx



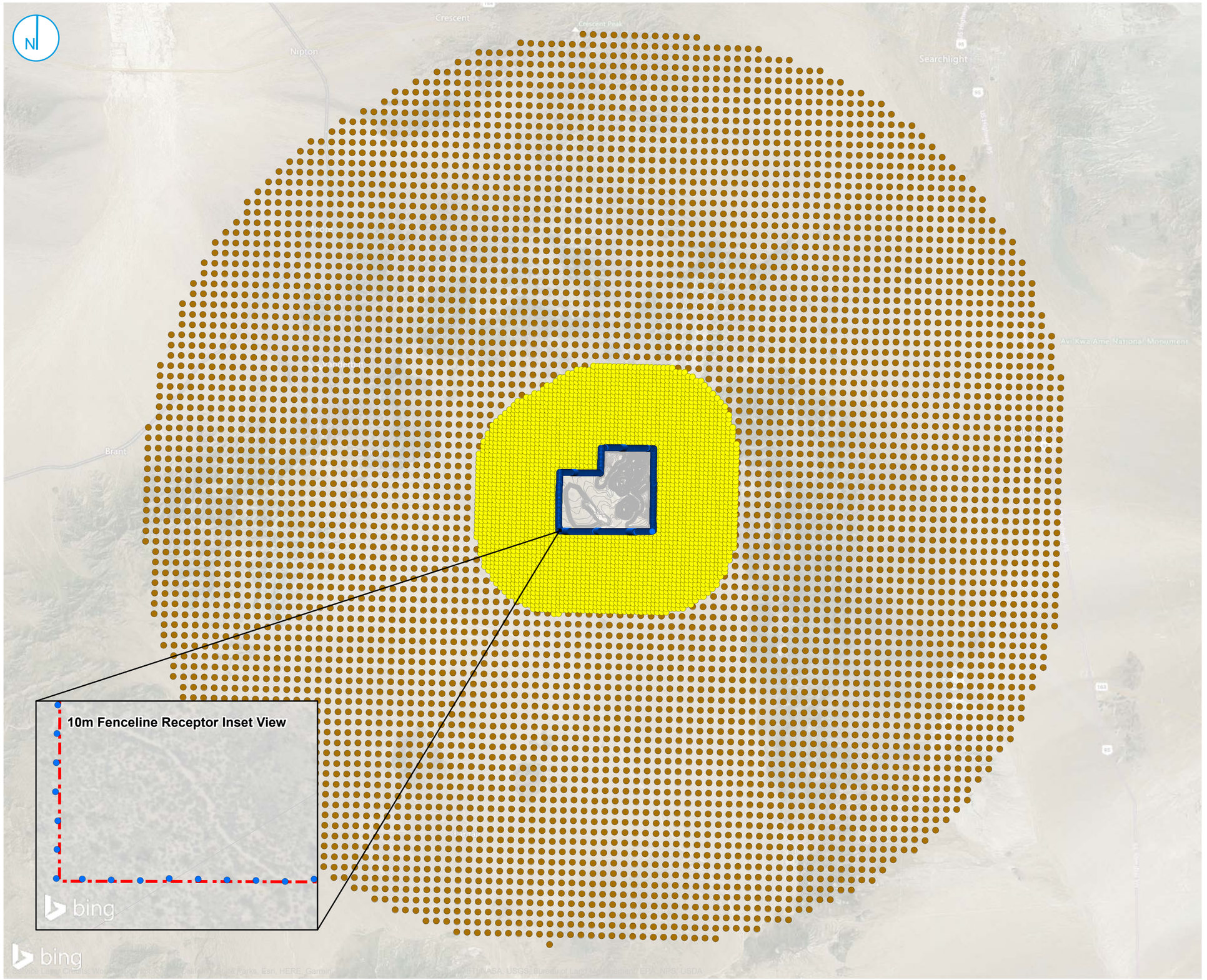
PROJECT: 1940107754 | DATED: 6/3/2024 | DESIGNER: CWILLIAMSFREIER

2021-2022 ONSITE STATION WIND ROSE

FIGURE 07

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY



Site Boundary

Receptor Locations

- 10m Fenceline Receptor
- 200m Receptor
- 500m Receptor



0 7,500 15,000 Feet

KEY MAP (not to scale)

RECEPTOR GRID

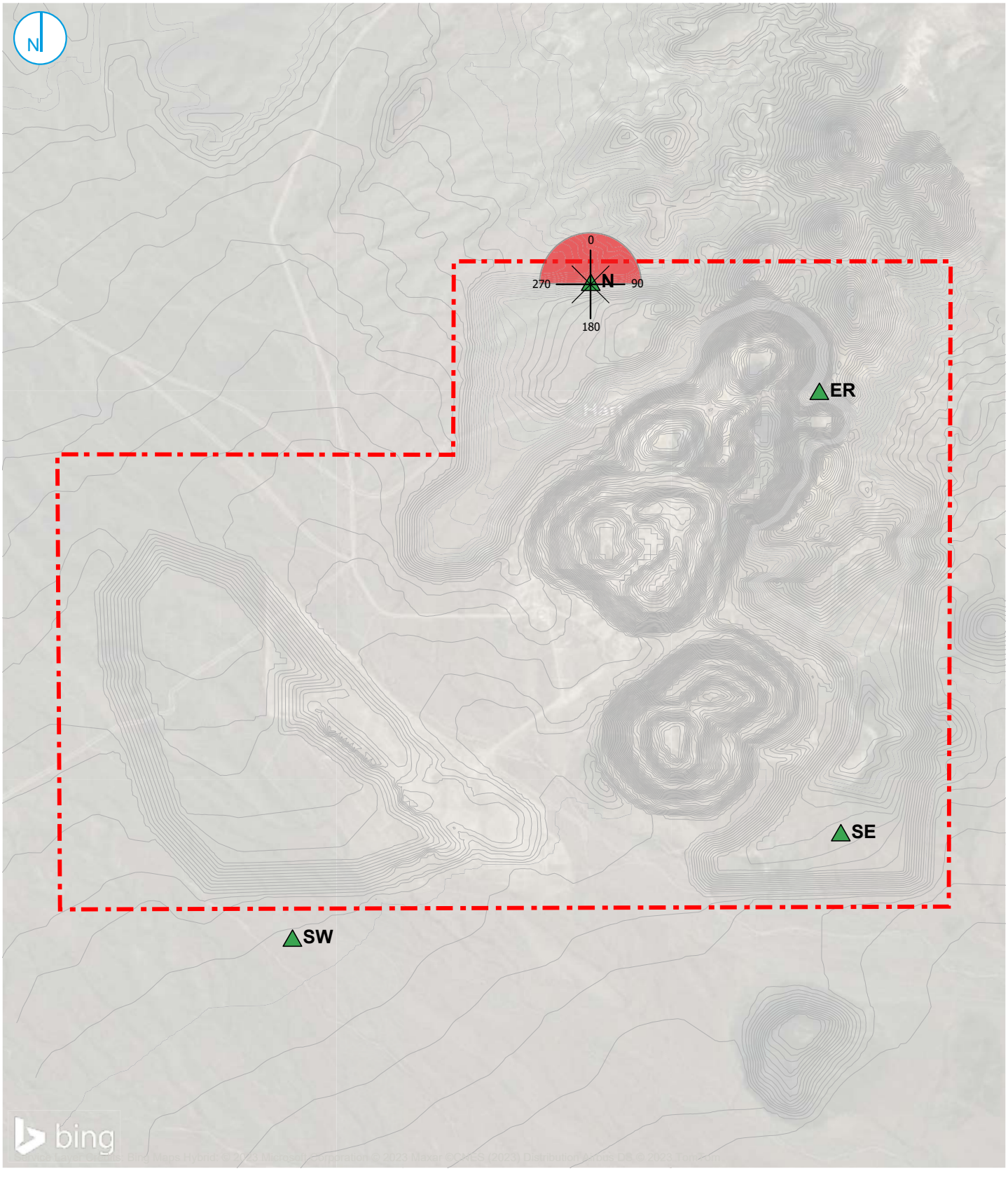
Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

FIGURE 08

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL

PROJECT: 1690025697 | DATED: 12/20/2023 | DESIGNER: CWILLIAMSFREIER C:\Users\CWILLIAMSFREIER\Ramboll\Melody Kneale - Projects\Castle Mountain Mine\03_GIS\20221025_FigureCreation\20221025_FigureCreation-US-PF1C5PT7.aprx\Figure 08 - Receptor Grid



C:\Users\CWILLIAMSFREIER\Ramboll\Melody Kneale - Projects\Castle Mountain Mine\03_GIS\20221025_FigureCreation\20221025_FigureCreation-US-PF1C5PT7.aprx\Figure 09 - Onsite Station Locations

Site Boundary

Castle Mountain Mine Air Monitoring Station Locations

Upwind

0 1,375 2,750 Feet

ONSITE STATION LOCATIONS

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

FIGURE 09

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL

ATTACHMENT 1
FIGURE 2-2 FROM THE JULY 2023 MINE PLAN AMENDMENT SUBMITTAL

0' 500' 1000'
SCALE IN FEET

CONTOUR INTERVAL: 50 FT

LEGEND:

DRAFT

- PROJECT BOUNDARY
- DISTURBANCE BOUNDARY (PROPOSED)
- MINE PIT LIMITS (MAX PROPOSED)

1. SUPPORT FACILITIES
2. ORO BELLE PIT (COMPLEX)
3. JUMBO PIT
4. JSLA PIT
5. SOUTH EXTENSION PIT (COMPLEX)
6. NORTH OVERBURDEN SITE
7. SOUTH OVERBURDEN SITE
8. HEAP LEACH PAD
9. CMM ACCESS ROAD
10. PRIMARY CRUSHING
11. SECONDARY & TERTIARY CRUSHING
12. COMMUNITION & AGGLOMERATION
13. PROCESS PLANT & PONDS

DATE: 28 JUN 23
REVISION: P3

EQUINOXGOLD
CASTLE MOUNTAIN VENTURE

San Bernardino County
California

FIGURE 2-2
MAXIMUM FACILITY DEVELOPMENT (PROPOSED)

File: \\file1.tucson.m3.local\Projects\2019\190397.013\500 ENGR\531 GA\Report Figures\Updated Figures - 05.2023\CAD Files\Figure 2-2.dwg LAST UPDATE:7/3/2023 1:38 PM BY: AGUSTIN PADRES

APPENDIX A
EMISSIONS INVENTORY

2022 Mine Plan of Operations: Table A-1
Criteria Air Pollutant and Greenhouse Gas Emissions Summary
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Type[1]	Maximum Daily Emissions (lb/day)						Annual Emissions (tpy)						Annual GHG Emissions (MT/yr)	
	PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	VOC	Biogenic	Non-biogenic
Material Transfers (fugitive)	185	28					31	4.6						
Material Transfers (stationary)	18	4.5					2.3	0.57						
Crushing	8.7	1.6					1.1	0.20						
Screening	26	3.9					3.1	0.47						
Diesel Generators[2]	0.15	0.15	16	0.058	0.56	0.99	0.020	0.020	2.9	0.0068	0.034	0.17		663
Power Generation (NG turbines)	17	17	85	1.5	231	23	3.1	3.1	16	0.28	42	4.2		49,816
On-site Unpaved Road Mobile Equipment (fugitive dust)	1,291	129					171	17						
Other On-site Off-Road Mobile Equipment (fugitive dust)	52	16					6.7	2.1						
On-site Mobile Equipment (exhaust)	38	38	3,046	6.6	3,510	202	5.6	5.6	464	0.98	514	30	86,411	2,429
Off-site Mobile Equipment (fugitive dust)	168	17					18.7	1.92						
Off-site Mobile Equipment (exhaust)	4.3	1.9	38	0.41	29	1.1	0.31	0.13	2.3	0.027	4.4	0.14	437	2,681
Disturbed Operational Areas	3.2	0.48					0.077	0.012						
Stockpile Wind Erosion	15	5.9					2.7	1.1						
Blasting and Blast Hole Drilling	230	13	569	0.10	2,309		22	1.3	87	0.015	351			8,921
Gasoline Dispensing Facility						0.42						0.076		
Fuel Storage Tanks						2.6						0.47		111
Electricity Usage														28,977
Solid Waste													60	494
Wastewater														68
Total Emissions	**2,055**	**277**	**3,754**	**8.7**	**6,079**	**230**	**267**	**38**	**571**	**1.3**	**912**	**35**	**86,908**	**94,160**

Notes:

1. Detailed emission calculations are presented in Tables A-3 through A-33.
2. Diesel generators are expected to use renewable diesel fuel, consistent with other offroad equipment, but have conservatively been assumed to use conventional diesel in this inventory, and thus resulting CO^2 emissions are characterized as non-biogenic.

Abbreviations:

CO - carbon monoxide
GHG - greenhouse gas
lb - pounds
MT - metric tons
NG - natural gas
NO_x - nitrogen oxides
PM - particulate matter
SO_x - sulfur oxides
tpy - tons per day
VOC - volatile organic gases
yr - year

2022 Mine Plan of Operations: Table A-2
Toxic Air Contaminant and Hazardous Air Pollutant Emissions Summary, On-Site Sources
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

TAC	CAS Number	Annual Emissions[1] (lb/yr)																	
		Refinery	Acid Tank Evaporation	Heap Leach Pad and Various Process Tanks	Material Transfers	Crushing	Screening	Power Generation (NG Turbines)	Diesel Generators (Emergency/ Supporting)[2]	Stockpile Erosion	On-Site Unpaved Road Mobile Equipment Fugitive Dust	On-Site Unpaved Road Mobile Equipment Exhaust[2]	Other On-Site Off-Road Mobile Equipment Fugitive Dust	Other On-Site Off-Road Mobile Equipment Exhaust[2]	Disturbed Operational Area	Blasting and Blast Hole Drilling	Gasoline Dispensing Facility	Storage Tanks	Total
1,2,4-Trimethylbenzene	95636											0.24		313					314
1,3-Butadiene	106990							0.12	14			0.14		112					127
2,2,4-Trimethylpentane	540841											0.31		177					178
2-Chloronaphthalene	91587							2.5E-04											2.5E-04
2-Methylnaphthalene	91576							0.0049											0.0049
Acenaphthene	83329							0.017	1.3										1.3
Acenaphthylene	208968							0.014	0.95										0.96
Acetaldehyde	75070							126	51			1.0		4,346					4,523
Acrolein	107028							17	2.2			0.025							20
Aluminum	7429905				3,702	120	355			308	13,688	0.0014	766	2.0	8.7	2,529			21,479
Ammonia	7664417							2,944	72							918			3,934
Ammonium	14798039										14								14
Anthracene	120127							0.031	0.43										0.47
Antimony	7440360				1.1	0.036	0.11			0.093	4.1	3.0E-04	0.23	0.40	0.0026	0.76			6.9
Arsenic	7440382				3.3	0.11	0.31		0.50	0.27	19	4.1E-05	0.68	0.056	0.0077	2.2			27
Barium	7440393				12	0.40	1.2			1.0	205		2.6		0.029	8.4			231
Benzene	71432							12	12			0.72		1,182			0.80		1,208
Benzaldehyde	100527								0.87										0.87
Benzo(a)anthracene	56553							0.021	0.013										0.034
Benzo(a)pyrene	50328							0.013	9.0E-04										0.014
Benzo(b)fluoranthene	205992							0.010	0.0024										0.013
Benzo(e)pyrene	192972							5.0E-04											5.0E-04
Benzo(g,h,i)perylene	191242							0.013	0.43										0.45
Benzo(k)fluoranthene	207089							0.010	7.4E-04										0.011
Beryllium	7440417				0.32	0.011	0.031			0.027			0.067		7.7E-04	0.22			0.68
Bromine	7726956										23	6.8E-04		0.20					23
Cadmium	7440439				0.011	3.6E-04	0.0011		0.097	9.2E-04	4.4	3.3E-04	0.0023	0.45	2.6E-05	0.0076			4.9
Chlorine	7782505											0.078		3.9					3.9
Chromium (hexavalent)	18540299								0.013										0.013
Chromium (total)	7440473				6.0	0.19	0.57		0.21	0.50	44	6.3E-04	1.2	0.13	0.014	4.1			57
Chrysene	218019							0.023	0.43										0.46
Cobalt	7440484										28	6.3E-04		0.12					28
Copper	7440508				0.91	0.029	0.087		0.27	0.076	74	7.4E-04	0.19	0.28	0.0022	0.62			76
Crotonaldehyde	4170303											0.018							0.018
Cumene	98828											0.0094		12					12
Cyclohexane	110827											0.066		17.7					18
Dibenz(a,h)anthracene	53703							0.022	0.0024										0.024
Diesel PM	9901								41			8,242		2,980					11,262
Ethanol	64175											0.0026		5.9					5.9
Ethyl Benzene	100414							16	0.71			0.25		183			0.66		201
Ethylene	74851											3.0		8,502					8,505
Fluoranthene	206440							0.040	0.43										0.47
Fluorene	86737							0.053	2.8										2.9
Formaldehyde	50000							844	112			2.3		8,697					9,655
n-Hexane	110543							238	1.7			0.20		95			2.8		338
Hydrogen Chloride	7647010		3.7						12									783	799
Hydrogen Cyanide[3]	74908			13,061												597			13,658
Indeno(1,2,3-c,d)pyrene	193395							0.022	0.0017										0.023
Isoprene	78795											0.019							0.019
Lead	7439921				1.9	0.062	0.18		0.54	0.16	16	3.4E-04	0.40	0.47	0.0045	1.3			22
Manganese	7439965				14	0.44	1.3		0.20	1.1	261	8.6E-04	2.8	0.45	0.032	9.3			290
Mercury	7439976	13			0.068	0.0022	0.0066		0.15	0.0057	5.6	2.5E-04	0.014	0.34	1.6E-04	0.047			19
Methanol	67561											0.10		18					18
Methyl Ethyl Ketone	78933											0.19		875					875
Methyl Tert-Butyl Ether	1634044											0.26							0.26
Naphthalene	91203							1.5	1.3			0.029		53			0.074		56
Nickel	7440020				0.30	0.0097	0.029		0.25	0.025	12	6.9E-04	0.062	0.21	7.1E-04	0.20			14
n-Pentane	109660											0.32		106					107
Perylene	198550							6.4E-04											6.4E-04
Phenanthrene	85018							0.29	5.6										5.9
Phosphorus	7723140				12	0.40	1.2			1.0	152	0.0010	2.6	1.4	0.029	8.4			180
Phosphorus pentoxide	1314563				33	1.1	3.1			2.7			6.7		0.077	22			68
Propionaldehyde	123386											0.14		574					574
Propylene	115071							709	30			1.0		1,537			0.0040		2,278
Propylene Oxide	75569							44											44
Pyrene	129000							0.025	0.95										0.98
Selenium	7782492				0.065	0.0021	0.0062		0.63	0.0054	0.68	8.2E-05	0.013	0.11	1.5E-04	0.044			1.6
Silica	14808607				50,687	1,640	4,866			4,215			10,482		120	34,626			106,636

TAC	CAS Number	Annual Emissions[1] (lb/yr)																
		Refinery	Acid Tank Evaporation	Heap Leach Pad and Various Process Tanks	Material Transfers	Crushing	Screening	Power Generation (NG Turbines)	Diesel Generators (Emergency/ Supporting)[2]	Stockpile Erosion	On-Site Unpaved Road Mobile Equipment Fugitive Dust	On-Site Unpaved Road Mobile Equipment Exhaust[2]	Other On-Site Off-Road Mobile Equipment Fugitive Dust	Other On-Site Off-Road Mobile Equipment Exhaust[2]	Disturbed Operational Area	Blasting and Blast Hole Drilling	Gasoline Dispensing Facility	Storage Tanks	Total
Silver	7440224				0.12	0.0040	0.012			0.010	2.5	2.3E-04	0.026	0.31	2.9E-04	0.085			3.1
Styrene	100425											0.025		35					36
Thallium	7440280				0.10	0.0033	0.0097			0.0084			0.021		2.4E-04	0.069			0.21
Toluene	108883							65	6.8			1.1		869			3.6		946
Vanadium	7440622				1.0	0.034	0.10			0.087	57	2.4E-04	0.22	0.33	0.0025	0.71			59
Xylenes	1330207							24	2.7			0.96		621			3.2		652
Zinc	7440666				5.5	0.18	0.52		1.4	0.45	65	0.0041	1.13	4.9	0.013	3.7			83

Notes:

1. Detailed emission calculations are presented in Tables A-3 through A-33. TAC and HAP emissions are quantified for on-site emission sources only.
2. For sources of diesel exhaust (e.g. generators, mobile equipment), both diesel particulate matter (Diesel PM) and speciated TAC and HAP emissions are presented, though Diesel PM is considered a surrogate for all diesel exhaust.
3. Hydrogen cyanide emissions from heap leaching operations and cyanide containing tanks are highly dependent on the characterization of the heap leach pad, solution pH, and temperatures. Conservative estimates of potential operating conditions have been utilized here.

Abbreviations:

HAP - Hazardous Air Pollutant
lb - pounds
NG - natural gas
PM - particulate matter
SCR - Selective Catalytic Reduction
TAC - Toxic Air Contaminant
yr - year

2022 Mine Plan of Operations: Table A-3
Material Transfer Emissions
Criteria Air Pollutants
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Description[1]	Source Area	Material Profile	Material Moisture Content[2] (%)	Process Rates[3]		Emission Factor[4,5,6,7] (lb/ton)		Add-On Control Method[8]	Control Efficiency[9,10]	Controlled Emissions			
				Daily (tpd)	Annual (tpy)					Daily (lb/day)		Annual (tpy)	
						PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Ore to Haul Trucks	Pits	Ore	3.0	79,200	19,200,000	0.0013	2.0E-04	Pit Enclosure	75%	26	3.9	3.2	0.48
Overburden to Haul Trucks	Pits	Overburden	5.0	166,089	60,622,662	6.4E-04	9.7E-05	Pit Enclosure	75%	27	4.0	4.9	0.74
Haul Trucks to Overburden Area	Overburden Area	Overburden	5.0	166,089	60,622,662	6.4E-04	9.7E-05	--	0%	107	16	19	2.9
Haul Trucks to Interim Ore Stockpile	Interim Ore Stockpile	Ore	3.0	19,800	4,800,000	0.0013	2.0E-04	--	0%	26	3.9	3.2	0.48
Haul Truck to Dump Hopper	Primary Crushing	Ore	3.0	79,200	19,200,000	4.6E-05	1.3E-05	Enclosure + Watering	0%	3.6	1.0	0.44	0.12
Dump Hopper to Feeder	Primary Crushing	Ore	3.0	79,200	19,200,000	4.6E-05	1.3E-05	Enclosure + Watering	0%	3.6	1.0	0.44	0.12
Feeder to Vibrating Grizzly	Primary Crushing	Ore	3.0	79,200	19,200,000	4.6E-05	1.3E-05	Enclosure + Watering	0%	3.6	1.0	0.44	0.12
Vibrating Grizzly to Primary Crusher Discharge Conveyor	Primary Crushing	Ore	3.0	65,714	15,930,775	4.6E-05	1.3E-05	Enclosure + Watering	0%	3.0	0.85	0.37	0.10
Crushed Ore Stockpile Reclaim Feeders to Secondary Screen Feed Conveyors	Secondary/Tertiary Crushing and Screening	Ore	3.0	79,200	19,200,000	0.0011	1.7E-04	Secondary/Tertiary Screening Dust Scrubber	99.5%	0.44	0.066	0.053	0.0080
Tertiary Screen Oversize Transfer Conveyor to Tertiary Crushing Feed Conveyor	Secondary/Tertiary Crushing and Screening	Ore	3.0	49,465	11,991,626	0.0011	1.7E-04	Secondary/Tertiary Crushing Dust Scrubber	99.5%	0.27	0.041	0.033	0.0050
Tertiary Crushing Feed Conveyor to Tertiary Crusher Surge Bin	Secondary/Tertiary Crushing and Screening	Ore	3.0	49,438	11,984,927	0.0011	1.7E-04	Secondary/Tertiary Crushing Dust Scrubber	99.5%	0.27	0.041	0.033	0.0050
Tertiary Crusher Discharge Conveyor to Stockpile Feed Conveyor	Product Stockpile	Ore	3.0	49,438	11,984,927	0.0011	1.7E-04	Secondary/Tertiary Crushing Dust Scrubber	99.5%	0.27	0.041	0.033	0.0050
Gravity Concentrate Storage Tank to Truck	Fine Ore Storage and Gravity Circuit	Ore	10	2.8	670	2.4E-04	3.7E-05	--	0%	6.7E-04	1.0E-04	8.1E-05	1.2E-05
Truck to Concentrate Feed Storage Cone	Fine Ore Storage and Gravity Circuit	Ore	10	2.8	670	2.4E-04	3.7E-05	--	0%	6.7E-04	1.0E-04	8.1E-05	1.2E-05
Stockpile Discharge Conveyor to Agglomeration Feed Bin	Agglomeration and Stacking	Ore	2.6	63,835	15,475,227	0.0016	2.4E-04	Agglomerator Feed Bin Vent	99.5%	0.51	0.078	0.062	0.0094
Truck to Cement Storage Silo	Cement	Cement	0.5	263	96,000	0.47	0.071	Cement Silo Bin Vent	99.5%	0.62	0.094	0.11	0.017
Cement Silo Feeder to Agglomerator Feed Bin	Cement	Cement	0.5	263	96,000	0.0028	4.2E-04	--	0%	0.74	0.11	0.13	0.020
Truck to Pebble Lime Silo	Heap Leach Pebble Lime	Lime	0.5	132	48,000	0.47	0.071	Pebble Lime Silo Bin Vent	99.5%	0.31	0.047	0.056	0.0085
Pebble Lime Silo Feeder to Agglomerator Feed Bin	Heap Leach Pebble Lime	Lime	0.5	132	48,000	0.0028	4.2E-04	--	0%	0.37	0.056	0.067	0.010
Carbon Handling Crane to Carbon Feed Tank	Carbon Regeneration	Carbon	0.5	0.016	6.0	0.016	0.0024	--	0%	2.7E-04	4.0E-05	4.8E-05	7.3E-06
									Total Emissions	**203**	**33**	**33**	**5.2**

Notes:

1. Material handling sources with high moisture contents will have negligible emissions. Therefore, emissions from these sources were not quantified in this table.
2. Material moisture contents were provided by Castle Mountain Venture.
3. Equipment specific information provided by Castle Mountain Venture.
4. Emission factors for primary crushing system material transfer points with watering controls are based on controlled conveyor transfer point emission factors from AP-42, Section 11.19.2, Table 11.19.2-2, consistent with NDEP guidance for the mining industry.
5. Emission factors for all other material transfer points within the crusher system are based on uncontrolled conveyor transfer point emission factors from AP-42, Section 11.19.2, Table 11.19.2-2, consistent with NDEP Guidance. AP-42, Section 11.19.2, Table 11.19.2-2 does not include an uncontrolled conveyor transfer point emission factor for $PM_{2.5}$ so the emission factor was estimated using the uncontrolled conveyor transfer point emission factor for PM_{10} and a multiplier of 0.053/0.35 based on AP-42, Chapter 13.2.4, consistent with NDEP guidance for the mining industry.

6. PM_{10} emission factors for pebble lime and cement material handling points were based on silo loading and unloading emission factors from AP-42, Section 11.12 and a multiplier of 0.053/0.35 for $PM_{2.5}$ based on AP-42, Chapter 13.2.4, consistent with NDEP guidance for the mining industry.
7. Emission factors for material transfer points that are not within the crusher system or associated with pebble lime and cement material handling were estimated using MDAQMD's "most complex" Material Handling Operations methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 PM_{10} and $PM_{2.5}$ multipliers (AP-42 Section 13.2.4, "Aerodynamic Particle Size Multiplier (k) for Equation 1" table) at the time of inventory preparation. A windspeed of 8.7 mph was used consistent with the annual average site-specific meteorological measurements for the period of January 2021 through December 2021.
8. Additional or revised controls may be evaluated at the time of engineering design.
9. A control efficiency of 75% is applied consistent with MDAQMD guidance for "complete coverage by windscreens (on the windward side)", assuming that the pit in which loading activities take place will effectively act as a windscreen and reduce particulate matter emissions. The dust scrubber and bin vent control efficiencies will be confirmed with vendor guarantees upon equipment design.
10. Material transfer points will be controlled with watering and enclosures, but the watering control is already accounted for in the controlled emission factor utilized so no additional control efficiency is included here.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768
NDEP. 2017. Guidance on Emission Factors for the Mining Industry. Available online at: https://ndep.nv.gov/uploads/air-permitting-docs/ndep-mining-emissions-guidance.pdf. May 31.
USEPA. 2004. AP-42, Section 11.19.2. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s1902.pdf. August.
USEPA. 2006. AP-42, Section 13.2.4. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/13.2.4_aggregate_handling_and_storage_piles.pdf. November.
USEPA. 2012. AP-42, Section 11.12. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s12.pdf. January.

Abbreviations:

lb - pound
MDAQMD - Mojave Desert Air Quality Management District
NDEP - Nevada Division of Environmental Protection
PM - particulate matter
tpd - tons per day
tpy - tons per year
USEPA - United States Environmental Protection Agency

2022 Mine Plan of Operations: Table A-4
Refinery Mercury Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Equipment	Source Area	Concentrate Throughput[1]		Mercury Concentration[2] (lb/ton)	Mercury Emissions	
		Daily (tpd)	Annual (tpy)		Daily (lb/day)	Annual (tpy)
Kiln Abatement, EQ Abatement, and Retort Carbon Bed	Refinery	0.045	17	0.8	0.036	0.0066

Notes:

1. Equipment specific information was provided by Castle Mountain Venture. Equipment is assumed to operate 24 hours per day and 365 days per year.
2. Mercury concentration of retort concentrate was assumed to be 0.8 lb/ton based on NESHAP Subpart EEEEEEE limit for new carbon processes with mercury retorts.

References:

USEPA. 2011. NESHAP for Gold Mine Ore Processing and Production (40 CFR Part 63 Subpart EEEEEEE). Available online at: https://www.govinfo.gov/content/pkg/FR-2011-02-17/pdf/2011-2608.pdf#page=2. February.

Abbreviations:

lb - pounds
NESHAP - National Emission Standards for Hazardous Air Pollutants
tpd - tons per day
tpy - tons per year

2022 Mine Plan of Operations: Table A-5a
Acid Tank Evaporative Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source	Source Area	Exposed Surface Area[1] (ft^2)	Liquid Molecular Weight (g/mol)	Annual Average Wind Speed[2] (m/s)	Percent HCl[3] (liquid wt%)	Liquid Vapor Pressure at Given Temperature[3] (mmHg)	Liquid Temperature[4] (K)	HCl Emissions[5]	
								Daily (lb/day)	Annual (tpy)
Acid Mix Tank	Refinery	8.6	36	3.9	5	7.6E-04	291	0.0036	6.5E-04
Acid Wash Tank	Refinery	16	36	3.9	5	7.6E-04	291	0.0066	0.0012

Notes:

1. Surface area was estimated from tank diameters provided by Castle Mountain Venture assuming a completely open topped cylindrical vertical tank, a highly conservative assumption, as these tanks are expected to be closed top tanks with vents.
2. For outdoor sources, a windspeed of 3.9 m/s was used consistent with the annual average site-specific meteorological measurements between January 2021 and December 2021.
3. Liquid vapor pressure were calculated using vapor pressure profiles from Perry et al. 1997, and conservatively rounding up the expected liquid temperature to the next highest value in the vapor pressure profile (20 C) and the next highest liquid weight percent (6%).
4. For outdoor sources, the liquid temperature was conservatively assumed to be equivalent to the annual average temperature (291 degrees K) from on-site meteorological measurements between January 2021 and December 2021.
5. Evaporative emissions were calculated using USEPA Risk Management Program guidance for evaporative losses from a defined surface area.

References:

Perry, Robert H et al. 1997. Perry's Chemical Engineers' Handbook. 7th Edition. Table 2-10. Partial Pressures of HCl over Aqueous Solutions of HCl.
USEPA. 2009. Risk Management Program for Offsite Consequence Analysis. Appendix D: D-1. Available online at: https://www.epa.gov/sites/production/files/2017-05/documents/oca-apds.pdf

Abbreviations:

ft^2 - square feet
g/mol - grams per mole
K - degrees Kelvin
lb - pounds
m/s - meters per second
mmHg - millimeters of mercury
tpy - tons per year
USEPA - United States Environmental Protection Agency
wt% - weight percent

2022 Mine Plan of Operations: Table A-5b
Heap Leach and Process Tank HCN Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Area[1] (acres)	pH[2]	NaCN Concentration[3] (lb/ton)	Free Cyanide Concentration[4] (g/m^3)	Temperature[5] (deg C)	Gas Phase Mass Transfer Coefficient[6] (m/s)	Flux[7] (g/m^2-s)	Flux Chamber Adjustment for Area (F_a)	Flux Chamber Adjustment for Wind Speed (F_w)[8]	F_a*F_w	Annual HCN Emissions[9] (lb/yr)
Active Pad, Wet Surface	100	10	0.40	106	17	7.0E-06		0.40	1.2	0.49	9,208
Active Pad, Dry Surface	285						7.9E-08	0.40	1.2	0.49	3,072
Inactive Pad	285						2.0E-08	0.40	1.2	0.49	762
Various Process Tanks	1	10	0.06	16	17	9.3E-06		0.40	1.2	0.49	18

Notes:

1. The Heap Leach Pad area was assumed to have up to 100 acres of wet active area, with the remaining area split between dry active area and inactive area. The surface area for the various process tanks at the facility was conservatively assumed to be 1 acre.
2. Average pH based on expected operating levels.
3. NaCN concentrations are based on expected operating levels, including a conservative buffer.
4. Free cyanide concentrations are calculated based on NaCN concentrations.
5. Average temperature based on hourly site-specific meteorological data for the period of January 2021 through December 2021.
6. Gas phase mass transfer coefficient values based on source category and EPA flux box results (EPA 2010).
7. Flux values based on source category and EPA flux box results (EPA 2010).
8. Annual mean wind speed based on site-specific meteorological data for the period of January 2021 through December 2021.
9. Gas phase mass transfer coefficients are used when the source area is wet and has a measurable pH level. Flux values are used for the dry active pad and inactive pad sources.

References:

Quality Assurance Project Plan, Comprehensive Air Emissions Testing for Hydrogen Cyanide *at Three Nevada Gold Mines Sites Using the USEPA Surface Isolation Flux Chamber Technology, Revision 2* (November 18, 2009). EPA-HQ-OAR-2010-0239-0163_attachment 5.

Evaluation of Air Emissions of Hydrogen Cyanide from Fugitive Sources at Nevada Gold Mines Using the USEPA Surface Insolation Flux Chamber Technology: Cortez, Gold Quarry & Round Mountain Mines. April 2010. Prepared by Dr. C.E. Schmidt and Tom Card. EPA-HQ-OAR-2010-0239-0163

USEPA. HCN Flux Box Results. 2010. EPA-HQ-OAR-2010-0239-0403. Available online at: https://downloads.regulations.gov/EPA-HQ-OAR-2010-0239-0403/content.pdf.

Abbreviations:

deg C = degrees Celsius
g = grams
lb = pound
m = meters
m^3 = cubic meters
s = seconds
yr = year

2022 Mine Plan of Operations: Table A-6
Crushing Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Source Area	Process Rates[1]		Emission Factor[2,3,4] (lb/ton)		Add-On Control Method	Control Efficiency[5,6]	Controlled Emissions			
		Daily (tpd)	Annual (tpy)					Daily (lb/day)		Annual (tpy)	
				PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Rock Breaker	Primary Crushing	792	192,000	8.0E-05	8.0E-05	Watering	0%	0.063	0.063	0.0077	0.0077
Primary Crusher and transfers in and out	Primary Crushing	13,486	3,269,225	5.4E-04	1.0E-04	Watering + Enclosure	0%	7.3	1.3	0.88	0.16
Secondary Crushers (2) and transfers in and out	Secondary/Tertiary Crushing	62,011	15,033,077	0.0024	3.6E-04	Secondary/Tertiary Crushing Dust Scrubber	99.5%	0.74	0.11	0.090	0.014
Tertiary Crusher and transfers in and out	Secondary/Tertiary Crushing	49,410	11,978,227	0.0024	3.6E-04	Secondary/Tertiary Crushing Dust Scrubber	99.5%	0.59	0.090	0.072	0.011
							Total Emissions	**8.7**	**1.6**	**1.1**	**0.20**

Notes:

1. Equipment specific information was provided by Castle Mountain Venture.
2. Emissions factors for the rock breaker are from AP-42, Section 11.19.2 for "Wet Drilling - Unfractured Stone". AP-42, Section 11.19.2 (Crushed Stone Processing and Pulverized Mineral Processing) defines wet material as material containing >1.5% water. $PM_{2.5}$ is conservatively assumed to be equal to PM_{10}.
3. Emission factors for the primary crusher were based on controlled tertiary crushing emission factors from AP-42, Section 11.19.2, Table 11.19.2-2. Tertiary crushing controlled emission factors were conservatively applied to the primary crusher units based on data availability, and per NDEP guidance.
4. Emission factors for the secondary and tertiary crushers were based on uncontrolled tertiary crushing emission factors from AP-42, Section 11.19.2, Table 11.19.2-2. Tertiary crushing emission factors were conservatively applied to the primary and secondary crusher units based on data availability, and per NDEP guidance. AP-42, Section 11.19.2, Table 11.19.2-2 does not include an uncontrolled tertiary crushing emission factor for $PM_{2.5}$ so the emission factor was estimated using the uncontrolled tertiary crushing emission factor for PM_{10} and a multiplier of 0.053/0.35 based on AP-42, Chapter 13.2.4, consistent with NDEP guidance for the mining industry.
5. The rock breaker will be controlled with watering, but this control is already accounted for in the wet drilling emission factor utilized so 0% control efficiency is listed here. The primary crusher will be controlled with watering and enclosure. The watering control is already accounted for in the controlled emission factor utilized, so no additional control efficiency is listed .
6. The dust scrubber control efficiencies will be confirmed with vendor guarantees upon equipment design.

References:

NDEP. 2017. Guidance on Emission Factors for the Mining Industry. Available online at: https://ndep.nv.gov/uploads/air-permitting-docs/ndep-mining-emissions-guidance.pdf. May 31.

USEPA. 2004. AP-42, Section 11.19.2 (Crushed Stone Processing and Pulverized Mineral Processing). Available online at: https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s1902.pdf

USEPA. 2006. AP-42, Section 13.2.4. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/13.2.4_aggregate_handling_and_storage_piles.pdf. November.

Abbreviations:

lb - pounds
NDEP - Nevada Division of Environmental Protection
PM - particulate matter
tpd - tons per day
tpy - tons per year
USEPA - United States Environmental Protection Agency

2022 Mine Plan of Operations: Table A-7
Screening Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Source Area	Process Rates[1]		Emission Factor[2] (lb/ton)		Add-On Control Method	Control Efficiency[3]	Controlled Emissions			
		Daily (tpd)	Annual (tpy)					Daily (lb/day)		Annual (tpy)	
				PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Secondary Screens (2) and transfers in and out	Secondary/Tertiary Screening	79,200	19,200,000	0.0087	0.0013	Secondary/Tertiary Screening Dust Scrubber	99.5%	3.4	0.52	0.42	0.063
Tertiary Screen and transfers in and out	Secondary/Tertiary Screening	62,011	15,033,077	0.072	0.011	Secondary/Tertiary Screening Dust Scrubber	99.5%	22	3.4	2.7	0.41
							Total Emissions	**26**	**3.9**	**3.1**	**0.47**

Notes:

1. Equipment specific information was provided by Castle Mountain Venture.
2. Emission factors for the secondary and tertiary screens were based on uncontrolled screening (secondary screens) and uncontrolled fines screening (tertiary screens) emission factors from AP-42, Section 11.19.2, Table 11.19.2-2. AP-42, Section 11.19.2, Table 11.19.2-2 does not include an uncontrolled screening or fines screening emission factors for $PM_{2.5}$ so these emission factors were estimated using the uncontrolled screening and fines screening emission factors for PM_{10} and a multiplier of 0.053/0.35 based on AP-42, Chapter 13.2.4, consistent with NDEP guidance for the mining industry.
3. The dust scrubber control efficiencies will be confirmed with vendor guarantees upon equipment design.

References:

NDEP. 2017. Guidance on Emission Factors for the Mining Industry. Available online at: https://ndep.nv.gov/uploads/air-permitting-docs/ndep-mining-emissions-guidance.pdf. May 31.

USEPA. 2004. AP-42, Section 11.19.2 (Crushed Stone Processing and Pulverized Mineral Processing). Available online at: https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s1902.pdf

USEPA. 2006. AP-42, Section 13.2.4. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/13.2.4_aggregate_handling_and_storage_piles.pdf.

Abbreviations:

lb - pounds
NDEP - Nevada Division of Environmental Protection
PM - particulate matter
tpd - tons per day
tpy - tons per year
USEPA - United States Environmental Protection Agency

2022 Mine Plan of Operations: Table A-8
On-site Mobile Fugitive Dust Emissions
Unpaved Road Travel
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Equipment Quantity[1]	Equipment Description	Average Vehicle Weight[2] (tons)	Unpaved Surface Silt Content (%)[3]	Emission Factor (lb/VMT)[4]		Maximum Equipment Hours[5]		Total Miles Traveled[6]		Control Efficiency (%)[7]	Number of Days with >0.01 Inches Precipitation[8] (days/yr)	Controlled Emissions			
													Daily (lb/day)		Annual (tpy)	
					PM_{10}	$PM_{2.5}$	Daily	Annual	Daily	Annually			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Haul Trucks	20	Caterpillar 793F	296	5	5.4	0.54	18	--	3,085	1,125,844	95%	31	831	83	139	14
Water Truck	2	Caterpillar 785G WTR MEGA	208	5	4.6	0.46	18	5,957	180	59,568	95%	31	83	8.3	6.3	0.63
Haul Truck	3	Caterpillar 773G	83	5	3.0	0.30	18	11,169	180	111,690	95%	31	82	8.2	7.8	0.78
Articulated Truck	1	Caterpillar 740GC	55.7	5	2.5	0.25	18	1,862	180	18,615	95%	31	23	2.3	1.1	0.11
Fuel and Lube Truck	1	Caterpillar 777 Mega System	132	5	3.7	0.37	18	4,468	180	44,676	95%	31	34	3.4	3.8	0.38
Tractor and Low Bed	1	--	160	5	4.1	0.41	18	745	180	7,446	95%	31	37	3.7	0.70	0.070
Flatbed Hiab Truck	1	--	10	5	1.2	0.12	18	2,606	180	26,061	95%	31	11	1.1	0.70	0.070
Mechanics Truck	1	8100 National	36.5	5	2.1	0.21	18	1,862	180	18,615	95%	31	19	1.9	0.89	0.089
Welding Truck	1	--	13.0	5	1.3	0.13	18	2,234	180	22,338	95%	31	12	1.2	0.67	0.067
Staff Pickup Trucks	10	--	1.0	5	0.42	0.042	24	29,784	240	297,840	95%	31	50	5.0	2.8	0.28
Pit Services Pickup	6	--	1.0	5	0.42	0.042	24	31,273	240	312,732	95%	31	30	3.0	3.0	0.30
Staff Pickup Trucks (Crewcab)	3	--	1.0	5	0.42	0.042	24	8,935	240	89,352	95%	31	15	1.5	0.85	0.085
Pit Services Pickup (Crewcab)	3	--	1.0	5	0.42	0.042	24	8,935	240	89,352	95%	31	15	1.5	0.85	0.085
Shovel Crew Flat Deck	1	--	7.5	5	1.0	0.10	18	1,489	180	14,892	95%	31	9.3	0.93	0.35	0.035
Shovel Crew Hiab	1	--	10	5	1.2	0.12	18	1,862	180	18,615	95%	31	11	1.1	0.50	0.050
Surface Crew Hiab	1	--	10	5	1.2	0.12	18	1,862	180	18,615	95%	31	11	1.1	0.50	0.050
Mine Rescue Vehicle	1	--	11.8	5	1.3	0.13	18	1,862	180	18,615	95%	31	11	1.1	0.54	0.054
Fuel Delivery Trucks	--	--	16.5	5	1.5	0.15	4	--	7.2	1,872	95%	31	0.53	0.053	0.063	0.0063
Product Delivery Trucks	--	--	16.5	5	1.5	0.15	1	--	3.8	99	95%	31	0.28	0.028	0.0033	3.3E-04
Contractor Trucks	--	--	16.5	5	1.5	0.15	3	--	11	3,960	95%	31	0.84	0.084	0.13	0.013
Other Delivery Trucks	--	--	16.5	5	1.5	0.15	14	--	53	14,049	95%	31	3.9	0.39	0.47	0.047
Reagent Delivery Trucks	--	--	16.5	5	1.5	0.15	11	--	42	3,751	95%	31	3.1	0.31	0.13	0.013
												Total Emissions	**1,291**	**129**	**171**	**17**

Notes:

1. Equipment counts provided by Castle Mountain Venture.
2. With the exception of Delivery Trucks, average weights are from Table 16-3 of Technical Report on the Castle Mountain Project Feasibility Study (March 2021) or based on equipment model specifications. Delivery truck weights assume heavy heavy-duty trucks (HHDT).
3. A roadway surface silt content of 5% was used, consistent with data provided by Castle Mountain Venture.
4. Fugitive dust emission factors calculated following MDAQMD's "most complex" Unpaved Roads methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 correlations for industrial roads (Equation 1a, Table 13.2.2-2, AP-42 Section 13.2.2) at the time of inventory preparation.
5. Maximum daily hours assumed to be 24 hours per day per piece of equipment for equipment with non-zero vehicle miles traveled except for the Fuel, Propane, Product, and Reagent Delivery Trucks. Delivery Trucks are assumed to make a maximum of one round-trip per hour, so the maximum daily hours are set equal to the number of daily trips presented in Table O-13b. Maximum annual hours provided by Castle Mountain Venture. Maximum annual hours are not presented for Caterpillar 793F Haul Trucks and Delivery Trucks as this information is not required for the calculation of vehicle miles traveled (VMT) or emissions.
6. Annual VMT for Caterpillar 793F Haul Trucks was provided by Castle Mountain Venture and daily VMT was set equal to annual VMT divided by 365 days per year. Annual VMT for Fuel, Propane, Product, and Reagent Delivery Trucks is shown in Table O-13b and daily VMT was calculated assuming 365 days per year and the days per year shown in Table O-13b. Annual and daily VMT for all other equipment was estimated based on hours of operation and a vehicle speed of 10 mph.
7. A control efficiency of 95% was used consistent with assumptions for watering, graveling surface, treatment with chemical stabilizers, and speed control from the 1997 Castle Mountain Mine Expansion Project EIS/EIR, and the understanding that chemical suppressants will be applied to all unpaved roadways.
8. Consistent with the AP-42 Section 13.2.2 unpaved roads methodology for industrial sites, Ramboll applied a precipitation reduction based on the number of days with greater than 0.01 inches precipitation per year based on site-specific meteorological measurements between January 2021 and December 2021.

References:

Bureau of Land Management. 1997. Castle Mountain Mine Expansion Project Final Environmental Impact Statement/Environmental Impact Report. October.

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

USEPA. 2006. AP-42, Section 13.2.2, Unpaved Roads. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0202.pdf. November.

Abbreviations:

HHDT - heavy heavy-duty truck
lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
mph - miles per hour
LNG - liquefied natural gas
PM - particulate matter
tpy - tons per year
USEPA - United States Environmental Protection Agency
VMT - vehicle miles traveled
yr - year

2022 Mine Plan of Operations: Table A-9
On-site Mobile Fugitive Dust Emissions Dozing/ Scraping/Grading and Similar Activity Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Equipment Quantity[1]	Equipment Description	Maximum Equipment Hours[1]		Control Efficiency[2] (%)	Emission Factor[3,4] (lb/hr)		Controlled Emissions			
								Daily (lb/day)		Annual (tpy)	
			Daily	Annual		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Production Blasthole Drill	3	Epiroc Pit Viper 235	18	19,859	98%	0.10	0.032	5.6	1.7	1.0	0.31
Wall Control Drill	2	Epiroc - SmartROC D65	18	13,190	98%	0.10	0.032	3.7	1.1	0.68	0.21
Hydraulic Shovel	3	Caterpillar 6060 FS	18	16,240	98%	0.10	0.032	5.6	1.7	0.84	0.26
Wheel Loader	2	Caterpillar 994K	18	11,315	98%	0.10	0.032	3.7	1.1	0.58	0.18
Track Dozer	5	Caterpillar D10T2	18	27,923	98%	0.10	0.032	9.3	2.8	1.4	0.44
Wheel Dozer	2	Caterpillar 844K	18	10,424	98%	0.10	0.032	3.7	1.1	0.54	0.16
Grader	3	Caterpillar 16MG	18	15,637	98%	0.10	0.032	5.6	1.7	0.81	0.25
Wheel Loader	1	Caterpillar 988KXE	18	4,468	98%	0.10	0.032	1.9	0.57	0.23	0.071
Excavator	1	Caterpillar 390D L	18	1,489	98%	0.10	0.032	1.9	0.57	0.077	0.024
Tire Manipulator	1	Caterpillar 988K CWS TM30P	18	1,117	98%	0.10	0.032	1.9	0.57	0.058	0.018
Vibratory Compactor	1	Caterpillar CS64	18	1,117	98%	0.10	0.032	1.9	0.57	0.058	0.018
Backhoe	1	Caterpillar 440	18	1,862	98%	0.10	0.032	1.9	0.57	0.096	0.029
Rough Terrain Forklift	1	Hyster 700	18	1,862	98%	0.10	0.032	1.9	0.57	0.096	0.029
Shop Forklift	1	Taylor-360M Forklift	18	1,862	98%	0.10	0.032	1.9	0.57	0.096	0.029
Hydraulic Hammer	1	TB-XC Hydraulic Breaker	18	1,862	98%	0.10	0.032	1.9	0.57	0.096	0.029
							Total Emissions	**52**	**16**	**6.7**	**2.1**

Notes:

1. Equipment specific information provided by Castle Mountain Venture.
2. Control efficiencies were calculated consistent with MDAQMD guidance for Dust Entrainment from Unpaved Roads as shown in Table A-18.
3. Fugitive dust emission factors for off-road equipment were calculated using Mojave Desert Air Quality Management District (MDAQMD) Bulldozing, Scraping and Grading of Materials "most complex" methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries document.
4. Emission factors are based on a material moisture content of 2% and a silt content of 5%, consistent with data provided by Castle Mountain Venture.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

Abbreviations:

lb - pounds
hr - hour
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
tpy - tons per year

2022 Mine Plan of Operations: Table A-10
On-site Mobile Vehicles
Exhaust Emission Factors
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Make/Model	Equipment Quantity[1]	Engine Size[1] (hp)	Equipment Tier[2]	OFFROAD2017 Equipment Type[3]	Load Factor[3]	Operating Hours[1]		Emission Factors (g/bhp-hr)[4]					
							(hr/yr)	(hr/day)	NO_x	SO_x	CO	ROG	PM_{10}	$PM_{2.5}$
Production Blasthole Drill	Epiroc Pit Viper 235	3	860	Tier 4 Final	Bore/Drill Rigs	0.50	19,859	18	2.6	0.0049	2.6	0.15	0.030	0.030
Wall Control Drill	Epiroc - SmartROC D65	2	540	Tier 4 Final	Bore/Drill Rigs	0.50	13,190	18	0.30	0.0049	2.6	0.15	0.015	0.015
Hydraulic Shovel	Caterpillar 6060 FS	3	2,996	Tier 4 Final	Other Construction Equipment	0.42	16,240	18	2.6	0.0049	2.6	0.15	0.030	0.030
Wheel Loader	Caterpillar 994K	2	1,739	Tier 4 Final	Rubber Tired Loaders	0.36	11,315	18	2.6	0.0049	2.6	0.15	0.030	0.030
Haul Trucks	Caterpillar 793F	20	2,650	Tier 4 Final	Off-Highway Trucks	0.38	114,040	18	2.6	0.0049	2.6	0.15	0.030	0.030
Track Dozer	Caterpillar D10T2	5	600	Tier 4 Final	Other Construction Equipment	0.42	27,923	18	0.30	0.0049	2.6	0.15	0.015	0.015
Wheel Dozer	Caterpillar 844K	2	620	Tier 4 Final	Rubber Tired Dozers	0.40	10,424	18	0.30	0.0049	2.6	0.15	0.015	0.015
Grader	Caterpillar 16MG	3	290	Tier 4 Final	Graders	0.41	15,637	18	0.30	0.0049	2.6	0.15	0.015	0.015
Water Truck	Caterpillar 785G WTR MEGA	2	1,450	Tier 4 Final	Off-Highway Trucks	0.38	5,957	18	2.6	0.0049	2.6	0.15	0.030	0.030
Wheel Loader	Caterpillar 988KXE	1	541	Tier 4 Final	Rubber Tired Loaders	0.36	4,468	18	0.30	0.0049	2.6	0.15	0.015	0.015
Haul Truck	Caterpillar 773G	3	825	Tier 4 Final	Off-Highway Trucks	0.38	11,169	18	2.6	0.0049	2.6	0.15	0.030	0.030
Excavator	Caterpillar 390D L	1	524	Tier 4 Final	Excavators	0.38	1,489	18	0.30	0.0049	2.6	0.15	0.015	0.015
Tire Manipulator	Caterpillar 988K CWS TM30P	1	541	Tier 4 Final	Other Construction Equipment	0.42	1,117	18	0.30	0.0049	2.6	0.15	0.015	0.015
Vibratory Compactor	Caterpillar CS64	1	130	Tier 4 Final	Other Construction Equipment	0.42	1,117	18	0.30	0.0049	3.7	0.15	0.015	0.015
Backhoe	Caterpillar 440	1	105	Tier 4 Final	Tractors/Loaders/Backhoes	0.37	1,862	18	0.30	0.0049	3.7	0.15	0.015	0.015
Articulated Truck	Caterpillar 740GC	1	450	Tier 4 Final	Off-Highway Trucks	0.38	1,862	18	0.30	0.0049	2.6	0.15	0.015	0.015
Fuel and Lube Truck	Caterpillar 777 Mega System	1	1,025	Tier 4 Final	Off-Highway Trucks	0.38	4,468	18	2.6	0.0049	2.6	0.15	0.030	0.030
Tractor and Low Bed	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	745	18	0.30	0.0049	2.6	0.15	0.015	0.015
Flatbed Hiab Truck	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	2,606	18	0.30	0.0049	2.6	0.15	0.015	0.015
Rough Terrain Forklift	Hyster 700	1	260	Tier 4 Final	Rough Terrain Forklifts	0.40	1,862	18	0.30	0.0049	2.6	0.15	0.015	0.015
Shop Forklift	Taylor-360M Forklift	1	173	Tier 4 Final	Forklifts	0.20	1,862	18	0.30	0.0049	3.7	0.15	0.015	0.015
Mechanics Truck	8100 National	1	330	Tier 4 Final	Off-Highway Trucks	0.38	1,862	18	0.30	0.0049	2.6	0.15	0.015	0.015
Welding Truck	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	2,234	18	0.30	0.0049	2.6	0.15	0.015	0.015
Shovel Crew Flat Deck	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	1,489	18	0.30	0.0049	2.6	0.15	0.015	0.015
Shovel Crew Hiab	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	1,862	18	0.30	0.0049	2.6	0.15	0.015	0.015
Surface Crew Hiab	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	1,862	18	0.30	0.0049	2.6	0.15	0.015	0.015
Lighting Tower	Amida	6	11	Tier 4 Final	Other Construction Equipment	0.42	11,169	18	5.3	0.0049	6.0	0.30	0.30	0.30
Hydraulic Hammer	TB-XC Hydraulic Breaker	1	172	Tier 4 Final	Other Construction Equipment	0.42	1,862	18	0.30	0.0049	3.7	0.15	0.015	0.015
Mine Rescue Vehicle	--	1	405	Tier 4 Final	Off-Highway Trucks	0.38	1,862	18	0.30	0.0049	2.6	0.15	0.015	0.015

Notes:

1. Equipment specific information provided by Castle Mountain Venture with the following exceptions: horsepower for Tractor and Low Bed, Flatbed Hiab Truck, Welding Truck, Shovel Crew Flat Deck, Shovel Crew Hiab, Surface Crew Hiab, and Hydraulic Hammer were obtained from EMFAC2021 in offroad emissions mode for MDAQMD in Calendar Year 2025.
2. All off-road equipment used at the facility will be Tier 4 Final.
3. Average equipment load factors were based on the CARB OFFROAD2017 Emission Factor Workbook (CARB 2017).
4. PM, CO, NO_x and VOC engine emission factors were based on CARB Tier 4 Final diesel engine standards. Emission factors for ROG were converted from NMHC Tier standards using USEPA hydrocarbon conversion factors (USEPA 2010). When applicable, the NMHC/NO_x combined Tier standard was split into NMHC and NO_x per BAAQMD guidance (assumed 5% NMHC, 95% NO_x). Emission factors for SO_x from diesel fuel are calculated from the California standard for diesel fuel of 15 ppm (http://www.arb.ca.gov/fuels/diesel/081404dslregs.pdf). Emission factor calculations assume a diesel fuel density of 7.1 lb/gal, heating value of 19,300 BTU/lb, BSFC of 7,000 BTU/hp-hr (USEPA 1996), and that all sulfur is converted to SO_2.

References:

BAAQMD. 2004. CARB Emission Factors for CI Diesel Engines - Percent HC in Relation to NMHC + NO_x.

CARB. Table 1: ARB and USEPA Off-Road Compression-Ignition (Diesel) Engine Standards. www.arb.ca.gov/msprog/ordiesel/documents/Off-Road_Diesel_Stds.xls.

CARB. 2017. 2017 Off-road Diesel Emission Factors. Available online at: https://ww2.arb.ca.gov/sites/default/files/2022-05/Off-road_CI_engine_standards_chart_04212022.pdf.

CARB 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250

USEPA. 2010. Conversion Factors for Hydrocarbon Emission Components, NR-002d. EPA-420-R-10-015. July. Available online at: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10081RP.pdf.

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
BSFC - brake-specific fuel consumption
BTU - British thermal units
CARB - California Air Resources Board
CO - carbon monoxide
EMFAC2021 - California Air Resources Board EMission FACtor model
g/bhp-hr - grams per brake horsepower-hour
gal - gallon
hp - horsepower
hr - hour
lb - pound
MDAQMD - Mojave Desert Air Quality Management District
NMHC - non-methane hydrocarbons
NO_x - nitrogen oxides
PM - particulate matter
ppm - parts per million
ROG - reactive organic gases
SO_x - sulfur oxides
USEPA - United States Environmental Protection Agency

2022 Mine Plan of Operations: Table A-11
On-site Mobile Vehicles
CAP Exhaust Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Daily Emissions[1] (lb/day)						Annual Emissions[1] (tpy)					
	NO_x	SO_x	CO	ROG	PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	ROG	PM_{10}	$PM_{2.5}$
Production Blasthole Drill	133	0.25	133	7.7	1.5	1.5	24	0.046	24	1.4	0.28	0.28
Wall Control Drill	6.4	0.11	56	3.2	0.32	0.32	1.2	0.019	10	0.59	0.059	0.059
Hydraulic Shovel	389	0.74	389	22	4.5	4.5	59	0.11	59	3.4	0.68	0.68
Wheel Loader	129	0.24	129	7.4	1.5	1.5	20	0.038	20	1.2	0.23	0.23
Haul Trucks	2,078	3.9	2,078	120	24	24	329	0.62	329	19	3.8	3.8
Track Dozer	15	0.25	130	7.5	0.75	0.75	2.3	0.038	20	1.2	0.12	0.12
Wheel Dozer	5.9	0.097	51	2.9	0.30	0.30	0.85	0.014	7.4	0.43	0.043	0.043
Grader	4.2	0.070	37	2.1	0.21	0.21	0.61	0.010	5.3	0.31	0.031	0.031
Water Truck	114	0.22	114	6.6	1.3	1.3	9.4	0.018	9.4	0.54	0.11	0.11
Wheel Loader	2.3	0.038	20	1.2	0.12	0.12	0.29	0.0047	2.5	0.14	0.014	0.014
Haul Truck	97	0.18	97	5.6	1.1	1.1	10	0.019	10	0.58	0.12	0.12
Excavator	2.4	0.039	21	1.2	0.12	0.12	0.098	0.0016	0.85	0.049	0.0049	0.0049
Tire Manipulator	2.7	0.044	23	1.4	0.14	0.14	0.084	0.0014	0.73	0.042	0.0042	0.0042
Vibratory Compactor	0.65	0.011	8.0	0.32	0.033	0.033	0.020	3.3E-04	0.25	0.010	0.0010	0.0010
Backhoe	0.46	0.008	5.7	0.23	0.023	0.023	0.024	3.9E-04	0.29	0.012	0.0012	0.0012
Articulated Truck	2.0	0.033	18	1.0	0.10	0.10	0.11	0.0017	0.91	0.053	0.0053	0.0053
Fuel and Lube Truck	40	0.076	40	2.3	0.46	0.46	5.0	0.0095	5.0	0.29	0.058	0.058
Tractor and Low Bed	1.8	0.030	16	0.91	0.092	0.092	0.038	6.2E-04	0.33	0.019	0.0019	0.0019
Flatbed Hiab Truck	1.8	0.030	16	0.91	0.092	0.092	0.13	0.0022	1.1	0.066	0.0066	0.0066
Rough Terrain Forklift	1.2	0.020	11	0.62	0.062	0.062	0.064	0.0011	0.55	0.032	0.0032	0.0032
Shop Forklift	0.41	0.0068	5.1	0.21	0.021	0.021	0.021	3.5E-04	0.26	0.011	0.0011	0.0011
Mechanics Truck	1.5	0.025	13	0.75	0.075	0.075	0.077	0.0013	0.67	0.039	0.0039	0.0039
Welding Truck	1.8	0.030	16	0.91	0.092	0.092	0.11	0.0019	0.98	0.057	0.0057	0.0057
Shovel Crew Flat Deck	1.8	0.030	16	0.91	0.092	0.092	0.076	0.0012	0.66	0.038	0.0038	0.0038
Shovel Crew Hiab	1.8	0.030	16	0.91	0.092	0.092	0.095	0.0016	0.82	0.047	0.0047	0.0047
Surface Crew Hiab	1.8	0.030	16	0.91	0.092	0.092	0.095	0.0016	0.82	0.047	0.0047	0.0047
Lighting Tower	5.7	0.0053	6.4	0.32	0.32	0.32	0.30	2.7E-04	0.33	0.017	0.017	0.017
Hydraulic Hammer	0.86	0.014	11	0.43	0.043	0.043	0.045	7.3E-04	0.55	0.022	0.0022	0.0022
Mine Rescue Vehicle	1.8	0.030	16	0.91	0.092	0.092	0.095	0.0016	0.82	0.047	0.0047	0.0047
Total Emissions	**3,045**	**6.6**	**3,507**	**202**	**38**	**38**	**464**	**0.97**	**513**	**30**	**5.6**	**5.6**

Notes:

[1.] Emissions based on parameters and emission factors presented in Table A-10.

Abbreviations:

CO - carbon monoxide
lb - pounds
NO_x - nitrogen oxides
PM - particulate matter
ROG - reactive organic gases
SO_x - sulfur oxides
tpy - tons per year

2022 Mine Plan of Operations: Table A-12
On-site Mobile Vehicles
GHG Exhaust Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Annual Fuel Usage[1] (gal/yr)	Emission Factors (kg/gal)[2,3]			Annual Emissions[4,5] (MT/yr)				
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Biogenic CO_2e	Non-biogenic CO_2e
Production Blasthole Drill	556,062	10.21	9.4E-04	8.7E-04	5,675	0.52	0.48	5,675	157
Wall Control Drill	224,235	10.21	9.4E-04	8.7E-04	2,289	0.21	0.20	2,289	63
Hydraulic Shovel	1,380,394	10.21	9.4E-04	8.7E-04	14,089	1.3	1.2	14,089	390
Wheel Loader	429,977	10.21	9.4E-04	8.7E-04	4,389	0.40	0.37	4,389	122
Haul Trucks	4,298,331	10.21	9.4E-04	8.7E-04	43,871	4.0	3.7	43,871	1,215
Track Dozer	530,528	10.21	9.4E-04	8.7E-04	5,415	0.50	0.46	5,415	150
Wheel Dozer	166,790	10.21	9.4E-04	8.7E-04	1,702	0.16	0.15	1,702	47
Grader	125,093	10.21	9.4E-04	8.7E-04	1,277	0.12	0.11	1,277	35
Water Truck	142,963	10.21	9.4E-04	8.7E-04	1,459	0.13	0.12	1,459	40
Wheel Loader	53,611	10.21	9.4E-04	8.7E-04	547	0.050	0.047	547	15
Haul Truck	134,028	10.21	9.4E-04	8.7E-04	1,368	0.126	0.12	1,368	38
Excavator	17,870	10.21	9.4E-04	8.7E-04	182	0.017	0.016	182	5.1
Tire Manipulator	12,286	10.21	9.4E-04	8.7E-04	125	0.012	0.011	125	3.5
Vibratory Compactor	7,818	10.21	9.4E-04	8.7E-04	80	0.0073	0.0068	80	2.2
Backhoe	9,308	10.21	9.4E-04	8.7E-04	95	0.0087	0.0081	95	2.6
Articulated Truck	7,446	10.21	9.4E-04	8.7E-04	76	0.0070	0.0065	76	2.1
Fuel and Lube Truck	53,611	10.21	9.4E-04	8.7E-04	547	0.050	0.047	547	15
Tractor and Low Bed	2,234	10.21	9.4E-04	8.7E-04	23	0.0021	0.0019	23	0.63
Flatbed Hiab Truck	7,818	10.21	9.4E-04	8.7E-04	80	0.0073	0.0068	80	2.2
Rough Terrain Forklift	5,585	10.21	9.4E-04	8.7E-04	57	0.0052	0.0049	57	1.6
Shop Forklift	3,723	10.21	9.4E-04	8.7E-04	38	0.0035	0.0032	38	1.1
Mechanics Truck	5,585	10.21	9.4E-04	8.7E-04	57	0.0052	0.0049	57	1.6
Welding Truck	6,701	10.21	9.4E-04	8.7E-04	68	0.0063	0.0058	68	1.9
Staff Pickup Trucks	89,352	10.21	9.4E-04	8.7E-04	912	0.084	0.078	912	25
Pit Services Pickup	93,820	10.21	9.4E-04	8.7E-04	958	0.088	0.082	958	27
Staff Pickup Trucks (Crewcab)	26,806	10.21	9.4E-04	8.7E-04	274	0.025	0.023	274	7.6
Pit Services Pickup (Crewcab)	26,806	10.21	9.4E-04	8.7E-04	274	0.025	0.023	274	7.6
Shovel Crew Flat Deck	4,468	10.21	9.4E-04	8.7E-04	46	0.0042	0.0039	46	1.3
Shovel Crew Hiab	7,446	10.21	9.4E-04	8.7E-04	76	0.0070	0.0065	76	2.1
Surface Crew Hiab	7,446	10.21	9.4E-04	8.7E-04	76	0.0070	0.0065	76	2.1
Lighting Tower	22,338	10.21	9.4E-04	8.7E-04	228	0.021	0.019	228	6.3
Mine Rescue Vehicle	5,585	10.21	9.4E-04	8.7E-04	57	0.0052	0.0049	57	1.6
Total Emissions					**86,409**	**8.0**	**7.4**	**86,409**	**2,394**

Notes:

1. Annual fuel usage was provided by Castle Mountain Venture.
2. CO_2 emission factor is from 40 CFR Part 98, Subpart C, Table C-1.
3. CH_4 and N_2O emission factors are from the EPA Center for Corporate Climate Leadership (2022, April 1) Emission Factors for Greenhouse Gas Inventories, Table 5 (available at https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf) which are calculated from the USEPA Inventory of U.S. Greenhouse Gas Emission and Sinks: 1990-2019.
4. Annual CO_2e emissions were calculated using global warming potentials (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).
5. CO_2 emissions are assumed to be 100% biogenic based on the assumption of the use of 100% renewable diesel fuel in off-road equipment, consistent with regulatory requirements under the CARB In-Use Off-Road Diesel-Fueled Fleets Regulation and CMV commitments.

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

CARB. 2022. In-Use Off-Road Diesel-Fueled Fleets regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/off-roaddiesel/appa-1.pdf

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

USEPA. 2021. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019. Available at: https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-annexes.pdf

Abbreviations:

CARB - California Air Resources Board
CH_4 - methane
CMV - Castle Mountain Venture
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
gal - gallons
GHG - greenhouse gas
GWP - global warming potential
kg - kilograms
MRR - Mandatory Reporting Regulation
MT - metric tons
N_2O - nitrous oxide
USEPA - United States Environmental Protection Agency
yr - year

2022 Mine Plan of Operations: Table A-13a
Off-site On-Road Mobile Vehicles
Trip Rates
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type[1]	Trip Type	Trip Rate (RT/day)	Trip Length (miles/RT)	Annual Activity (days/yr)	Annual Trips (RT/yr)	Daily VMT (miles/day)	Annual VMT (miles/yr)
Employee Vehicles[2]	Employee Vehicles - Full Commute	30	170	200	6,000	5,100	1,020,000
	Employee Vehicles - To/From Vans/Buses	160	12	365	58,400	1,920	700,800
Vans/Buses[3]	Vans/Buses	5	170	365	1,825	850	310,250
Fuel Delivery Trucks[4]	Fuel Delivery Trucks	4	206	260	1,040	824	214,240
LNG Delivery Trucks[5]	LNG Delivery Trucks	3	368	365	1,095	1,104	402,960
Product Delivery Trucks[6]	Product Delivery Trucks (gold to market)	1	836	26	26	836	21,736
Contractor Trucks[7]	Blasting Contractor Trucks	1	206	312	312	206	64,272
	Maintenance Contractor Trucks	2	206	365	730	412	150,380
Other Delivery Trucks[7]	Other Delivery Trucks (Warehouse to Coyote)	9	52	208	1,872	468	97,344
	Other Delivery Trucks (Las Vegas Origin)	5	206	365	1,825	1,030	375,950
Reagent Delivery Trucks[7]	Reagent Delivery Trucks (Antiscalant)	1	1,442	5	5	1,442	7,210
	Reagent Delivery Trucks (Carbon)	1	1,024	2	2	1,024	2,048
	Reagent Delivery Trucks (Caustic Soda)	1	578	26	26	578	15,028
	Reagent Delivery Trucks (Flocculant, Anionic)	1	574	12	12	574	6,888
	Reagent Delivery Trucks (Fluxes)	1	574	6	6	574	3,444
	Reagent Delivery Trucks (Pebble Lime)	3	206	260	780	618	160,680
	Reagent Delivery Trucks (Sodium Cyanide)	3	1,118	52	156	3,354	174,408

Notes:

1. Fleet mixes are defined in Table A-14a.
2. Employee vehicle trip rates were based on the number of employees working at the facility and were provided by Castle Mountain Venture. Each employee was assumed to make one roundtrip per day, to and from the Project site. Employee activity was assumed to occur 365 days per year. A portion of the employees were assumed to commute the full distance between home and the facility in their personal vehicles. The remainder of the employees were assumed to commute an average of 12 miles roundtrip between home and the van/bus pickup locations in their personal vehicles. Potential van/bus pick up locations may include Las Vegas, NV, Henderson, NV, and Bullhead City/Laughlin, NV.
3. Van/bus trip rates were calculated based on the number of van/bus commuters and an assumption of 35 passengers/vehicle. An average roundtrip distance between the Henderson, NV, Bullhead City/Laughlin, NV, and Las Vegas, NV bus/van locations and the facility was assumed.
4. Annual trip rates for Fuel Delivery calculated based on daily average trip rates provided by Castle Mountain Venture and 260 days per year of activity. Daily trip rates were conservatively rounded up to the nearest whole number. Trip lengths assume all fuel would be delivered from Las Vegas, NV.
5. Annual trip rates for LNG Delivery calculated based on daily average trip rates provided by Castle Mountain Venture and 365 days per year of activity. Trip length was provided by Castle Mountain Venture based on expected supplier.
6. Daily and annual trip rates assume one Product Delivery trip every other week. Trip length was provided by Castle Mountain Venture.
7. Daily trip rates, trip lengths, and annual activity for Contractors, Other Delivery Trucks, and Reagent Delivery Trucks were provided by Castle Mountain Venture.

Abbreviations:

LNG - liquefied natural gas
RT - roundtrips
VMT - vehicle miles traveled
yr - year

2022 Mine Plan of Operations: Table A-13b
On-site On-Road Mobile Vehicles
Trip Rates
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type[1]	Trip Type	Trip Rate (RT/day)	Trip Length (miles/RT)	Annual Activity (days/yr)	Annual Trips[1] (RT/yr)	Annual VMT[2] (miles/yr)
On-site Pickup Trucks	Staff Pickup Trucks			365		297,840
	Pit Services Pickup			365		312,732
	Staff Pickup Trucks (Crewcab)			365		89,352
	Pit Services Pickup (Crewcab)			365		89,352
Fuel Delivery Trucks	Fuel Delivery Trucks	4	1.8	260	1,040	1,872
LNG Delivery Trucks	LNG Delivery Trucks	3	1.8	365	1,095	1,971
Product Delivery Trucks	Product Delivery Trucks (gold to market)	1	3.8	26	26	99
Contractor Trucks	Blasting Contractor Trucks	1	3.8	312	312	1,186
	Maintenance Contractor Trucks	2	3.8	365	730	2,774
Other Delivery Trucks	Other Delivery Trucks (Warehouse to Coyote)	9	3.8	208	1,872	7,114
	Other Delivery Trucks (Las Vegas Origin)	5	3.8	365	1,825	6,935
Reagent Delivery Trucks	Reagent Delivery Trucks (Antiscalant)	1	3.8	5	5	19
	Reagent Delivery Trucks (Carbon)	1	3.8	2	2	7.6
	Reagent Delivery Trucks (Caustic Soda)	1	3.8	26	26	99
	Reagent Delivery Trucks (Flocculant, Anionic)	1	3.8	12	12	46
	Reagent Delivery Trucks (Fluxes)	1	3.8	6	6	23
	Reagent Delivery Trucks (Pebble Lime)	3	3.8	260	780	2,964
	Reagent Delivery Trucks (Sodium Cyanide)	3	3.8	52	156	593

Notes:

1. Fleet mixes are defined in Table A-14b. Diesel MDVs (on-site pickup trucks fleet) only generate emissions on a per mile basis, therefore annual trip rates are not presented in this table. On-site pickup trucks are assumed to operate 365 days per year. Delivery truck trips originate off-site and the emissions generated on a per trip basis are already accounted for in the off-site mobile calculations (Tables A-13a, A-14a, A-15a, A-16a, and A-17a. Trip rate data for delivery trucks is still presented, however, as part of the calculation of annual VMT.
2. Annual VMT for the on-site pickup trucks is calculated in Table A-8. Delivery trucks to the site will travel a short distance on-site in addition to the off-site activity presented in Table A-13a. Total annual onsite VMT was calculated based on the on-site mileage per trip (provided by Castle Mountain Venture) and the annual trip rates shown in Table A-13a.

Abbreviations:

LNG - liquefied natural gas
MDV - medium-duty truck
RT - roundtrips
VMT - vehicle miles traveled
yr - year

2022 Mine Plan of Operations: Table A-14a
Off-site On-Road Mobile Vehicles
Fleet Mix Distribution
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type	Vehicle Type	Percentage of Fleet Mix[1]	Percent by Fuel Type[1]				
			Gas	Diesel	Renewable Natural Gas	Electric	Plug-in Hybrid
Employee Vehicles	LDA	55.2%	89.5%	0%	0%	6.9%	3.4%
	LDT1	3.9%	99.0%	0.008%	0%	0.52%	0.45%
	LDT2	24.0%	97.3%	0.35%	0%	0.96%	1.4%
	MCY	0.39%	100%	0%	0%	0%	0%
	MDV	16.6%	95.8%	1.5%	0%	1.5%	1.2%
Vans/Buses	LHDT1	78.5%	100%	0%	0%	0%	0%
	LHDT2	21.5%	100%	0%	0%	0%	0%
Fuel Delivery Trucks	HHDT	100%	0%	100%	0%	0%	0%
LNG Delivery Trucks	HHDT	100%	0%	0%	100%	0%	0%
Product Delivery, Contractor, Other Delivery, and Reagent Delivery Trucks	MHDT	6.9%	0%	100%	0%	0%	0%
	HHDT	93.1%	0%	100%	0%	0%	0%

Notes:

1. Fleet mixes and percentages by fuel type are calculated based on EMFAC2021 v1.0.2 vehicle miles traveled projections for MDAQMD with the exception of Vans which are assumed to be exclusively gasoline-fueled, LNG Delivery Trucks which are assumed to be fueled exclusively with renewable compressed natural gas, and Delivery Trucks which are assumed to be exclusively diesel-fueled. EMFAC2021 v1.0.2 was run in Emission Rates mode for calendar year 2027 in the annual season.

References:

California Air Resources Board (ARB) 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250

Abbreviations:

EMFAC2021 - California Air Resources Board EMission FACtor model
HHDT - heavy-heavy-duty truck
LDA - passenger car
LDT - light-duty truck
LHDT - light-heavy-duty truck
LNG - liquefied natural gas
MCY - motorcycle
MDAQMD - Mojave Desert Air Quality Management District
MDV - medium-duty truck
MHDT - medium-heavy-duty truck

2022 Mine Plan of Operations: Table A-14b
On-site On-Road Mobile Vehicles
Fleet Mix Distribution
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type	Vehicle Type	Percentage of Fleet Mix[1]	Percent by Fuel Type[1]				
			Gas	Diesel	Renewable Natural Gas	Electric	Plug-in Hybrid
On-site Pickup Trucks	MDV	100%	50%	50%	0%	0%	0%
Fuel Delivery Trucks	HHDT	100%	0%	100%	0%	0%	0%
LNG Delivery Trucks	HHDT	100%	0%	0%	100%	0%	0%
Product Delivery, Contractor, Other Delivery, and Reagent Delivery Trucks	MHDT	6.9%	0%	100%	0%	0%	0%
	HHDT	93.1%	0%	100%	0%	0%	0%

Notes:

1. On-site Pickup Trucks are assumed to be 50% gasoline-fueled and 50% diesel-fueled. Delivery Trucks are assumed to be 100% diesel-fueled. LNG Delivery Trucks are assumed to be 100% renewable compressed natural gas-fueled. EMFAC2021 v1.0.2 was run in Emission Rates mode for MDAQMD for calendar year 2027 in the annual season.

References:

California Air Resources Board (ARB) 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250

Abbreviations:

EMFAC2021 - California Air Resources Board EMission FACtor model
HHDT - heavy heavy-duty truck
LNG - liquefied natural gas
MDAQMD - Mojave Desert Air Quality Management District
MDV - medium-duty truck
MHDT - medium heavy-duty truck

2022 Mine Plan of Operations: Table A-15a
Off-site On-Road Mobile Vehicles
Exhaust and Brake Wear/Tire Wear Emission Factors
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Scenario		Emission Factor Units	Mobile Emission Factors[1]									
			CAPs						GHGs[2]			
Year	Fleet Type		ROG	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x	CO_2	CH_4	N_2O	CO_2e
2027	Employee Vehicles	g/mile	0.014	0.056	0.015	0.0050	0.76	0.0029	294	0.0031	0.0054	296
		g/trip	1.1	0.26	0.0019	0.0018	3.0	7.2E-04	73	0.069	0.032	84
	Vans/Buses	g/mile	0.023	0.17	0.090	0.031	1.2	0.0061	615	0.0047	0.0095	618
		g/trip	0.77	0.61	3.2E-04	3.0E-04	3.4	3.3E-04	34	0.040	0.049	49
	Fuel Delivery Trucks	g/mile	0.012	1.4	0.14	0.067	0.034	0.014	1,450	5.6E-04	0.23	1,518
		g/trip	0.48	7.7	0.0021	0.0020	7.0	0.0098	1,030	0.022	0.16	1,079
	LNG Delivery Trucks	g/mile	0.012	0.28	0.12	0.038	5.0	0	1,080	0.83	0.22	1,167
		g/trip	0.057	1.5	0.0044	0.0041	7.9	0	1,149	4.0	0.23	1,320
	Product Delivery, Contractor, Other Delivery, and Reagent Delivery Trucks	g/mile	0.012	1.3	0.14	0.064	0.035	0.013	1,423	5.6E-04	0.22	1,490
		g/trip	0.44	7.4	0.0020	0.0019	6.6	0.0092	969	0.021	0.15	1,015

Notes:

1. Emission factors were estimated using EMFAC2021 for MDAQMD. EMFAC2021 was run in Emission Rates mode for calendar year 2027 in the annual season. The following processes have units of g/trip: DIURN, HOTSOAK, RESTLOSS, STREX, and IDLEX. The following processes have units of g/mile: PMBW, PMTW, RUNEX, and RUNLOSS. Processes with units of g/vehicle/day were converted to g/trip using the population and trip rate values given in the EMFAC2021 run.
2. Annual CO_2e emissions were calculated using GWP values from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

CARB 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CAP - Criteria Air Pollutant
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
DIURN - diurnal evaporative hydrocarbon emissions
EMFAC2021 - California Air Resources Board EMission FACtor model
g - grams
GHG - greenhouse gas
GWP - global warming potential
HOTSOAK - hot soak evaporative hydrocarbon emissions
IDLEX - idle exhaust emissions
LNG - liquefied natural gas
MDAQMD - Mojave Desert Air Quality Management District
MRR - Mandatory Reporting Regulation
N_2O - nitrous oxide
NO_x - nitrogen oxides
PM - particulate matter
PMBW - brake wear particulate matter emissions
PMTW - tire wear particulate matter emissions
RESTLOSS - resting evaporative losses
ROG - reactive organic gases
RUNEX - running exhaust emissions
RUNLOSS - running loss evaporative hydrocarbon emissions
STREX - start exhaust tailpipe emissions
SO_x - sulfur oxides
USEPA - United States Environmental Protection Agency

2022 Mine Plan of Operations: Table A-15b
On-site On-Road Mobile Vehicles
Exhaust and Brake Wear/Tire Wear Emission Factors
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Scenario		Emission Factor Units	Mobile Emission Factors[1]									
			CAPs						GHGs[2]			
Year	Fleet Type		ROG	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x	CO_2	CH_4	N_2O	CO_2e
2027	On-site Pickup Trucks	g/mile	0.015	0.11	0.019	0.0084	0.59	0.0040				
		g/trip	0.70	0.20	0.0010	9.6E-04	1.9	5.1E-04				
	Fuel Delivery Trucks	g/mile	0.012	1.4	0.14	0.067	0.034	0.014	1,450	5.6E-04	0.23	1,518
	LNG Delivery Trucks	g/mile	0.012	0.28	0.12	0.038	5.0	0	1,080	0.83	0.22	1,167
	Product Delivery, Contractor, Other Delivery, and Reagent Delivery Trucks	g/mile	0.012	1.3	0.14	0.064	0.035	0.013	1,423	5.6E-04	0.22	1,490

Notes:

1. Emission factors were estimated using EMFAC2021 for MDAQMD. EMFAC2021 was run in Emission Rates mode for calendar year 2027 in the annual season. The following processes have units of g/mile: PMBW, PMTW, RUNEX, and RUNLOSS. For the Delivery Truck fleets, the g/trip emission factors are not presented because these trips originate off-site and the emissions generated on a per trip basis are already accounted for in Tables A-13a, A-14a, A-15a, A-16a, and A-17a.
2. GHG emissions for the On-site Pickup Trucks are based on fuel consumption rates and are calculated in Table A-12. Annual CO2e emissions for the Delivery Truck fleets are calculated using GWP values from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

California Air Resources Board (CARB) 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CAP - Criteria Air Pollutant
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
EMFAC2021 - California Air Resources Board EMission FACtor model
g - grams
GHG - greenhouse gas
GWP - global warming potential
LNG - liquefied natural gas
MDAQMD - Mojave Desert Air Quality Management District
MRR - Mandatory Reporting Rule
N_2O - nitrous oxide
NO_x - nitrogen oxides
PM - particulate matter
PMBW - brake wear particulate matter emissions
PMTW - tire wear particulate matter emissions
ROG - reactive organic gases
RUNEX - running exhaust emissions
RUNLOSS - running loss evaporative hydrocarbon emissions
SO_x - sulfur oxides
USEPA - United States Environmental Protection Agency

2022 Mine Plan of Operations: Table A-16a
Off-site On-Road Mobile Vehicles
Exhaust and Brake Wear/Tire Wear Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Daily Emission Rates[1]

Year	Fleet Type	Emissions from Mobile Sources					
		ROG[2]	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x
		(lb/day)					
2027	Employee Vehicles	0.66	0.97	0.23	0.079	13	0.045
	Vans/Buses	0.051	0.32	0.17	0.059	2.3	0.011
	Fuel Delivery Trucks	0.026	2.6	0.26	0.12	0.12	0.025
	LNG Delivery Trucks	0.029	0.69	0.28	0.092	12	0
	Product Delivery Trucks	0.023	2.5	0.25	0.12	0.079	0.025
	Contractor Trucks	0.019	1.9	0.19	0.087	0.091	0.018
	Other Delivery Trucks	0.053	4.6	0.45	0.21	0.32	0.045
	Reagent Delivery Trucks	0.23	24	2.5	1.2	0.79	0.24
Total Emissions		**1.1**	**38**	**4.3**	**1.9**	**29**	**0.41**

Annual Emission Rates[1]

Year	Fleet Type	Emissions from Mobile Sources										
		ROG[2]	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x	CO_2	CH_4	N_2O	Biogenic CO_2e	Non-biogenic CO_2e
		(tons/yr)						(MT/yr)				
2027	Employee Vehicles	0.10	0.12	0.028	0.0097	1.7	0.0056	510	0.010	0.011	0	514
	Vans/Buses	0.0094	0.059	0.031	0.011	0.43	0.0021	191	0.0015	0.0030	0	192
	Fuel Delivery Trucks	0.0034	0.34	0.033	0.016	0.016	0.0033	312	1.4E-04	0.049	0	326
	LNG Delivery Trucks[3]	0.0053	0.13	0.051	0.017	2.2	0	437	0.34	0.089	437	35
	Product Delivery Trucks	3.0E-04	0.032	0.0033	0.0015	0.0010	3.2E-04	31	1.3E-05	0.0049	0	32
	Contractor Trucks	0.0033	0.32	0.032	0.015	0.016	0.0032	306	1.4E-04	0.048	0	321
	Other Delivery Trucks	0.0080	0.73	0.071	0.033	0.045	0.0071	677	3.4E-04	0.11	0	709
	Reagent Delivery Trucks	0.0054	0.55	0.056	0.026	0.021	0.0055	527	2.3E-04	0.083	0	552
Total Emissions		**0.14**	**2.3**	**0.31**	**0.13**	**4.4**	**0.027**	**2,991**	**0.35**	**0.40**	**437**	**2,681**

Notes:

1. Trip generation rates and emission factors used in emissions calculations are shown in Tables A-13a and A-15a, respectively.
2. ROG is assumed to equal VOC.
3. LNG Delivery Trucks will be fueled exclusively by renewable compressed natural gas. Therefore, the associated CO_2 emissions are treated as biogenic.

Abbreviations:

CO - carbon monoxide
CO_2e - carbon dioxide equivalents
lb - pound
LNG - liquefied natural gas
MT - metric ton(s)
NO_x - nitrogen oxides
PM - particulate matter
ROG - reactive organic gases
SO_x - sulfur oxides
VOC - volatile organic compounds
yr - year

2022 Mine Plan of Operations: Table A-16b
On-site On-Road Mobile Vehicles
Exhaust and Brake Wear/Tire Wear Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Daily Emission Rates[1]

Year	Fleet Type	Emissions from Mobile Sources					
		ROG[2]	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x
		(lb/day)					
2027	On-site Pickup Trucks	0.070	0.52	0.090	0.040	2.8	0.019
	Fuel Delivery Trucks	1.9E-04	0.022	0.0023	0.0011	5.5E-04	2.2E-04
	LNG Delivery Trucks	1.4E-04	0.0033	0.0014	4.5E-04	0.060	0
	Product Delivery Trucks	1.0E-04	0.011	0.0011	5.4E-04	2.9E-04	1.1E-04
	Contractor Trucks	3.0E-04	0.034	0.0034	0.0016	8.8E-04	3.4E-04
	Other Delivery Trucks	0.0014	0.16	0.016	0.0075	0.0041	0.0016
	Reagent Delivery Trucks	0.0011	0.12	0.013	0.0059	0.0032	0.0012
Total Emissions		**0.073**	**0.87**	**0.13**	**0.057**	**2.9**	**0.023**

Annual Emission Rates[1]

Year	Fleet Type	Emissions from Mobile Sources										
		ROG[2]	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x	CO_2	CH_4	N_2O	Biogenic CO_2e	Non-biogenic CO_2e
		(tpy)						(MT/yr)				
2027	On-site Pickup Trucks	0.013	0.095	0.016	0.0073	0.52	0.0035	0	0	0	0	0
	Fuel Delivery Trucks	2.5E-05	0.0029	2.9E-04	1.4E-04	7.1E-05	2.8E-05	2.7	1.0E-06	4.3E-04	0	2.8
	LNG Delivery Trucks[3]	2.6E-05	6.1E-04	2.5E-04	8.2E-05	0.011	0	2.1	0.0016	4.3E-04	2.1	0.17
	Product Delivery Trucks	1.3E-06	1.5E-04	1.5E-05	7.0E-06	3.8E-06	1.5E-06	0.14	5.5E-08	2.2E-05	0	0.15
	Contractor Trucks	5.2E-05	0.0058	6.0E-04	2.8E-04	1.5E-04	5.9E-05	5.6	2.2E-06	8.9E-04	0	5.9
	Other Delivery Trucks	1.9E-04	0.021	0.0021	9.9E-04	5.4E-04	2.1E-04	20	7.8E-06	0.0031	0	21
	Reagent Delivery Trucks	4.9E-05	0.0055	0.00056	2.6E-04	1.4E-04	5.6E-05	5.3	2.1E-06	8.4E-04	0	5.6
Total Emissions		**0.013**	**0.13**	**0.020**	**0.0091**	**0.53**	**0.0039**	**36**	**0.0017**	**0.0058**	**2.1**	**36**

Notes:

1. Trip generation rates, VMT, and emission factors used in emissions calculations are shown in Tables A-13b and A-15b, respectively. GHG emissions from on-site pickup trucks are calculated based on fuel consumption and are presented in Table A-12.
2. ROG is assumed to equal VOC.
3. LNG Delivery Trucks will be fueled exclusively by renewable compressed natural gas. Therefore, the associated CO^2 emissions are treated as biogenic.

Abbreviations:

CO - carbon monoxide
CO_2e - carbon dioxide equivalent
lb - pound
LNG - liquefied natural gas
MT - metric ton
NO_x - nitrogen oxides
PM - particulate matter
ROG - reactive organic gases
SO_x - sulfur oxides
VMT - vehicle miles traveled
VOC - volatile organic compound
tpy - tons per year
yr - year

2022 Mine Plan of Operations: Table A-17a
Off-site On-Road Mobile Vehicles
Fugitive Dust Emissions - Paved Roads
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Entrained Roadway Dust Constants for San Bernardino County (MDAQMD)		
Roadway Category	**Silt Loading[1] (g/m^2)**	**Travel Fraction[1]**
Freeway	0.015	52%
Major	0.08	32%
Collector	0.08	9.0%
Local	0.84	7.0%
Weighted Silt Loading Factor	**0.099**	**100%**

Road Dust Equation[2]
E = k*(sL)^0.91 * (W)^1.02 * (1-P/4N)

Parameter[2]	**Value**
E = annual average emission factor in the same units as k	[calculated]
k = particle size multiplier for particle size range and units of interest	
PM_{10} (lb/VMT)	0.0022
$PM_{2.5}$ (lb/VMT)	3.3E-04
sL = road surface silt loading (grams per square meter) (g/m^2)	0.099
W = average weight (tons) of all the vehicles traveling the road	2.4
P = number of "wet" days with at least 0.01 inches of precipitation during averaging period[3]	45
N number of days in the averaging period	365

Vehicle Miles Traveled[4]

Fleet Type	**Miles/Day**	**Miles/Year**
Employee Vehicles	5,940	1,504,800
Vans/Buses	670	244,550
Fuel Delivery Trucks	680	176,800
LNG Delivery Trucks	996	363,540
Product Delivery Trucks	800	20,800
Contractor Trucks	510	177,140
Other Delivery Trucks	994	340,202
Reagent Delivery Trucks	7,768	334,174

Parameter[5]	**Fugitive PM_{10}**	**Fugitive $PM_{2.5}$**	**Units**
Emission Factor	6.4E-04	9.6E-05	lb/VMT

Fleet Type	**Daily Emissions (lb/day)**		**Annual Emissions (tpy)**	
	PM_{10}	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Employee Vehicles	3.8	0.57	0.48	0.072
Vans/Buses	0.43	0.064	0.078	0.012
Fuel Delivery Trucks	0.43	0.065	0.056	0.0085
LNG Delivery Trucks	0.63	0.095	0.12	0.017
Product Delivery Trucks	0.51	0.077	0.0066	9.9E-04
Contractor Trucks	0.33	0.049	0.056	0.0085
Other Delivery Trucks	0.63	0.095	0.11	0.016
Reagent Delivery Trucks	5.0	0.74	0.11	0.016
Total Emissions	**12**	**1.8**	**1.0**	**0.15**

Notes:

1. Travel fraction by roadway category and silt loading are from the ARB's March 2021 update to Entrained Road Travel Emission Inventory Source Methodology, Tables 2 and 4, respectively.
2. The road dust equation for paved roads is from the ARB's March 2021 update to Entrained Road Travel Emission Inventory Source Methodology.

3. The number of "wet" days for San Bernardino County (MDAQMD) from Table 5 of the ARB's March 2021 update to Entrained Road Travel Emission Inventory Source Methodology.
4. Vehicle miles traveled from A-13a account for the fact that the last 18 miles to and from Castle Mountain Mine are unpaved. Fugitive dust emissions associated with the unpaved portion of vehicle miles traveled are presented in Table A-17b.
5. $PM_{2.5}$ is assumed to be 15% of PM_{10} based on paved road dust sampling in California (ARB Speciation Profile #471), which is a more representative fraction than provided in the older AP-42 fugitive dust methodology as discussed in ARB 2021 (page 36).

References:

California Air Resources Board. 2021. Miscellaneous Process Methodology 7.9, Entrained Road Travel, Paved Road Dust. March. Available online at: https://ww3.arb.ca.gov/ei/areasrc/fullpdf/2021_paved_roads_7_9.pdf

USEPA. 2011. AP 42. Compilation of Air Pollutant Emission Factors, Volume 1. Fifth Edition. Chapter 13.2.1, Paved Roads. Available online at: http://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0201.pdf.

Abbreviations:

ARB - California Air Resources Board
g - gram(s)
lb - pounds
LNG - liquefied natural gas
MDAQMD - Mojave Desert Air Quality Management District
m^2 - square meter
PM - particulate matter
tpy - tons per year
USEPA - United States Environmental Protection Agency
VMT - vehicle miles traveled

2022 Mine Plan of Operations: Table A-17b
Off-site On-Road Mobile Vehicles
Fugitive Dust Emissions - Unpaved Roads
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Type	Daily Unpaved Road VMT Traveled (miles/day)[1]	Annual Unpaved Road VMT Traveled (miles/yr)[1]	Mean Vehicle Weight (tons)[2]	Emission Factor (lb/VMT)[3]		Control Efficiency (%)[4]	Number of Days with >0.01 Inches Precipitation[5] (day/yr)	Controlled Emissions			
								Daily (lb/day)		Annual (tpy)	
				PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Employee Vehicles	1,080	216,000	2.4	0.62	0.062	95%	30	31	3.1	3.1	0.31
Vans/Buses	180	65,700	15	1.4	0.14	95%	30	12	1.2	2.1	0.21
Fuel Delivery Trucks	144	37,440	30	1.9	0.19	95%	30	13	1.3	1.7	0.17
LNG Delivery Trucks	108	39,420	30	1.9	0.19	95%	30	9.5	0.95	1.7	0.17
Product Delivery Trucks	36	936	30	1.9	0.19	95%	30	3.2	0.32	0.041	0.0041
Contractor Trucks	108	37,512	30	1.9	0.19	95%	30	9.5	0.95	1.7	0.17
Other Delivery Trucks	504	133,092	30	1.9	0.19	95%	30	44	4.4	5.9	0.59
Reagent Delivery Trucks	396	35,532	30	1.9	0.19	95%	30	35	3.5	1.6	0.16
							Total Emissions	**157**	**16**	**18**	**1.8**

Notes:

1. Vehicle miles traveled are from Table A-13a and account for the fact that the last 18 miles to and from Castle Mountain Mine are unpaved. Fugitive dust emissions associated with the paved portion of vehicle miles traveled are presented in Table A-17a.
2. Mean vehicle weights estimated based on typical vehicle weights for each vehicle type as shown in Table A-14a.
3. Emission factors for fugitive dust were calculated following MDAQMD's "most complex" Unpaved Roads methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 correlations for industrial roads (Equation 1a, Table 13.2.2-2, AP-42 Section 13.2.2) at the time of inventory preparation. A surface silt loading content of 5% was provided by Castle Mountain Venture.
4. A control efficiency of 95% used consistent with assumptions from the 1997 Castle Mountain Mine Expansion Project EIS/EIR, and the understanding that chemical suppressants will be applied to all unpaved roadways.
5. Consistent with the AP-42 Section 13.2.2 unpaved roads methodology for industrial sites, Ramboll applied a precipitation reduction based on the number of days with greater than 0.01 inches precipitation per year based on guidance in AP-42 Section 13.2.2, Figure 13.2.2-1.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

USEPA. 2006. AP-42, Section 13.2.2, Unpaved Roads. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0202.pdf. November.

Abbreviations:

lb - pounds
LNG - liquefied natural gas
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
tpy - tons per year
USEPA - United States Environmental Protection Agency
VMT - vehicle miles traveled
yr - year

2022 Mine Plan of Operations: Table A-18
Watering Assumptions for Disturbed Operational Areas
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter	Value	Data Source
Average Hourly Traffic Rate	3 vehicles/hr	Only loaders and water trucks would disturb ore areas (haul trucks travel exclusively on roads). Per Castle Mountain Venture, a maximum of two loaders plus a water truck per hour is expected.
Time Between Water Applications	1 hours	Per Castle Mountain Venture, watering occurs approximately once per hour.
Average Annual Class A Pan Evaporation	75 inches	MDAQMD Mineral Guidance, conservative default
Water Application Intensity	0.11 gallons/yd^2	MDAQMD Mineral Guidance, conservative default
Control Efficiency	98 %	MDAQMD Mineral Guidance, Pg. 26

Notes:

1. Watering control efficiencies calculated consistent with MDAQMD guidance for Dust Entrainment from Unpaved Roads.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

Abbreviations:

hr - hour
MDAQMD - Mojave Desert Air Quality Management District
yd^2 - square yard

2022 Mine Plan of Operations: Table A-19
Disturbed Operational Area Emissions
Wind Erosion
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Daily Disturbed Surface Area[1] (acres)		Control Efficiency[2] (%)	Daily Emissions[3,4,5] (lb/day)		Annual Emissions[3,4,5] (tpy)	
	Average	Maximum		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Disturbed Areas	0.77	0.77	98%	3.2	0.48	0.077	0.012
Total Emissions				**3.2**	**0.48**	**0.077**	**0.012**

Notes:

1. Average and maximum daily disturbed surface area based on information provided by Castle Mountain Venture.
2. Control efficiency accounts for watering of disturbed areas. The watering control efficiency was calculated consistent with MDAQMD guidance for Dust Entrainment from Unpaved Roads as shown in Table A-18.
3. Windblown dust from disturbed areas assumed to be a "limited" reservoir consistent with MDAQMD definitions due to the significant crusting that occurs on the mine ore and overburden areas.
4. Emissions estimated using MDAQMD's "most complex" Wind Erosion from Unpaved Operational Areas and Roads methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest $PM_{2.5}$ aerodynamic factor from AP-42 (Table 13.2.5-1 in AP-42 Section 13.2.5). Threshold friction velocity selected from the MDAQMD guidance based on an area use of "disturbed desert".
5. The maximum daily windspeeds required for input into the MDAQMD equation were assumed to be the "fastest mile" windspeed from each day (consistent with AP-42 Section 13.2.5 guidance, which the MDAQMD equation is based on). The fastest mile wind speeds were calculated using hourly site-specific meteorological data from January 2021 through December 2021 by scaling up the maximum hourly average wind speed to a fastest mile windspeed using the equation:

$$u+ = 1.52u/1.2$$

Where: u+ = fastest mile wind speed, and u = hourly mean wind speed. This empirical relationship is based on a conversion of the hourly average wind speed to a 3-second gust wind speed with the coefficient 1.52 (Dregger 2005), then a conversion of the 3-second gust windspeed to a fastest mile of wind with the coefficient 1/1.2 (Fouad and Calvert 2002).

References:

Dregger. 2005. The Wind Investigator: How to Approximate Wind Velocities at Roof Level. October.

Fouad and Calvert. 2002. Wind Load Provisions in the 2001 Supports Specification. November.

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

USEPA. 2006. AP-42, Section 13.2.5, Industrial Wind Erosion. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0205.pdf. November.

Abbreviations:

lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
USEPA - United States Environmental Protection Agency
tpy - tons per year

2022 Mine Plan of Operations: Table A-20
Stockpile Wind Erosion Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Storage Pile Area[1] (acres)	Storage Pile Silt Loading[2] (%)	Percentage of Year Stockpile Operates[3] (%)	Percentage of Time with Wind Speed > 12 mph[4] (%)	Number of Days with >0.01 Inches Precipitation[5] (day/yr)	Daily Water Application Rate[6] (gal/acre)	Watering Control Efficiency[7] (%)	Daily PM_{10} Emissions[8] (lb/day)	Daily $PM_{2.5}$ Emissions[8] (lb/day)	Annual PM_{10} Emissions[8] (tpy)	Annual $PM_{2.5}$ Emissions[8] (tpy)
Interim Ore Stockpile	6.2	15	25	24	31	2,130	50	15	5.9	2.7	1.1

Notes:

1. Storage pile area based on information provided by Castle Mountain Venture.
2. Storage pile silt loading of 15% was used, consistent with the default value for "blend ore and dirt" in MDAQMD guidance for Wind Erosion from Stockpiles.
3. Ore stockpile will operate during crushing stoppages, assumed to be 25% of the year based on crushing circuit design availability.
4. Percentage of time with wind speed greater than 12 mph based on hourly site-specific meteorological data for the period of January 2021 through December 2021.
5. Number of days with greater than 0.01 inches precipitation per year based on site-specific meteorological data for the period of January 2021 through December 2021.
6. Daily water application rate based on MDAQMD default watering intensity of 0.11 gal/yd^2 for unpaved road control, assuming water is applied 4 times per day to the Ore Stockpile.
7. Control efficiency for watering based on MDAQMD guidance for Wind Erosion from Stockpiles and daily water application rate.
8. Fugitive dust emissions calculated consistent with the most complex method from MDAQMD guidance for Wind Erosion from Stockpiles.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

Abbreviations:

gal = gallon
lb = pound
MDAQMD = Mojave Desert Air Quality Management District
mph = miles per hour
$PM_{2.5}$ = particulate matter less than 2.5 microns in diameter
PM_{10} = particulate matter less than 10 microns in diameter
tpy = tons per year

2022 Mine Plan of Operations: Table A-21
Fugitive Blast Hole Drilling Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Maximum Blast Holes[1]		Emission Factor[2] (lb/hole)		Control Efficiency[3] (%)	Maximum Daily Emissions (lb/day)		Annual Emissions (tpy)	
	Annual (holes/yr)	Daily (holes/day)	PM_{10}	$PM_{2.5}$		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Blast Hole Drilling	87,599	281	0.68	0.039	75%	47	2.7	7.4	0.43

Notes:

1. Facility specific information provided by Castle Mountain Venture. Quantity of blast holes includes ROM Ore, Waste Rock, Trim/Buffer drilling and conservatively includes Pre-shear. Maximum daily holes blasted assumes 6 days/week.
2. Emission factors are calculated using MDAQMD's "most complex" Blast Hole Drilling methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 PM2.5 multiplier (AP-42 Section 11.9, Table 11.9-1) at the time of inventory preparation.
3. A control efficiency of 75% is applied consistent with MDAQMD guidance for "complete coverage by windscreens (on the windward side)", assuming that the pit in which blasting activities take place will effectively act as a windscreen and reduce particulate matter

References:

USEPA. 1998. AP-42, Section 11.9, Western Surface Coal Mining. Available online at: https://www3.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf. October.

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

Abbreviations:

lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
tpy - tons per year
USEPA - United States Environmental Protection Agency
yr - year

2022 Mine Plan of Operations: Table A-22
Fugitive Dust Entrainment from Blasting Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Maximum Blast Holes[1]		Maximum Blasts[1]		Horizontal Area Shifted per Blast (sf)	Emission Factor[2] (lb/blast)		Control Efficiency[3] (%)	Maximum Daily Emissions (lb/day)		Annual Emissions (tpy)	
	Annual (holes/yr)	Daily (holes/day)	Annual (blasts/yr)	Daily (blasts/day)		PM_{10}	$PM_{2.5}$		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
ROM Ore	15,750	110	72	1	116,380	289	16.7	75%	72	4.2	2.6	0.15
Waste Rock	46,924	110	214	1	153,913	440	25.4	75%	110	6.3	12	0.68
Trim/Buffer	5,394	0	25	0	74,483	148	8.5	75%	0	0	0.46	0.027
								Total Emissions	**182**	**11**	**15**	**0.86**

Notes:

1. Facility specific information provided by Castle Mountain Venture. Pre-shear blasting is not shown here as it does not significantly shift material. Daily maximum blast holes were calculated using the total annual quantity of ROM Ore, Waste Rock, and Trim/Buffer blast holes and 312 days per year of operations, resulting in a lower maximum daily blast holes compared to Table A-21 due to the exclusion of the Pre-shear quantity. Although daily activity may correspond to any of the blast types, a typical blast with an even split between ROM Ore and Waste rock holes was assumed. The number of blasts was calculated assuming 220 holes/blast.
2. Emission factors are calculated based on MDAQMD's "most complex" Dust Entrainment from Blasting methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 correlations (AP-42, Chapter 11.9, Table 11.9-1) including corrections to typographical errors included in the 1995 version.
3. A control efficiency of 75% is applied consistent with MDAQMD guidance for "complete coverage by windscreens (on the windward side)", assuming that the pit in which blasting activities take place will effectively act as a windscreen and reduce particulate matter emissions.

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

USEPA. 1998. AP-42, Section 11.9, Western Surface Coal Mining. Available online at: https://www3.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf. October.

Abbreviations:

lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
sf - square feet
tpy - tons per year
USEPA - United States Environmental Protection Agency
yr - year

2022 Mine Plan of Operations: Table A-23
Emissions from Blasting Explosives
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Blasting Explosives					Units
Explosive Type[1]		ANFO	TNT	PETN	RDX	Total	--
Amount of Explosive Detonated[1]		10,184	22	6.0	6.0		tpy
		33	0.072	0.019	0.019		tons/day
Emission Factors[2,3]	CO	67	796	297	196		lb/ton
	NO_x	17					lb/ton
	SO_2	0.0030					lb/ton
	Ammonia		29	2.5	44		lb/ton
	HCN		27				lb/ton
	CO_2	0.189					ton/ton
	CH_4		14.3				lb/ton
Maximum Daily Emissions	CO	2,243	57	5.7	3.8	2,309	lb/day
	NO_x	569				569	lb/day
	SO_2	0.10				0.10	lb/day
	Ammonia		2.1	0.048	0.85	3.0	lb/day
	HCN		1.9			1.9	lb/day
Maximum Annual Emissions	CO	341	8.8	0.88	0.58	351	tpy
	NO_x	87				87	tpy
	SO_2	0.015				0.015	tpy
	Ammonia		0.32	0.0074	0.13	0.46	tpy
	HCN		0.30			0.30	tpy
	CO_2	1,746				1,746	MT/yr
	CH_4		287			287	MT/yr

Notes:

1. Explosive type and amount of explosive detonated per year was provided by Castle Mountain Venture. The amount of explosive detonated per day was calculated using the maximum daily blast holes from Table A-22 and the maximum quantity of explosive per blast hole provided by Castle Mountain Venture.
2. Emission factors for all species other than SO_2 and CO_2 are based on AP-42, Section 13.3, Table 13.3.
3. Emission factor for SO_2 is based on diesel fuel sulfur content limit of 15 ppm and the assumption that the amount of diesel fuel is equal to 5% of the amount of ANFO.
4. Emission factor for CO_2 is based on guidance from The Mining Association of Canada.

References:

The Mining Association of Canada. 2014. Toward Sustainable Mining: Energy and GHG Emissions Management Reference Guide. June. Available online at: https://mining.ca/wp-content/uploads/dlm_uploads/2021/06/EnergyandGreenhouseGasEmissionsManagementReferenceGuide2014.

USEPA. 1980. AP-42, Section 13.3, Explosives Detonation. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s03.pdf. February.

Abbreviations:

ANFO - ammonium nitrate fuel oil
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
HCN - hydrogen cyanide
lb - pounds
MT - metric tons
NO_x - nitrogen oxides
PETN - pentaerythritol tetranitrate
RDX - Royal Demolition eXplosive
SO_2 - sulfur dioxide
TNT - trinitrotoluene
tpy - tons per year
USEPA - United States Environmental Protection Agency
yr - year

2022 Mine Plan of Operations: Table A-24a
Toxic Air Contaminant and Hazardous Air Pollutant Emissions (On-Site Dust Emissions from Fugitive and Stationary Points)
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source		Material Transfer		Crushing	Screening	Stockpile Erosion	Haul Road Fugitive Dust	Off-Road Fugitive Dust	Disturbed Operational Area	Blast Hole Drilling	Blasting Fugitive Dust Entrainment	Total
Material Profile[1,2]		Ore	Overburden	Ore	Ore	Ore	Desert Dust	Ore/ Overburden	Ore/ Overburden	Ore/ Overburden	Ore/ Overburden	
Annual PM_{10} Emissions (lb/yr)		16,412	48,655	2105	6,247	5,411	341,796	13,455	154	14,804	29,645	
Annual Emissions (lb/yr)	Aluminum	934	2,768	120	355	308	13,688	766	8.7	842	1,687	**21,477**
	Ammonium						14					**14**
	Antimony	0.28	0.84	0.036	0.11	0.093	4.1	0.23	0.0026	0.25	0.51	**6.5**
	Arsenic	0.83	2.4	0.11	0.31	0.27	19	0.68	0.0077	0.74	1.5	**26**
	Barium	3.1	9.2	0.40	1.2	1.0	205	2.6	0.029	2.8	5.6	**231**
	Beryllium	0.082	0.24	0.011	0.031	0.027		0.067	7.7E-04	0.074	0.15	**0.68**
	Bromine						23					**23**
	Cadmium	0.0028	0.0083	3.6E-04	0.0011	9.2E-04	4.4	0.0023	2.6E-05	0.0025	0.0050	**4.4**
	Chromium (total)	1.5	4.5	0.19	0.57	0.50	44	1.2	0.014	1.4	2.7	**56**
	Cobalt						28					**28**
	Copper	0.23	0.68	0.029	0.087	0.076	74	0.19	0.0022	0.21	0.42	**76**
	Lead	0.48	1.4	0.062	0.18	0.16	16	0.40	0.0045	0.44	0.87	**21**
	Manganese	3.4	10	0.44	1.31	1.1	261	2.8	0.032	3.1	6.2	**289**
	Mercury	0.017	0.051	0.0022	0.0066	0.0057	5.6	0.014	1.6E-04	0.016	0.031	**5.8**
	Nickel	0.075	0.22	0.0097	0.0287	0.025	12	0.062	7.1E-04	0.068	0.14	**13**
	Phosphorus	3.1	9.2	0.40	1.2	1.0	152	2.6	0.029	2.8	5.6	**178**
	Phosphorus pentoxide	8.2	24	1.1	3.1	2.7		6.7	0.077	7.4	15	**68**
	Selenium	0.016	0.049	0.0021	0.0062	0.0054	0.68	0.013	1.5E-04	0.015	0.030	**0.82**
	Silica	12,785	37,902	1,640	4,866	4,215		10,482	120	11,532	23,094	**106,636**
	Silver	0.031	0.093	0.0040	0.012	0.010	2.5	0.026	2.9E-04	0.028	0.057	**2.7**
	Thallium	0.025	0.075	0.0033	0.0097	0.0084		0.021	2.4E-04	0.023	0.046	**0.21**
	Vanadium	0.26	0.78	0.034	0.10	0.087	57	0.22	0.0025	0.24	0.47	**59**
	Zinc	1.4	4.1	0.18	0.52	0.45	65	1.1	0.013	1.2	2.5	**77**

Notes:

1. Ramboll applied the maximum of material hazardous air pollutant (HAP) and toxic air contaminant (TAC) profiles from two Castle Mountain samples to all Ore and Overburden fugitive material handling PM_{10} emissions. Emission factors for desert soils from MDAQMD. Silver content of sludge was provided by Castle Mountain Venture.
2. Material composition data, and subsequent emission estimates, are subject to future refined testing of ore and overburden materials.

Reference:

Mojave Desert Air Quality Management District (MDAQMD). 2005. *Default Emission Factors for Desert Soils.*

Abbreviations:

lb - pounds
HAP - hazardous air pollutant
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
TAC - toxic air contaminant
yr - year

2022 Mine Plan of Operations: Table A-24b
Toxic Air Contaminant and Hazardous Air Pollutant Emissions (On-Site Mobile Exhaust)
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source		PM_{10} Weight Fractions[1,3]		VOC Weight Fractions[2,4]		Mobile Diesel Equipment Exhaust		Mobile Gasoline Equipment Exhaust	Total
Material Profile		Mobile Source Diesel Combustion	Mobile Source Gasoline Combustion	Mobile Source Diesel Combustion	Mobile Source Gasoline Combustion	Onroad	Offroad	Onroad	
Annual PM_{10} Emissions[5] (lb/yr)						8.2	11,222	1.1	
Annual VOC Emissions[6] (lb/yr)						12	59,125	14	
Annual Emissions (lb/yr)	1,2,4-Trimethylbenzene			0.0053	0.013	0.066	313	0.17	**314**
	1,3-Butadiene			0.0019	0.0083	0.024	112	0.11	**112**
	2,2,4-Trimethylpentane			0.0030	0.020	0.037	177	0.27	**178**
	Acetaldehyde			0.074	0.0075	0.91	4,346	0.10	**4,347**
	Acrolein				0.0018			0.025	**0.025**
	Aluminum	1.8E-04				0.0014	2.0		**2.0**
	Antimony	3.6E-05				3.0E-04	0.40		**0.40**
	Arsenic	5.0E-06				4.1E-05	0.056		**0.056**
	Benzene			0.020	0.034	0.25	1,182	0.47	**1,183**
	Bromine	1.8E-05	5.0E-04			1.5E-04	0.20	5.3E-04	**0.20**
	Cadmium	4.0E-05				3.3E-04	0.45		**0.45**
	Chlorine	3.4E-04	0.070			0.0028	3.9	0.075	**3.9**
	Chromium (total)	1.2E-05	5.0E-04			9.8E-05	0.13	5.3E-04	**0.14**
	Cobalt	1.1E-05	5.0E-04			9.0E-05	0.12	5.3E-04	**0.12**
	Copper	2.5E-05	5.0E-04			2.0E-04	0.28	5.3E-04	**0.28**
	Crotonaldehyde				0.0013			0.018	**0.018**
	Cumene			2.0E-04	5.0E-04	0.0025	12	0.0069	**12**
	Cyclohexane			3.0E-04	0.0045	0.0037	18	0.062	**18**
	Ethanol			1.0E-04	1.0E-04	0.0012	5.9	0.0014	**5.9**
	Ethyl Benzene			0.0031	0.015	0.038	183	0.21	**184**
	Ethylene			0.14	0.089	1.8	8,502	1.2	**8,505**
	Formaldehyde			0.15	0.031	1.8	8,697	0.43	**8,699**
	Hexane			0.0016	0.013	0.020	95	0.18	**95**
	Isoprene				0.0014			0.019	**0.019**
	Lead	4.2E-05				3.4E-04	0.47		**0.47**
	Manganese	4.0E-05	5.0E-04			3.3E-04	0.45	5.3E-04	**0.45**
	Mercury	3.0E-05				2.5E-04	0.34		**0.34**
	Methanol			3.0E-04	0.0070	0.0037	18	0.097	**18**
	Methyl Ethyl Ketone			0.015	6.0E-04	0.18	875	0.0083	**875**
	Methyl Tert-Butyl Ether				0.019			0.257	**0.26**
	Naphthalene			9.0E-04	0.0013	0.011	53	0.018	**53**
	Nickel	1.9E-05	5.0E-04			1.6E-04	0.21	5.3E-04	**0.21**
	n-Pentane			0.0018	0.022	0.022	106	0.30	**107**
	Phosphorus	1.3E-04				0.0010	1.4		**1.4**
	Propionaldehyde			0.0097	0.0013	0.12	574	0.018	**574**
	Propylene			0.026	0.049	0.32	1,537	0.68	**1,538**
	Selenium	1.0E-05				8.2E-05	0.11		**0.11**
	Silver	2.8E-05				2.3E-04	0.31		**0.31**
	Styrene			6.0E-04	0.0013	0.0074	35	0.018	**36**
	Toluene			0.015	0.068	0.18	869	0.94	**870**
	Vanadium	2.9E-05				2.4E-04	0.33		**0.33**
	m-Xylene			0.0061	0.045	0.075	361	0.61	**361**
	o-Xylene			0.0034	0.016	0.042	201	0.21	**201**
	p-Xylene			0.0010		0.012	59		**59**
	Zinc	4.4E-04	5.0E-04			0.0036	4.9	5.3E-04	**4.9**

Notes:

1. Diesel combustion PM weight fractions are based on ARB particulate matter chemical profile 425 from ARB speciation profiles. Profile selection based on ARB reference numbers for PM profiles.
2. Gasoline combustion PM weight fractions are based on ARB particulate matter chemical profile 399 from ARB speciation profiles. Profile selection based on ARB reference numbers for PM profiles.
3. Diesel combustion VOC weight fractions are based on ARB organic chemical profile 818 from ARB speciation profiles. Profile selection based on ARB reference numbers for VOC profiles.
4. Gasoline combustion VOC weight fractions are based on ARB organic chemical profile 401 from ARB speciation profiles. Profile selection based on ARB reference numbers for VOC profiles.
5. PM_{10} emissions for each source category are based on emissions from Table A-11 and Table A-16b. PM_{10} emissions from onroad mobile sources represent exhaust emissions only and are split by diesel and gasoline fuel sources for purposes of applying corresponding chemical profiles. TAC and HAP emissions from NG mobile
6. VOC emissions for each source category are based on emissions from Table A-11 and Table A-16b. VOC emissions from onroad mobile sources are split by diesel and gasoline fuel sources for purposes of applying corresponding chemical profiles. TAC and HAP emissions from NG mobile sources are de minimis.

Reference:

California Air Resources Board (ARB). *Speciation Profiles Used in CARB Modeling.* Available at: https://ww2.arb.ca.gov/speciation-profiles-used-carb-modeling

California Air Resources Board (ARB). Particulate Matter chemical speciation profiles for source categories. Available at: https://ww2.arb.ca.gov/sites/default/files/2025-05/pmchemprofile29apr25.xlsx

California Air Resources Board (ARB). Particulate Matter reference number for particulate matter profiles. Available at: https://ww2.arb.ca.gov/sites/default/files/2025-05/pmprof_ref29apr25.xlsx

California Air Resources Board (ARB). VOC chemical speciation profiles for source categories. Available at: https://ww2.arb.ca.gov/sites/default/files/2024-10/orgprofile20sep24.xlsx

California Air Resources Board (ARB). VOC reference number for VOC profiles. Available at :https://ww2.arb.ca.gov/sites/default/files/2024-

Abbreviations:

ARB - California Air Resources Board
lb - pounds
HAP - hazardous air pollutant
LNG - liquefied natural gas
PM - particulate matter
TAC - toxic air contaminant
yr - year

2022 Mine Plan of Operations: Table A-25
Diesel Generators
Criteria Air Pollutants and Greenhouse Gases
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Emergency Generators #1 through #4	Diesel Water Well Generators #1 and #2	Units
Quantity		4	2	--
Maximum Engine Rating		778	65.7	HP
		580	49	KW
Generator Power		455	36	kW
Fuel Type		Diesel	Diesel	--
Fuel Consumption		33.4	2.93	gallons/hr
Load		100%	100%	--
Maximum Daily Hours		1	24	hrs
Annual Hours		100	8,760	hrs
Emission Factors[1,2,3,4]	ROG/VOC	0.021	0.17	g/kW-hr
	NO_x	0.10	3.0	g/kW-hr
	SO_x	0.0055	0.0057	g/kW-hr
	CO	0.10	0.0094	g/kW-hr
	PM	0.010	0.019	g/kW-hr
	PM_{10}	0.010	0.019	g/kW-hr
	$PM_{2.5}$	0.010	0.019	g/kW-hr
	CO_2	73.96	73.96	kg/MMBtu
	CH_4	0.0030	0.0030	kg/MMBtu
	N_2O	6.0E-04	6.0E-04	kg/MMBtu
Maximum Daily Emissions[5]	ROG/VOC	0.11	0.89	lb/day
	NO_x	0.51	16	lb/day
	SO_x	0.028	0.030	lb/day
	CO	0.51	0.049	lb/day
	PM	0.051	0.097	lb/day
	PM_{10}	0.051	0.097	lb/day
	$PM_{2.5}$	0.051	0.097	lb/day
	CO_2	1.4	1.4	MT/day
	CH_4	5.5E-05	5.8E-05	MT/day
	N_2O	1.1E-05	1.2E-05	MT/day
	CO_2e	1.4	1.4	MT/day
Maximum Annual Emissions[5]	ROG/VOC	0.0055	0.16	tpy
	NO_x	0.026	2.9	tpy
	SO_x	0.0014	0.0054	tpy
	CO	0.026	0.0089	tpy
	PM	0.0026	0.018	tpy
	PM_{10}	0.0026	0.018	tpy
	$PM_{2.5}$	0.0026	0.018	tpy
	CO_2	136	524	MT/yr
	CH_4	0.0055	0.021	MT/yr
	N_2O	0.0011	0.0043	MT/yr
	CO_2e	137	526	MT/yr

Notes:

1. VOC, NO_x, CO and PM emission factors are from generator spec sheets. PM_{10} was conservatively assumed equal to PM emissions. The 778 HP diesel generators are CARB Family Name FCPXL18.1HTG and the 65.7 HP diesel generators are CARB Family Name FSZXL02.2PXB.

2. SO_x emission factors based on MDAQMD guidance and are equivalent to the diesel fuel sulfur content California regulatory standard of 15 ppm.
3. GHG emission factors are from 40 CFR Part 98, Subpart C Tables C-1 and C-2.
4. ROG and VOC assumed to be interchangeable terminologies.
5. CO_2 equivalent (CO_2e) emissions calculated based on CO_2, N_2O, and CH_4 emissions and the corresponding global warming potentials (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR). Diesel generators are expected to use renewable diesel fuel, consistent with other offroad equipment, but have conservatively been assumed to use conventional diesel in this inventory, and thus resulting CO_2 emissions are characterized as non-biogenic.

References:

Code of Federal Regulations. Title 40 Chapter I Subchapter C Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

MDAQMD. 2015. Default Emission Factors for Internal Combustion Engines. http://mdaqmd.ca.gov/home/showdocument?id=722

Abbreviations:

CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
g - gram
GHG - greenhouse gas
GWP - global warming potential
HP - horsepower
hr - hour
kg - kilogram
kW - kilowatt
lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
MMBtu - million British thermal units
MRR - Mandatory Reporting Rule
MT - metric ton
NO_x - nitrogen oxides
N_2O - nitrous oxide
PM - particulate matter
ROG - reactive organic gas
SO_x - sulfur oxides
tpy - tons per year
VOC - volatile organic compound
yr - year

2022 Mine Plan of Operations: Table A-26
Diesel Generators
Toxic Air Contaminants and Hazardous Air Pollutants
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Emergency Generators #1 through #4[1]	Diesel Water Well Generators #1 and #2[1]	Units
Quantity		4	2	--
Maximum Engine Rating		778	65.7	HP
		580	49	kW
Generator Power		455	36	kW
Fuel Type		Diesel	Diesel	--
Fuel Consumption		33.4	2.93	gal/hr
Load		100%	100%	--
Maximum Daily Hours		1	24	hrs
Annual Hours		100	8,760	hrs
Emission Factors	1,3-Butadiene	2.2E-04	2.2E-04	lb/gal
	Acenaphthene	2.0E-05	2.0E-05	lb/gal
	Acenaphthylene	1.5E-05	1.5E-05	lb/gal
	Acetaldehyde	7.8E-04	7.8E-04	lb/gal
	Acrolein	3.4E-05	3.4E-05	lb/gal
	Ammonia	0.0054		lb/gal
	Anthracene	6.7E-06	6.7E-06	lb/gal
	Arsenic	7.8E-06	7.8E-06	lb/gal
	Benzene	1.9E-04	1.9E-04	lb/gal
	Benzaldehyde	1.4E-05	1.4E-05	lb/gal
	Benzo(a)anthracene	8.5E-08	2.3E-07	lb/gal
	Benzo(a)pyrene	1.8E-08	1.3E-08	lb/gal
	Benzo(b)fluoranthene	1.5E-07	6.8E-09	lb/gal
	Benzo(g,h,i)perylene	6.7E-06	6.7E-06	lb/gal
	Benzo(k)fluoranthene	1.5E-08	1.1E-08	lb/gal
	Cadmium	1.5E-06	1.5E-06	lb/gal
	Chlorobenzene	2.0E-07	2.0E-07	lb/gal
	Chromium (hexavalent)	2.0E-07	2.0E-07	lb/gal
	Chromium (total)	3.2E-06	3.2E-06	lb/gal
	Chrysene	6.7E-06	6.7E-06	lb/gal
	Copper	4.1E-06	4.1E-06	lb/gal
	Dibenz(a,h)anthracene	2.4E-08	4.0E-08	lb/gal
	DPM[2]	3.8E-04	6.9E-04	lb/gal
	Ethyl benzene	1.1E-05	1.1E-05	lb/gal
	Fluoranthene	6.7E-06	6.7E-06	lb/gal
	Fluorene	4.3E-05	4.3E-05	lb/gal
	Formaldehyde	0.0017	0.0017	lb/gal
	Hexane	2.7E-05	2.7E-05	lb/gal
	Hydrogen chloride	1.9E-04	1.9E-04	lb/gal
	Indeno(1,2,3-cd)pyrene	2.8E-08	2.6E-08	lb/gal
	Lead	8.3E-06	8.3E-06	lb/gal
	Manganese	3.1E-06	3.1E-06	lb/gal
	Mercury	2.3E-06	2.3E-06	lb/gal
	Naphthalene	2.0E-05	2.0E-05	lb/gal
	Nickel	3.9E-06	3.9E-06	lb/gal
	PAH	5.6E-05	5.6E-05	lb/gal
	Phenanthrene	8.7E-05	8.7E-05	lb/gal
	Propylene	4.7E-04	4.7E-04	lb/gal
	Pyrene	1.5E-05	1.5E-05	lb/gal
	Selenium	9.8E-06	9.8E-06	lb/gal
	Toluene	1.1E-04	1.1E-04	lb/gal
	Xylenes	4.2E-05	4.2E-05	lb/gal
	Zinc	2.2E-05	2.2E-05	lb/gal

Parameter		Emergency Generators #1 through #4[1]	Diesel Water Well Generators #1 and #2[1]	Units
Maximum Annual Emissions	1,3-Butadiene	2.9	11	lb/yr
	Acenaphthene	0.27	1.0	lb/yr
	Acenaphthylene	0.20	0.75	lb/yr
	Acetaldehyde	10	40	lb/yr
	Acrolein	0.45	1.7	lb/yr
	Ammonia	72		lb/yr
	Anthracene	0.090	0.34	lb/yr
	Arsenic	0.10	0.40	lb/yr
	Benzene	2.5	9.6	lb/yr
	Benzaldehyde	0.18	0.69	lb/yr
	Benzo(a)anthracene	0.0011	0.012	lb/yr
	Benzo(a)pyrene	2.4E-04	6.6E-04	lb/yr
	Benzo(b)fluoranthene	0.0020	3.5E-04	lb/yr
	Benzo(g,h,i)perylene	0.090	0.34	lb/yr
	Benzo(k)fluoranthene	2.0E-04	5.4E-04	lb/yr
	Cadmium	0.020	0.077	lb/yr
	Chromium (hexavalent)	0.0027	0.010	lb/yr
	Chromium (total)	0.043	0.16	lb/yr
	Chrysene	0.090	0.34	lb/yr
	Copper	0.055	0.21	lb/yr
	Dibenz(a,h)anthracene	3.2E-04	0.0020	lb/yr
	DPM	5.1	36	lb/yr
	Ethyl benzene	0.15	0.56	lb/yr
	Fluoranthene	0.090	0.34	lb/yr
	Fluorene	0.58	2.2	lb/yr
	Formaldehyde	23	89	lb/yr
	Hexane	0.36	1.4	lb/yr
	Hydrogen chloride	2.5	9.6	lb/yr
	Indeno(1,2,3-cd)pyrene	3.8E-04	0.0013	lb/yr
	Lead	0.11	0.43	lb/yr
	Manganese	0.041	0.16	lb/yr
	Mercury	0.031	0.12	lb/yr
	Naphthalene	0.26	1.0	lb/yr
	Nickel	0.052	0.20	lb/yr
	PAH	0.75	2.9	lb/yr
	Phenanthrene	1.2	4.5	lb/yr
	Propylene	6.2	24	lb/yr
	Pyrene	0.20	0.75	lb/yr
	Selenium	0.13	0.50	lb/yr
	Toluene	1.4	5.4	lb/yr
	Xylenes	0.57	2.2	lb/yr
	Zinc	0.30	1.1	lb/yr

Notes:

1. TAC and HAP emission factors for Emergency Generators #1 through #4 are based on default MDAQMD guidance for diesel generators with SCR rated higher than 600 HP and the emission factors for Water Well Generators #1 and #2 are based on default MDAQMD guidance for uncontrolled diesel generators rated less than 600 HP. These emission factors are likely conservative since the diesel generators have Tier 4 engines which have VOC and PM controls that would similarly reduce organic and inorganic TAC emissions.
2. Diesel PM emissions are assumed to be equal to PM10 emissions, presented in Table A-25.

References:

MDAQMD. 2015. Default Emission Factors for Internal Combustion Engines. http://mdaqmd.ca.gov/home/showdocument?id=722

Abbreviations:

DPM - diesel particulate matter
gal - gallon
HAP - hazardous air pollutant
HP - horsepower
hr - hour
kW - kilowatt
lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
SCR - selective catalytic reduction
TAC - toxic air contaminant
yr - year

2022 Mine Plan of Operations: Table A-27
Gasoline Dispensing Facility Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter	Daily Throughput (gal/day)	Annual Throughput (gal/yr)
Throughput[1]	274	100,000
Control[2]	Phase I and II	

Pollutant	Emission Factor[3] (lb/1000 gal)	Daily Emissions (lb/day)	Annual Emissions (tpy)
TOG	1.5	0.42	0.076
Benzene	0.0080	0.0022	4.0E-04
Ethyl benzene	0.0066	0.0018	3.3E-04
n-Hexane	0.028	0.0076	0.0014
Naphthalene	7.4E-04	2.0E-04	3.7E-05
Propylene (propene)	4.0E-05	1.1E-05	2.0E-06
Toluene	0.036	0.0098	0.0018
Xylene	0.032	0.0088	0.0016

Notes:

1. Annual gasoline throughput provided by Castle Mountain Venture and is a conservative overestimate compared to actual projected usage. Daily gasoline throughput is based on annual throughput and 365 days/yr of operation.
2. MDAQMD default pre-EVR emission factors for aboveground storage tank gasoline dispensing from CARB/CAPCOA guidance since the guidance does not include post-EVR emission factors.

References:

CARB/CAPCOA. 2022. Gasoline Service Industry Risk Assessment Technical Guidance. February 18. https://www.mdaqmd.ca.gov/home/showpublisheddocument/9310/637850250462300000

Abbreviations:

CARB - California Air Resources Board
CAPCOA - California Air Pollution Control Officers Association
gal - gallons
HAP - hazardous air pollutant
lb - pounds
MDAQMD - Mojave Desert Air Quality Management District
TAC - toxic air contaminant
TOG - total organic gas
tpy- tons per year
yr - year

2022 Mine Plan of Operations: Table A-28a
Storage Tank Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name	Quantity	Tank Volume[1] (gallons)	Annual Tank Throughput[1] (gal/yr)	Breathing Losses[2,3,4] (lb/yr)	Working Losses[2,3,4] (lb/yr)	Daily VOC Emissions (lb/day)	Annual VOC Emissions (tpy)
Off-road Diesel Storage Tanks	3	20,000	4,369,443	0.0054	72	0.59	0.11
Stationary Equipment Diesel Storage Tank	1	10,000	64,694	0.0031	3.5	0.0096	0.0017
GDF Clear Diesel Storage Tank	1	3,000	30,000	2.6E-04	1.0	0.0028	5.1E-04
LNG Storage Tanks[5]	8	20,000	11,354,292			2.0	0.36
					Total	**2.6**	**0.47**

Source Name	Quantity	Tank Volume[2] (gallons)	Annual Tank Throughput[2] (gal/yr)	Breathing Losses (lb/yr)	Working Losses (lb/yr)	Daily HCl Emissions (lb/day)	Annual HCl Emissions (tpy)
Hydrochloric Acid Storage Tank	1	4,993	608,333	155	628	2.1	0.39

Notes:

1. Tank parameters and annual tank throughput based on guidance from Castle Mountain Venture.
2. Emissions calculated according to the methodology presented in AP-42, Section 7.1. Breathing and working losses presented here represent losses from a single tank in lb/yr, calculated based on the USEPA AP-42 methodology. These losses are converted to daily and annual emissions based on the equipment quantity. Thus, it is conservatively assumed (if there are multiple tanks) that each tank has the same throughput.
3. Meteorological data from AP-42, Table 7.1-7 for Las Vegas, NV is used.
4. Paint solar absorptance from AP-42, Table 7.1-6.
5. The LNG storage tanks will be designed to minimize or eliminate boil-off conditions. This will be managed by balancing fuel storage with the rate of use by the turbines, such that the fuel in tanks will be kept fresh to eliminate any pressure discharges. Potential fugitive GHG emissions from equipment leaks are conservatively quantified in **Table A-28b**. VOC emissions are estimated based on the methane emissions in **Table A-28b** by applying the average ratio of ethane to methane in LNG (based on LNG stream compositions as presented in API 2015). Other VOC constituents (propane, butane, etc.) are expected to be minimal.

References:

API. 2015. Liquefied Natural Gas (LNG) Operations: Consistent Methodology for Estimating Greenhouse Gas Emissions. May. Available online at: https://www.api.org/-/media/Files/EHS/climate-change/api-lng-ghg-emissions-guidelines-05-2015.pdf.
USEPA. 2020. AP-42, Section 7.1, Organic Liquid Storage Tanks. June. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/ch07s01.pdf.

Abbreviations:

gal - gallons
GHG - greenhouse gas
HCl - hydrochloric acid
lb - pounds
LNG - liquefied natural gas
tpy - tons per year
USEPA - United States Environmental Protection Agency
VOC - volatile organic compound
yr- year

2022 Mine Plan of Operations: Table A-28b
GHG Emissions from LNG Storage
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fugitive Leak Emissions

Component	Component Count[1]	Total Leaking Time[2] (hr/yr)	CH_4 Emission Factor[3] (scf/hr/component)	Annual Fugitive Leak CH_4 Emissions[4] (scf/yr)	Annual Fugitive Leak CH_4 Emissions[5] (MT/yr)	Annual Fugitive Leak CO_2e Emissions[6] (MT/yr)
Valve	32	2,190	1.19	83,395	1.6	40
Pump Seal	0	2,190	4.00	0	0	0
Connector	32	2,190	0.34	23,827	0.46	11
Other	32	2,190	1.77	124,042	2.4	60
			Total	231,264	4.4	111

Notes:

1. Component count estimates provided by the LNG supplier. Pumps, and therefore pump seals, are not expected to be used.
2. Conservatively assumes fugitive leaks occur over one quarter of the year.
3. Fugitive leak CH_4 emission factors are from Appendix A, Table 5 of the California Mandatory Reporting Regulation (MRR).
4. Fugitive leak CH_4 emissions are calculated based on component counts, total leaking time, and CH_4 emission factors.
5. Methane mass emissions based on density of methane as specified in Section 95153(t) of the California MRR, and methane volume emissions.
6. CO_2 equivalent (CO_2e) emissions calculated based on CH_4 emissions and the corresponding global warming potential (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California MRR.

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CH_4 - methane
CO_2e - carbon dioxide equivalents
GHG - greenhouse gas
GWP - global warming potential
hr - hour
LNG - liquefied natural gas
MRR - Mandatory Reporting Regulation
MT - metric ton
scf - standard cubic feet
yr - year

2022 Mine Plan of Operations: Table A-29
GHG Emissions from Electricity Usage
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Historical Electricity Intensity

Provider	Annual Electricity Data	2021	2022	2023	Average[1]	Units
Nevada Energy	CO_2e Intensity Factor per Total Energy Delivered[2]	763	772	754	763	lb CO_2e/MWh delivered
	% of Total Energy From Nevada RPS-Eligible Renewables[3]	31%	36%	40%	35%	-
	CO_2e Intensity Factor per Total Non-RPS-Eligible Energy[4]	1,101	1,200	1,250	1,184	lb CO_2e/MWh delivered
Southern California Edison	CO_2e Intensity Factor per Total Energy Delivered[5]	452	444	374	423	lb CO_2e/MWh delivered
	% of Total Energy From California RPS-Eligible Renewables[5]	36%	36%	41%	38%	-
	CO_2e Intensity Factor per Total Non-RPS-Eligible Energy[4]	704	696	632	677	lb CO_2e/MWh delivered

Estimated Intensity Factor for Total Grid Energy Delivered

Provider	Model Year	2021	2022	2023	Average[1]	Units
Nevada Energy	2027 RPS (42%)[7]	638	696	725	687	lb CO_2e/MWh delivered
Southern California Edison	2027 RPS (52%)[8]	338	334	303	325	lb CO_2e/MWh delivered

Electricity Use Rates[9]

	Running Load (MW)	Annual (MWh/yr)
On-site Facilities - Nevada Energy (NVE)	10	87,600
Off-site Facilities (Water Sourcing) - Southern California Edison (SCE)	1.3	11,511
Total Emissions	**11.3**	**99,111**

Electricity Emissions[10]

	CO_2e Emissions (MT/yr)
On-site Facilities	27,280
Off-site Facilities (Water Sourcing)	1,697
Total Emissions	**28,977**

Notes:

1. Average uses data from years 2021-2023.
2. Total CO_2e intensity factors for Nevada Energy are from 2021-2023 NV Energy Sustainability Reports.

3. Percentage of energy from Nevada RPS-Eligible Renewables for Nevada Energy are from the Nevada Governor's Office of Energy's 2022 and 2024 Status of Energy Reports.
4. The emissions metric presented here is calculated based on the total CO_2e intensity factor divided by the percent of energy delivered from non-RPS-eligible renewable sources. This CO_2e intensity factor includes both fossil fuel and carbon-free sources of energy, such as largescale hydro and nuclear.
5. The intensity factor for total energy delivered is estimated by multiplying the percentage of energy delivered from non-RPS-eligible renewable energy by the CO_2e emissions per total non-RPS-eligible renewable energy metric calculated above.
6. Total CO_2e intensity factors and percentage of energy from RPS-Eligible Renewables for SCE are from the 2021-2023 Edison International Sustainability Reports.
7. Nevada Energy RPS value for 2027 based on scheduled renewable energy rate increases as outlined in https://puc.nv.gov/Renewable_Energy/Portfolio_Standard/.
8. Southern California Edison RPS value for 2027 based on requirement in Senate Bill 100 as outlined in https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/rps/rps-compliance-rules-and-process/60-percent-rps-procurement-rules.
9. Running loads provided by Castle Mountain Venture. An electricity load of 20 MW is anticipated on an annual/regular basis. On-site power generation will account for 10 MW of the on-site electricity load, with the remaining on-site load from grid power. Annual electricity use rates calculated assuming 8,760 hours per year of facility operation.
10. Emissions calculated based on intensity factor and electricity use rate.

References:

California Public Utilities Commission. 60% RPS Procurement Rules. Available online at: https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/rps/rps-compliance-rules-and-process/60-percent-rps-procurement-rules

Edison International. 2021 Sustainability Report. Available online at: https://www.edison.com/_gallery/get_file/?file_id=634a11c88ed7df0e03e0e410&file_ext=.pdf&page_id=

Edison International. 2022 Sustainability Report. Available online at: https://www.edison.com/_gallery/get_file/?file_id=6477e962b3aed34e0382ae64&file_ext=.pdf&page_id=

Edison International. 2023 Sustainability Report. Available online at: https://www.edison.com/_gallery/get_file/?file_id=6657b3b63d6332eaafbcc867&file_ext=.pdf&page_id=

NV Energy. 2021 NV Energy Sustainability Report. Available online at: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/cleanenergy/sustainability/2021-sustainability-nvenergy.pdf

NV Energy. 2022 NV Energy Sustainability Report. Available online at: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/cleanenergy/sustainability/2022-sustainability-nvenergy.pdf

NV Energy. 2023 NV Energy Sustainability Report. Available online at: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/cleanenergy/sustainability/2023-sustainability-nvenergy.pdf

Nevada Governor's Office of Energy. 2023. 2022 Status of Energy Report. January. Available online at: https://energy.nv.gov/uploadedFiles/energynvgov/content/Media/2022_status_of_energy_final.pdf.

Nevada Governor's Office of Energy. 2024. 2024 Status of Energy Report. January. Available online at: https://energy.nv.gov/uploadedFiles/energynvgov/content/Home/Features/2024%20Status%20of%20Energy%20Report_Final.pdf

State of Nevada Public Utilities Commission. Renewable Portfolio Standard. Available online at: https://puc.nv.gov/Renewable_Energy/Portfolio_Standard/

Abbreviations:

CO_2e - carbon dioxide equivalents
lb - pounds
MT - metric tons
MW - megawatts
MWh - megawatt hours
RPS - renewable portfolio standard
SCE - Southern California Edison
yr - year

2022 Mine Plan of Operations: Table A-30
GHG Emissions from Solid Waste Generation
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Solid Waste Generation Rate[1]

Waste Type	Solid Waste Generation Rate (lb/employee/day)	Number of Employees	Annual Solid Waste Generation (tpy)
Organic	8.93	423	689

Solid Waste Landfill Gas (LFG) Treatment Types[2]

Landfill, No Gas Capture	Landfill, Capture Gas Flare
100%	0%

Solid Waste Landfill Gas Emission Factors[3]

Description	CO_2 Emissions (ton/ton waste)	CH_4 Emissions (ton/ton waste)
No LFG Collection	0.097	0.032

Solid Waste GHG Emissions[4]

Waste Type	CO_2 Emissions (MT/yr)	CH_4 Emissions (MT/yr)	CO_2e Emissions (MT/yr)
Organic	60	20	555

Notes:

1. Waste generation rate based on industrial waste generation rate per employee from City of Los Angeles CEQA Thresholds Guide and number of employees at the facility.
2. Solid Waste Landfill Gas Treatment Types from Appendices C and G of the CalEEMod® User's Guide, with the exception that "Landfill, No Gas Capture" was conservatively set to 100%.
3. Solid Waste Landfill Gas Emission Factors from Table G-37 of CalEEMod® User's Guide, Appendix G.
4. CO_2 equivalent (CO_2e) emissions calculated based on CO_2 and CH_4 emissions and the corresponding global warming potentials (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

California Air Pollution Control Officers Association (CAPCOA). 2022. User's Guide of CalEEMod® Version 2022.1. May. Available online at: https://www.caleemod.com/user-guide

City of Los Angeles. 2006. L.A. CEQA Thresholds Guide: Your Resource for Preparing CEQA Analyses in Los Angeles. Available online at: https://planning.lacity.org/eir/CrossroadsHwd/deir/files/references/A07.pdf

Code of Federal Regulations. Title 40 Chapter I Subchapter C Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CalEEMod® - California Emissions Estimator Model
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
GWP - global warming potential
lb - pounds
LFG - Landfill Gas
MRR - Mandatory Reporting Regulation
MT - metric ton
tpy - tons per year
yr - year

2022 Mine Plan of Operations: Table A-31
GHG Emissions from Wastewater Treatment
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Water Use Rates[1]

End Use	Average Demand (gpm)	Annual Average Demand (MMgal/yr)
Ancillary Facilities/Offices	22	12

Wastewater Treatment Direct Emission Factors[2]

Wastewater Treatment Type	CO_2 Biogenic (ton/gal)	CO_2 Non-Biogenic (ton/gal)	CH_4 (ton/gal)	N_2O (ton/gal)
Septic	0	0	2.5E-07	8.52E-10

Wastewater Treatment Direct Emissions[3]

End Use	Total Direct Emissions (MT CO_2e/yr)
Ancillary Facilities/Offices	68

Notes:

1. Water use rates provided by Castle Mountain Venture. Annual water use rates calculated assuming continuous operation of water pumps (24/7). Emissions are only expected from the wastewater treatment of potable water. Potable water will be supplied from onsite wells and thus emissions associated with pumping and supplying water to ancillary facilities/offices are assumed to be captured in the well generator emissions.
2. Wastewater Treatment Direct Emission Factors from Table G-35 of Appendix G of the CalEEMod® User's Guide. All wastewater is assumed to be treated with an on-site septic system.
3. CO_2 equivalent (CO_2e) emissions calculated based on CO_2, N_2O, and CH_4 emissions and the corresponding global warming potentials (GWP) from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

California Air Pollution Control Officers Association (CAPCOA). 2022. User's Guide of CalEEMod® Version 2022.1. April. Available online at: https://www.caleemod.com/user-guide

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

United States Environmental Protection Agency (USEPA). 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

CalEEMod® - California Emissions Estimator Model
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
gal - gallon
gpm - gallons per minute
GWP - global warming potential
MMgal - million gallons
MRR - Mandatory Reporting Regulation
MT - metric ton
N_2O - nitrous oxide
yr - year

2022 Mine Plan of Operations: Table A-32
On-site Power Generation Emissions from Natural Gas Turbines
Criteria Air Pollutants and Greenhouse Gases
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Value	Units
Fuel Type		Natural Gas	--
Total Capacity		10.4	MW
Total Fuel Throughput		2,571	MMBTU/day
		938,371	MMBTU/yr
Load		100%	--
Daily hours		24	hrs
Annual Hours		8,760	hrs
Vendor or Default Emission Factors[1,2,3,4]	ROG/VOC	0.009	lb/MMBtu
	NO_x	0.033	lb/MMBtu
	SO_x	0.0006	lb/MMBtu
	CO	0.090	lb/MMBtu
	PM	0.0066	lb/MMBtu
	PM_{10}	0.0066	lb/MMBtu
	$PM_{2.5}$	0.0066	lb/MMBtu
	CO_2	53	kg/MMBtu
	CH_4	1.0	g/MMBtu
	N_2O	0.10	g/MMBtu
Maximum Daily Emissions	ROG/VOC	23	lb/day
	NO_x	85	lb/day
	SO_x	1.5	lb/day
	CO	231	lb/day
	PM	17	lb/day
	PM_{10}	17	lb/day
	$PM_{2.5}$	17	lb/day
Maximum Annual Emissions[5]	ROG/VOC	4.2	tpy
	NO_x	16	tpy
	SO_x	0.28	tpy
	CO	42	tpy
	PM	3.1	tpy
	PM_{10}	3.1	tpy
	$PM_{2.5}$	3.1	tpy
	CO_2	49,790	MT/yr
	CH_4	0.47	MT/yr
	N_2O	0.047	MT/yr
	CO_2e	49,816	MT/yr

Notes:

1. With the exception of ROG/VOC, NO_x, and CO, CAP emission factors are based on SCAQMD combustion default emission factors, dated December 2024, for the "Natural Gas/Micro Turbine" category (https://www.aqmd.gov/docs/default-source/planning/annual-emission-reporting/combustion-default-emission-factors-2024.pdf?sfvrsn=9c358361_9) and a higher heating value (HHV) of 1020 Btu/scf consistent with the California Mandatory Reporting Regulation (MRR). The current proposed turbine configuration would consist of microturbines, packaged into 1 MW units, which each consisting of five 200 kW engine bays. In this table these units are simply referred to as "turbines".
2. The ROG/VOC, NO_x, and CO emission factors are based on manufacturer's specification sheets for the mictroturbines which list exhaust concentrations of 7 ppmv (as CH_4 equivalent), 9 ppmvd, and 40 ppmvd at 15% O_2, and are converted to lb/MMBTU using the dry F-factor method for natural gas.
3. ROG and VOC assumed to be interchangeable terminologies.
4. CO_2, CH_4, and N_2O emission factors based on USEPA emission factors for greenhouse gas inventories for natural gas combustion in stationary equipment from 40 CFR Part 98, Tables C-1 and C-2.
5. CO_2 equivalent emissions calculated based on CO_2, N_2O, and CH_4 emissions and the corresponding GWP from 40 CFR Part 98, Subpart A, Table A-1, as published in the CFR on 12/11/2014 for consistency with the California Mandatory Reporting Regulation (MRR).

References:

California Air Resources Board (CARB). 2018. Mandatory Greenhouse Gas Reporting Regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

Code of Federal Regulations. Title 40 Chapter I Subchapter C Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

SCAQMD Combustion Default Emission Factors. December 2024. Available online here: https://www.aqmd.gov/docs/default-source/planning/annual-emission-reporting/combustion-default-emission-factors-2024.pdf?sfvrsn=9c358361_9

United States Environmental Protection Agency (USEPA). Method 19: Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates. Available online at: https://www.epa.gov/sites/production/files/2017-08/documents/method_19.pdf

USEPA. 2014. Final rule, 79 FR 73750 (December 11, 2014), codified at 40 CFR Part 98. Available online at: https://www.federalregister.gov/documents/2014/12/11/2014-28444/greenhouse-gas-reporting-program-addition-of-global-warming-potentials-to-the-general-provisions-and

Abbreviations:

BACT - Best Available Control Technology
Btu - British thermal units
CAP - criteria air pollutant
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
g - gram
GHG - greenhouse gas
GWP - global warming potential
HHV - high heating value
hr - hour
kg - kilogram
lb - pounds
MMBtu - million British thermal units
MRR - Mandatory Reporting Regulation
MT - metric ton
MW - megawatt
MWh - megawatt-hour
NO_x - nitrogen oxides
N_2O - nitrous oxide
PM - particulate matter
ROG - reactive organic gas
SCAQMD - South Coast Air Quality Management District
scf - standard cubic feet
SO_x - sulfur oxides
tpy - tons per year
VOC - volatile organic compound
yr - year

2022 Mine Plan of Operations: Table A-33
On-site Power Generation Emissions from Natural Gas Turbines
Toxic Air Contaminants and Hazardous Air Pollutants
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter		Value	Units
Fuel Type		Natural Gas	--
Total Capacity		10.4	MW
Total Fuel Throughput		2,571	MMBTU/day
		938,371	MMBTU/yr
Load		100%	--
Daily hours		24	hrs
Annual Hours		8,760	hrs
Emission Factors[1,2]	1,3-Butadiene	1.2E-07	lb/MMBtu
	2-Chloronaphthalene	2.7E-10	lb/MMBtu
	2-Methylnaphthalene	5.2E-09	lb/MMBtu
	Acenaphthene	1.9E-08	lb/MMBtu
	Acenaphthylene	1.4E-08	lb/MMBtu
	Acetaldehyde	1.3E-04	lb/MMBtu
	Acrolein	1.9E-05	lb/MMBtu
	Ammonia	0.0031	lb/MMBtu
	Anthracene	3.3E-08	lb/MMBtu
	Benzene	1.3E-05	lb/MMBtu
	Benzo(a)anthracene	2.2E-08	lb/MMBtu
	Benzo(a)pyrene	1.4E-08	lb/MMBtu
	Benzo(b)fluoranthene	1.1E-08	lb/MMBtu
	Benzo(e)pyrene	5.3E-10	lb/MMBtu
	Benzo(g,h,i)perylene	1.3E-08	lb/MMBtu
	Benzo(k)fluoranthene	1.1E-08	lb/MMBtu
	Chrysene	2.5E-08	lb/MMBtu
	Dibenz(a,h)anthracene	2.3E-08	lb/MMBtu
	Ethylbenzene	1.8E-05	lb/MMBtu
	Fluoranthene	4.2E-08	lb/MMBtu
	Fluorene	5.7E-08	lb/MMBtu
	Formaldehyde	9.0E-04	lb/MMBtu
	Hexane	2.5E-04	lb/MMBtu
	Indeno(1,2,3-c,d)pyrene	2.3E-08	lb/MMBtu
	Naphthalene	1.6E-06	lb/MMBtu
	Perylene	6.9E-10	lb/MMBtu
	Phenanthrene	3.1E-07	lb/MMBtu
	Propylene	7.6E-04	lb/MMBtu
	Propylene Oxide	4.7E-05	lb/MMBtu
	Pyrene	2.7E-08	lb/MMBtu
	Toluene	7.0E-05	lb/MMBtu
	Xylene (total)	2.6E-05	lb/MMBtu

Parameter		Value	Units
Maximum Annual Emissions	1,3-Butadiene	0.12	lb/yr
	2-Chloronaphthalene	2.5E-04	lb/yr
	2-Methylnaphthalene	0.0049	lb/yr
	Acenaphthene	0.017	lb/yr
	Acenaphthylene	0.014	lb/yr
	Acetaldehyde	126	lb/yr
	Acrolein	17	lb/yr
	Ammonia	2,944	lb/yr
	Anthracene	0.031	lb/yr
	Benzene	12	lb/yr
	Benzo(a)anthracene	0.021	lb/yr
	Benzo(a)pyrene	0.013	lb/yr
	Benzo(b)fluoranthene	0.010	lb/yr
	Benzo(e)pyrene	5.0E-04	lb/yr
	Benzo(g,h,i)perylene	0.013	lb/yr
	Benzo(k)fluoranthene	0.010	lb/yr
	Chrysene	0.023	lb/yr
	Dibenz(a,h)anthracene	0.022	lb/yr
	Ethylbenzene	16	lb/yr
	Fluoranthene	0.040	lb/yr
	Fluorene	0.053	lb/yr
	Formaldehyde	844	lb/yr
	Hexane	238	lb/yr
	Indeno(1,2,3-c,d)pyrene	0.022	lb/yr
	Naphthalene	1.5	lb/yr
	Perylene	6.4E-04	lb/yr
	Phenanthrene	0.29	lb/yr
	Propylene	709	lb/yr
	Propylene Oxide	44	lb/yr
	Pyrene	0.025	lb/yr
	Toluene	65	lb/yr
	Xylene (total)	24	lb/yr

Notes:

1. With the exception of ammonia, emission factors for turbines are from CATEF emission factors for natural gas turbines with no control and a HHV of 1020 Btu/scf. The CATEF mean value was chosen for each air toxic.
2. The ammonia emission factor for turbines is based on the SCAQMD default emission factor for natural gas turbines and microturbines of all sizes without SNCR or SCR.

References:

CATEF emission factors: https://ww3.arb.ca.gov/ei/catef/catef.csv

SCAQMD. Combustion Default Emission Factors (revised December 2024). https://www.aqmd.gov/docs/default-source/planning/annual-emission-reporting/combustion-default-emission-factors-2024.pdf?sfvrsn=9c358361_9.

Abbreviations:

Btu - British thermal units
CATEF - California Air Toxics Emission Factor database
HHV - high heating value
hr - hour
lb - pounds
MMBtu - million British thermal units
MW - megawatt
MWh - megawatt-hour
SCAQMD - South Coast Air Quality Management District
scf - standard cubic feet
SCR - selective catalytic reduction
SNCR - selective non-catalytic reduction
yr - year

APPENDIX B
SOURCE GROUPS AND MODELED EMISSION RATES

Appendix B
Table B-1
Modeled Emissions by Source - Stationary Sources
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Modeled Source Description[1]				Source Operating Schedule[2]		Modeled Emission Rates (g/s)[3]								
						PM_{10}		$PM_{2.5}$		NOx		CO	SO_2	
Source Group Description	AERMOD Source Group Name	AERMOD Source ID(s)	Source Type	Modeled Daily Hours (hrs/day)	Modeled Annual Hours (hrs/yr)	24-hour	Annual	24-hour	Annual	1-hour	Annual	1-hour 8-hour	1-hour 3-hour	24-hour
Secondary/Tertiary Crushing Dust Collector	CDUST	CRUSHDUST	Point	24	8,760	0.011	0.0075	0.0017	0.0011					
Secondary/Tertiary Screening Dust Collector	SDUST	SCREENDUST	Point	24	8,760	0.14	0.091	0.021	0.014					
Pebble Lime Silo Dust Collector	LIDUST	LIDUST	Point	24	8,760	0.0016	0.0016	2.5E-04	2.5E-04					
Cement Silo Dust Collector	CEMDUST	CEMDUST	Point	24	8,760	0.0032	0.0032	4.9E-04	4.9E-04					
Emergency Generator #1	EGEN1	EGEN1	Point	--	8,760	1.8E-05	1.8E-05	1.8E-05	1.8E-05	1.8E-04	1.8E-04	1.8E-06	1.0E-07	1.0E-07
Emergency Generator #2	EGEN2	EGEN2	Point	--	8,760	1.8E-05	1.8E-05	1.8E-05	1.8E-05	1.8E-04	1.8E-04	1.8E-06	1.0E-07	1.0E-07
Emergency Generator #3	EGEN3	EGEN3	Point	--	8,760	1.8E-05	1.8E-05	1.8E-05	1.8E-05	1.8E-04	1.8E-04	1.8E-06	1.0E-07	1.0E-07
Emergency Generator #4	EGEN4	EGEN4	Point	--	8,760	1.8E-05	1.8E-05	1.8E-05	1.8E-05	1.8E-04	1.8E-04	1.8E-06	1.0E-07	1.0E-07
Diesel Water Well Generator #1	WWGEN1	WWGEN1	Point	24	8,760	2.6E-04	2.6E-04	2.6E-04	2.6E-04	0.041	0.041	1.3E-04	7.8E-05	7.8E-05
Diesel Water Well Generator #2	WWGEN2	WWGEN2	Point	24	8,760	2.6E-04	2.6E-04	2.6E-04	2.6E-04	0.041	0.041	1.3E-04	7.8E-05	7.8E-05
On-site Power Generation	LNGT1-1	LNGT1-1	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT1-2	LNGT1-2	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT1-3	LNGT1-3	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT1-4	LNGT1-4	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT1-5	LNGT1-5	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT2-1	LNGT2-1	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT2-2	LNGT2-2	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT2-3	LNGT2-3	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT2-4	LNGT2-4	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT2-5	LNGT2-5	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT3-1	LNGT3-1	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT3-2	LNGT3-2	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT3-3	LNGT3-3	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT3-4	LNGT3-4	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT3-5	LNGT3-5	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT4-1	LNGT4-1	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT4-2	LNGT4-2	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT4-3	LNGT4-3	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT4-4	LNGT4-4	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT4-5	LNGT4-5	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT5-1	LNGT5-1	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT5-2	LNGT5-2	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT5-3	LNGT5-3	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT5-4	LNGT5-4	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT5-5	LNGT5-5	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT6-1	LNGT6-1	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT6-2	LNGT6-2	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT6-3	LNGT6-3	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT6-4	LNGT6-4	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT6-5	LNGT6-5	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT7-1	LNGT7-1	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT7-2	LNGT7-2	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT7-3	LNGT7-3	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT7-4	LNGT7-4	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT7-5	LNGT7-5	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT8-1	LNGT8-1	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT8-2	LNGT8-2	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT8-3	LNGT8-3	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT8-4	LNGT8-4	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT8-5	LNGT8-5	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT9-1	LNGT9-1	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT9-2	LNGT9-2	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT9-3	LNGT9-3	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT9-4	LNGT9-4	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT9-5	LNGT9-5	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT10-1	LNGT10-1	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT10-2	LNGT10-2	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT10-3	LNGT10-3	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT10-4	LNGT10-4	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT10-5	LNGT10-5	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT11-1	LNGT11-1	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT11-2	LNGT11-2	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT11-3	LNGT11-3	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT11-4	LNGT11-4	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT11-5	LNGT11-5	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT12-1	LNGT12-1	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT12-2	LNGT12-2	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT12-3	LNGT12-3	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT12-4	LNGT12-4	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT12-5	LNGT12-5	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT13-1	LNGT13-1	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT13-2	LNGT13-2	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT13-3	LNGT13-3	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT13-4	LNGT13-4	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
On-site Power Generation	LNGT13-5	LNGT13-5	Point	24	8,760	1.4E-03	1.4E-03	1.4E-03	1.4E-03	6.9E-03	6.9E-03	1.9E-02	1.2E-04	1.2E-04
Stationary Grizzly	GRIZZLY	GRIZZLY	Volume	24	8,760	0.019	0.013	0.0057	0.0038					
Primary Crushing Transfers	PTRANS	PRIMTRANS	Volume	24	8,760	0.092	0.061	0.022	0.015					
Gravity Circuit Transfers	GTRANS	GRAVTRANS	Volume	24	8,760	7.1E-06	4.7E-06	1.1E-06	7.1E-07					
Agglomeration Transfers	AGTRANS	AGGTRANS	Volume	24	8,760	0.0085	0.0076	0.0013	0.0011					
Carbon Regeneration/Refinery	CARBON	CARBON	Volume	12	4,380	2.8E-06	2.8E-06	4.2E-07	4.2E-07					

Notes:

1. Sources are illustrated in the accompanying figures for this Modeling Protocol.

2. The Carbon Regeneration source is located in the Refinery process area which operates 12 hours per day and 365 days per year. The Emergency Generators are assumed to operate 100 hours per year, but are modeled over 8,760 hours per EPA Guidance for intermittent stationary sources. All other sources are assumed to operate continuously.

3. Modeled emission rates are calculated using the maximum hourly, daily, or annual emission rates from the project emissions inventory (Appendix A) and the operating schedule presented in the table. Gray shading indicates that the given pollutant and/or averaging period is not applicable to the source.

Abbreviations:

g/s - grams per second
hrs - hours

Appendix B
Table B-2
Modeled Emissions by Source - Pits, Overburden, and Heap Leach - Maximum Emissions Scenario
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Modeled Source Description[1]				Source Operating Schedule[2]		Area (m2)	Modeled Emission Rates (g/s)[3]								
							PM_{10}		$PM_{2.5}$		NO_x		CO	SO_2	
Source Group Description	AERMOD Source Group Name	AERMOD Source ID(s)	Source Type	Modeled Daily Hours (hrs/day)	Modeled Annual Hours (hrs/yr)		24-hour	Annual	24-hour	Annual	1-hour	Annual	1-hour, 8-hour	1-hour, 3-hour	24-hour
Haul Truck Loading Fugitive Dust at Northern Pit Complex	PT_N_LD	PT_N_LD/PT_N_LD1	Areapoly	24	8,760	2,103,998	--	0.064	--	0.010					
Haul Truck Loading Fugitive Dust at South Extension Pit	PT_S_LD	PT_S_LD/PT_S_LD1	Areapoly	24	8,760	983,855	1.1	0.86	0.17	0.13					
Haul Truck Unloading Fugitive Dust at North Overburden	OV_N_LD	OV_N_LD/OV_N_LD1	Volume	24	8,760	--	--	--	--	--					
Haul Truck Unloading Fugitive Dust at South Overburden	OV_S_LD	OV_S_LD/OV_S_LD1	Volume	24	8,760	--	--	--	--	--					
Haul Truck Unloading Fugitive Dust at Northern Pit Complex (Backfill)	BKFL_LD	BKFL_LD/BKFL_LD1	Areapoly	24	8,760	2,103,998	0.56	0.56	0.085	0.085					
Offroad Equipment (Drilling) Fugitive Dust at Northern Pit Complex	PT_N_DF	PT_N_DF/PT_N_DF1	Areapoly	24	8,760	2,103,998	--	0.0053	--	0.0016					
Offroad Equipment (Drilling) Fugitive Dust at South Extension Pit	PT_S_DF	PT_S_DF/PT_S_DF1	Areapoly	24	8,760	983,855	0.088	0.071	0.027	0.022					
Offroad Equipment (General) Fugitive Dust at Northern Pit Complex	PT_N_EF	PT_N_EF/PT_N_EF1	Areapoly	24	8,760	2,103,998	--	0.0041	--	0.0012					
Offroad Equipment (General) Fugitive Dust at South Extension Pit	PT_S_EF	PT_S_EF/PT_S_EF1	Areapoly	24	8,760	983,855	0.093	0.055	0.028	0.017					
Offroad Equipment (General) Fugitive Dust at North Overburden	OV_N_EF	OV_N_EF/OV_N_EF1	Areapoly	24	8,760	1,592,265	--	--	--	--					
Offroad Equipment (General) Fugitive Dust at South Overburden	OV_S_EF	OV_S_EF/OV_S_EF1	Areapoly	24	8,760	2,282,207	--	--	--	--					
Offroad Equipment (General) Fugitive Dust at Northern Pit Complex (Backfill)	BKFL_EF	BKFL_EF/BKFL_EF1	Areapoly	24	8,760	2,103,998	0.093	0.059	0.028	0.018					
Erosion Fugitive Dust at Northern Pit Complex	PT_N_ER	PT_N_ER/PT_N_ER1	Areapoly	24	8,760	2,103,998	--	5.6E-05	--	8.4E-06					
Erosion Fugitive Dust at South Extension Pit	PT_S_ER	PT_S_ER/PT_S_ER1	Areapoly	24	8,760	983,855	0.0061	7.5E-04	9.2E-04	1.1E-04					
Erosion Fugitive Dust at North Overburden	OV_N_ER	OV_N_ER/OV_N_ER1	Areapoly	24	8,760	1,592,265	--	--	--	--					
Erosion Fugitive Dust at South Overburden	OV_S_ER	OV_S_ER/OV_S_ER1	Areapoly	24	8,760	2,282,207	--	--	--	--					
Erosion Fugitive Dust at Northern Pit Complex (Backfill)	BKFL_ER	BKFL_ER/BKFL_ER1	Areapoly	24	8,760	2,103,998	0.0061	8.1E-04	9.2E-04	1.2E-04					
Haul Truck Loading Fugitive Dust at Interim Ore Stockpile	INO_LD	INORST_LD/INORST_LD1	Areapoly	24	8,760	24,928	0.14	0.091	0.021	0.014					
Erosion Fugitive Dust at Interim Ore Stockpile	INO_ER	INORST_ER/INORST_ER1	Areapoly	24	8,760	24,928	0.078	0.078	0.031	0.031					
Erosion Fugitive Dust at Heap Leach Pad	HL_CON	HL_CON/HL_CON1	Areapoly	24	8,760	2,709,704	0.0045	5.9E-04	6.7E-04	8.9E-05					
Blast Hole Drilling Fugitive Dust at Northern Pit Complex	PT_N_BF	PT_N_BF/PT_N_BF1	Areapoly	12	4,380	2,103,998	--	0.12	--	0.0068					
Blast Hole Drilling Fugitive Dust at South Extension Pit	PT_S_BF	PT_S_BF/PT_S_BF1	Areapoly	12	4,380	983,855	2.0	1.6	0.12	0.091					
Offroad Equipment (Drilling) Exhaust at Northern Pit Complex	PT_N_DE	PT_N_DE/PT_N_DE1	Volume	24	8,760	--	--	0.0020	--	0.0020	--	0.17	--	--	--
Offroad Equipment (Drilling) Exhaust at South Extension Pit	PT_S_DE	PT_S_DE/PT_S_DE1	Volume	24	8,760	--	0.034	0.027	0.034	0.027	3.7	2.3	4.1	0.0078	0.0058
Offroad Equipment (General) Exhaust at Northern Pit Complex	PT_N_EE	PT_N_EE/PT_N_EE1	Volume	24	8,760	--	--	4.5E-04	--	4.5E-04	--	0.025	--	--	--
Offroad Equipment (General) Exhaust at South Extension Pit	PT_S_EE	PT_S_EE/PT_S_EE1	Volume	24	8,760	--	0.0085	0.0061	0.0085	0.0061	0.58	0.33	1.5	0.0029	0.0022
Offroad Equipment (General) Exhaust at North Overburden	OV_N_EE	OV_N_EE/OV_N_EE1	Volume	24	8,760	--	--	--	--	--	--	--	--	--	--
Offroad Equipment (General) Exhaust at South Overburden	OV_S_EE	OV_S_EE/OV_S_EE1	Volume	24	8,760	--	--	--	--	--	--	--	--	--	--
Offroad Equipment (General) Exhaust at Northern Pit Complex (Backfill)	BKFL_EE	BKFL_EE/BKFL_EE1	Volume	24	8,760	--	0.0085	0.0065	0.0085	0.0065	0.58	0.36	1.5	0.0029	0.0022
Blasting at Northern Pit Complex	PT_N_BL	PT_N_BL/PT_N_BL1	Volume	12	4,380	--	--	0.24	--	0.014	--	0.34	--	--	--
Blasting at South Extension Pit	PT_S_BL	PT_S_BL/PT_S_BL1	Volume	12	4,380	--	7.7	3.2	0.44	0.18	72	4.6	291	0.013	0.0011

Notes:

1. Sources are illustrated in the accompanying figures for this Modeling Protocol.
2. Blasting is assumed to occur once per day for a period of one hour during daylight hours (6AM - 6PM) and 250 days per year. The annualized model emission rate is calculated by averaging over 12 hours per day and 365 days per year (total of 4,380 hours). Blasting sources are modeled with an EMISFACT of 0*6 1*12 0*6. All other sources are assumed to operate continuously.
3. Modeled emission rates are calculated using the maximum hourly, daily, or annual emission rates from the project emissions inventory (Appendix A) and the operating schedule presented in the table. Gray shading indicates that the given pollutant and/or averaging period is not applicable to the source. Dashes ("--") indicate that the given pollutant and/or averaging period is not applicable to this scenario.

Abbreviations:

g/s - grams per second
hrs - hours

Appendix B
Table B-3
Modeled Emissions by Source - Pits, Overburden, and Heap Leach - Maximum Emissions Scenario - Assumed North Operations
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Modeled Source Description[1]				Source Operating Schedule[2]		Area (m^2)	Modeled Emission Rates (g/s)[3]								
							PM_{10}		$PM_{2.5}$		NO_x		CO	SO_2	
Source Group Description	AERMOD Source Group Name	AERMOD Source ID(s)	Source Type	Modeled Daily Hours (hrs/day)	Modeled Annual Hours (hrs/yr)		24-hour	Annual	24-hour	Annual	1-hour	Annual	1-hour, 8-hour	1-hour, 3-hour	24-hour
Haul Truck Loading Fugitive Dust at Northern Pit Complex	PT_N_LD	PT_N_LD/PT_N_LD1	Areapoly	24	8,760	2,103,998	1.1	0.92	0.17	0.14					
Haul Truck Loading Fugitive Dust at South Extension Pit	PT_S_LD	PT_S_LD/PT_S_LD1	Areapoly	24	8,760	983,855	--	--	--	--					
Haul Truck Unloading Fugitive Dust at North Overburden	OV_N_LD	OV_N_LD/OV_N_LD1	Volume	24	8,760	--	0.56	0.56	0.085	0.085					
Haul Truck Unloading Fugitive Dust at South Overburden	OV_S_LD	OV_S_LD/OV_S_LD1	Volume	24	8,760	--	--	--	--	--					
Haul Truck Unloading Fugitive Dust at Northern Pit Complex (Backfill)	BKFL_LD	BKFL_LD/BKFL_LD1	Areapoly	24	8,760	2,103,998	--	--	--	--					
Offroad Equipment (Drilling) Fugitive Dust at Northern Pit Complex	PT_N_DF	PT_N_DF/PT_N_DF1	Areapoly	24	8,760	2,103,998	0.088	0.076	0.027	0.023					
Offroad Equipment (Drilling) Fugitive Dust at South Extension Pit	PT_S_DF	PT_S_DF/PT_S_DF1	Areapoly	24	8,760	983,855	--	--	--	--					
Offroad Equipment (General) Fugitive Dust at Northern Pit Complex	PT_N_EF	PT_N_EF/PT_N_EF1	Areapoly	24	8,760	2,103,998	0.093	0.059	0.028	0.018					
Offroad Equipment (General) Fugitive Dust at South Extension Pit	PT_S_EF	PT_S_EF/PT_S_EF1	Areapoly	24	8,760	983,855	--	--	--	--					
Offroad Equipment (General) Fugitive Dust at North Overburden	OV_N_EF	OV_N_EF/OV_N_EF1	Areapoly	24	8,760	1,592,265	0.093	0.059	0.028	0.018					
Offroad Equipment (General) Fugitive Dust at South Overburden	OV_S_EF	OV_S_EF/OV_S_EF1	Areapoly	24	8,760	2,282,207	--	--	--	--					
Offroad Equipment (General) Fugitive Dust at Northern Pit Complex (Backfill)	BKFL_EF	BKFL_EF/BKFL_EF1	Areapoly	24	8,760	2,103,998	--	--	--	--					
Erosion Fugitive Dust at Northern Pit Complex	PT_N_ER	PT_N_ER/PT_N_ER1	Areapoly	24	8,760	2,103,998	0.0061	8.1E-04	9.2E-04	1.2E-04					
Erosion Fugitive Dust at South Extension Pit	PT_S_ER	PT_S_ER/PT_S_ER1	Areapoly	24	8,760	983,855	--	--	--	--					
Erosion Fugitive Dust at North Overburden	OV_N_ER	OV_N_ER/OV_N_ER1	Areapoly	24	8,760	1,592,265	0.0061	8.1E-04	9.2E-04	1.2E-04					
Erosion Fugitive Dust at South Overburden	OV_S_ER	OV_S_ER/OV_S_ER1	Areapoly	24	8,760	2,282,207	--	--	--	--					
Erosion Fugitive Dust at Northern Pit Complex (Backfill)	BKFL_ER	BKFL_ER/BKFL_ER1	Areapoly	24	8,760	2,103,998	--	--	--	--					
Haul Truck Loading Fugitive Dust at Interim Ore Stockpile	INO_LD	INORST_LD/INORST_LD1	Areapoly	24	8,760	24,928	0.14	0.091	0.021	0.014					
Erosion Fugitive Dust at Interim Ore Stockpile	INO_ER	INORST_ER/INORST_ER1	Areapoly	24	8,760	24,928	0.078	0.078	0.031	0.031					
Erosion Fugitive Dust at Heap Leach Pad	HL_CON	HL_CON/HL_CON1	Areapoly	24	8,760	2,709,704	0.0045	5.9E-04	6.7E-04	8.9E-05					
Blast Hole Drilling Fugitive Dust at Northern Pit Complex	PT_N_BF	PT_N_BF/PT_N_BF1	Areapoly	12	4,380	2,103,998	2.0	1.7	0.12	0.10					
Blast Hole Drilling Fugitive Dust at South Extension Pit	PT_S_BF	PT_S_BF/PT_S_BF1	Areapoly	12	4,380	983,855	--	--	--	--					
Offroad Equipment (Drilling) Exhaust at Northern Pit Complex	PT_N_DE	PT_N_DE/PT_N_DE1	Volume	24	8,760	--	0.034	0.029	0.034	0.029	3.7	2.4	4.1	0.0078	0.0058
Offroad Equipment (Drilling) Exhaust at South Extension Pit	PT_S_DE	PT_S_DE/PT_S_DE1	Volume	24	8,760	--	--	--	--	--	--	--	--	--	--
Offroad Equipment (General) Exhaust at Northern Pit Complex	PT_N_EE	PT_N_EE/PT_N_EE1	Volume	24	8,760	--	0.0085	0.0065	0.0085	0.0065	0.58	0.36	1.5	0.0029	0.0022
Offroad Equipment (General) Exhaust at South Extension Pit	PT_S_EE	PT_S_EE/PT_S_EE1	Volume	24	8,760	--	--	--	--	--	--	--	--	--	--
Offroad Equipment (General) Exhaust at North Overburden	OV_N_EE	OV_N_EE/OV_N_EE1	Volume	24	8,760	--	0.0085	0.0065	0.0085	0.0065	0.58	0.36	1.5	0.0029	0.0022
Offroad Equipment (General) Exhaust at South Overburden	OV_S_EE	OV_S_EE/OV_S_EE1	Volume	24	8,760	--	--	--	--	--	--	--	--	--	--
Offroad Equipment (General) Exhaust at Northern Pit Complex (Backfill)	BKFL_EE	BKFL_EE/BKFL_EE1	Volume	24	8,760	--	--	--	--	--	--	--	--	--	--
Blasting at Northern Pit Complex	PT_N_BL	PT_N_BL/PT_N_BL1	Volume	12	4,380	--	7.7	3.4	0.44	0.20	72	5.0	291	0.013	0.0011
Blasting at South Extension Pit	PT_S_BL	PT_S_BL/PT_S_BL1	Volume	12	4,380	--	--	--	--	--	--	--	--	--	--

Notes:

1. Sources are illustrated in the accompanying figures for this Modeling Protocol.
2. Blasting is assumed to occur once per day for a period of one hour during daylight hours (6AM - 6PM) and 250 days per year. The annualized model emission rate is calculated by averaging over 12 hours per day and 365 days per year (total of 4,380 hours). Blasting sources are modeled with an EMISFACT of 0*6 1*12 0*6. All other sources are assumed to operate continuously.
3. Modeled emission rates are calculated using the maximum hourly, daily, or annual emission rates from the project emissions inventory (Appendix A) and the operating schedule presented in the table. Gray shading indicates that the given pollutant and/or averaging period is not applicable to the source. Dashes ("--") indicate that the given pollutant and/or averaging period is not applicable to this scenario.

Abbreviations:

g/s - grams per second
hrs - hours

Appendix B
Table B-4
Modeled Emissions by Source - Pits, Overburden, and Heap Leach - Maximum Emissions Scenario - Assumed South Operations
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Modeled Source Description[1]				Source Operating Schedule[2]			Modeled Emission Rates (g/s)[3]								
							PM_{10}		$PM_{2.5}$		NO_x		CO	SO_2	
Source Group Description	AERMOD Source Group Name	AERMOD Source ID(s)	Source Type	Modeled Daily Hours (hrs/day)	Modeled Annual Hours (hrs/yr)	Area (m2)	24-hour	Annual	24-hour	Annual	1-hour	Annual	1-hour, 8-hour	1-hour, 3-hour	24-hour
Haul Truck Loading Fugitive Dust at Northern Pit Complex	PT_N_LD	PT_N_LD/PT_N_LD1	Areapoly	24	8,760	2,103,998	--	--	--	--					
Haul Truck Loading Fugitive Dust at South Extension Pit	PT_S_LD	PT_S_LD/PT_S_LD1	Areapoly	24	8,760	983,855	1.1	0.92	0.17	0.14					
Haul Truck Unloading Fugitive Dust at North Overburden	OV_N_LD	OV_N_LD/OV_N_LD1	Volume	24	8,760	--	--	--	--	--					
Haul Truck Unloading Fugitive Dust at South Overburden	OV_S_LD	OV_S_LD/OV_S_LD1	Volume	24	8,760	--	0.56	0.56	0.085	0.085					
Haul Truck Unloading Fugitive Dust at Northern Pit Complex (Backfill)	BKFL_LD	BKFL_LD/BKFL_LD1	Areapoly	24	8,760	2,103,998	--	--	--	--					
Offroad Equipment (Drilling) Fugitive Dust at Northern Pit Complex	PT_N_DF	PT_N_DF/PT_N_DF1	Areapoly	24	8,760	2,103,998	--	--	--	--					
Offroad Equipment (Drilling) Fugitive Dust at South Extension Pit	PT_S_DF	PT_S_DF/PT_S_DF1	Areapoly	24	8,760	983,855	0.088	0.076	0.027	0.023					
Offroad Equipment (General) Fugitive Dust at Northern Pit Complex	PT_N_EF	PT_N_EF/PT_N_EF1	Areapoly	24	8,760	2,103,998	--	--	--	--					
Offroad Equipment (General) Fugitive Dust at South Extension Pit	PT_S_EF	PT_S_EF/PT_S_EF1	Areapoly	24	8,760	983,855	0.093	0.059	0.028	0.018					
Offroad Equipment (General) Fugitive Dust at North Overburden	OV_N_EF	OV_N_EF/OV_N_EF1	Areapoly	24	8,760	1,592,265	--	--	--	--					
Offroad Equipment (General) Fugitive Dust at South Overburden	OV_S_EF	OV_S_EF/OV_S_EF1	Areapoly	24	8,760	2,282,207	0.093	0.059	0.028	0.018					
Offroad Equipment (General) Fugitive Dust at Northern Pit Complex (Backfill)	BKFL_EF	BKFL_EF/BKFL_EF1	Areapoly	24	8,760	2,103,998	--	--	--	--					
Erosion Fugitive Dust at Northern Pit Complex	PT_N_ER	PT_N_ER/PT_N_ER1	Areapoly	24	8,760	2,103,998	--	--	--	--					
Erosion Fugitive Dust at South Extension Pit	PT_S_ER	PT_S_ER/PT_S_ER1	Areapoly	24	8,760	983,855	0.0061	8.1E-04	9.2E-04	1.2E-04					
Erosion Fugitive Dust at North Overburden	OV_N_ER	OV_N_ER/OV_N_ER1	Areapoly	24	8,760	1,592,265	--	--	--	--					
Erosion Fugitive Dust at South Overburden	OV_S_ER	OV_S_ER/OV_S_ER1	Areapoly	24	8,760	2,282,207	0.0061	8.1E-04	9.2E-04	1.2E-04					
Erosion Fugitive Dust at Northern Pit Complex (Backfill)	BKFL_ER	BKFL_ER/BKFL_ER1	Areapoly	24	8,760	2,103,998	--	--	--	--					
Haul Truck Loading Fugitive Dust at Interim Ore Stockpile	INO_LD	INORST_LD/INORST_LD1	Areapoly	24	8,760	24,928	0.14	0.091	0.021	0.014					
Erosion Fugitive Dust at Interim Ore Stockpile	INO_ER	INORST_ER/INORST_ER1	Areapoly	24	8,760	24,928	0.078	0.078	0.031	0.031					
Erosion Fugitive Dust at Heap Leach Pad	HL_CON	HL_CON/HL_CON1	Areapoly	24	8,760	2,709,704	0.0045	5.9E-04	6.7E-04	8.9E-05					
Blast Hole Drilling Fugitive Dust at Northern Pit Complex	PT_N_BF	PT_N_BF/PT_N_BF1	Areapoly	12	4,380	2,103,998	--	--	--	--					
Blast Hole Drilling Fugitive Dust at South Extension Pit	PT_S_BF	PT_S_BF/PT_S_BF1	Areapoly	12	4,380	983,855	2.0	1.7	0.12	0.10					
Offroad Equipment (Drilling) Exhaust at Northern Pit Complex	PT_N_DE	PT_N_DE/PT_N_DE1	Volume	24	8,760	--	--	--	--	--	--	--	--	--	--
Offroad Equipment (Drilling) Exhaust at South Extension Pit	PT_S_DE	PT_S_DE/PT_S_DE1	Volume	24	8,760	--	0.034	0.029	0.034	0.029	3.7	2.4	4.1	0.0078	0.0058
Offroad Equipment (General) Exhaust at Northern Pit Complex	PT_N_EE	PT_N_EE/PT_N_EE1	Volume	24	8,760	--	--	--	--	--	--	--	--	--	--
Offroad Equipment (General) Exhaust at South Extension Pit	PT_S_EE	PT_S_EE/PT_S_EE1	Volume	24	8,760	--	0.0085	0.0065	0.0085	0.0065	0.58	0.36	1.5	0.0029	0.0022
Offroad Equipment (General) Exhaust at North Overburden	OV_N_EE	OV_N_EE/OV_N_EE1	Volume	24	8,760	--	--	--	--	--	--	--	--	--	--
Offroad Equipment (General) Exhaust at South Overburden	OV_S_EE	OV_S_EE/OV_S_EE1	Volume	24	8,760	--	0.0085	0.0065	0.0085	0.0065	0.58	0.36	1.5	0.0029	0.0022
Offroad Equipment (General) Exhaust at Northern Pit Complex (Backfill)	BKFL_EE	BKFL_EE/BKFL_EE1	Volume	24	8,760	--	--	--	--	--	--	--	--	--	--
Blasting at Northern Pit Complex	PT_N_BL	PT_N_BL/PT_N_BL1	Volume	12	4,380	--	--	--	--	--	--	--	--	--	--
Blasting at South Extension Pit	PT_S_BL	PT_S_BL/PT_S_BL1	Volume	12	4,380	--	7.7	3.4	0.44	0.20	72	5.0	291	0.013	0.0011

Notes:

1. Sources are illustrated in the accompanying figures for this Modeling Protocol.
2. Blasting is assumed to occur once per day for a period of one hour during daylight hours (6AM - 6PM) and 250 days per year. The annualized model emission rate is calculated by averaging over 12 hours per day and 365 days per year (total of 4,380 hours). Blasting sources are modeled with an EMISFACT of 0*6 1*12 0*6. All other sources are assumed to operate continuously.
3. Modeled emission rates are calculated using the maximum hourly, daily, or annual emission rates from the project emissions inventory (Appendix A) and the operating schedule presented in the table. Gray shading indicates that the given pollutant and/or averaging period is not applicable to the source. Dashes ("--") indicate that the given pollutant and/or averaging period is not applicable to this scenario.

Abbreviations:

g/s - grams per second
hrs - hours

Appendix B
Table B-5
Modeled Emissions by Source - Haul Roads - Maximum Emissions Scenario
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Modeled Source Description[1]				Source Operating Schedule[2]		Modeled Emission Rates (g/s)[3]								
						PM_{10}		$PM_{2.5}$		NO_x		CO	SO_2	
Source Group Description	AERMOD Source Group Name	AERMOD Source ID(s)	Source Type	Modeled Daily Hours (hrs/day)	Modeled Annual Hours (hrs/yr)	24-hour	Annual	24-hour	Annual	1-hour	Annual	1-hour, 8-hour	1-hour, 3-hour	24-hour
South Extension Phase I Haul Route	EXTPI	EXTPI1 - EXTPI114	Series of Volume	24	8,760	1.4	1.3	0.18	0.16	4.6	2.9	4.6	0.0087	0.0064
South Extension Phase II Haul Route	EXTPII	EXTPII1 - EXTPII103	Series of Volume	24	8,760	0.70	0.61	0.086	0.074	2.1	1.3	2.1	0.0040	0.0030
East Ridge Haul Route	ERIDGE	ERIDGE1 - ERIDGE57	Series of Volume	24	8,760	0.10	0.077	0.015	0.011	0.50	0.35	0.50	9.4E-04	8.1E-04
JSLA Backfill Haul Route	JSLAB	JSLAB1 - JSLAB86	Series of Volume	24	8,760	0.60	0.52	0.074	0.064	1.8	1.2	1.8	0.0035	0.0026
JSLA East Haul Route	JSLAE	JSLAE1 - JSLAE86	Series of Volume	24	8,760	0.60	0.52	0.074	0.064	1.8	1.2	1.8	0.0035	0.0026
JSLA West Haul Route	JSLAW	JSLAW1 - JSLAW42	Series of Volume	24	8,760	--	--	--	--	--	--	--	--	--
Jumbo Oro Belle Haul Route	JBOB	JBOB1 - JBOB210	Series of Volume	24	8,760	1.5	1.3	0.18	0.16	4.4	2.8	4.4	0.0084	0.0063
North Overburden Haul Route	OVNORTH	OVNORTH1 - OVNORTH118	Series of Volume	24	8,760	--	--	--	--	--	--	--	--	--
South Overburden Haul Route	OVSOUTH	OVSOUTH1 - OVSOUTH98, OVSOUTH132	Series of Volume	24	8,760	--	--	--	--	--	--	--	--	--
Miscellaneous Medium + Heavy Duty Truck Route	MISCTRK	MISCTRK1 - MISCTRK179	Series of Volume	24	8,760	1.4	0.53	0.15	0.059	1.2	0.49	2.1	0.0039	0.0029
Miscellaneous Light Duty Truck Route	MISCLDV	MISCLDV1 - MISCLDV529	Series of Volume	24	8,760	0.58	0.22	0.058	0.022	0.0027	0.0027	0.015	1.0E-04	1.0E-04
Fuel Delivery Truck Route	FUELTRK	FUELTRK1 - FUELTRK61	Series of Volume	24	8,760	0.0049	0.0037	4.9E-04	3.8E-04	8.3E-04	1.0E-04	2.5E-03	6.9E-06	1.1E-06
Product + Reagent Delivery Truck Route	DELIVTRK	DELIVTRK1 - DELIVTRK196	Series of Volume	24	8,760	0.043	0.021	0.0043	0.0022	0.0100	9.2E-04	2.6E-04	1.0E-04	1.7E-05

Notes:

1. Sources are illustrated in the accompanying figures for this Modeling Protocol.
2. Onsite mobile activity is assumed to occur continuously.
3. Modeled emission rates are calculated using the maximum hourly, daily, or annual emission rates from the project emissions inventory (Appendix A) and the operating schedule presented in the table. Dashes ("--") indicate that the given pollutant and/or averaging period is not applicable to this scenario.

Abbreviations:

g/s - grams per second
hrs - hours

Appendix B
Table B-6
Modeled Emissions by Source - Haul Roads - Maximum Emissions Scenario - Assumed North Operations
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Modeled Source Description[1]				Source Operating Schedule[2]		Modeled Emission Rates (g/s)[3]								
						PM_{10}		$PM_{2.5}$		NO_x		CO	SO_2	
Source Group Description	AERMOD Source Group Name	AERMOD Source ID(s)	Source Type	Modeled Daily Hours (hrs/day)	Modeled Annual Hours (hrs/yr)	24-hour	Annual	24-hour	Annual	1-hour	Annual	1-hour, 8-hour	1-hour, 3-hour	24-hour
South Extension Phase I Haul Route	EXTPI	EXTPI1 - EXTPI114	Series of Volume	24	8,760	--	--	--	--	--	--	--	--	--
South Extension Phase II Haul Route	EXTPII	EXTPII1 - EXTPII103	Series of Volume	24	8,760	--	--	--	--	--	--	--	--	--
East Ridge Haul Route	ERIDGE	ERIDGE1 - ERIDGE57	Series of Volume	24	8,760	0.57	0.50	0.071	0.061	1.8	1.1	1.8	0.0034	0.0025
JSLA Backfill Haul Route	JSLAB	JSLAB1 - JSLAB86	Series of Volume	24	8,760	--	--	--	--	--	--	--	--	--
JSLA East Haul Route	JSLAE	JSLAE1 - JSLAE86	Series of Volume	24	8,760	0.86	0.75	0.11	0.093	2.7	1.7	2.7	0.0051	0.0038
JSLA West Haul Route	JSLAW	JSLAW1 - JSLAW42	Series of Volume	24	8,760	0.42	0.37	0.052	0.045	1.3	0.84	1.3	0.0025	0.0019
Jumbo Oro Belle Haul Route	JBOB	JBOB1 - JBOB210	Series of Volume	24	8,760	2.1	1.8	0.26	0.23	6.6	4.2	6.6	0.012	0.0094
North Overburden Haul Route	OVNORTH	OVNORTH1 - OVNORTH118	Series of Volume	24	8,760	1.0	0.83	0.12	0.10	2.9	1.8	2.9	0.0055	0.0041
South Overburden Haul Route	OVSOUTH	OVSOUTH1 - OVSOUTH98, OVSOUTH132	Series of Volume	24	8,760	--	--	--	--	--	--	--	--	--
Miscellaneous Medium + Heavy Duty Truck Route	MISCTRK	MISCTRK1 - MISCTRK179	Series of Volume	24	8,760	1.4	0.53	0.15	0.059	1.2	0.49	2.1	0.0039	0.0029
Miscellaneous Light Duty Truck Route	MISCLDV	MISCLDV1 - MISCLDV529	Series of Volume	24	8,760	0.58	0.22	0.058	0.022	0.0027	0.0027	0.015	1.0E-04	1.0E-04
Fuel Delivery Truck Route	FUELTRK	FUELTRK1 - FUELTRK61	Series of Volume	24	8,760	0.0049	0.0037	4.9E-04	3.8E-04	8.3E-04	1.0E-04	2.5E-03	6.9E-06	1.1E-06
Product + Reagent Delivery Truck Route	DELIVTRK	DELIVTRK1 - DELIVTRK196	Series of Volume	24	8,760	0.043	0.021	0.0043	0.0022	0.0100	9.2E-04	2.6E-04	1.0E-04	1.7E-05

Notes:

1. Sources are illustrated in the accompanying figures for this Modeling Protocol.
2. Onsite mobile activity is assumed to occur continuously.
3. Modeled emission rates are calculated using the maximum hourly, daily, or annual emission rates from the project emissions inventory (Appendix A) and the operating schedule presented in the table. Dashes ("--") indicate that the given pollutant and/or averaging period is not applicable to this scenario.

Abbreviations:

g/s - grams per second
hrs - hours

Appendix B
Table B-7
Modeled Emissions by Source - Haul Roads - Maximum Emissions Scenario - Assumed South Operations
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Modeled Source Description[1]				Source Operating Schedule[2]		Modeled Emission Rates (g/s)[3]								
						PM_{10}		$PM_{2.5}$		NO_x		CO	SO_2	
Source Group Description	AERMOD Source Group Name	AERMOD Source ID(s)	Source Type	Modeled Daily Hours (hrs/day)	Modeled Annual Hours (hrs/yr)	24-hour	Annual	24-hour	Annual	1-hour	Annual	1-hour, 8-hour	1-hour, 3-hour	24-hour
South Extension Phase I Haul Route	EXTPI	EXTPI1 - EXTPI114	Series of Volume	24	8,760	1.9	1.6	0.23	0.20	5.9	3.8	5.9	0.011	0.0085
South Extension Phase II Haul Route	EXTPII	EXTPII1 - EXTPII103	Series of Volume	24	8,760	1.7	1.5	0.21	0.18	5.4	3.4	5.4	0.010	0.0076
East Ridge Haul Route	ERIDGE	ERIDGE1 - ERIDGE57	Series of Volume	24	8,760	--	--	--	--	--	--	--	--	--
JSLA Backfill Haul Route	JSLAB	JSLAB1 - JSLAB86	Series of Volume	24	8,760	--	--	--	--	--	--	--	--	--
JSLA East Haul Route	JSLAE	JSLAE1 - JSLAE86	Series of Volume	24	8,760	--	--	--	--	--	--	--	--	--
JSLA West Haul Route	JSLAW	JSLAW1 - JSLAW42	Series of Volume	24	8,760	--	--	--	--	--	--	--	--	--
Jumbo Oro Belle Haul Route	JBOB	JBOB1 - JBOB210	Series of Volume	24	8,760	--	--	--	--	--	--	--	--	--
North Overburden Haul Route	OVNORTH	OVNORTH1 - OVNORTH118	Series of Volume	24	8,760	--	--	--	--	--	--	--	--	--
South Overburden Haul Route	OVSOUTH	OVSOUTH1 - OVSOUTH98, OVSOUTH132	Series of Volume	24	8,760	1.3	1.1	0.16	0.14	3.9	2.5	3.9	0.0075	0.0056
Miscellaneous Medium + Heavy Duty Truck Route	MISCTRK	MISCTRK1 - MISCTRK179	Series of Volume	24	8,760	1.4	0.53	0.15	0.059	1.2	0.49	2.1	0.0039	0.0029
Miscellaneous Light Duty Truck Route	MISCLDV	MISCLDV1 - MISCLDV529	Series of Volume	24	8,760	0.58	0.22	0.058	0.022	0.0027	0.0027	0.015	1.0E-04	1.0E-04
Fuel Delivery Truck Route	FUELTRK	FUELTRK1 - FUELTRK61	Series of Volume	24	8,760	0.0049	0.0037	4.9E-04	3.8E-04	8.3E-04	1.0E-04	2.5E-03	6.9E-06	1.1E-06
Product + Reagent Delivery Truck Route	DELIVTRK	DELIVTRK1 - DELIVTRK196	Series of Volume	24	8,760	0.043	0.021	0.0043	0.0022	0.0100	9.2E-04	2.6E-04	1.0E-04	1.7E-05

Notes:

1. Sources are illustrated in the accompanying figures for this Modeling Protocol.
2. Onsite mobile activity is assumed to occur continuously.
3. Modeled emission rates are calculated using the maximum hourly, daily, or annual emission rates from the project emissions inventory (Appendix A) and the operating schedule presented in the table. Dashes ("--") indicate that the given pollutant and/or averaging period is not applicable to this scenario.

Abbreviations:

g/s - grams per second
hrs - hours

APPENDIX C
MODELED SOURCE PARAMETERS

Appendix C
Table C-1
Modeled Source Parameters - Stationary Sources
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Point Sources

Source Group Description	AERMOD Source Group Name	AERMOD Source ID(s)	Source Location Data	Source Parameters[2]			
			Elevation (m)[1]	Stack Height (m)	Stack Exit Temperature (K)	Stack Exit Velocity (m/s)	Stack Diameter (m)
Secondary/Tertiary Crushing Dust Collector	CDUST	CRUSHDUST	1,291.9	12.19	297.98	16.17	0.91
Secondary/Tertiary Screening Dust Collector	SDUST	SCREENDUST	1,292.1	12.19	297.98	17.97	0.91
Pebble Lime Silo Dust Collector	LIDUST	LIDUST	1,290.7	21.95	297.98	0.31	1.01
Cement Silo Dust Collector	CEMDUST	CEMDUST	1,290.5	21.34	297.98	0.31	1.01
Emergency Generator #1	EGEN1	EGEN1	1,274.1	3.05	699.26	95.00	0.12
Emergency Generator #2	EGEN2	EGEN2	1,274.0	3.05	699.26	95.00	0.12
Emergency Generator #3	EGEN3	EGEN3	1,273.9	3.05	699.26	95.00	0.12
Emergency Generator #4	EGEN4	EGEN4	1,273.8	3.05	699.26	95.00	0.12
Diesel Water Well Generator #1	WWGEN1	WWGEN1	1,389.8	3.05	675.37	38.85	0.12
Diesel Water Well Generator #2	WWGEN2	WWGEN2	1,279.7	3.05	675.37	38.85	0.12
On-site Power Generation	LNGT1-1	LNGT1-1	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT1-2	LNGT1-2	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT1-3	LNGT1-3	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT1-4	LNGT1-4	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT1-5	LNGT1-5	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT2-1	LNGT2-1	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT2-2	LNGT2-2	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT2-3	LNGT2-3	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT2-4	LNGT2-4	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT2-5	LNGT2-5	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT3-1	LNGT3-1	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT3-2	LNGT3-2	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT3-3	LNGT3-3	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT3-4	LNGT3-4	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT3-5	LNGT3-5	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT4-1	LNGT4-1	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT4-2	LNGT4-2	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT4-3	LNGT4-3	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT4-4	LNGT4-4	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT4-5	LNGT4-5	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT5-1	LNGT5-1	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT5-2	LNGT5-2	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT5-3	LNGT5-3	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT5-4	LNGT5-4	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT5-5	LNGT5-5	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT6-1	LNGT6-1	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT6-2	LNGT6-2	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT6-3	LNGT6-3	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT6-4	LNGT6-4	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT6-5	LNGT6-5	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT7-1	LNGT7-1	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT7-2	LNGT7-2	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT7-3	LNGT7-3	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT7-4	LNGT7-4	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT7-5	LNGT7-5	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT8-1	LNGT8-1	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT8-2	LNGT8-2	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT8-3	LNGT8-3	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT8-4	LNGT8-4	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT8-5	LNGT8-5	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT9-1	LNGT9-1	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT9-2	LNGT9-2	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT9-3	LNGT9-3	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT9-4	LNGT9-4	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT9-5	LNGT9-5	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT10-1	LNGT10-1	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT10-2	LNGT10-2	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT10-3	LNGT10-3	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT10-4	LNGT10-4	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT10-5	LNGT10-5	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT11-1	LNGT11-1	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT11-2	LNGT11-2	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT11-3	LNGT11-3	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT11-4	LNGT11-4	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT11-5	LNGT11-5	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT12-1	LNGT12-1	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT12-2	LNGT12-2	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT12-3	LNGT12-3	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT12-4	LNGT12-4	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT12-5	LNGT12-5	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT13-1	LNGT13-1	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT13-2	LNGT13-2	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT13-3	LNGT13-3	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT13-4	LNGT13-4	1,311.6	3.03	553.15	28.54	0.30
On-site Power Generation	LNGT13-5	LNGT13-5	1,311.6	3.03	553.15	28.54	0.30

Volume Sources

Source Group Decription[1]	AERMOD Source Group Name	AERMOD Source ID(s)	Source Location Data	Source Parameters[2]		
			Elevation (m)[1]	Release Height (m)	Initial Lateral Dimension (m)	Initial Vertical Dimension (m)
Stationary Grizzly	GRIZZLY	GRIZZLY	1,308.3	9.75	4.66	2.27
Primary Crushing Transfers	PTRANS	PRIMTRANS	1,307.8	3.96	2.44	0.92
Gravity Circuit Transfers	GTRANS	GRAVTRANS	1,290.5	3.66	8.63	0.85
Agglomeration Transfers	AGTRANS	AGGTRANS	1,290.6	8.84	6.68	2.06
Carbon Regeneration/Refinery	CARBON	CARBON	1,273.9	3.05	4.85	0.71

Notes:

1. Sources are illustrated in the accompanying figures for this Modeling Protocol. Source elevation data obtained from Global Mapper software for the USGS 3DEP Elevation dataset.

2. Source parameters were developed from information provided by Castle Mountain Venture. For point sources, a stack exit temperature of 298 K represents ambient conditions. Consistent with the US EPA AERMOD User Guide, the initial lateral dimension for volume sources was calculated as the side length divided by 4.3 and the initial vertical dimension for volume sources (elevated, not on or adjacent to a building) was calculated as the release height divided by 4.3.

Abbreviations:

K - degrees Kelvin
m - meter
m/s - meters/second

References:

Blue Marble Geographics. Global Mapper Version 23.0. Available online at: https://www.bluemarblegeo.com/global-mapper/

US EPA. October 2023. User's Guide for the AMS/EPA Regulatory Model (AERMOD). Available online at: https://gaftp.epa.gov/Air/aqmg/SCRAM/models/preferred/aermod/aermod_userguide.pdf

Appendix C
Table C-2
Modeled Source Parameters - Pits, Overburden, and Heap Leach
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Area Sources

Source Group Description	AERMOD Source Group Name	AERMOD Source ID(s)	Source Location Data[1]	Source Parameters[2]		
			Elevation (m)	Release Height (m)	Number of Vertices	Initial Vertical Dimension (m)
Haul Truck Loading Fugitive Dust at Northern Pit Complex	PT_N_LD	PT_N_LD / PT_N_LD1	1,224.28	2	5	1.86
Haul Truck Loading Fugitive Dust at South Extension Pit	PT_S_LD	PT_S_LD / PT_S_LD1	1,112.52	2	5	1.86
Offroad Equipment (Drilling) Fugitive Dust at Northern Pit Complex	PT_N_DF	PT_N_DF / PT_N_DF1	1,224.28	5	5	4.65
Offroad Equipment (Drilling) Fugitive Dust at South Extension Pit	PT_S_DF	PT_S_DF / PT_S_DF1	1,112.52	5	5	4.65
Offroad Equipment (General) Fugitive Dust at Northern Pit Complex	PT_N_EF	PT_N_EF / PT_N_EF1	1,224.28	5	5	4.65
Offroad Equipment (General) Fugitive Dust at South Extension Pit	PT_S_EF	PT_S_EF / PT_S_EF1	1,112.52	5	5	4.65
Offroad Equipment (General) Fugitive Dust at North Overburden	OV_N_EF	OV_N_EF / OV_N_EF1	1,386.84	5	8	4.65
Offroad Equipment (General) Fugitive Dust at South Overburden	OV_S_EF	OV_S_EF / OV_S_EF1	1,295.40	5	8	4.65
Erosion Fugitive Dust at Northern Pit Complex	PT_N_ER	PT_N_ER / PT_N_ER1	1,224.28	1	5	0.93
Erosion Fugitive Dust at South Extension Pit	PT_S_ER	PT_S_ER / PT_S_ER1	1,112.52	1	5	0.93
Erosion Fugitive Dust at North Overburden	OV_N_ER	OV_N_ER / OV_N_ER1	1,386.84	1	8	0.93
Erosion Fugitive Dust at South Overburden	OV_S_ER	OV_S_ER / OV_S_ER1	1,295.40	1	8	0.93
Haul Truck Loading Fugitive Dust at Interim Ore Stockpile	INO_LD	INORST_LD / INORST_LD1	1,309.11	3.81	5	3.54
Erosion Fugitive Dust at Interim Ore Stockpile	INO_ER	INORST_ER / INORST_ER1	1,309.11	3.81	5	3.54
Erosion Fugitive Dust at Heap Leach Pad	HL_CON	HL_CON / HL_CON1	1,363.98	1	9	0.93
Blast Hole Drilling Fugitive Dust at Northern Pit Complex	PT_N_BF	PT_N_BF / PT_N_BF1	1,224.28	1	5	0.93
Blast Hole Drilling Fugitive Dust at South Extension Pit	PT_S_BF	PT_S_BF / PT_S_BF1	1,112.52	1	5	0.93

Volume Sources

Source Group Description	AERMOD Source Group Name	AERMOD Source ID(s)	Source Location Data[1]	Source Parameters[2]		
			Elevation (m)	Release Height (m)	Initial Lateral Dimension (m)	Initial Vertical Dimension (m)
Offroad Equipment (Drilling) Exhaust at Northern Pit Complex	PT_N_DE	PT_N_DE /PT_N_DE1	1,224.28	5	337.88	4.65
Offroad Equipment (Drilling) Exhaust at South Extension Pit	PT_S_DE	PT_S_DE /PT_S_DE1	1,112.52	5	190.32	4.65
Offroad Equipment (General) Exhaust at Northern Pit Complex	PT_N_EE	PT_N_EE /PT_N_EE1	1,224.28	5	337.88	4.65
Offroad Equipment (General) Exhaust at South Extension Pit	PT_S_EE	PT_S_EE /PT_S_EE1	1,112.52	5	190.32	4.65
Haul Truck Unloading Fugitive Dust at North Overburden	OV_N_LD	OV_N_LD /OV_N_LD1	1,386.84	5	230.27	4.65
Haul Truck Unloading Fugitive Dust at South Overburden	OV_S_LD	OV_S_LD /OV_S_LD1	1,295.40	5	278.89	4.65
Offroad Equipment (General) Exhaust at North Overburden	OV_N_EE	OV_N_EE /OV_N_EE1	1,386.84	5	230.27	4.65
Offroad Equipment (General) Exhaust at South Overburden	OV_S_EE	OV_S_EE /OV_S_EE1	1,295.40	5	278.89	4.65
Blasting at Northern Pit Complex	PT_N_BL	PT_N_BL /PT_N_BL1	1,224.28	10	337.88	9.30
Blasting at South Extension Pit	PT_S_BL	PT_S_BL /PT_S_BL1	1,112.52	10	190.32	9.30

Notes:

1. Sources are illustrated in the accompanying figures for this Modeling Protocol. Source elevation data obtained from the Castle Mountain Venture Mine Plan Amendment (2022).
2. Release heights were selected using engineering judgement, and were assumed to be 1/2 the total vertical height. Consistent with US EPA AERMOD guidance, the initial vertical dimension of the pits, overburden, and heap leach area and volume sources was calculated as the total vertical height divided by 2.15. The initial lateral dimension for volume sources was calculated as the side length divided by 4.3, consistent with AERMOD guidance for a single volume source.

Abbreviations:

m - meters

References:

US EPA. October 2023. User's Guide for the AMS/EPA Regulatory Model (AERMOD). Available online at: https://gaftp.epa.gov/Air/aqmg/SCRAM/models/preferred/aermod/aermod_userguide.pdf

Appendix C
Table C-3
Modeled Source Parameters - Haul Roads
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Series of Volume Sources

Source Group Description	AERMOD Source Group Name	AERMOD Source ID(s)	Source Location Data[1]	Source Parameters[2]		
			Elevation (m)	Release Height (m)	Initial Lateral Dimension (m)	Initial Vertical Dimension (m)
South Extension Phase I Haul Route	EXTPI	EXTPI1 - EXTPI114	Variable	8.50	16.97	7.91
South Extension Phase II Haul Route	EXTPII	EXTPII1 - EXTPII103				
East Ridge Haul Route	ERIDGE	ERIDGE1 - ERIDGE57				
JSLA Backfill Haul Route	JSLAB	JSLAB1 - JSLAB86				
JSLA East Haul Route	JSLAE	JSLAE1 - JSLAE86				
JSLA West Haul Route	JSLAW	JSLAW1 - JSLAW42				
Jumbo Oro Belle Haul Route	JBOB	JBOB1 - JBOB210				
North Overburden Haul Route	OVNORTH	OVNORTH1 - OVNORTH118				
South Overburden Haul Route	OVSOUTH	OVSOUTH1 - OVSOUTH98, OVSOUTH132				
Miscellaneous Medium + Heavy Duty Truck Route	MISCTRK	MISCTRK1 - MISCTRK179		2.55	7.44	2.37
Miscellaneous Light Duty Truck Route	MISCLDV	MISCLDV1 - MISCLDV529				
Fuel Delivery Truck Route	FUELTRK	FUELTRK1 - FUELTRK61				
Product + Reagent Delivery Truck Route	DELIVTRK	DELIVTRK1 - DELIVTRK196				

Notes:

1. Sources are illustrated in the accompanying figures for this Modeling Protocol. Source elevation data obtained from Global Mapper software for the USGS 3DEP Elevation dataset for each individual volume source.
2. Source parameters were calculated consistent with US EPA Haul Road Workgroup Final Report Submission. The default vehicle height of 10m was used for mining truck haul routes and a default vehicle height of 3m was used for the miscellaneous and delivery truck routes. Release height was calculated as the vehicle height multiplied by 1.7 and divided by 2. The initial vertical dimension was calculated as the total vertical height multiplied by 1.7 and divided by 2.15. The initial lateral dimension was calculated as the plume width divided by 2.15. An average road width of approximately 30.5m was used for the mining truck haul routes and an average road width of approximately 10m was used for the miscellaneous and delivery truck routes. The plume width was assumed to be an additional 6m larger than the corresponding road widths.

Abbreviations:

m - meters

References:

Blue Marble Geographics. Global Mapper Version 23.0. Available online at: https://www.bluemarblegeo.com/global-mapper/

US EPA. March 2012. Haul Road Workgroup Final Report Submission to EPA-OAQPS. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/haul_road_workgroup-final_report_package-20120302.pdf

ATTACHMENT 2
ANNUALIZED, MAXIMUM DAILY PROJECT EMISSIONS FOR Q/D CALCULATION

Attachment 2. Onsite Annualized Maximum Daily Emissions
2022 Mine Plan of Operations
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Type	Maximum Daily Emissions[8] (lb/day)		
	PM_{10}	NO_x	SO_x
Material Transfers (fugitive)[1]	185		
Material Transfers (stationary)[1]	18		
Crushing[1]	8.7		
Screening[1]	26		
Diesel Generators[2]	0.15	16.2	0.058
Power Generation (NG turbines)[3]	17.0	85.2	1.5
On-site Unpaved Road Mobile Equipment (fugitive dust)[4]	1291		
Other On-site Off-Road Mobile Equipment (fugitive dust)[4]	52		
On-site Mobile Equipment (exhaust)[4]	38	3,046	6.6
Disturbed Operational Areas[5]	3.2		
Stockpile Wind Erosion[6]	15		
Blasting and Blast Hole Drilling[7]	230	569	0.10
Total Onsite Emissions (lbs/day)	1,883	3,717	8.3
Converted Annualized Emissions (tons/yr)[9]			
Total Onsite Emissions (tons/yr)	344	678	1.5

Notes:

1. Maximum daily material handling, crushing, and screening emissions are based on maximum daily material throughputs. Material handling sources may operate up to 24 hours per day.

2. Emergency generators are assumed to operate up to 1 hour per day. Water well generators as assumed to operate up to 24 hours per day.

3. NG turbines are assumed to operate up to 24 hours per day.

4. Haul trucks and heavy off-road equipment are assumed to operate up to 18 hours per day, while light duty trucks are assumed to operate up to 24 hours per day. Supporting delivery trucks (e.g. fuel and reagents) may operate variable hours in a given day depending on the frequency.

5. Fugitive dust emissions from disturbed operational areas is based on the maximum daily disturbed acreage. Emissions may occur over any of the 24 hours of the day.

6. Fugitive dust emissions from stockpiles are based on storage pile area. Since the stockpile is for the storage of interim ore, it is assumed to be present up to 25% of the year, and thus may be present less than 24 hours per day.

7. Maximum daily blasting emissions are based on peak quantities of blast holes and explosive use. Blasts are assumed to occur within 1 hour of the day.

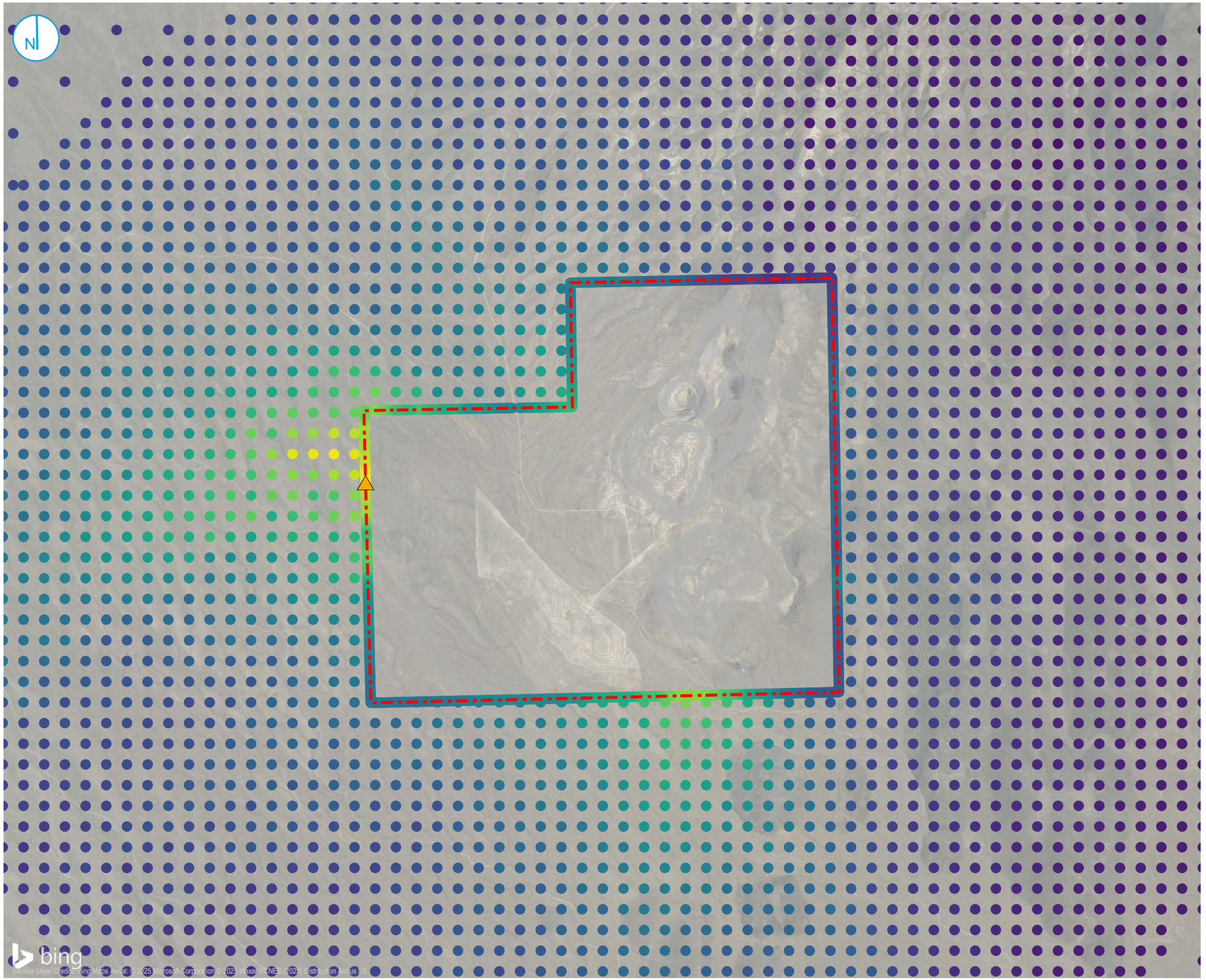
8. Further details of emissions methodology and assumptions are presented in **Appendix A of the modeling protocol**.

9. Maximum Daily Emissions are conservatively converted to annual emissions assuming 365 days per year. Some of these sources will not operate all days of the year, e.g. blasting is expected to occur over 312 days per year.

Abbreviations:

lb - pounds
MT - metric tons
NG - natural gas
NO_x - nitrogen oxides
PM - particulate matter
SO_x - sulfur oxides
yr - year

ATTACHMENT 3
GRAPHICAL PLOTS OF PROJECT IMPACTS FOR EACH MODELING SCENARIO AND AIR QUALITY STANDARD



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.0040

0.40

0 1,500 3,000 Feet

0 500 1,000 Meters

MAXIMUM EMISSIONS SCENARIO

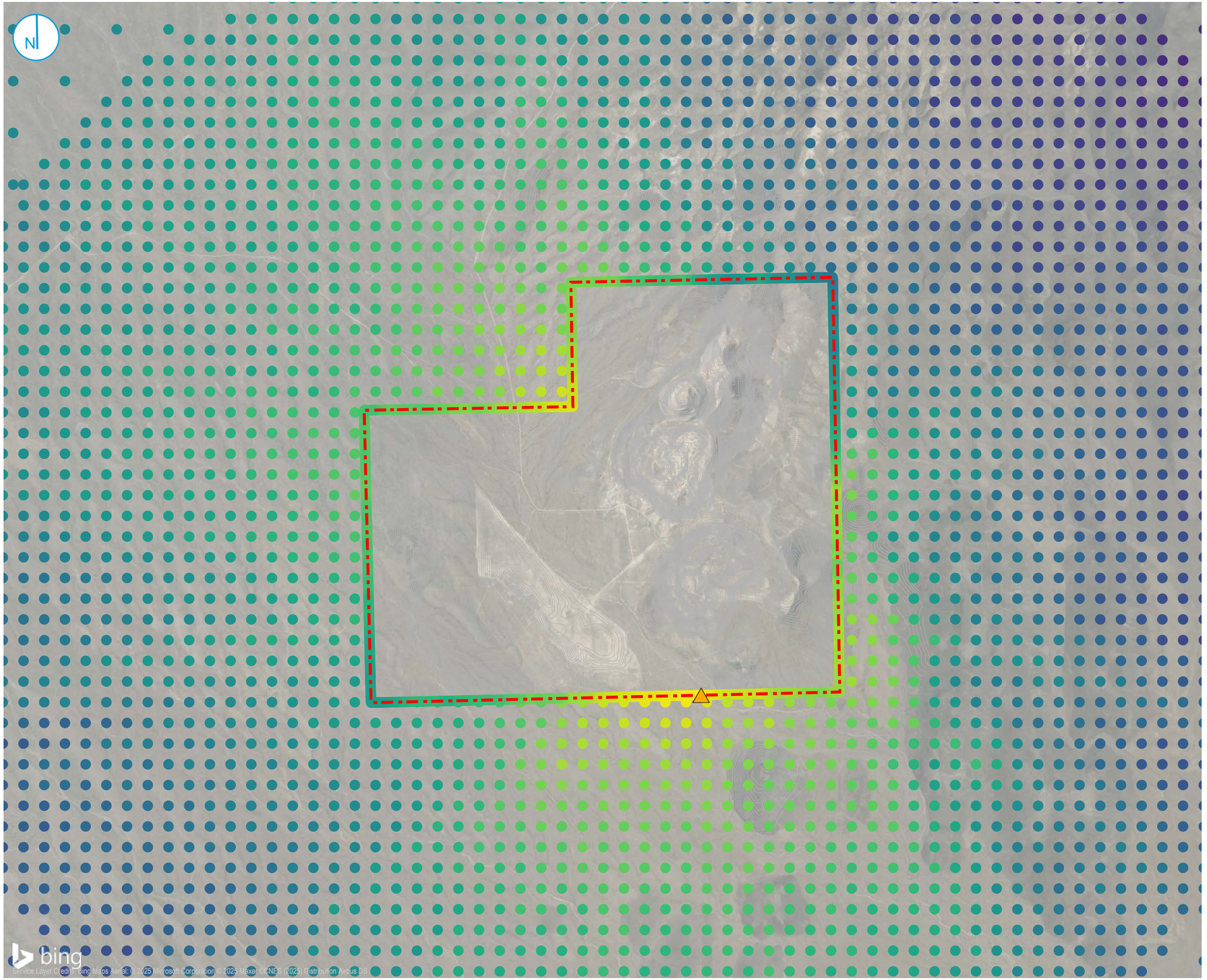
SO_2, 1-HR 99TH PERCENTILE (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

3.3

100

0 1,500 3,000 Feet

0 500 1,000 Meters

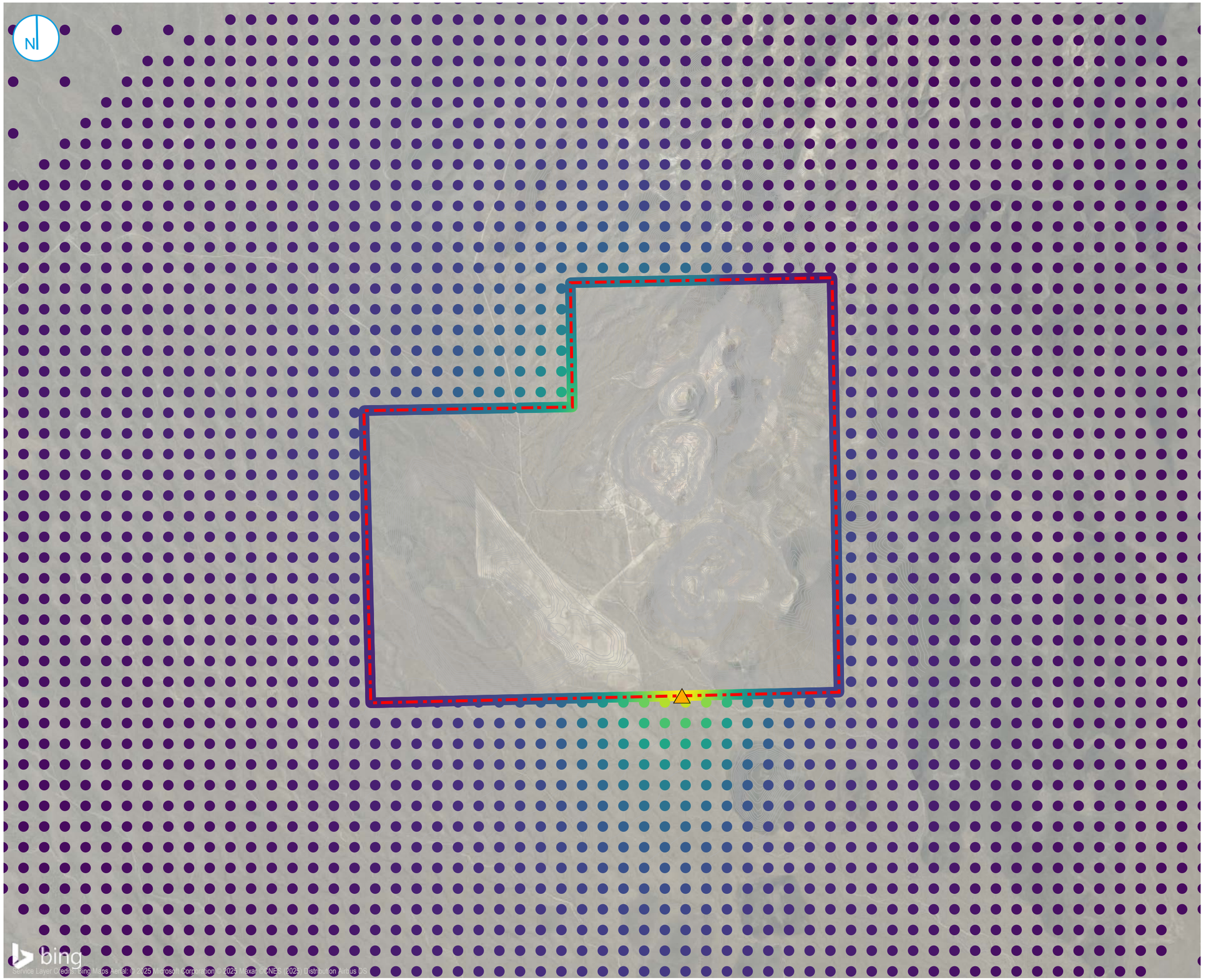
MAXIMUM EMISSIONS SCENARIO
NO_2, 1-HR 98TH PERCENTILE (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.017

5.9

0 1,500 3,000 Feet

0 500 1,000 Meters

MAXIMUM EMISSIONS SCENARIO

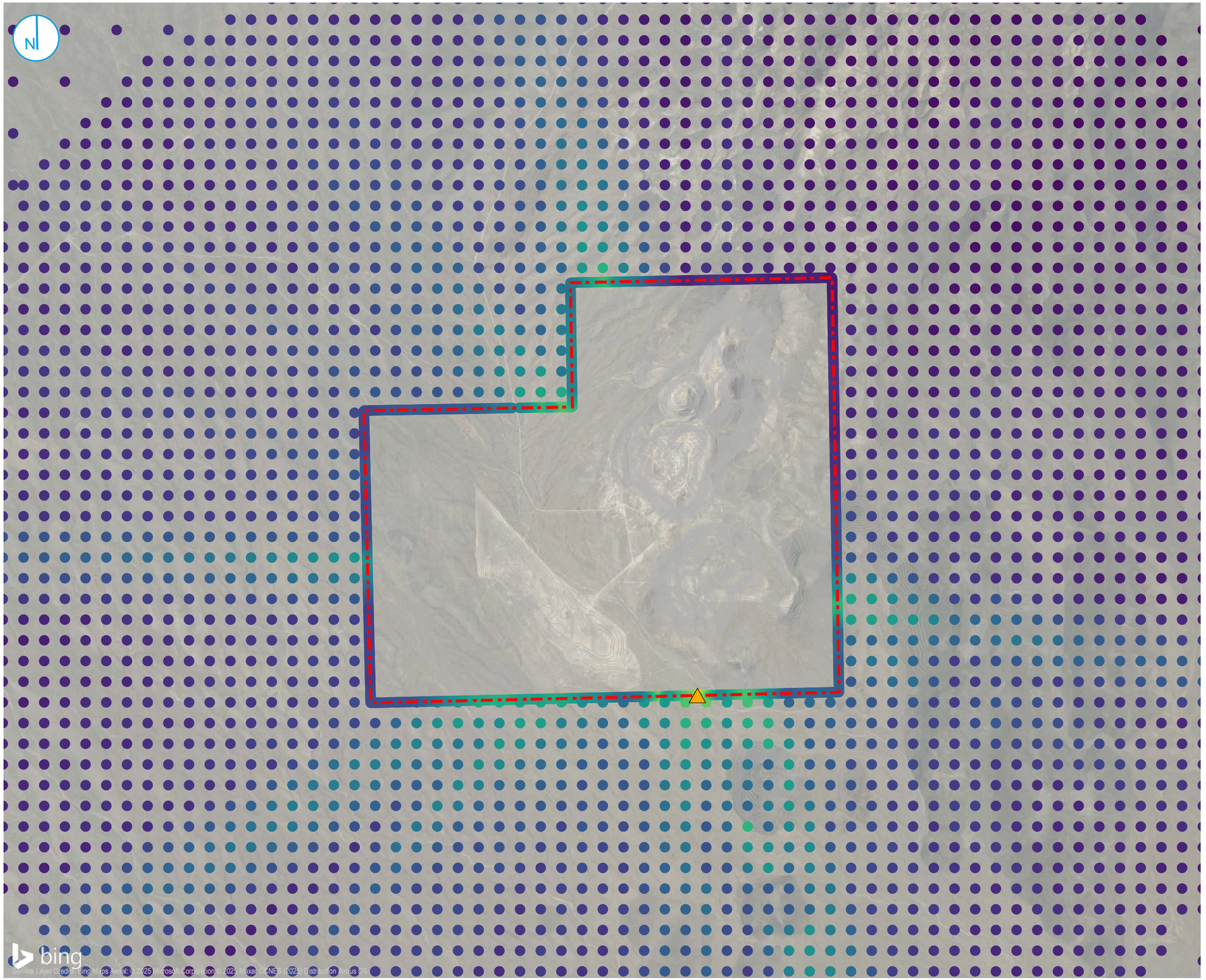
NO_2, ANNUAL, MAXIMUM (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 3

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

25

3,200

0 1,500 3,000 Feet

0 500 1,000 Meters

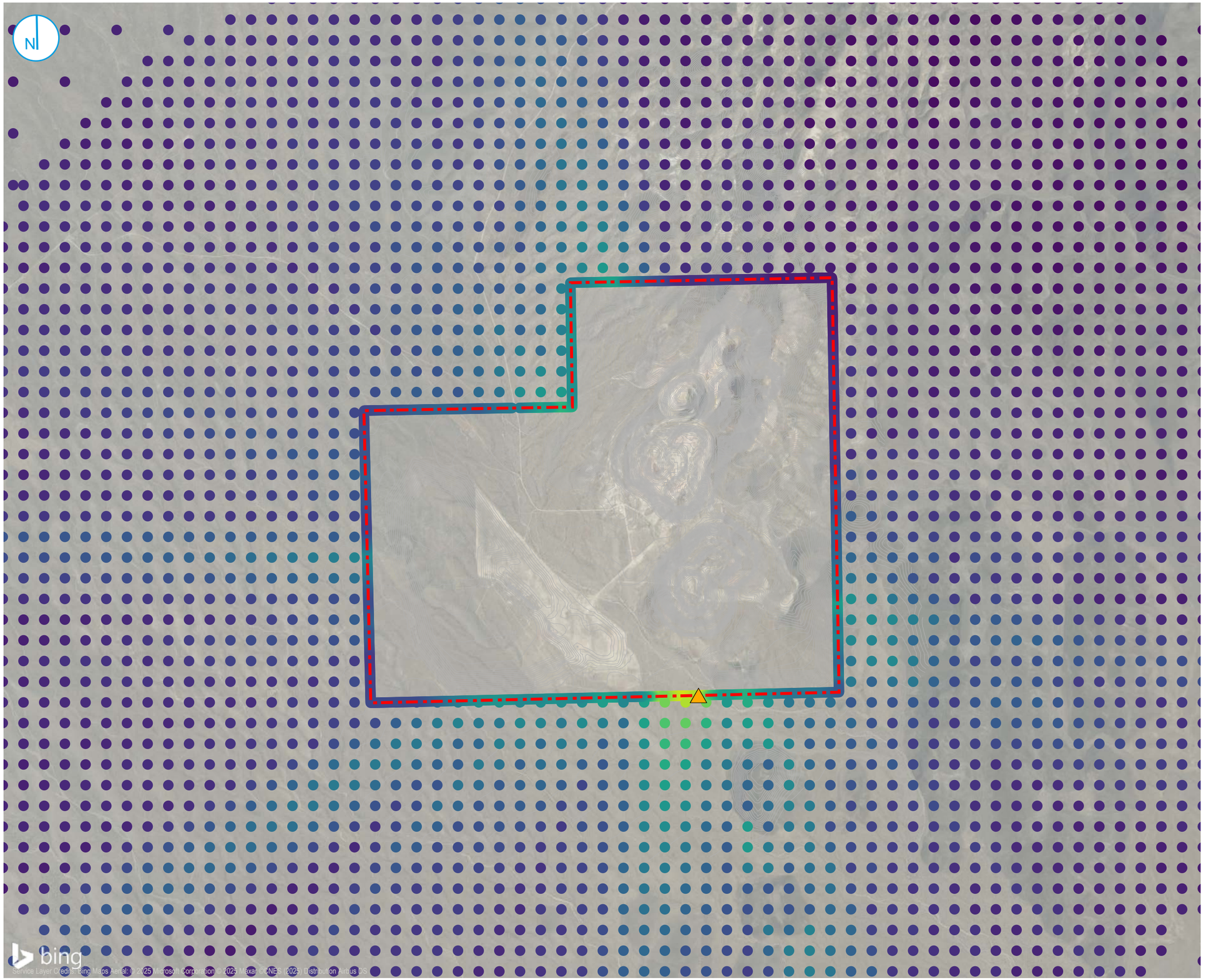
MAXIMUM EMISSIONS SCENARIO
CO, 1-HR 2ND HIGH (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 4

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

3.5

490

0 1,500 3,000 Feet

0 500 1,000 Meters

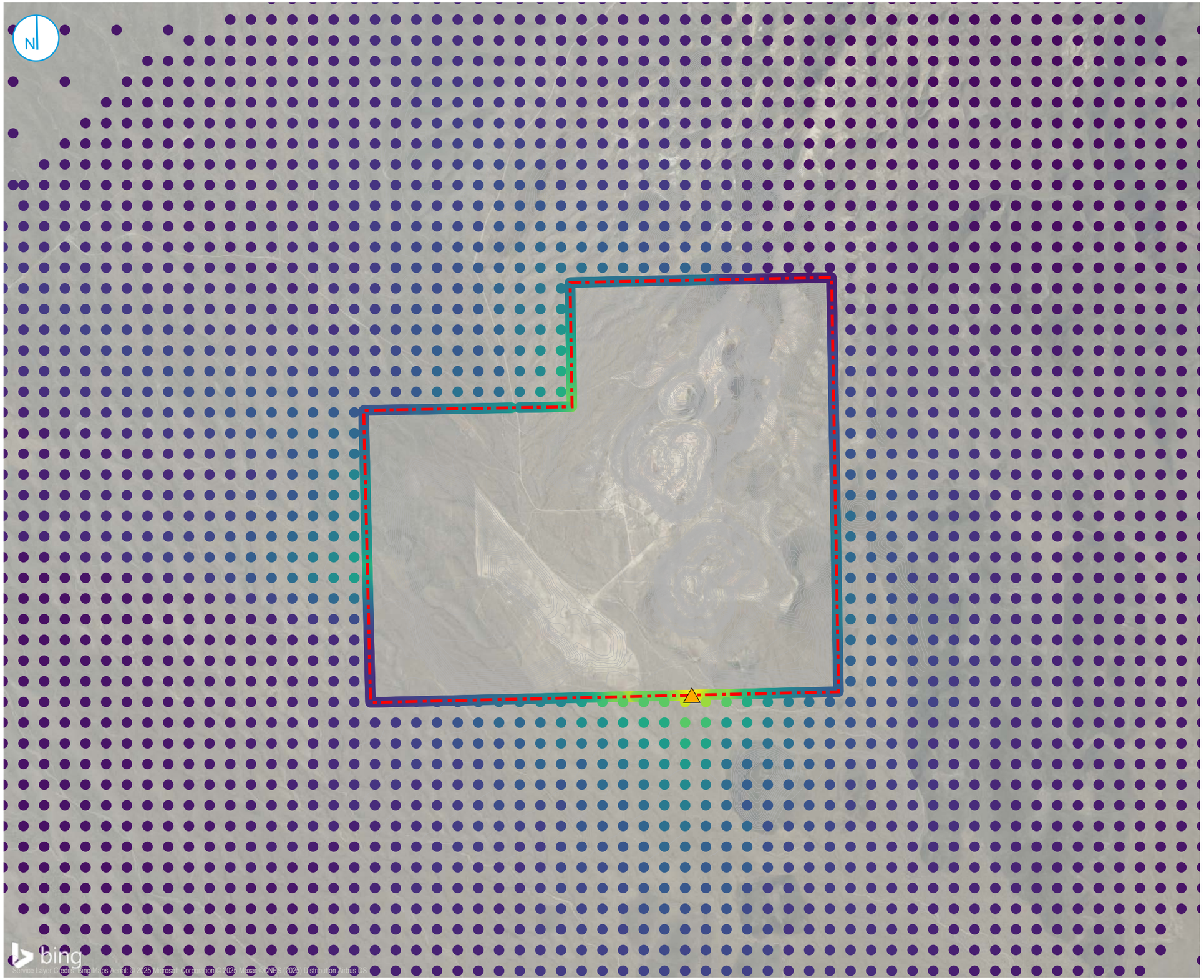
MAXIMUM EMISSIONS SCENARIO
CO, 8-HR 2ND HIGH (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 5

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

20

29

Notes

1. Maximum Modeled Concentration (Design Value) includes the background contribution.

0 1,500 3,000 Feet

0 500 1,000 Meters

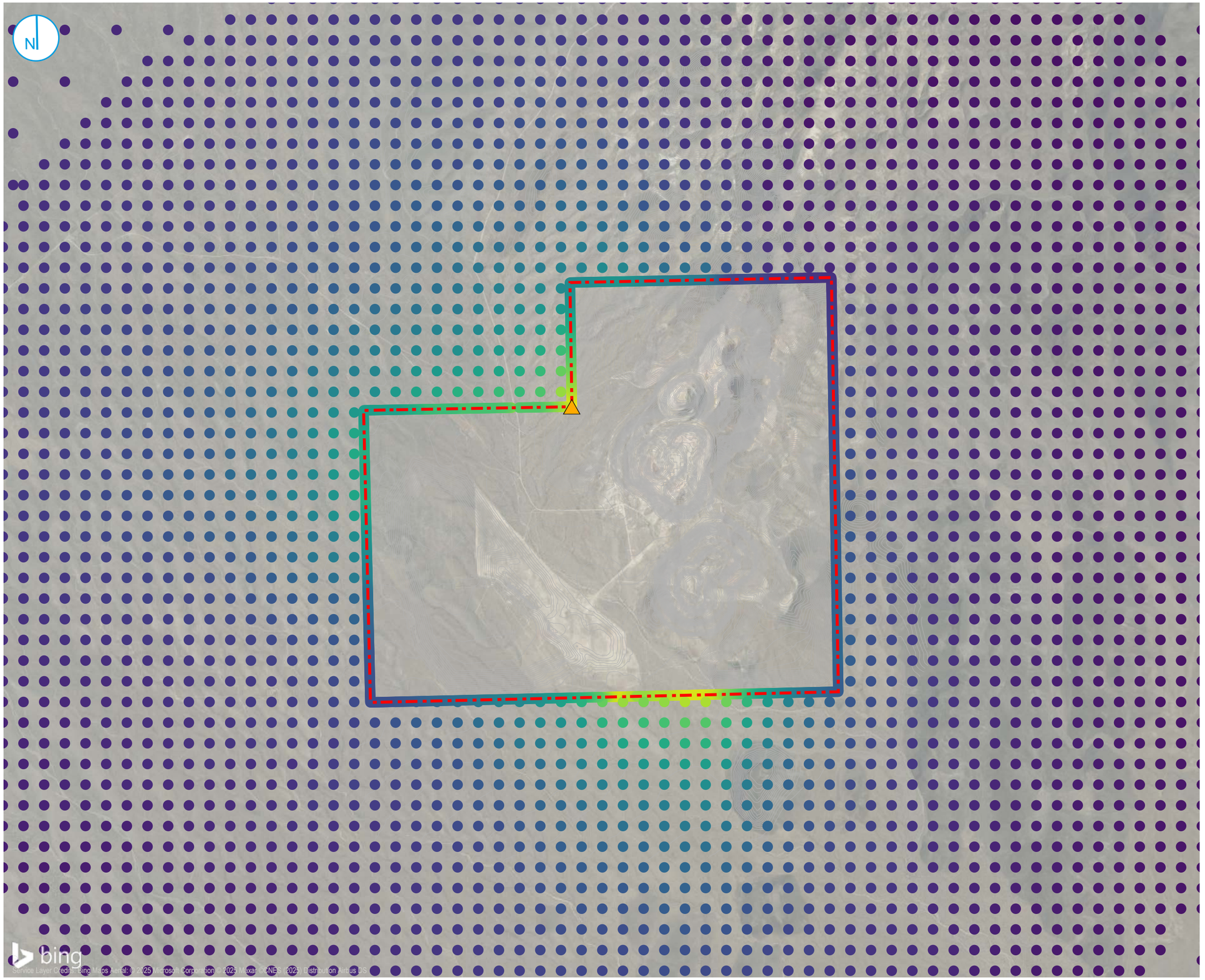
MAXIMUM EMISSIONS SCENARIO
PM_{10}, 24-HR 2ND HIGH (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 6

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.0071

1.5

0 1,500 3,000 Feet

0 500 1,000 Meters

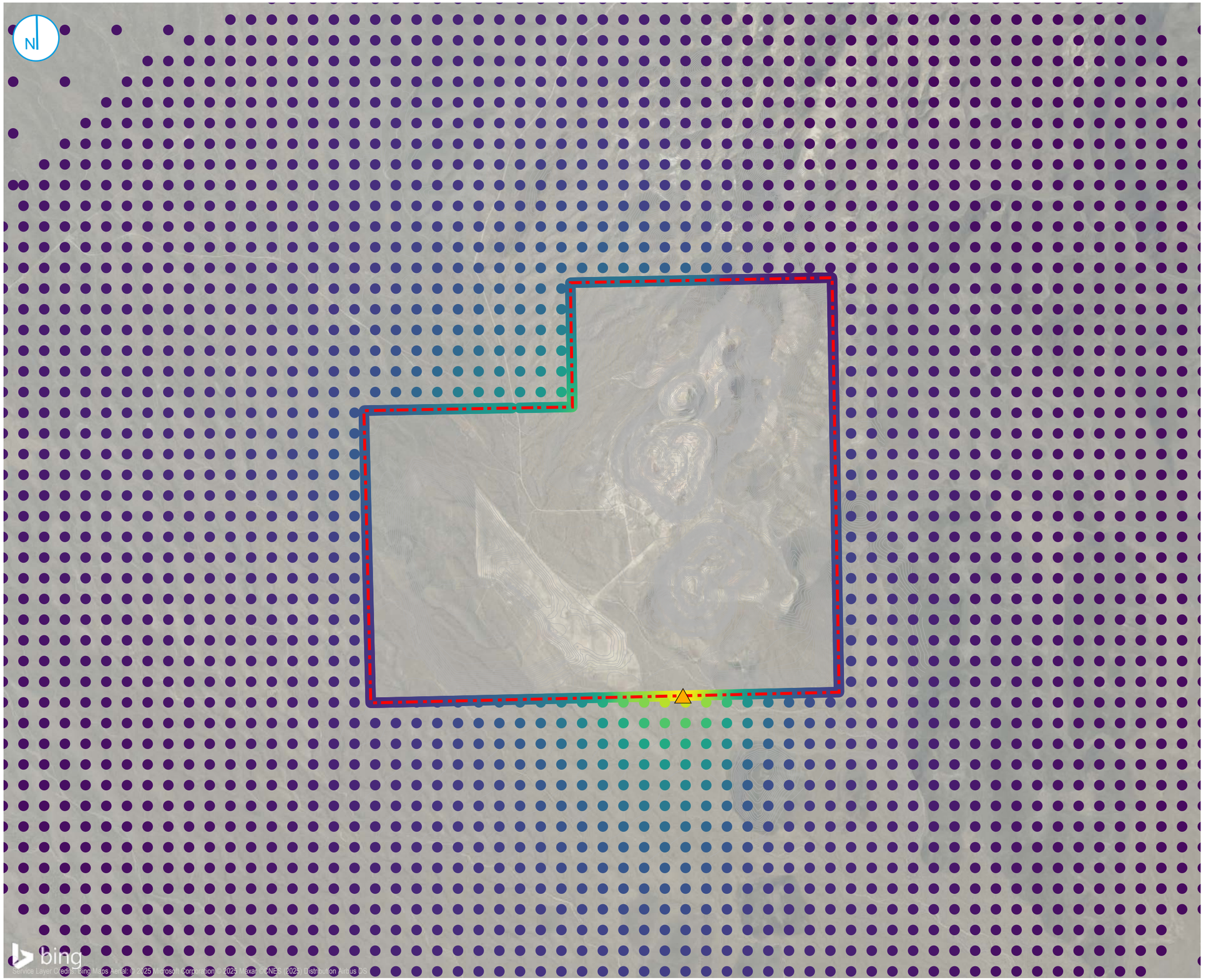
MAXIMUM EMISSIONS SCENARIO
$PM_{2.5}$, 24-HR 98TH PERCENTILE (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 7

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.0013

0.46

0 1,500 3,000 Feet

0 500 1,000 Meters

MAXIMUM EMISSIONS SCENARIO

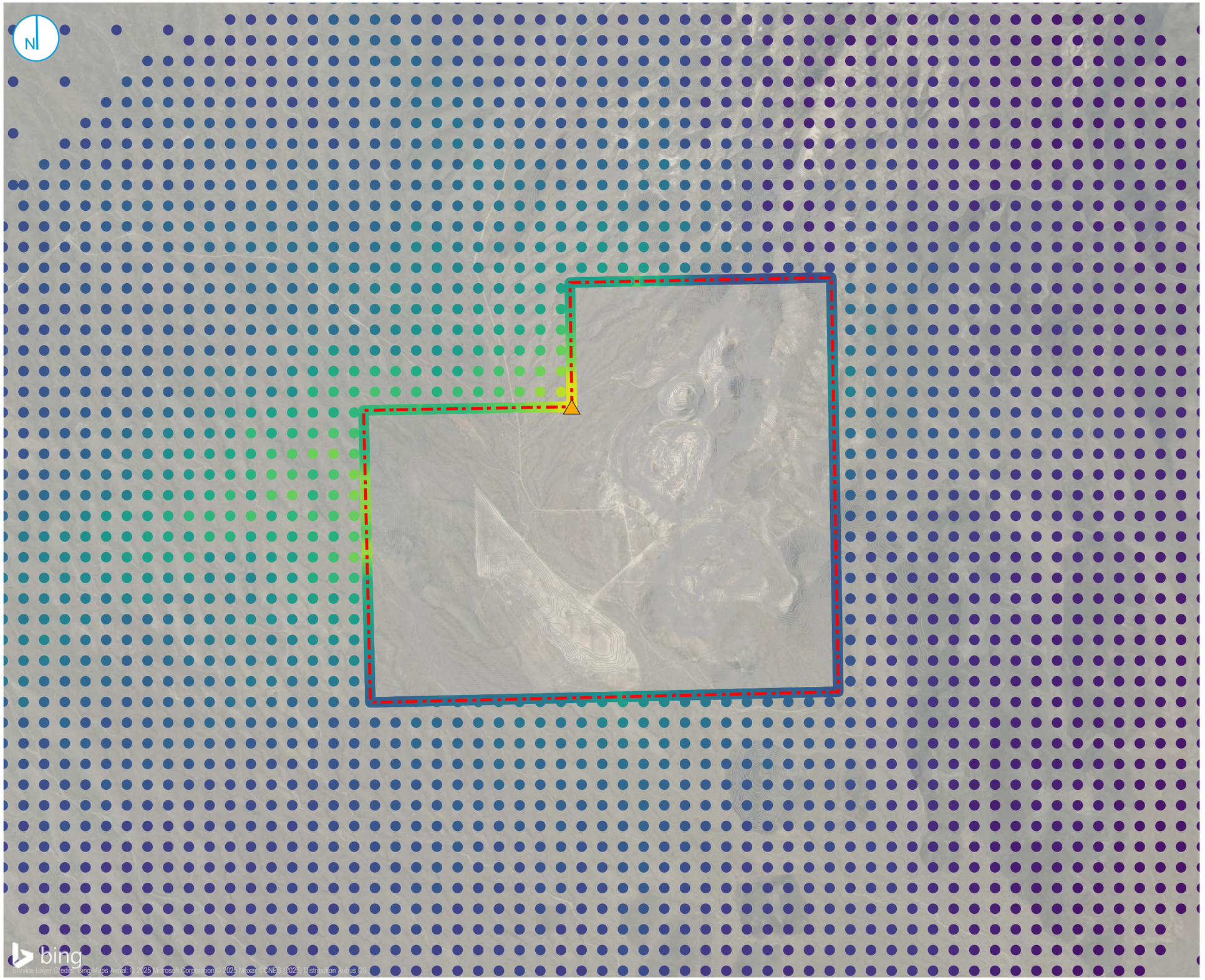
$PM_{2.5}$, ANNUAL, MAXIMUM (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 8

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.0039

0.42

0 1,500 3,000 Feet

0 500 1,000 Meters

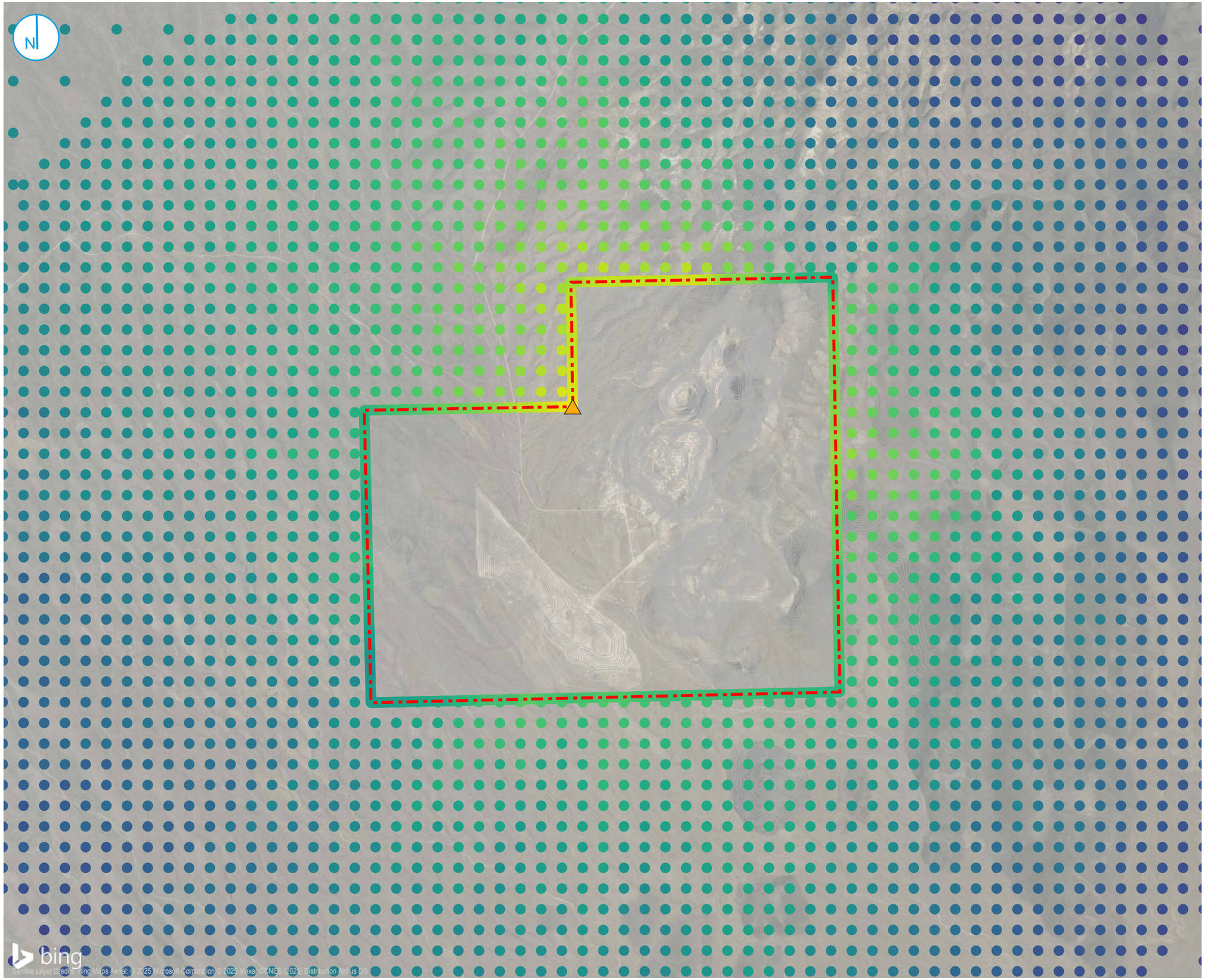
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
SO_2, 1-HR 99TH PERCENTILE (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 9

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

3.3

110

0 1,500 3,000 Feet

0 500 1,000 Meters

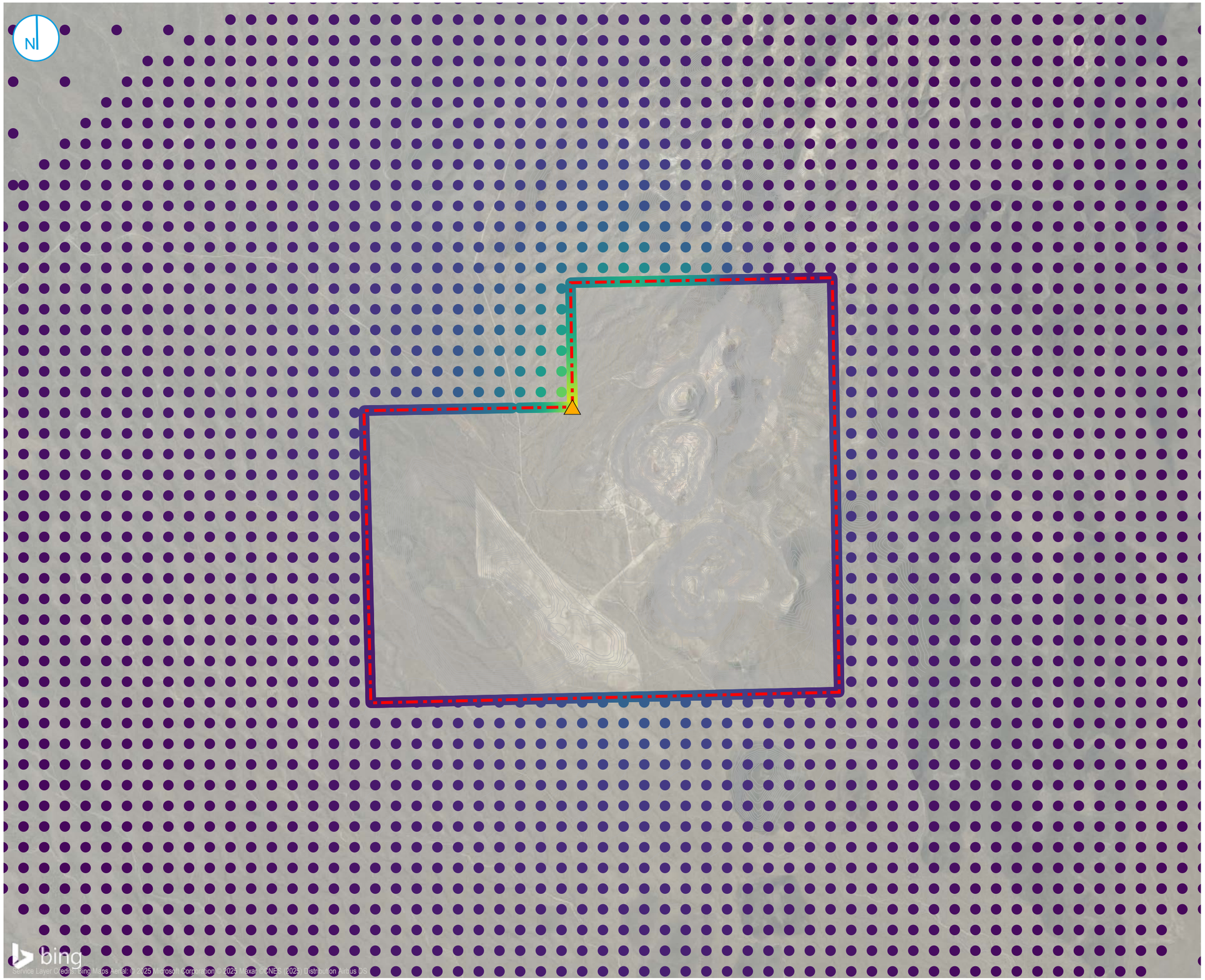
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
NO_2, 1-HR 98TH PERCENTILE (NAAQS)

Castle Mountain Mine 2022
Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 10

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.017

8.0

0 1,500 3,000 Feet

0 500 1,000 Meters

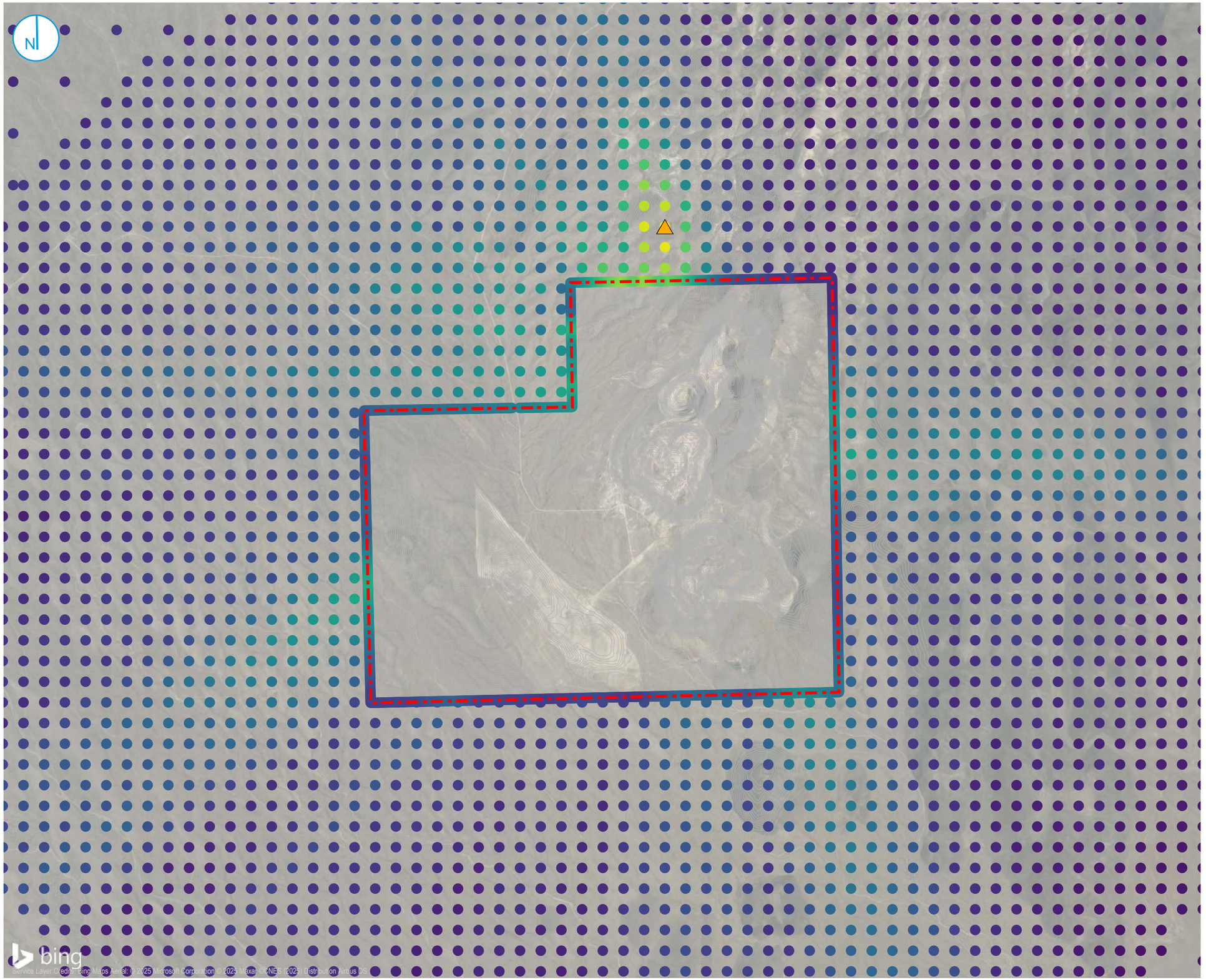
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
NO_2, ANNUAL, MAXIMUM (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 11

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

25

3,100

0 1,500 3,000 Feet

0 500 1,000 Meters

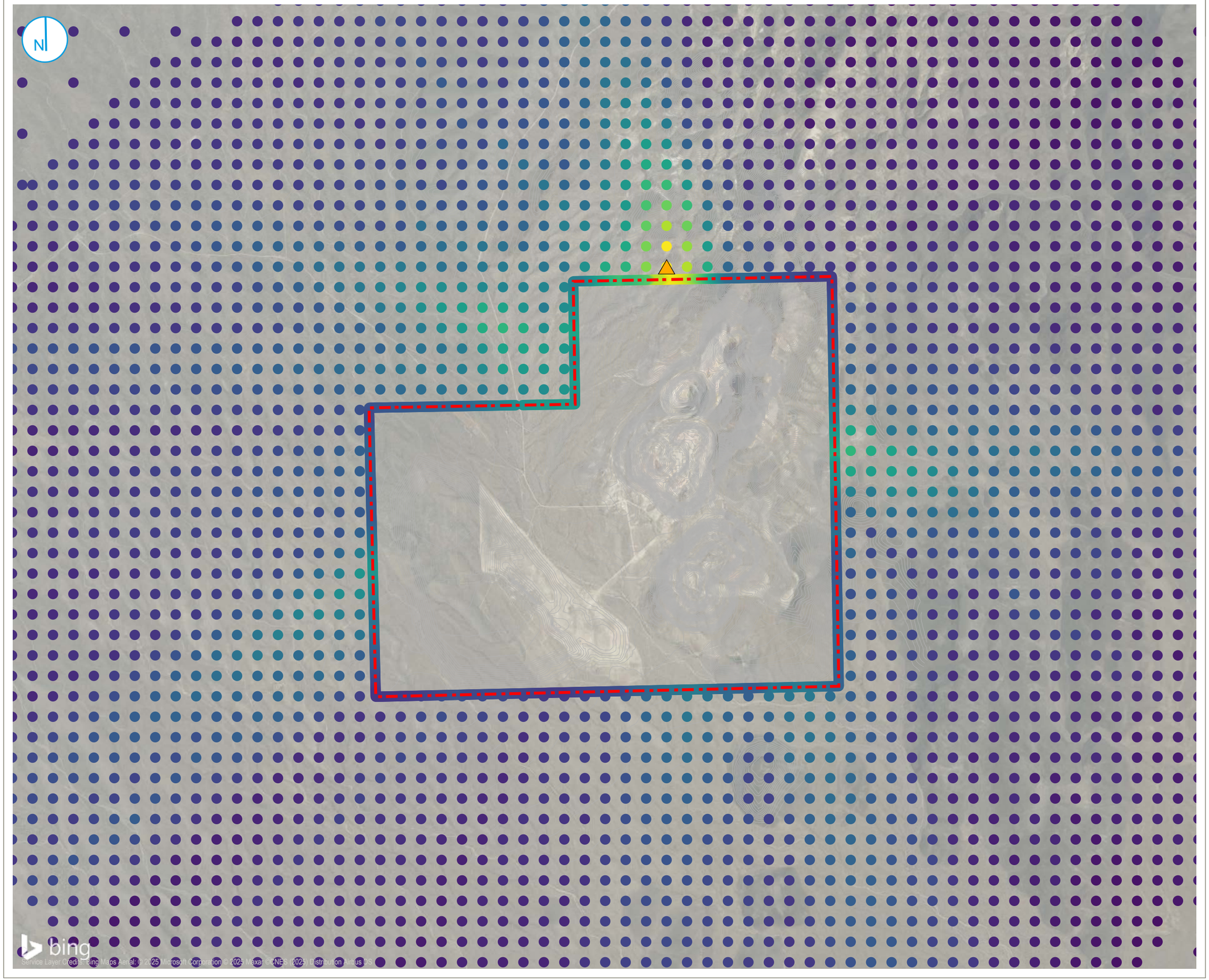
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
CO, 1-HR 2ND HIGH (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 12

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

3.5

490

0 1,500 3,000 Feet

0 500 1,000 Meters

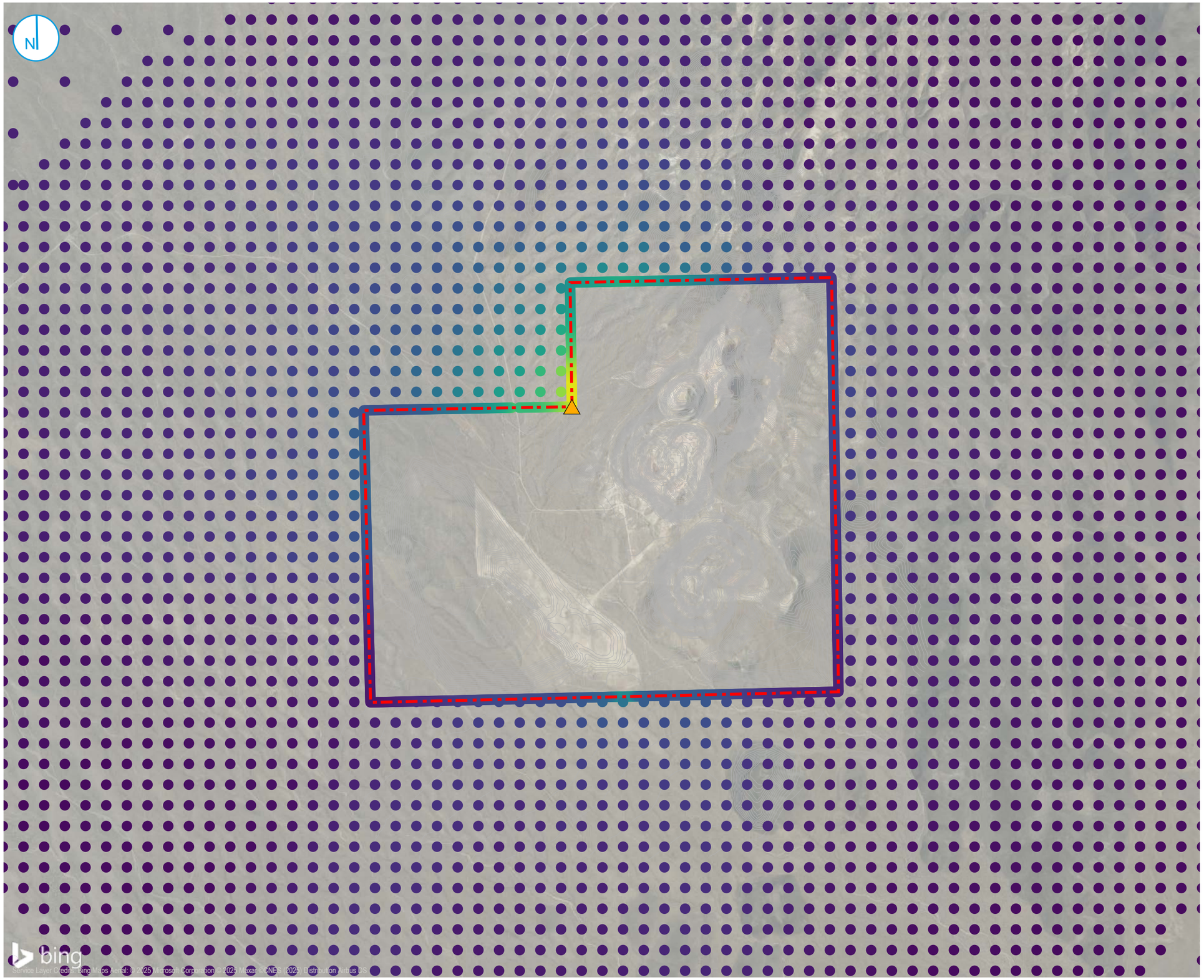
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
CO, 8-HR 2ND HIGH (NAAQS)

Castle Mountain Mine 2022
Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 13

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

20

34

Notes

1. Maximum Modeled Concentration (Design Value) includes the background contribution.

0 1,500 3,000 Feet

0 500 1,000 Meters

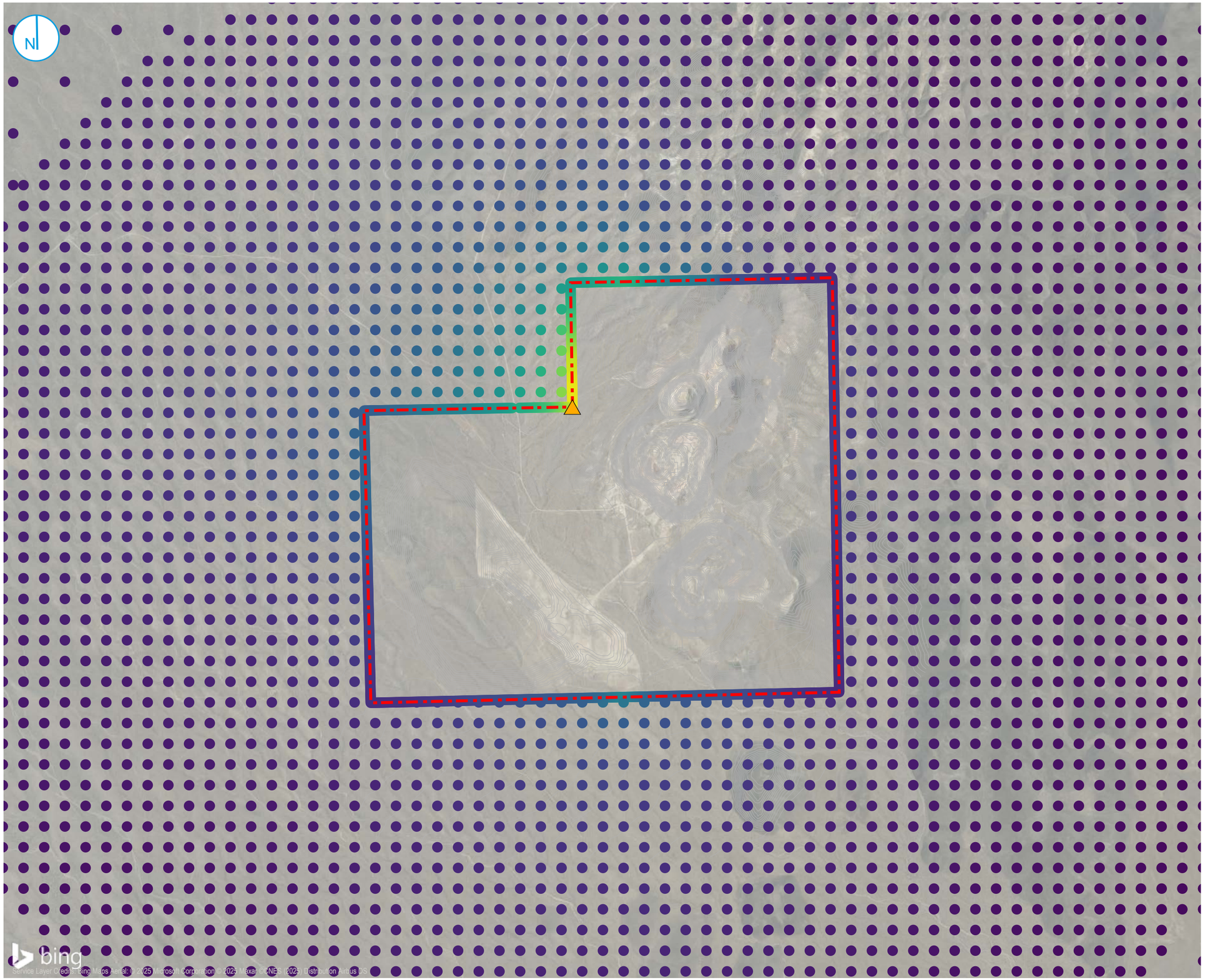
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
PM_{10}, 24-HR 2ND HIGH (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 14

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.0072

2.6

0 1,500 3,000 Feet

0 500 1,000 Meters

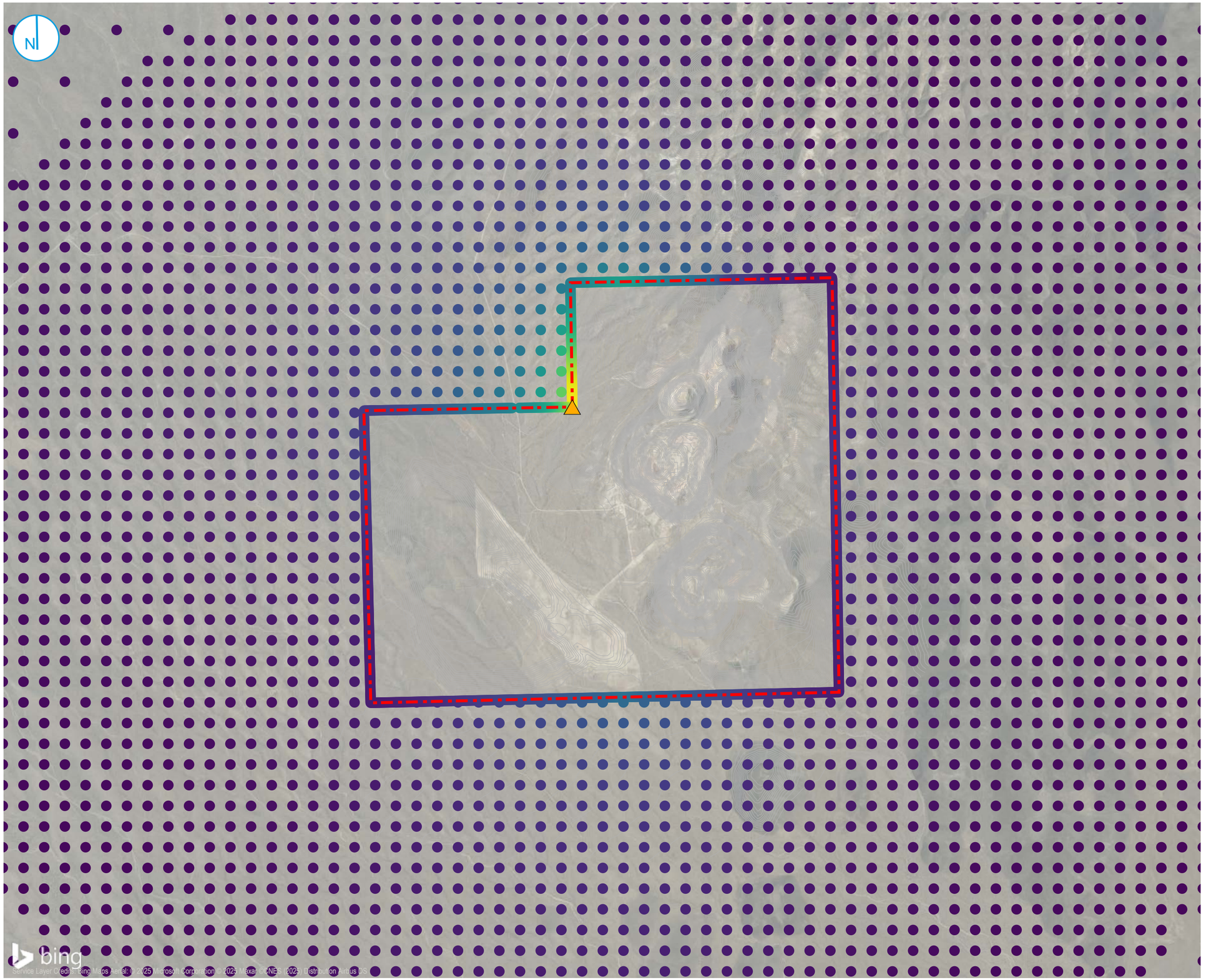
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
$PM_{2.5}$, 24-HR 98TH PERCENTILE (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 15

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.0013

0.76

0 1,500 3,000 Feet

0 500 1,000 Meters

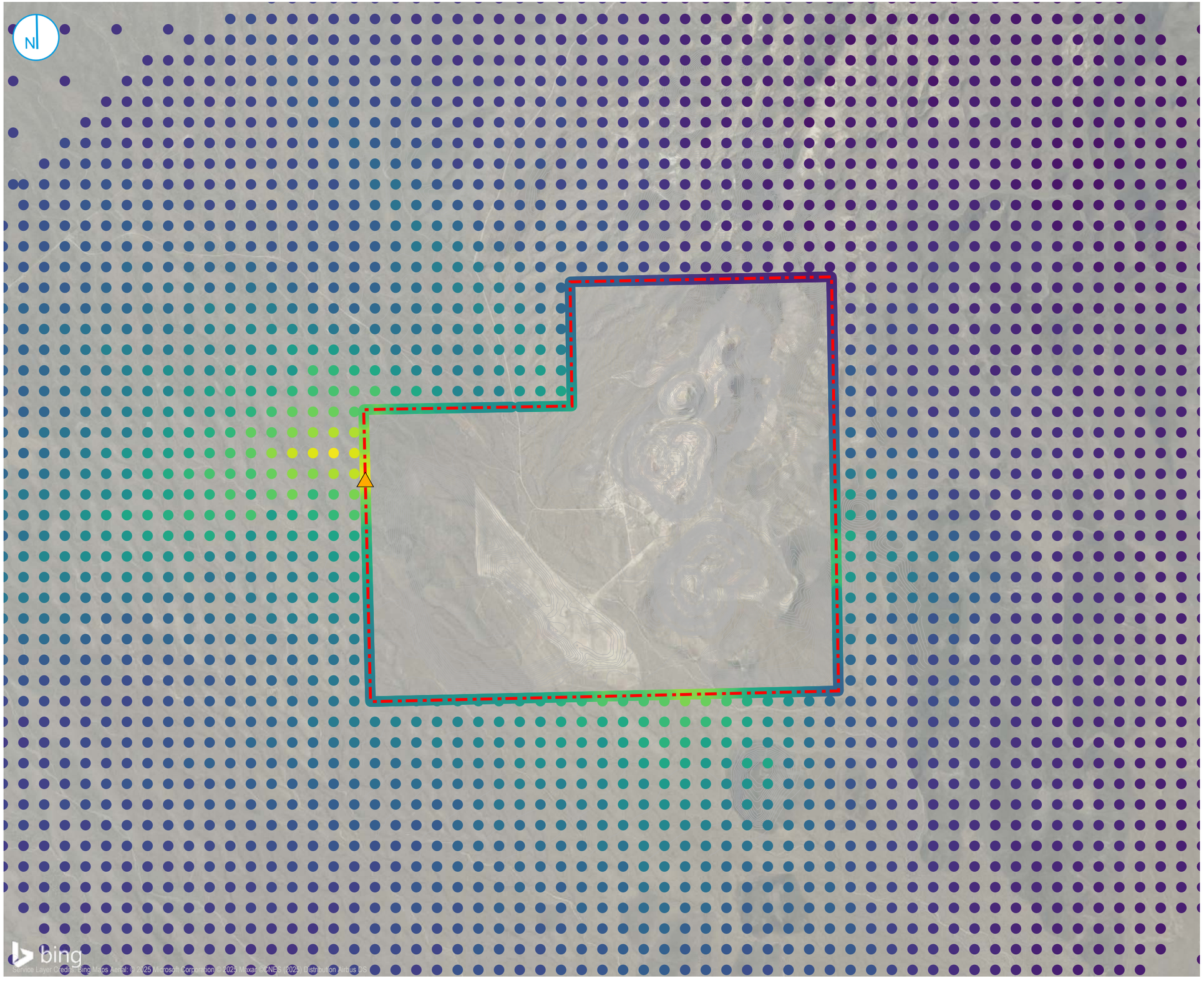
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
$PM_{2.5}$, ANNUAL, MAXIMUM (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 16

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.0041

0.47

0 1,500 3,000 Feet

0 500 1,000 Meters

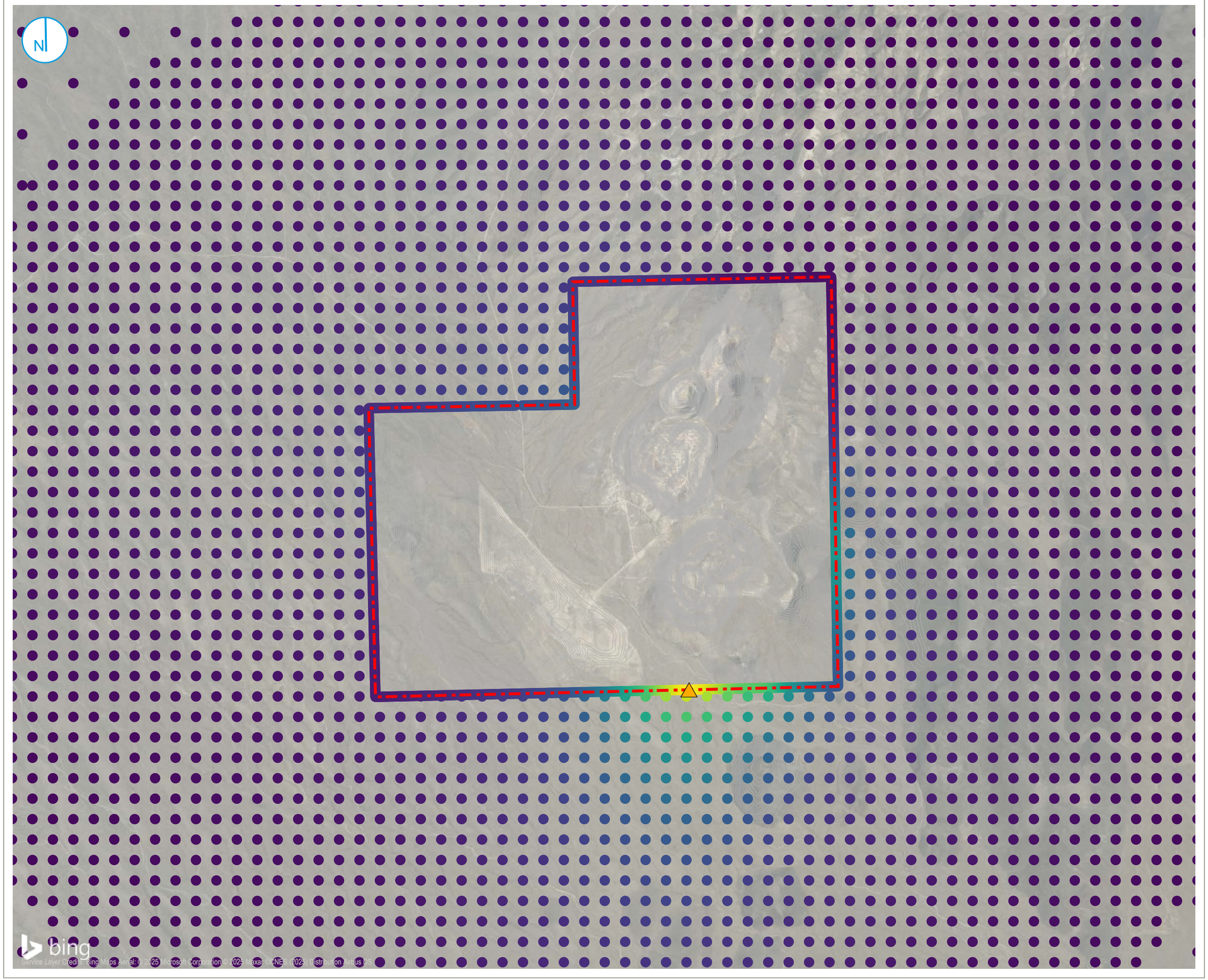
MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
SO_2, 1-HR 99TH PERCENTILE (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 17

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.017

7.5

0 1,500 3,000 Feet

0 500 1,000 Meters

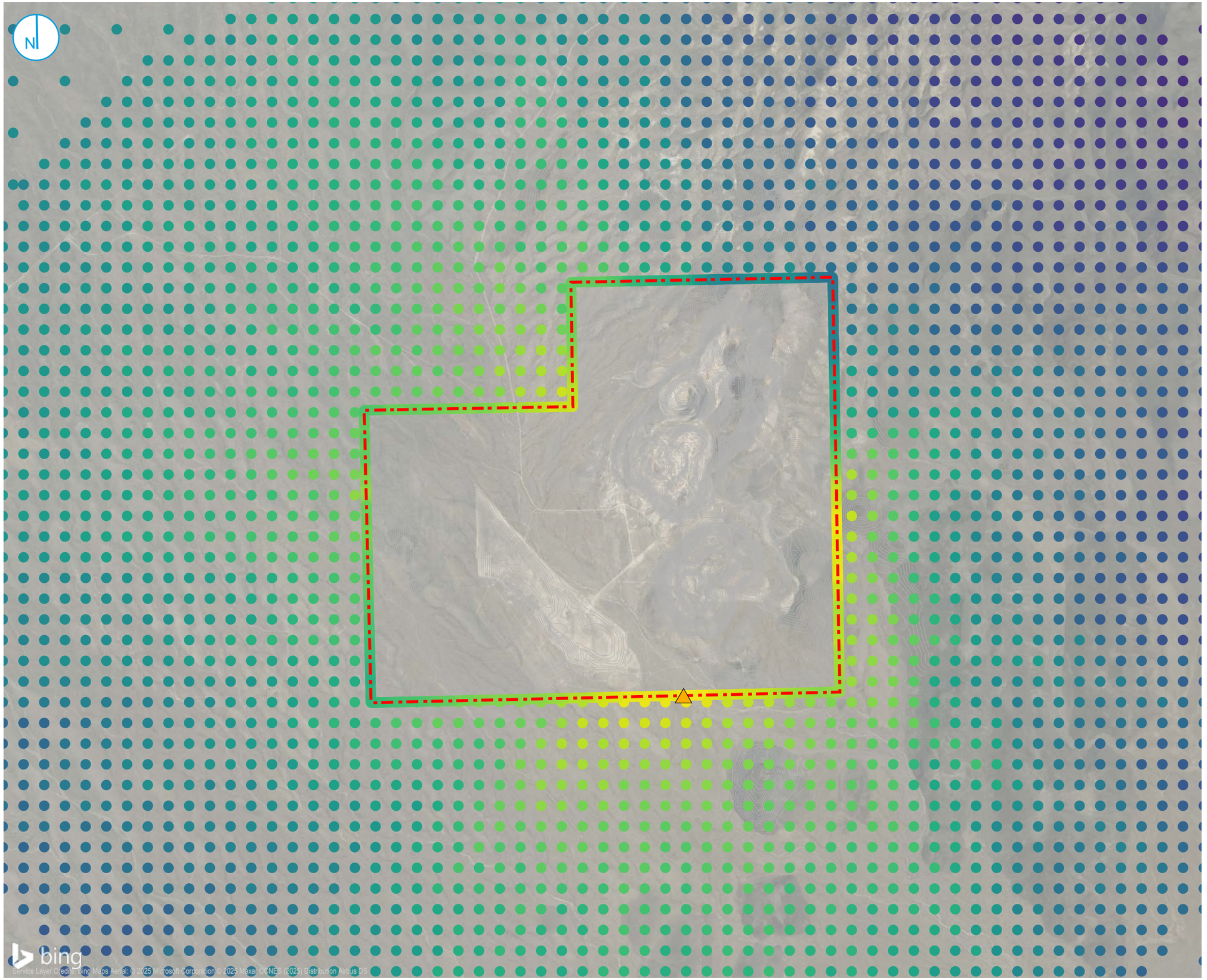
MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
NO_2, ANNUAL, MAXIMUM (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 18

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

3.3

100

0 1,500 3,000 Feet

0 500 1,000 Meters

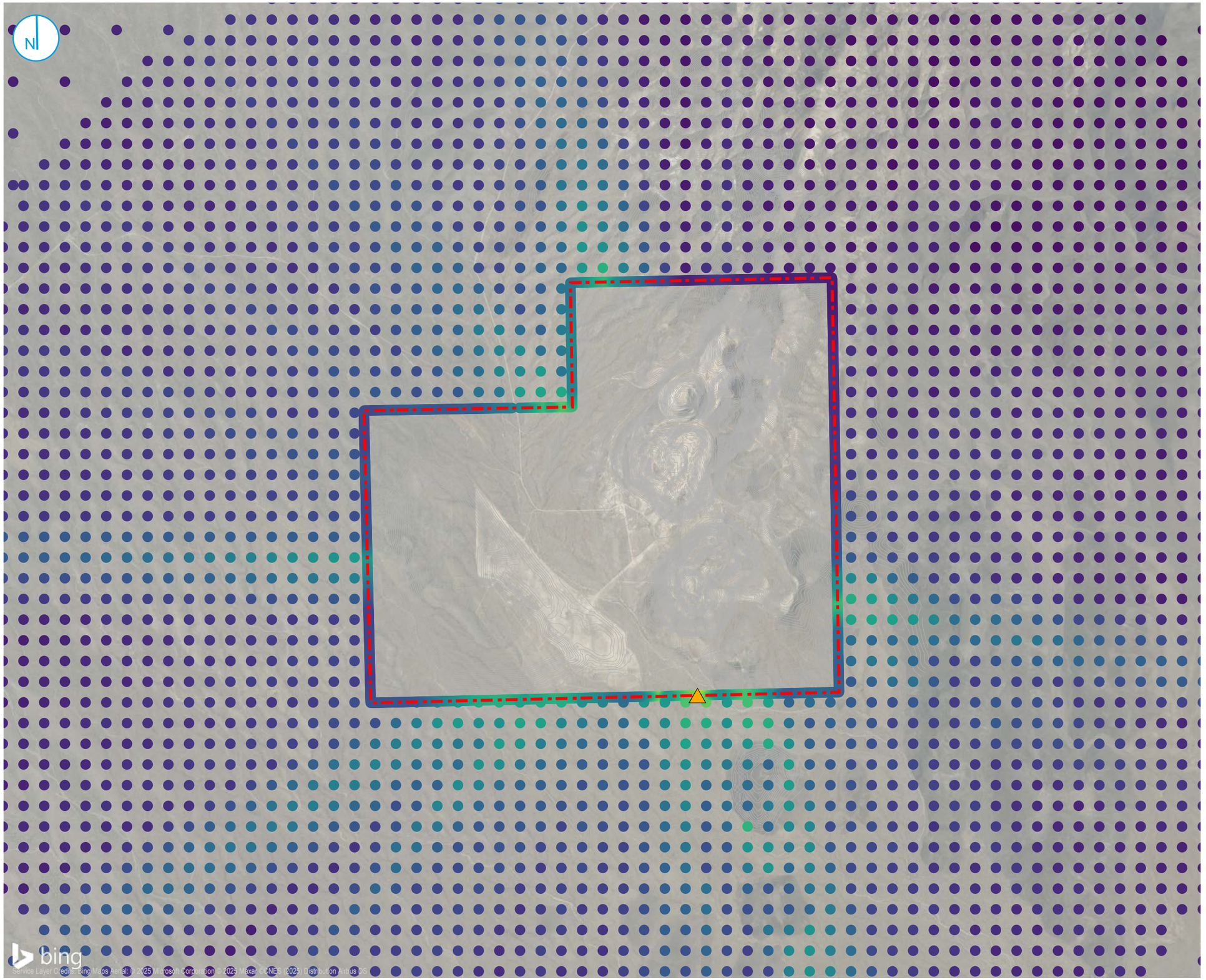
MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
NO_2, 1-HR 98TH PERCENTILE (NAAQS)

Castle Mountain Mine 2022
Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 19

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

25

3,200

0 1,500 3,000 Feet

0 500 1,000 Meters

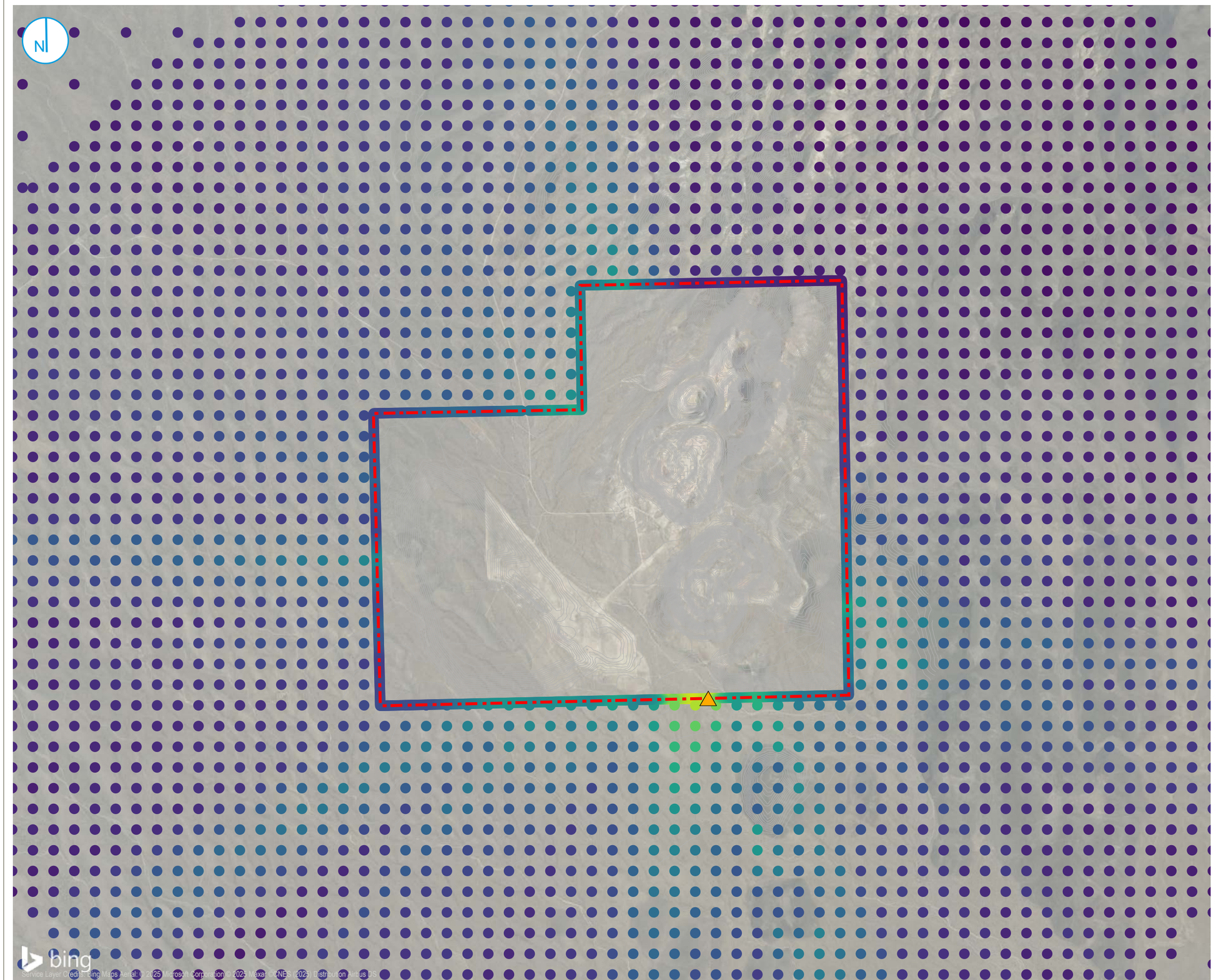
MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
CO, 1-HR 2ND HIGH (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 20

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

3.5

490

0 1,500 3,000 Feet

0 500 1,000 Meters

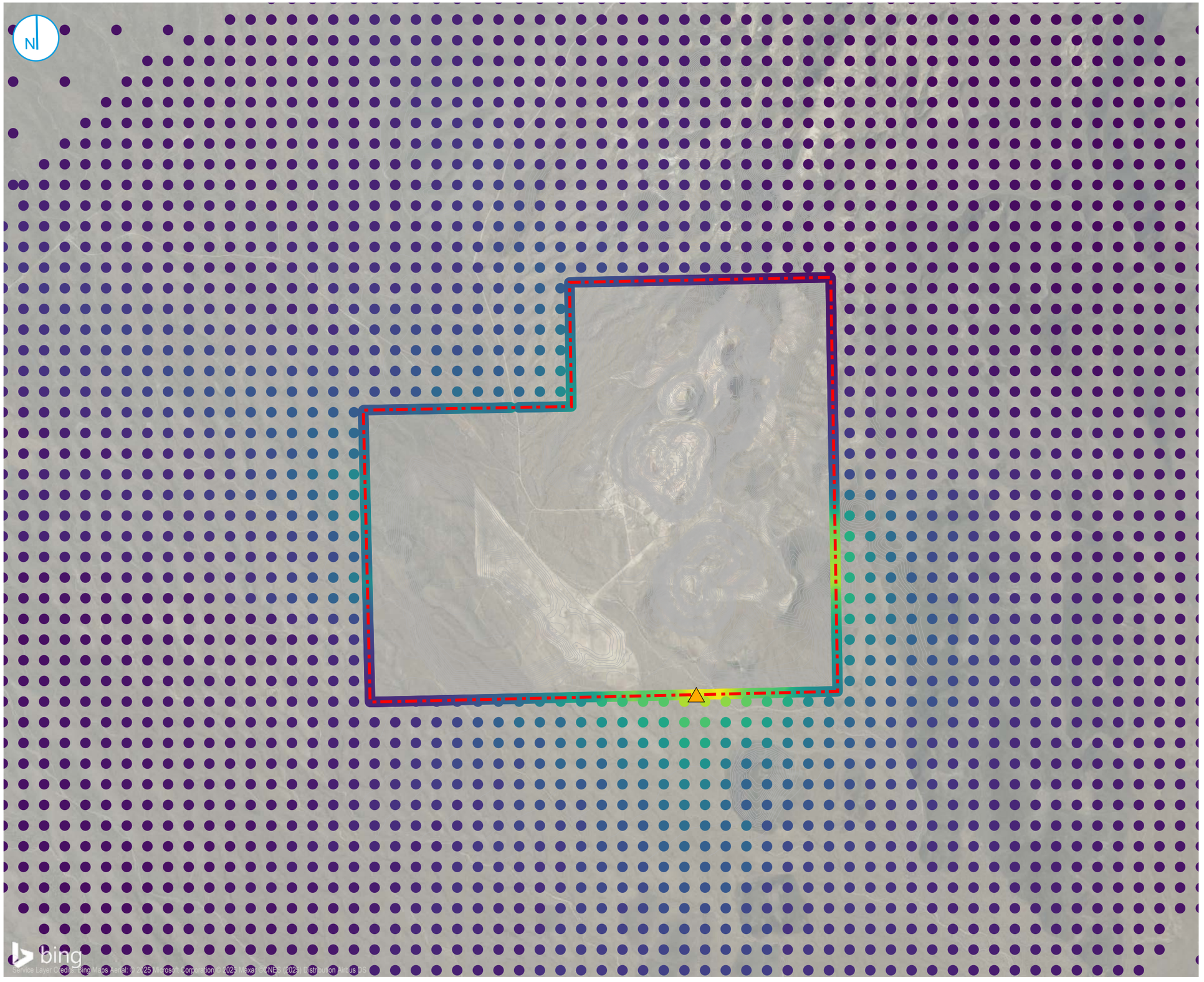
MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
CO, 8-HR 2ND HIGH (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 21

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

20

30

Notes

1. Maximum Modeled Concentration (Design Value) includes the background contribution.

0 1,500 3,000 Feet

0 500 1,000 Meters

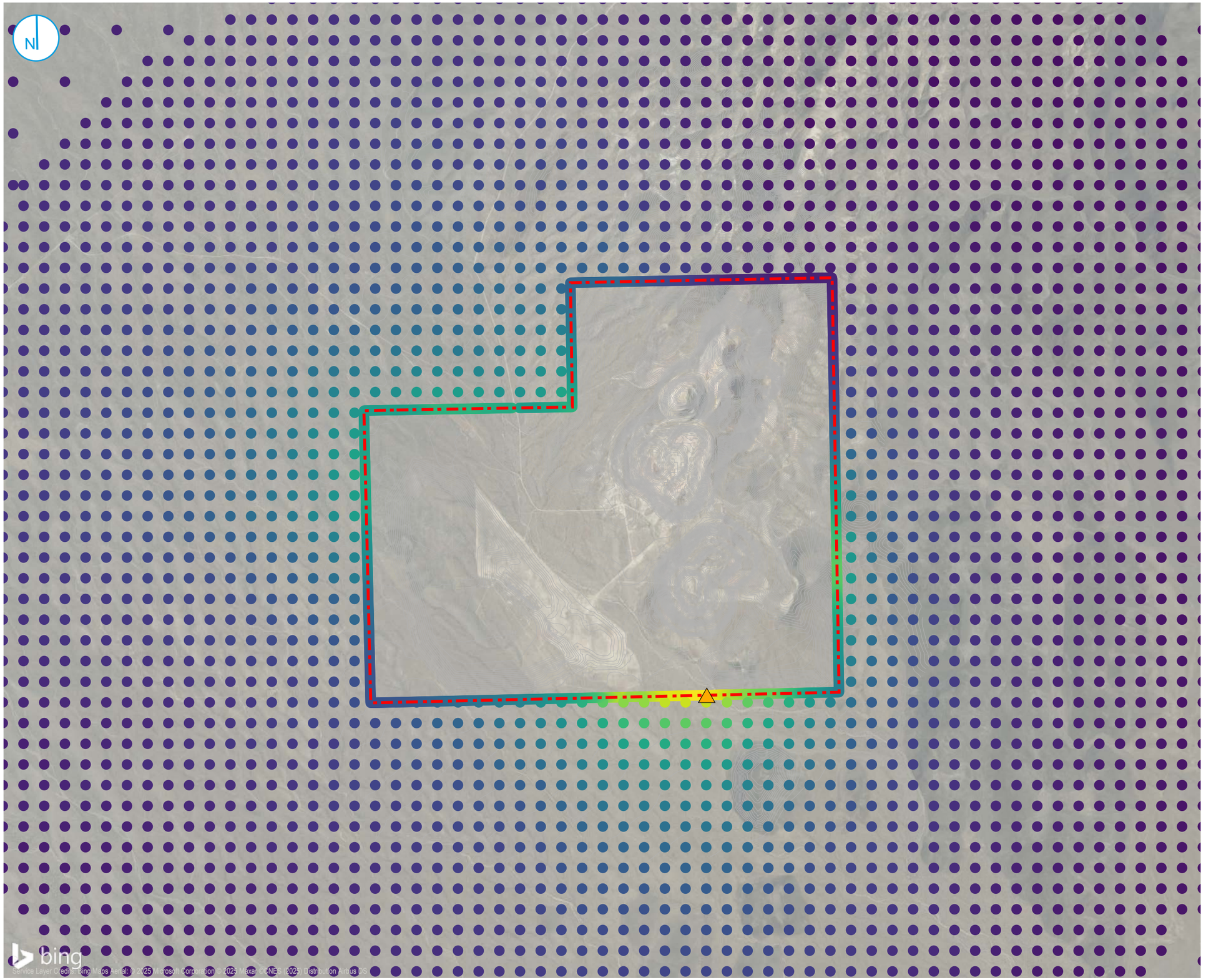
MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
PM_{10}, 24-HR 2ND HIGH (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 22

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.0072

1.6

0 1,500 3,000 Feet

0 500 1,000 Meters

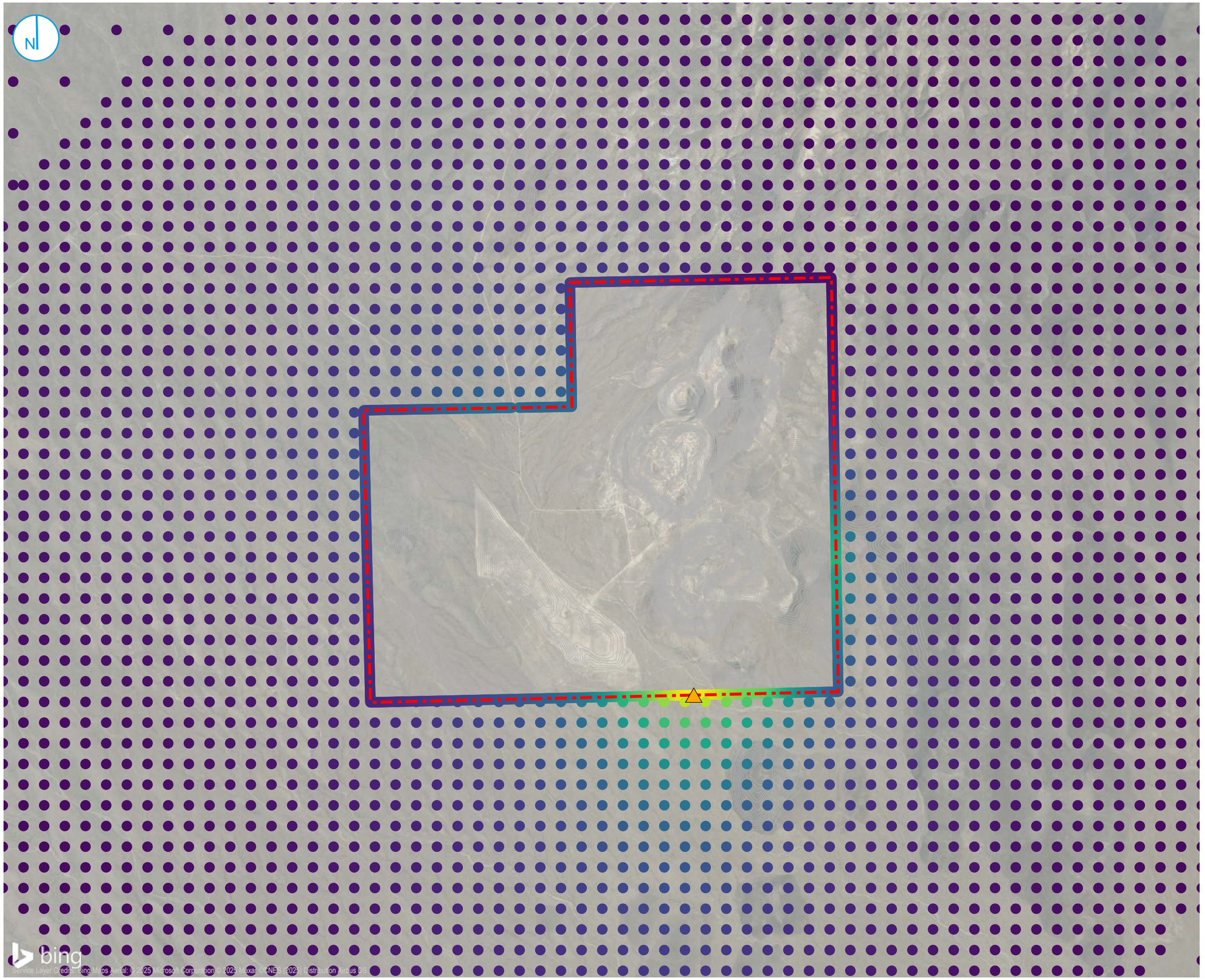
MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
$PM_{2.5}$, 24-HR 98TH PERCENTILE (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 23

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.0014

0.58

0 1,500 3,000 Feet

0 500 1,000 Meters

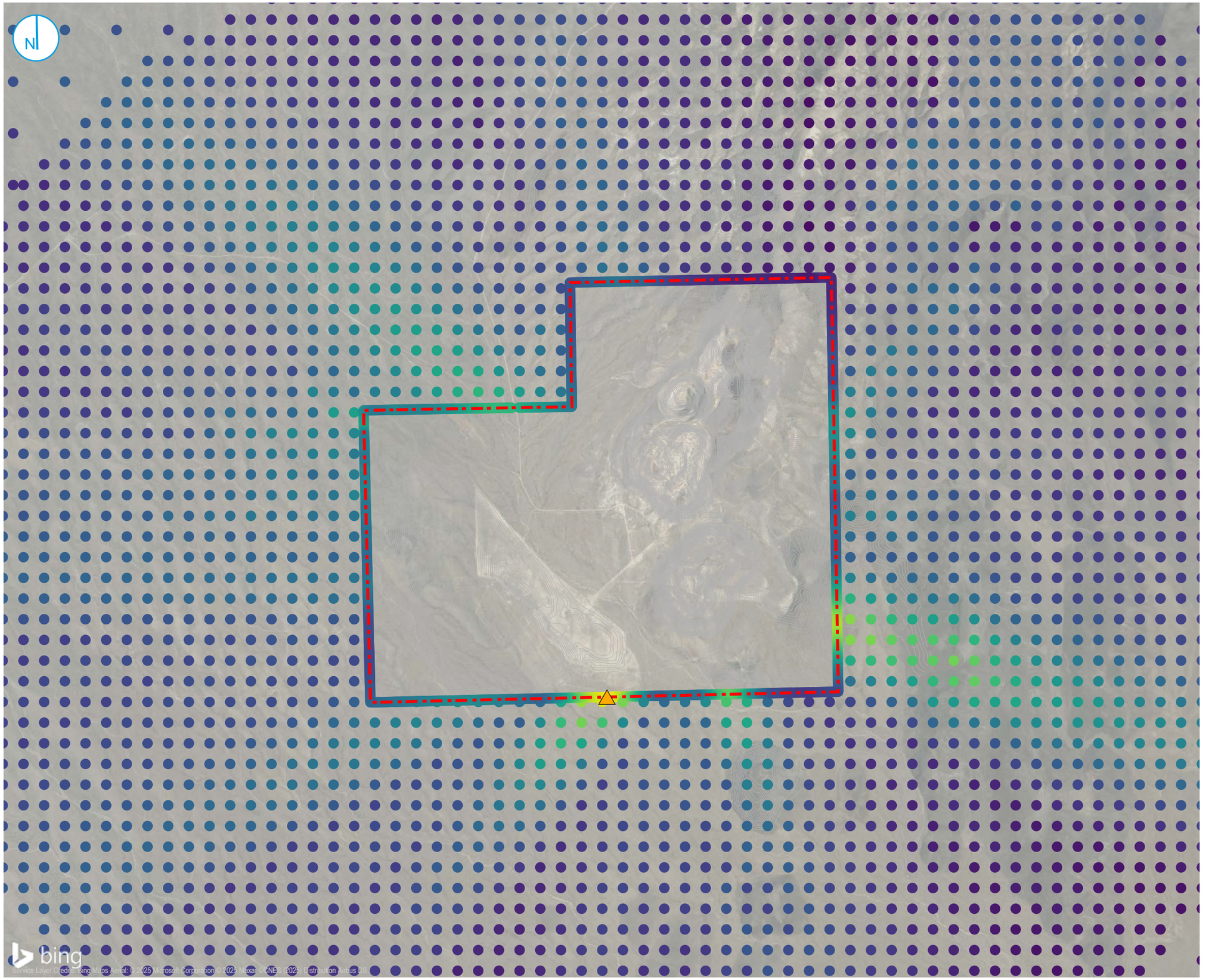
MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
$PM_{2.5}$, ANNUAL, MAXIMUM (NAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 24

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.011

0.92

0 1,500 3,000 Feet

0 500 1,000 Meters

MAXIMUM EMISSIONS SCENARIO

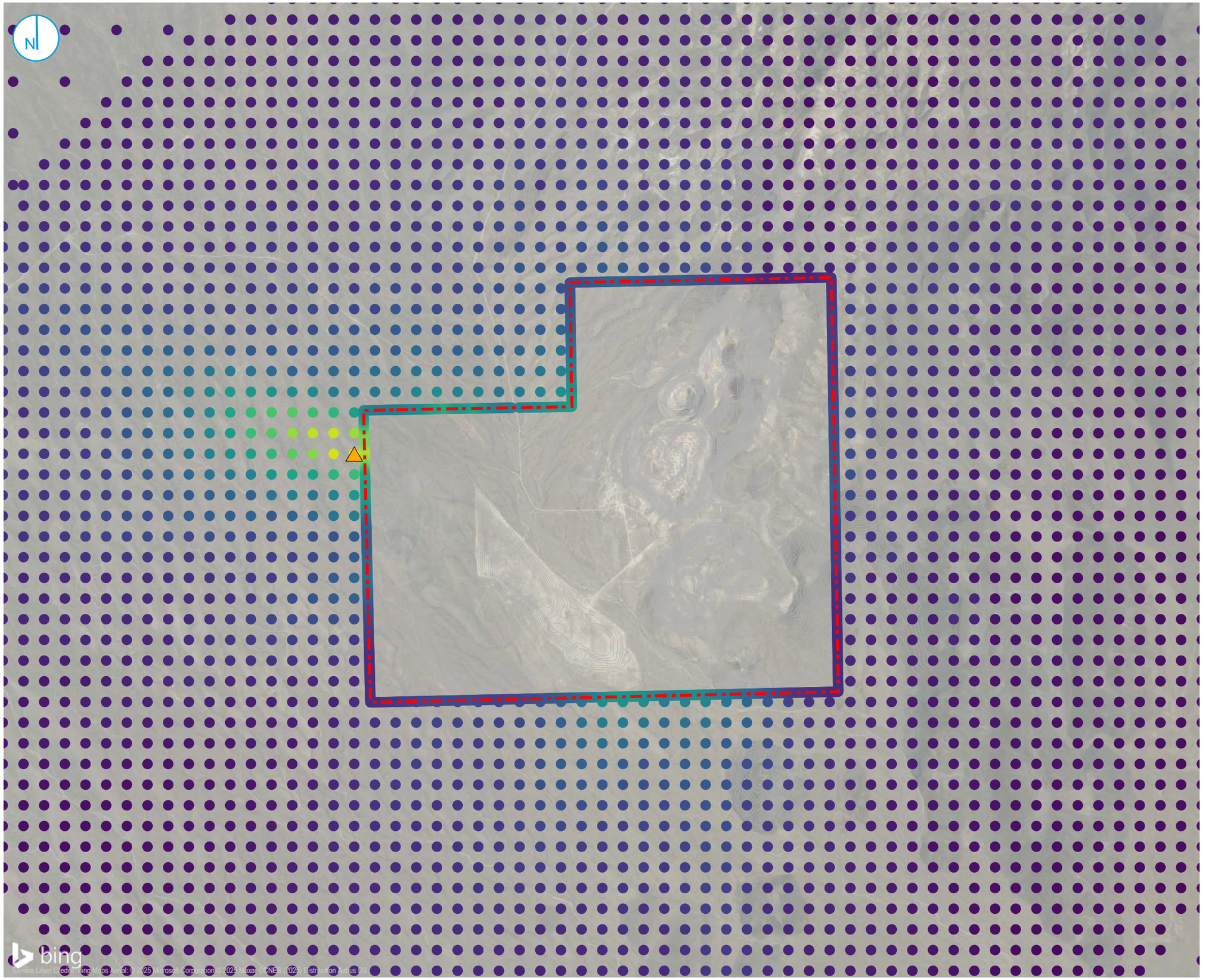
SO_2, 1-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 25

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.00034

0.10

0 1,500 3,000 Feet

0 500 1,000 Meters

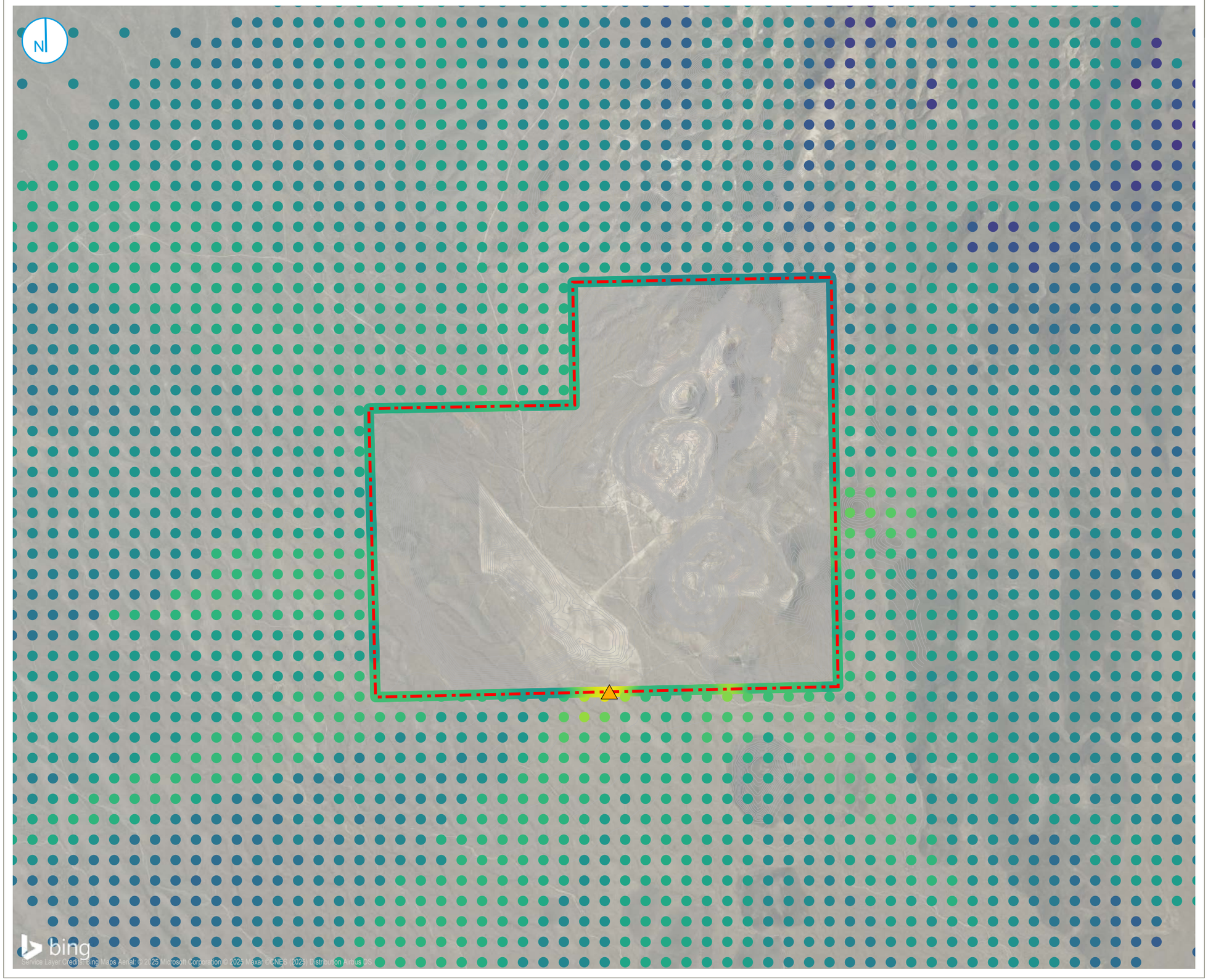
MAXIMUM EMISSIONS SCENARIO
SO_2, 24-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022
Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 26

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

13

160

0 1,500 3,000 Feet

0 500 1,000 Meters

MAXIMUM EMISSIONS SCENARIO

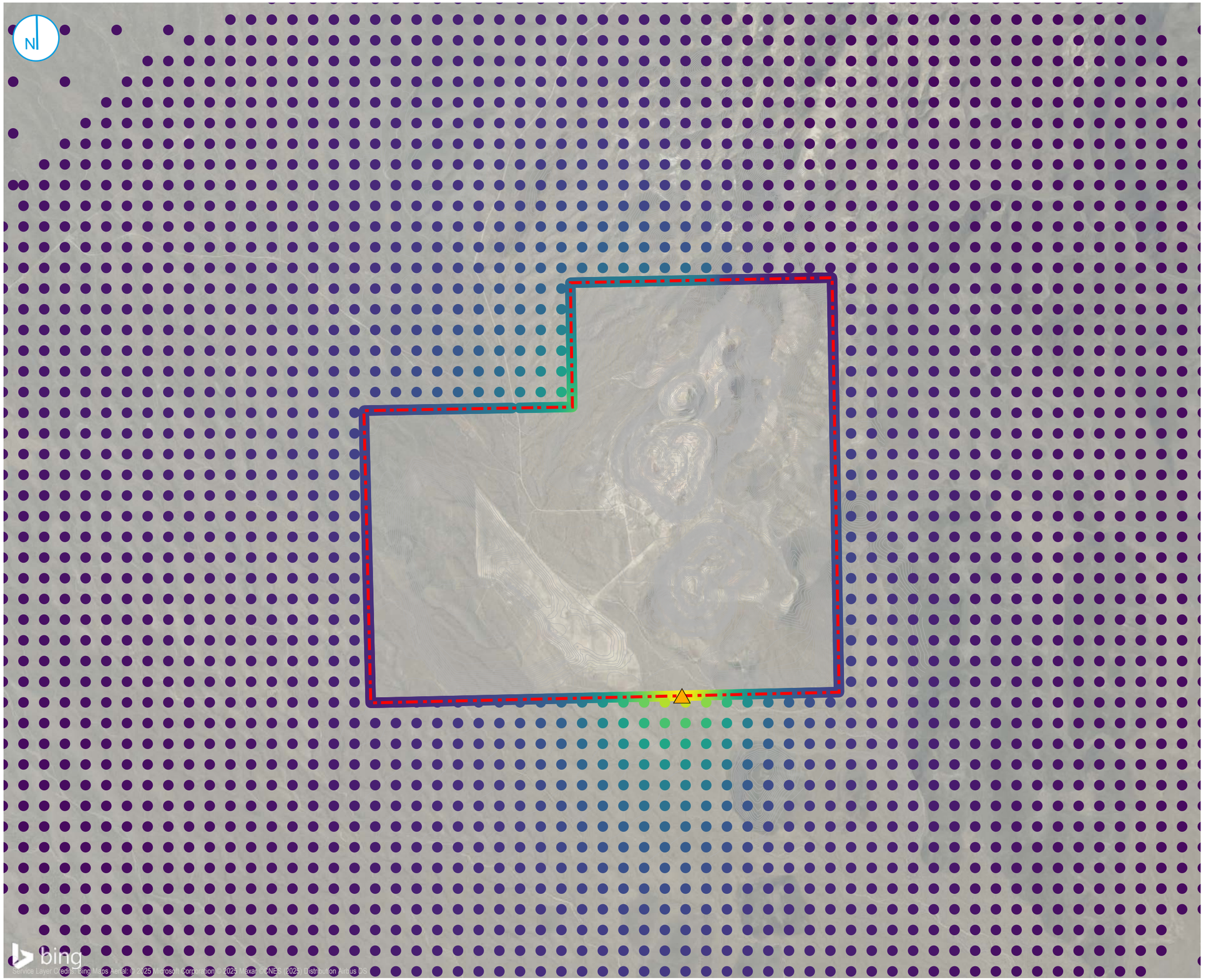
NO_2, 1-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022
Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 27

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.017

5.9

0 1,500 3,000 Feet

0 500 1,000 Meters

MAXIMUM EMISSIONS SCENARIO

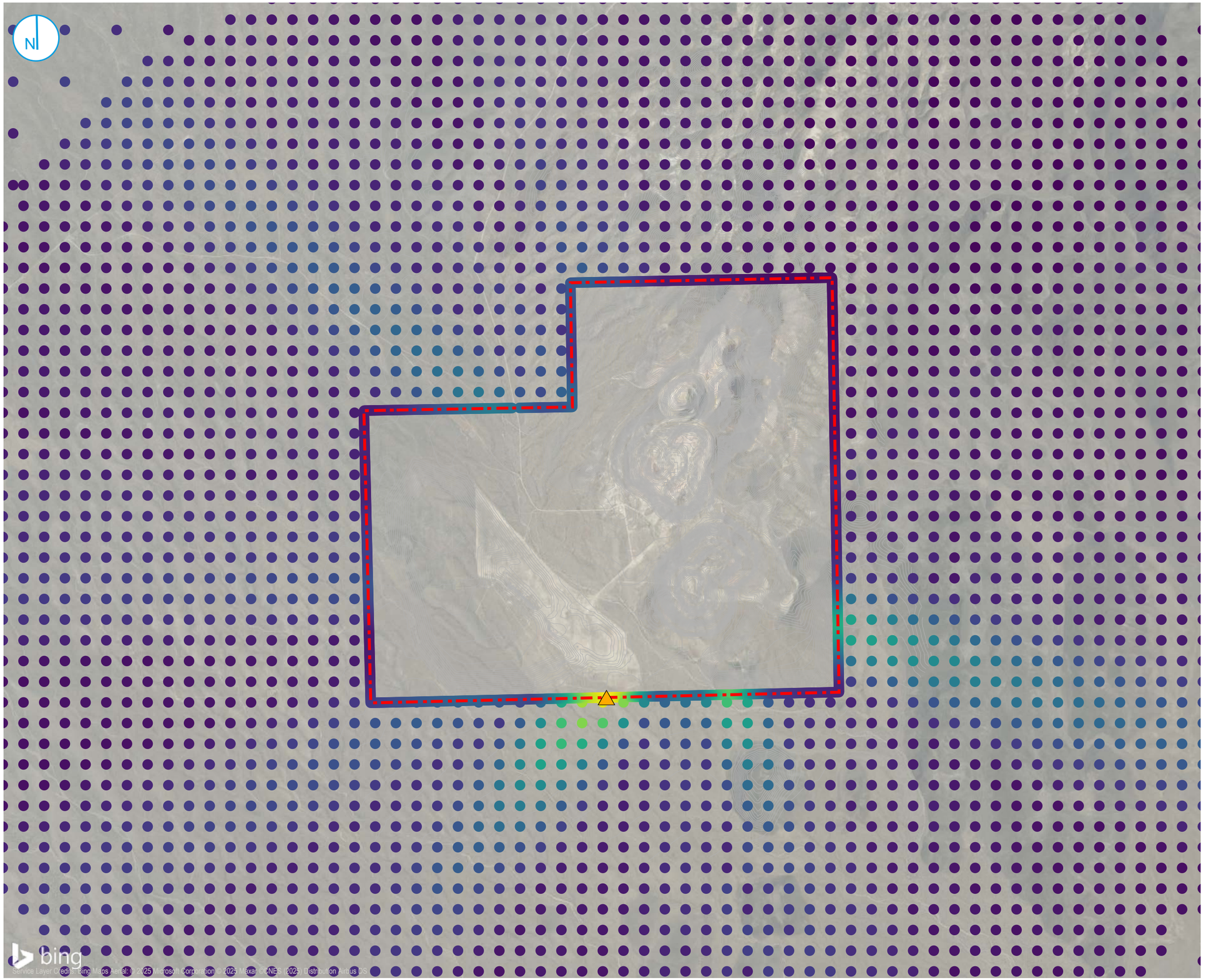
NO_2, ANNUAL, MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 28

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

49

9,000

0 1,500 3,000 Feet

0 500 1,000 Meters

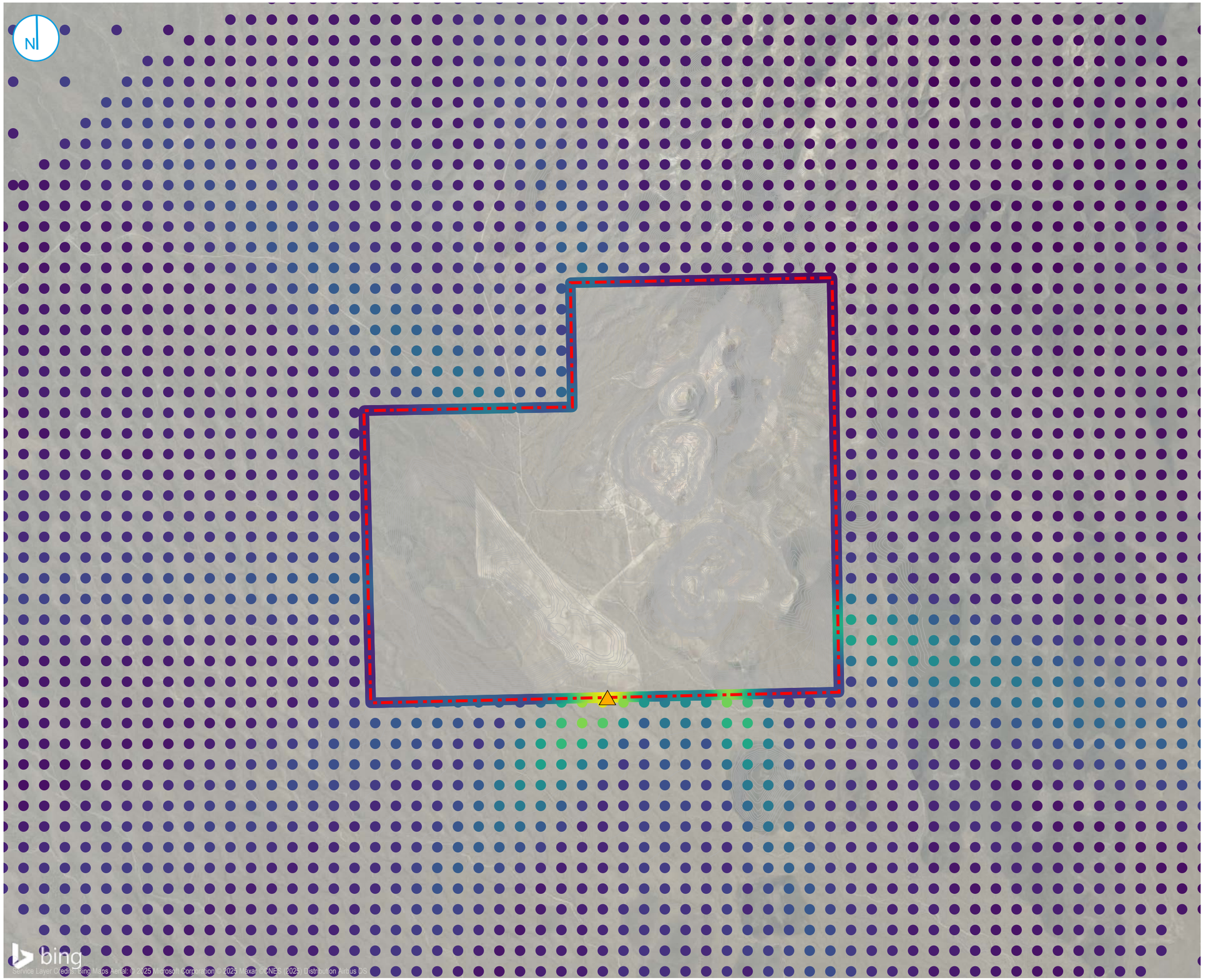
MAXIMUM EMISSIONS SCENARIO
CO, 1-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 29

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

6.9

1,100

0 1,500 3,000 Feet

0 500 1,000 Meters

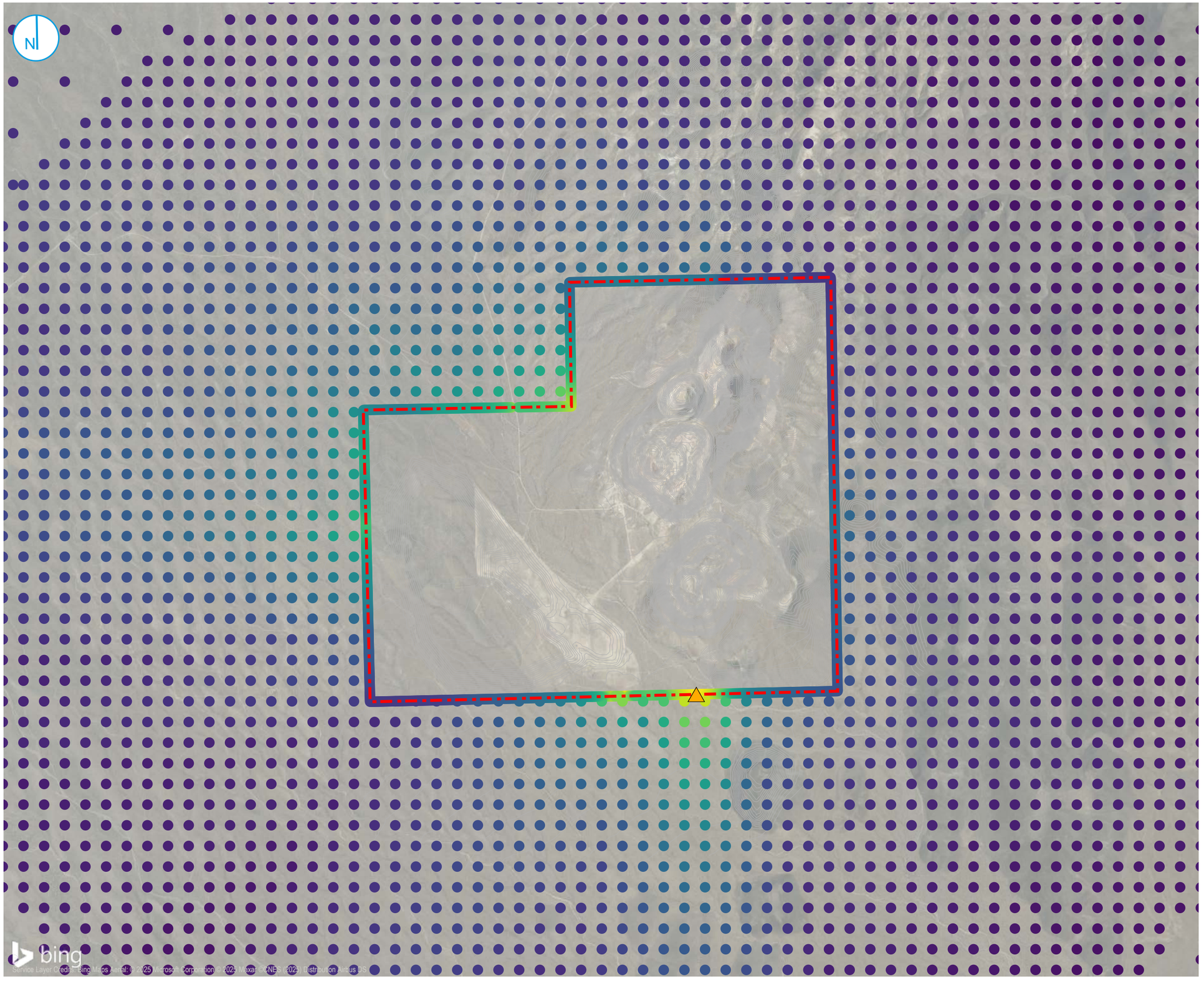
MAXIMUM EMISSIONS SCENARIO
CO, 8-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 30

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

20

30

Notes

1. Maximum Modeled Concentration (Design Value) includes the background contribution.

0 1,500 3,000 Feet

0 500 1,000 Meters

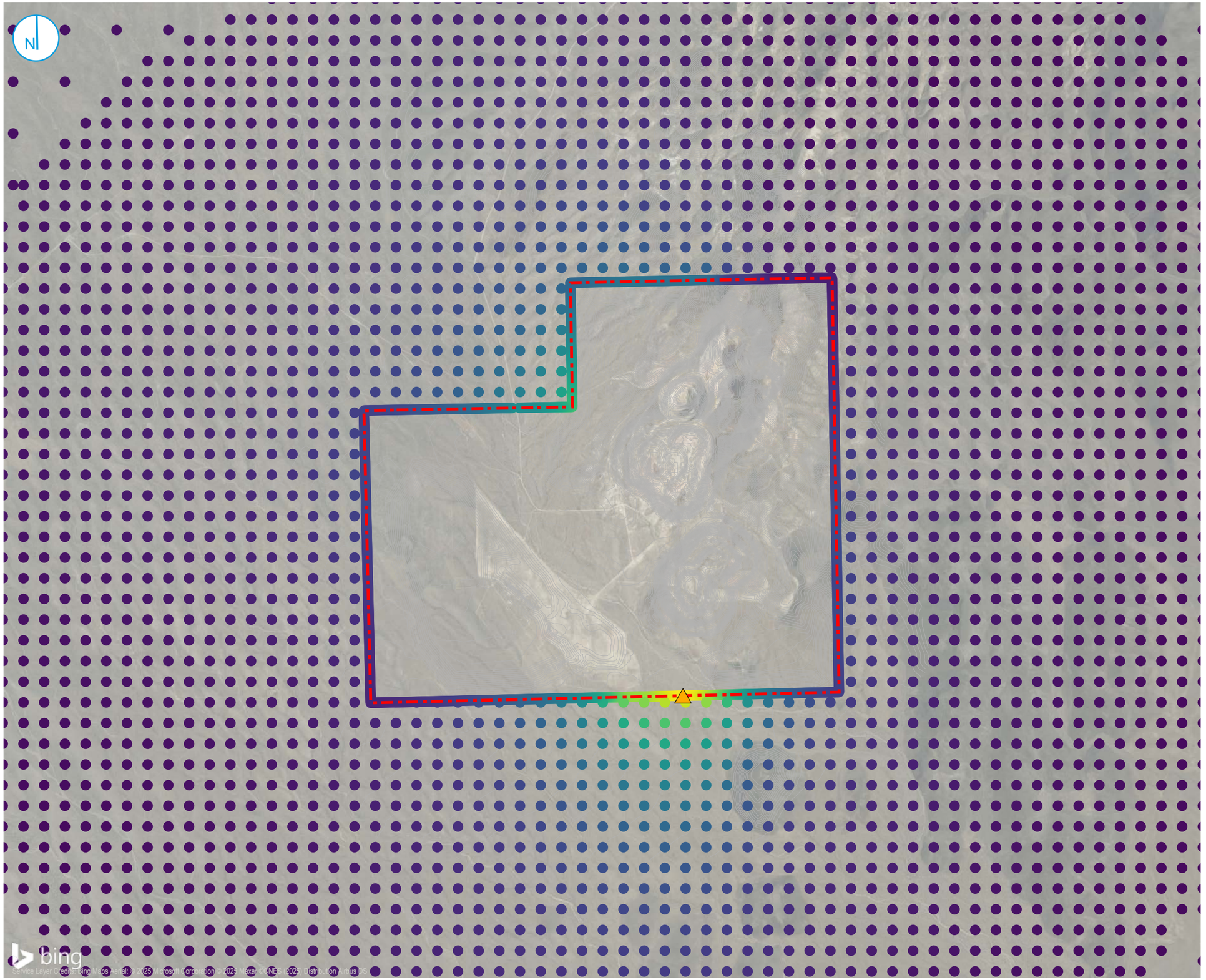
MAXIMUM EMISSIONS SCENARIO
PM_{10}, 24-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 31

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.0089

3.5

0 1,500 3,000 Feet

0 500 1,000 Meters

MAXIMUM EMISSIONS SCENARIO

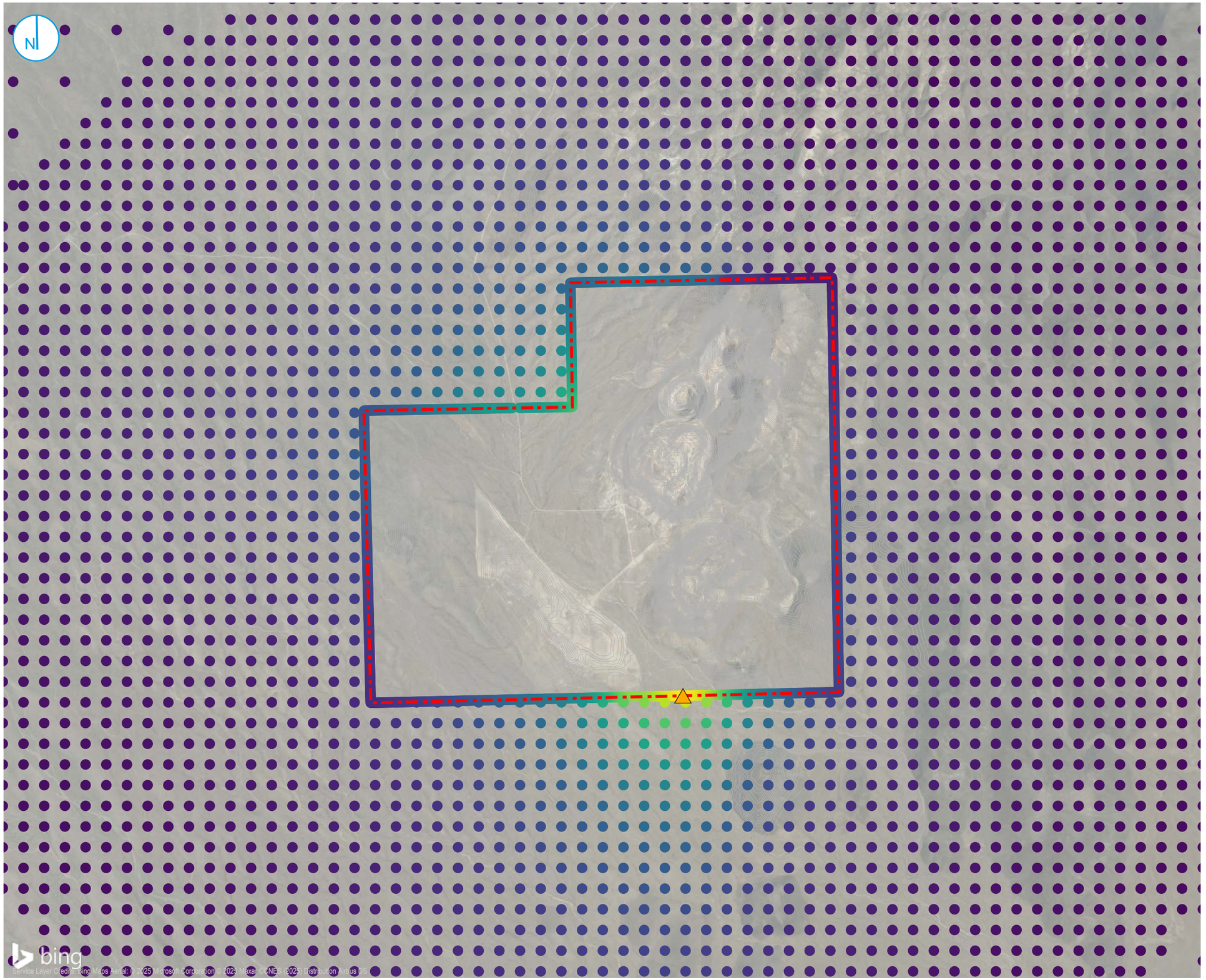
PM_{10}, ANNUAL, MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 32

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.0013

0.46

0 1,500 3,000 Feet

0 500 1,000 Meters

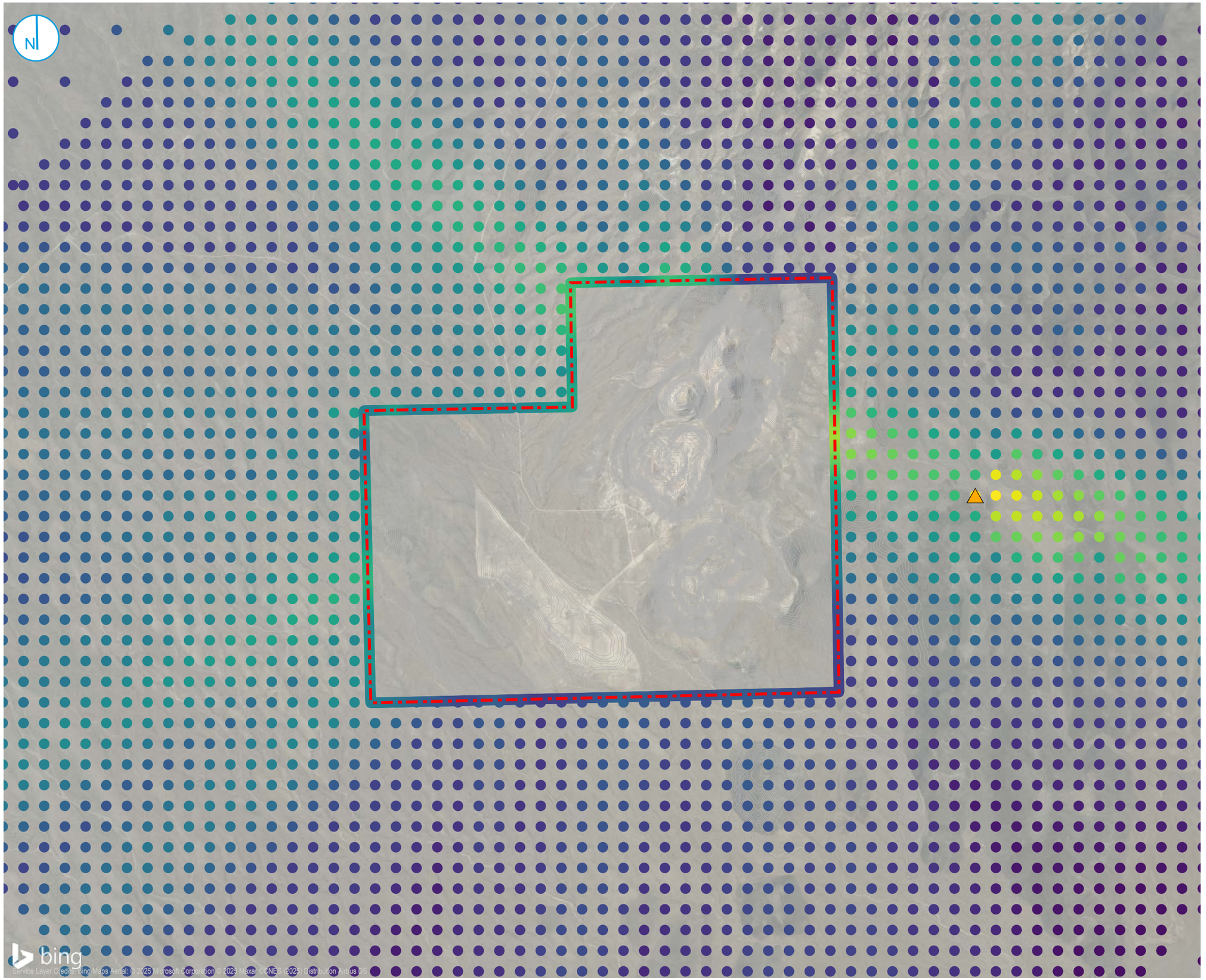
MAXIMUM EMISSIONS SCENARIO
$PM_{2.5}$, ANNUAL, MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 33

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.010

0.76

0 1,500 3,000 Feet

0 500 1,000 Meters

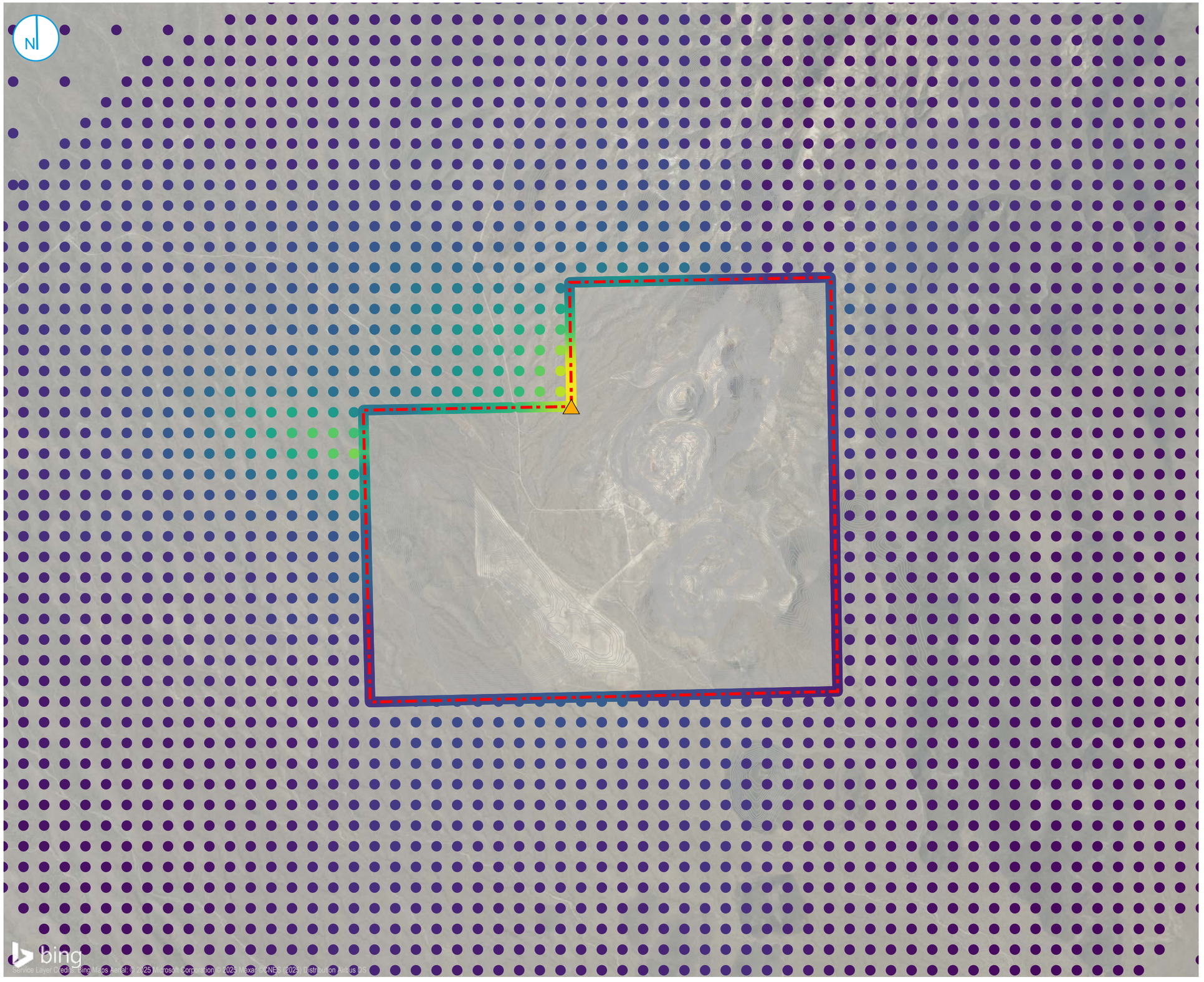
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
SO_2, 1-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 34

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.00034

0.11

0 1,500 3,000 Feet

0 500 1,000 Meters

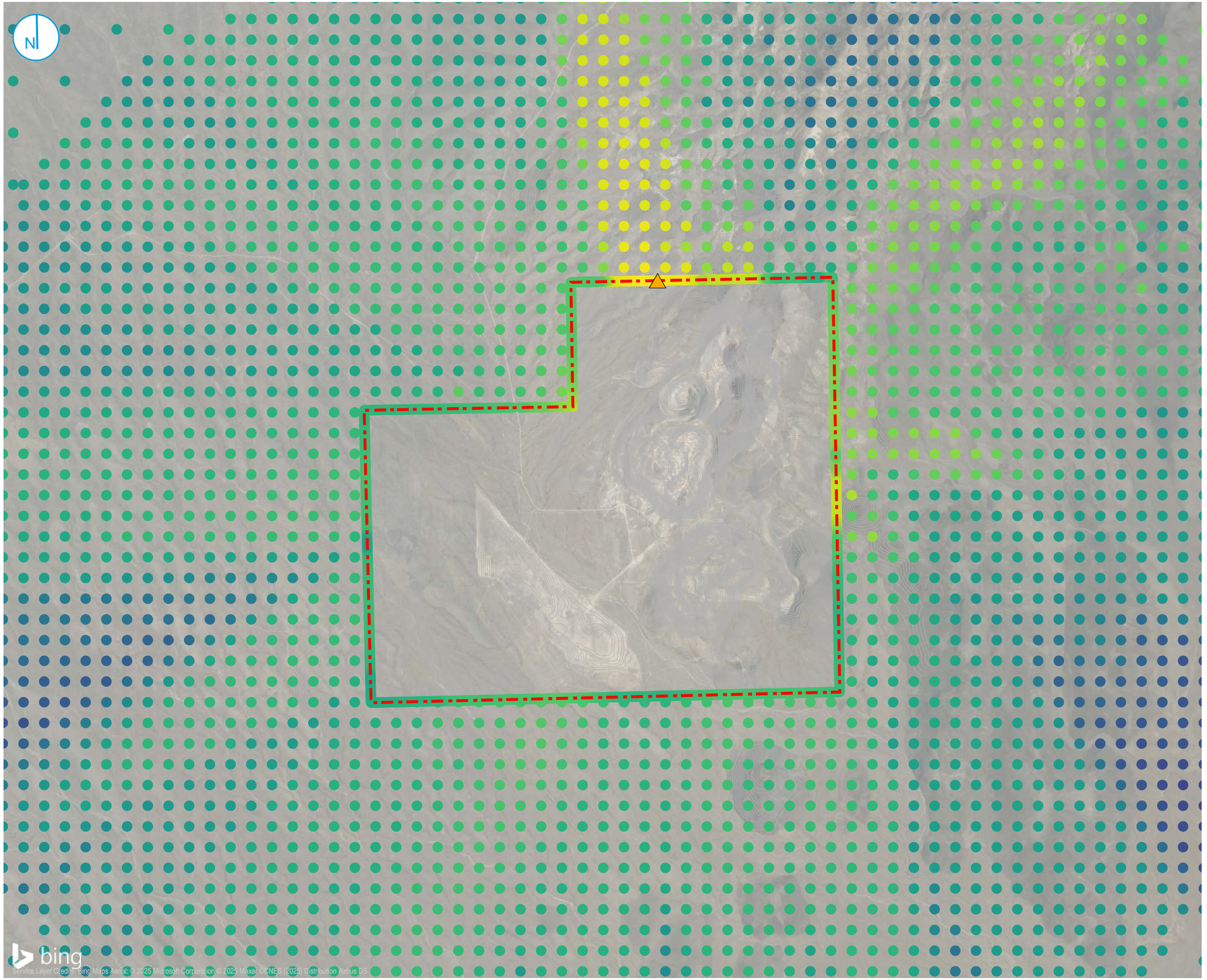
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
SO_2, 24-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022
Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 35

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

5.6

140

0 1,500 3,000 Feet

0 500 1,000 Meters

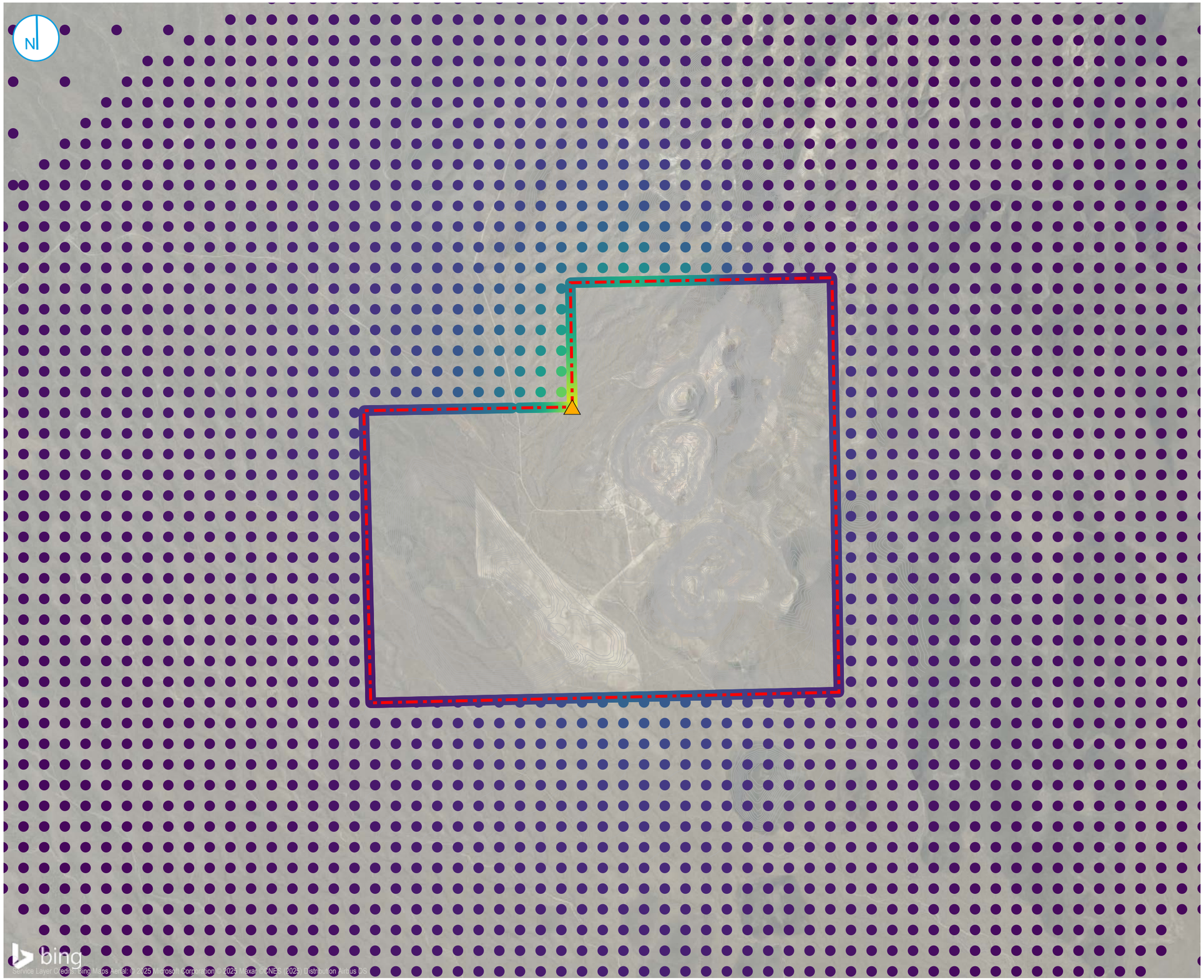
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
NO_2, 1-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022
Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 36

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.017

8.0

0 1,500 3,000 Feet

0 500 1,000 Meters

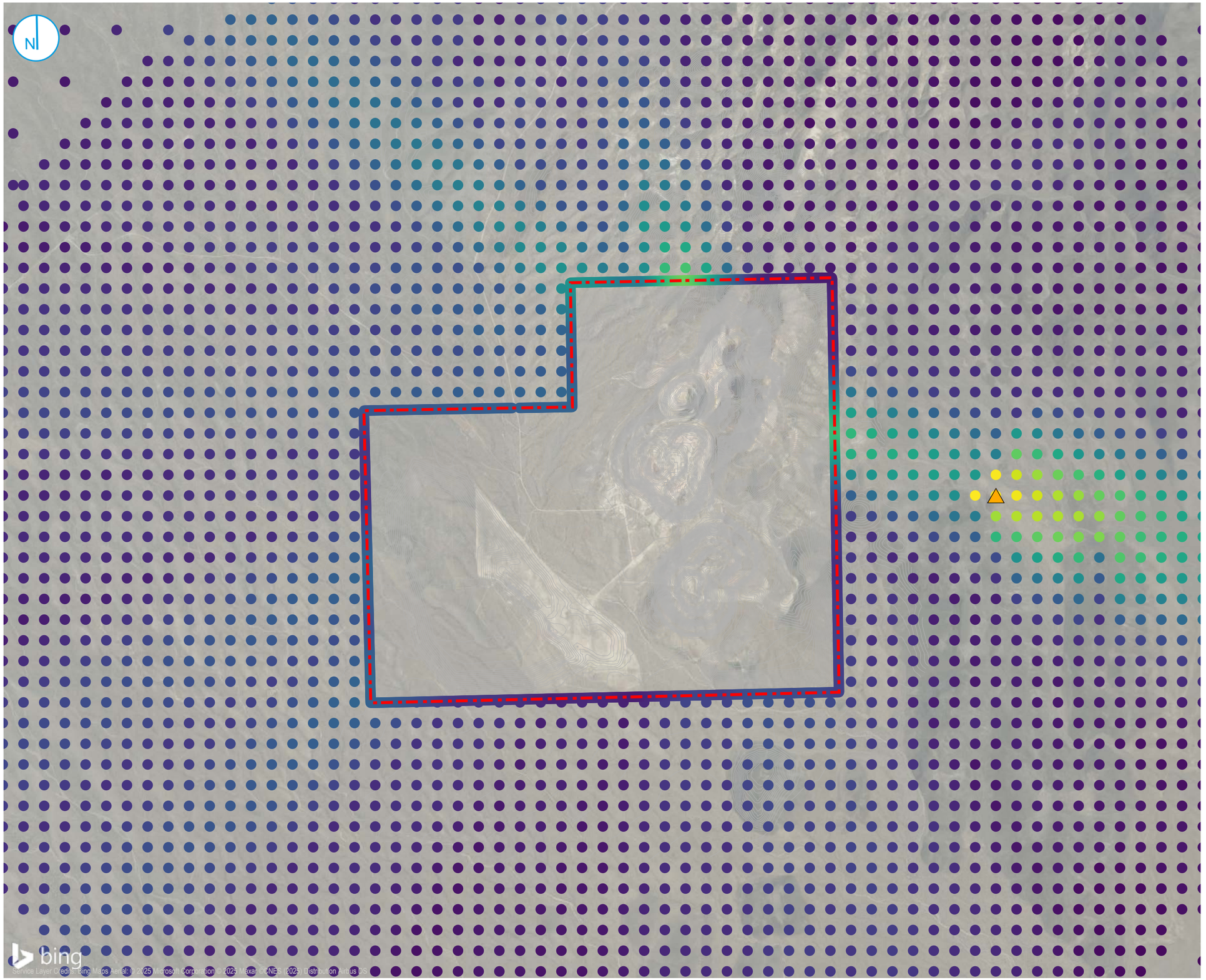
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
NO_2, ANNUAL, MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 37

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

46

6,200

0 1,500 3,000 Feet

0 500 1,000 Meters

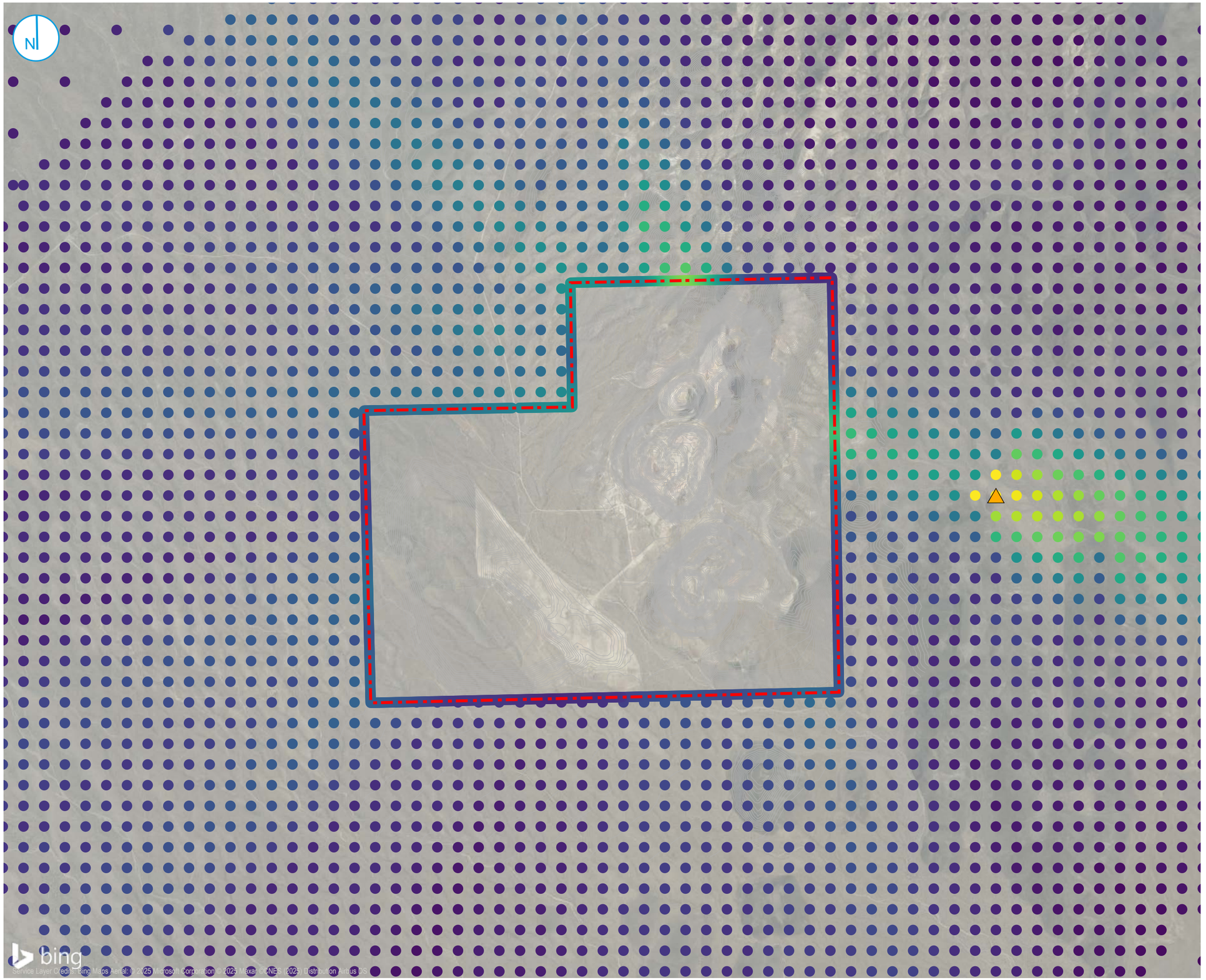
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
CO, 1-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 38

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

6.4

780

0 1,500 3,000 Feet

0 500 1,000 Meters

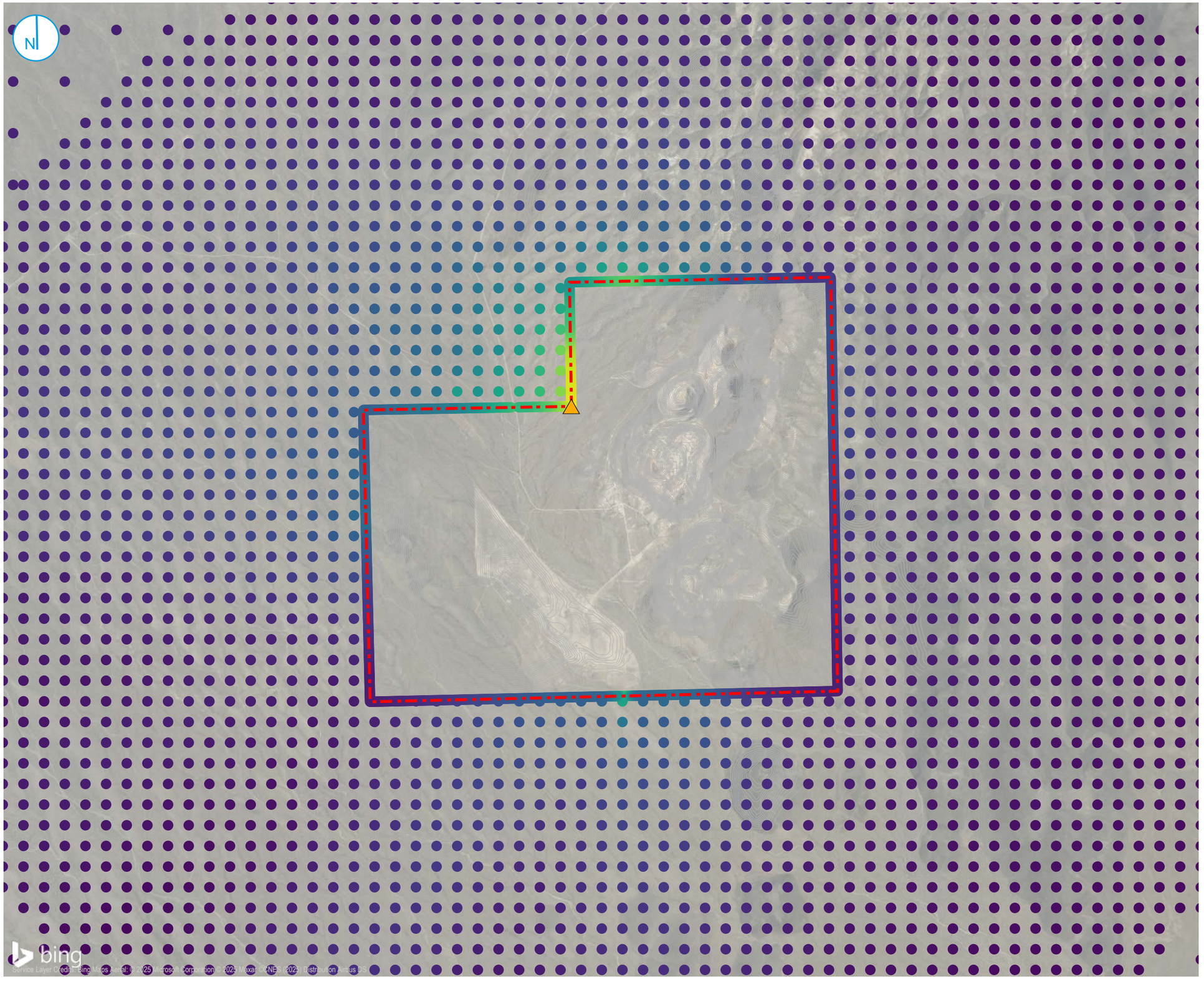
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
CO, 8-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 39

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

20

35

Notes

1. Maximum Modeled Concentration (Design Value) includes the background contribution.

0 1,500 3,000 Feet

0 500 1,000 Meters

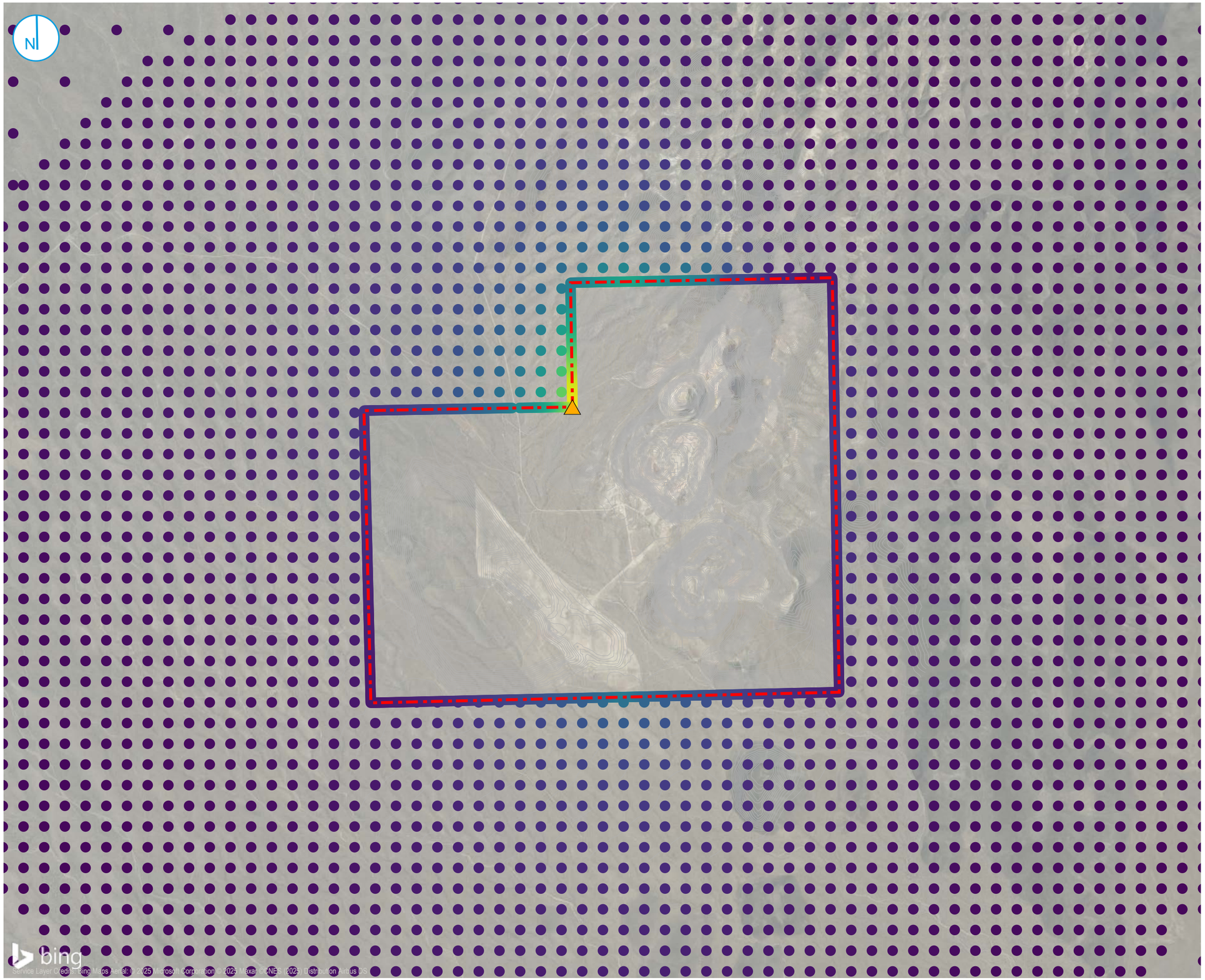
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
PM_{10}, 24-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 40

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.0092

5.3

0 1,500 3,000 Feet

0 500 1,000 Meters

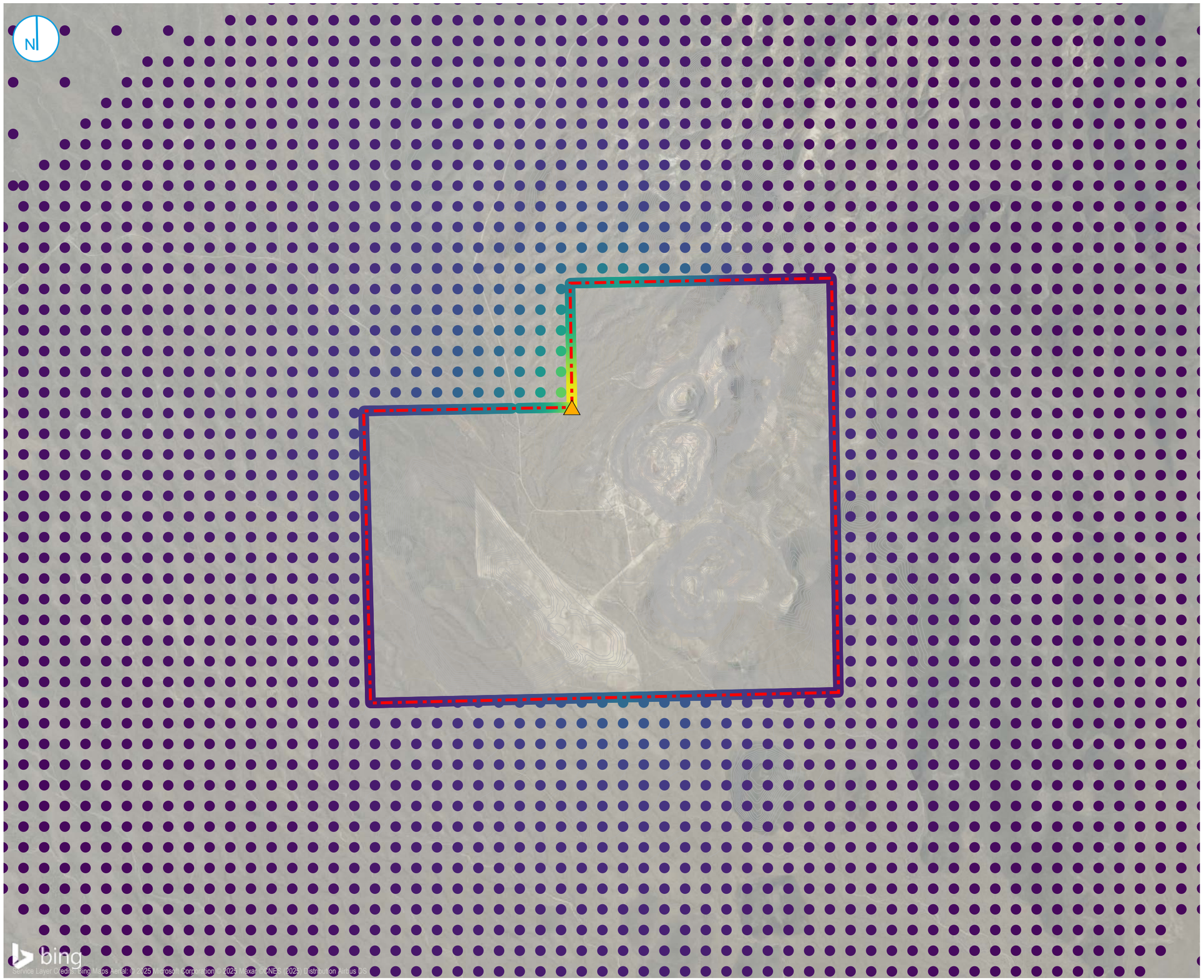
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
PM_{10}, ANNUAL, MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 41

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.0013

0.76

0 1,500 3,000 Feet

0 500 1,000 Meters

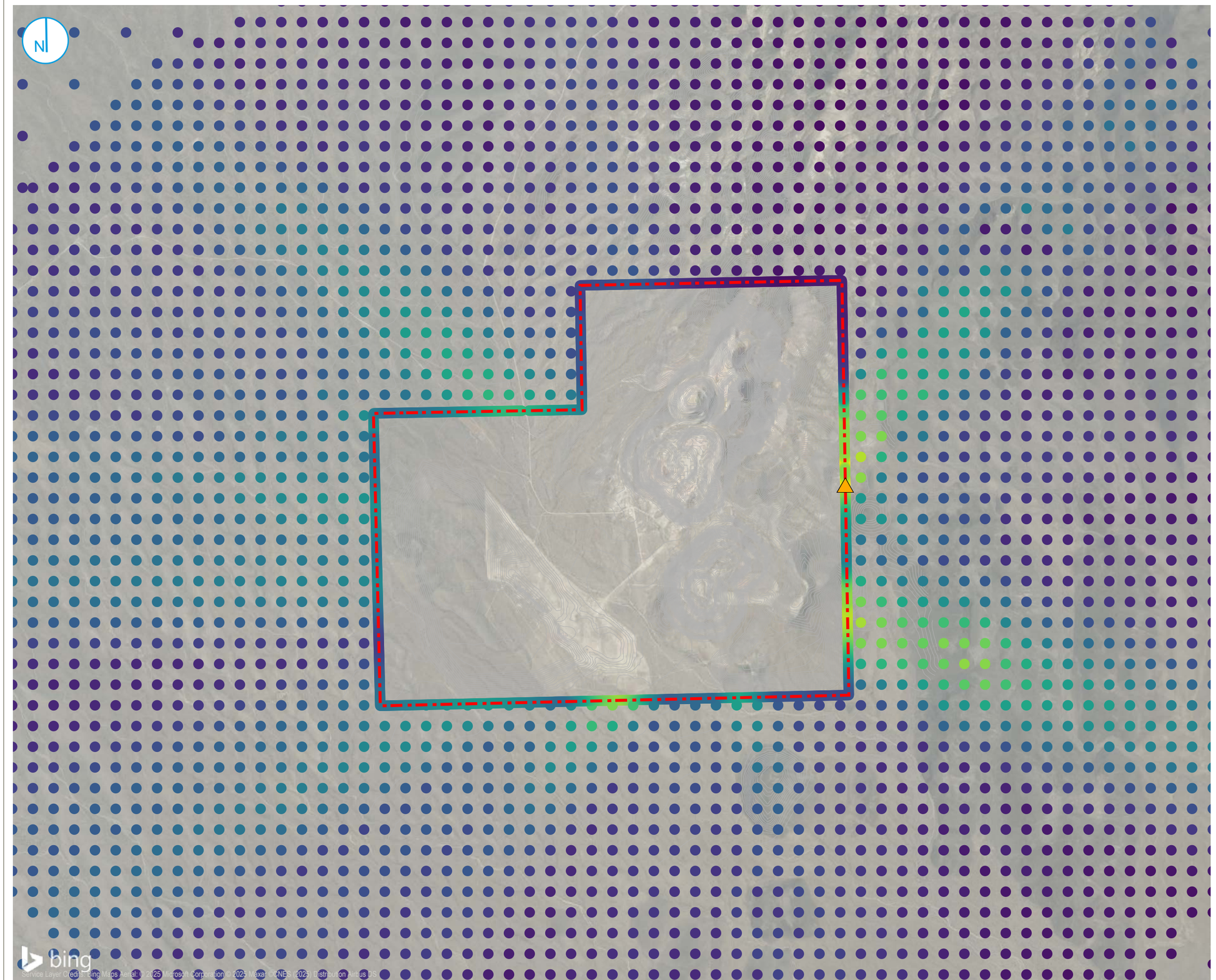
MAXIMUM EMISSIONS SCENARIO
ASSUMED NORTH OPERATIONS
$PM_{2.5}$, ANNUAL, MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 42

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.011

1.2

0 1,500 3,000 Feet

0 500 1,000 Meters

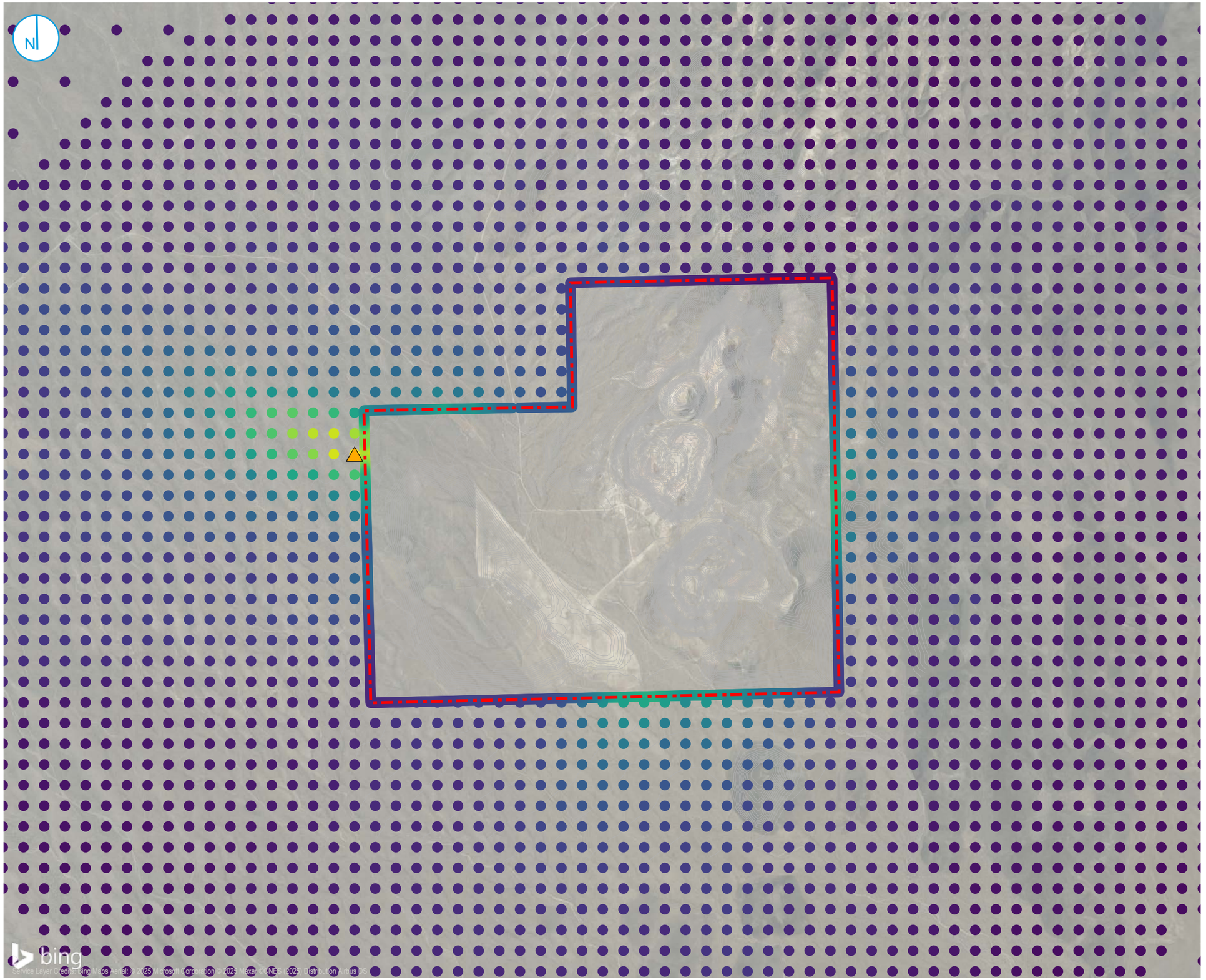
MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
SO_2, 1-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 43

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.00035

0.11

0 1,500 3,000 Feet

0 500 1,000 Meters

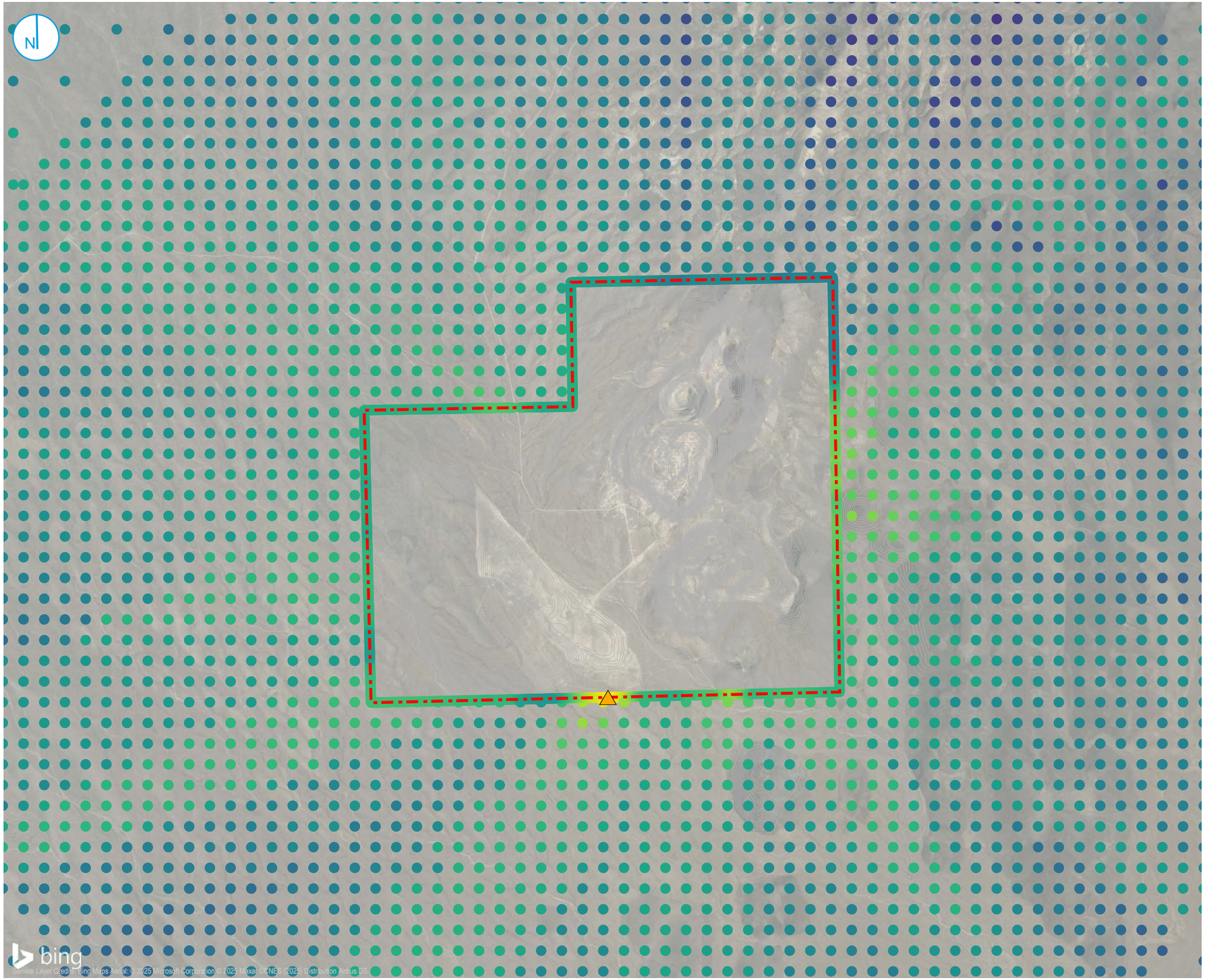
MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
SO_2, 24-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 44

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

13

170

0 1,500 3,000 Feet

0 500 1,000 Meters

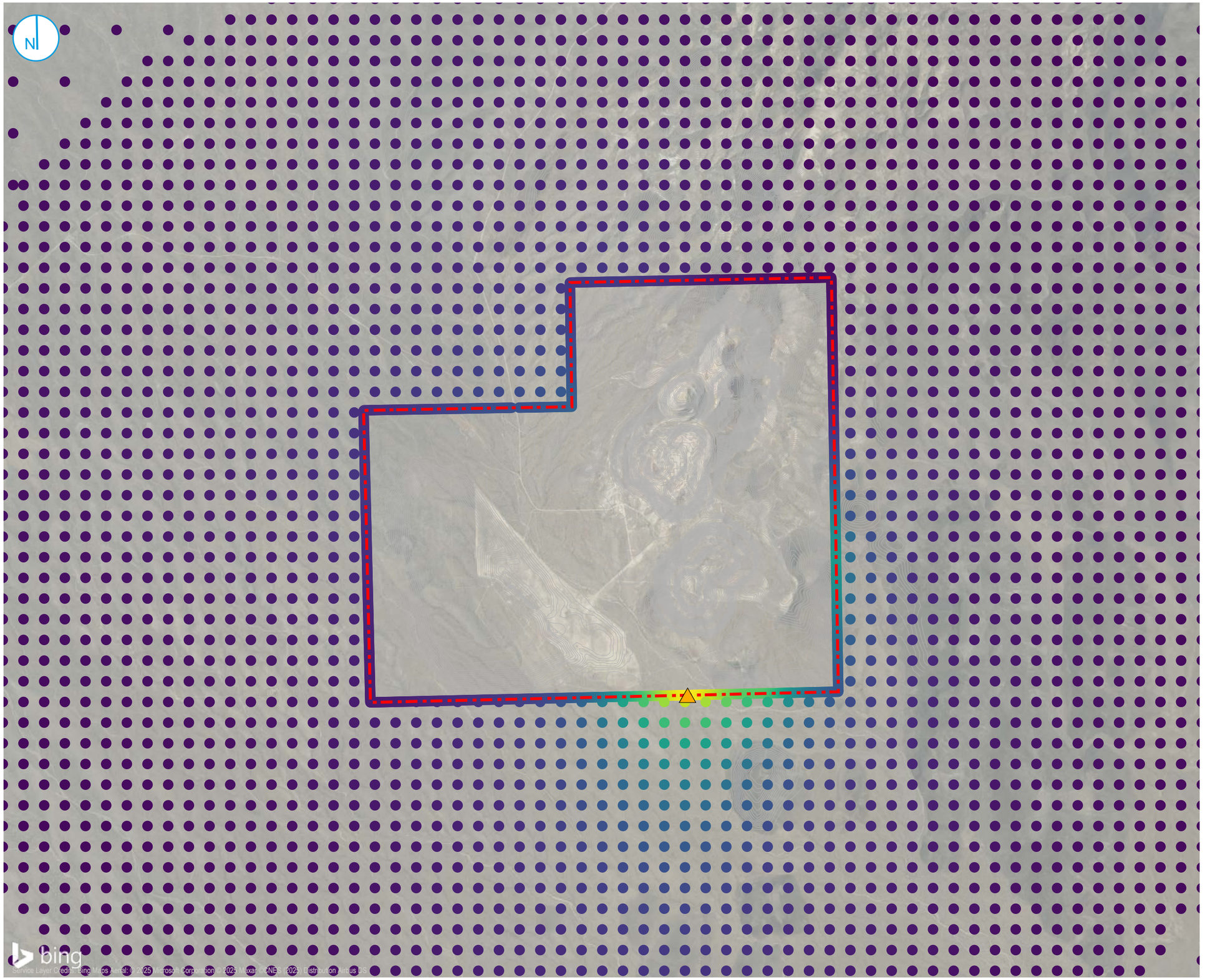
MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
NO_2, 1-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022
Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 45

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.017

7.5

0 1,500 3,000 Feet

0 500 1,000 Meters

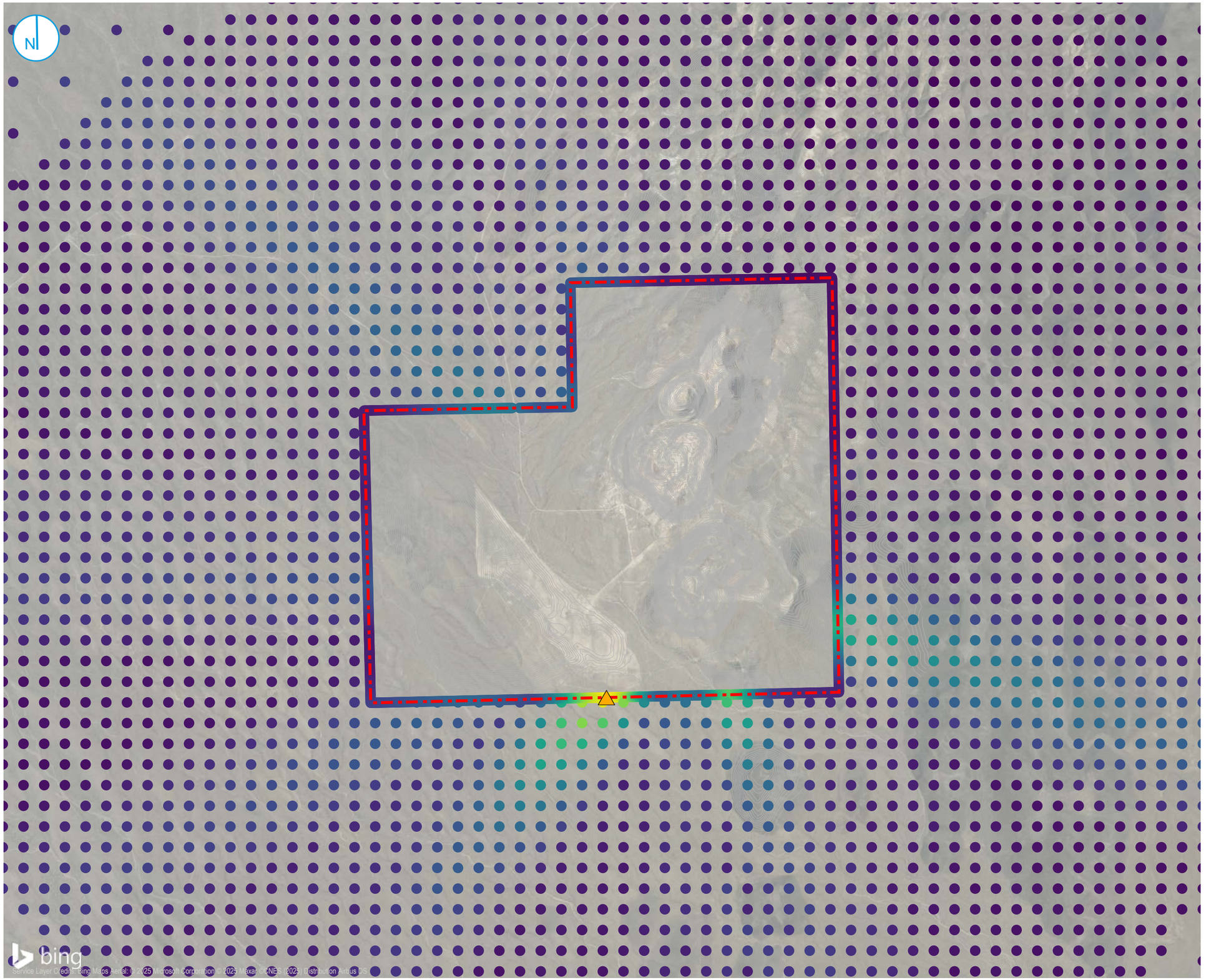
MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
NO_2, ANNUAL, MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 46

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

49

9,000

0 1,500 3,000 Feet

0 500 1,000 Meters

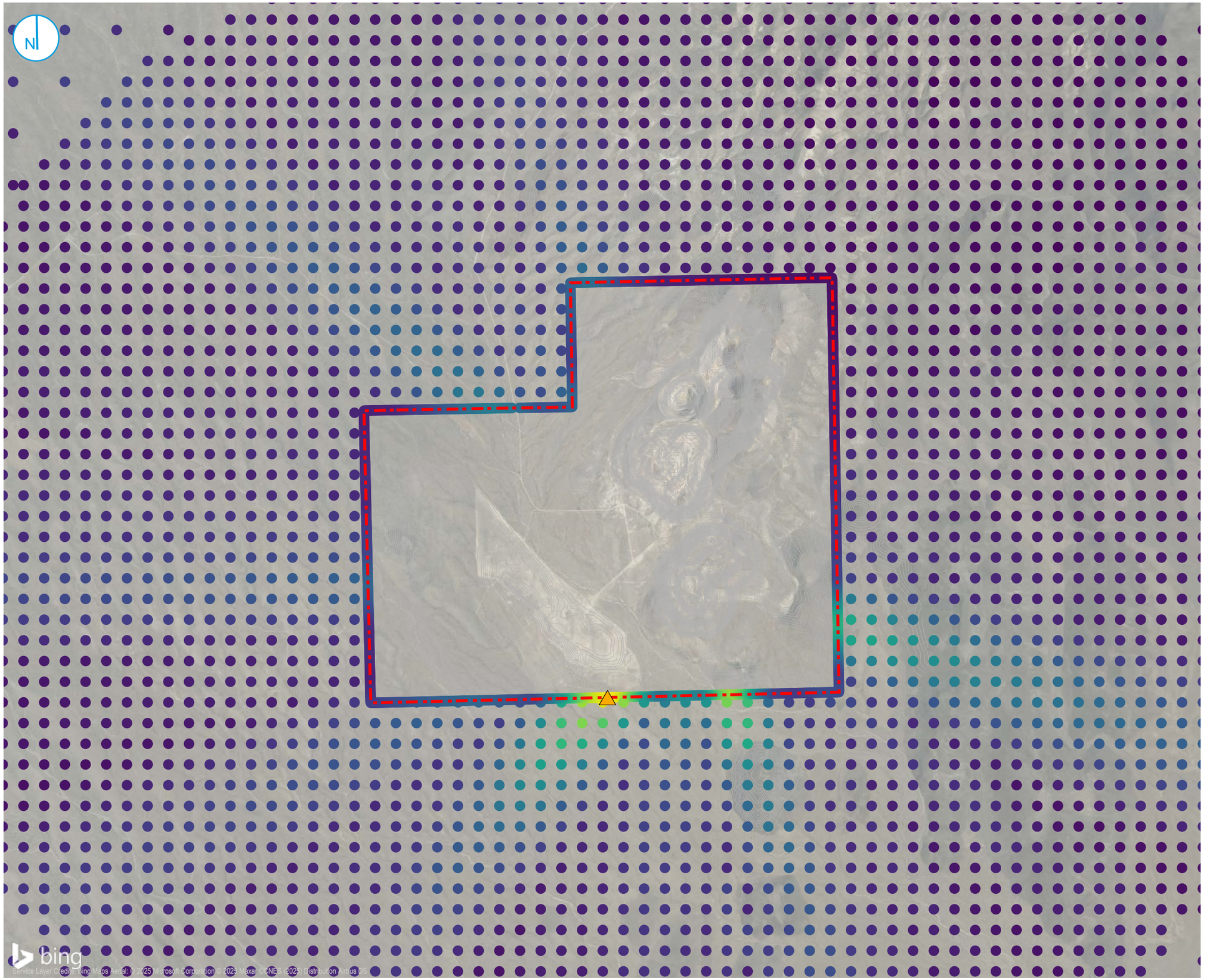
MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
CO, 1-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 47

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

6.9

1,100

0 1,500 3,000 Feet

0 500 1,000 Meters

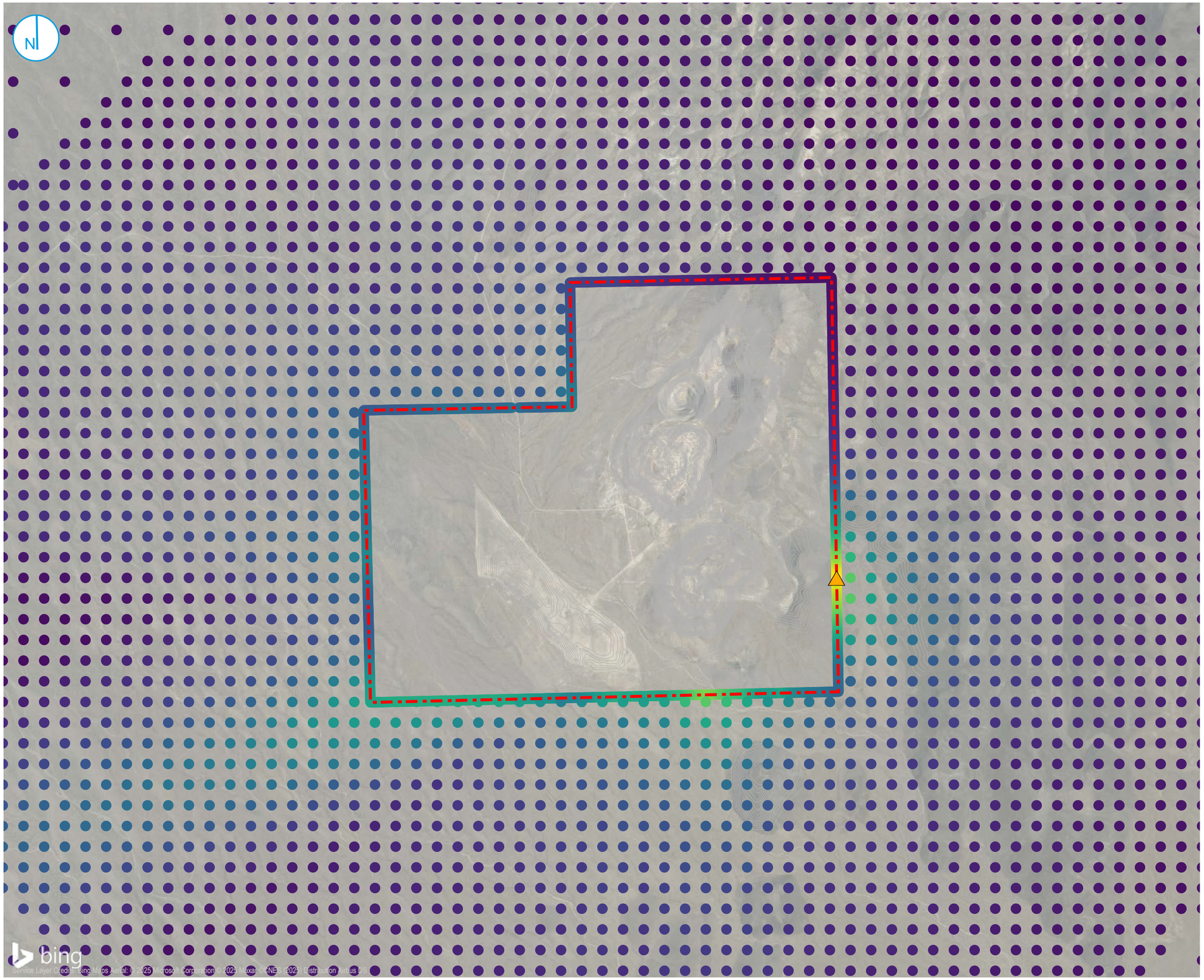
MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
CO, 8-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 48

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

20

33

Notes

1. Maximum Modeled Concentration (Design Value) includes the background contribution.

0 1,500 3,000 Feet

0 500 1,000 Meters

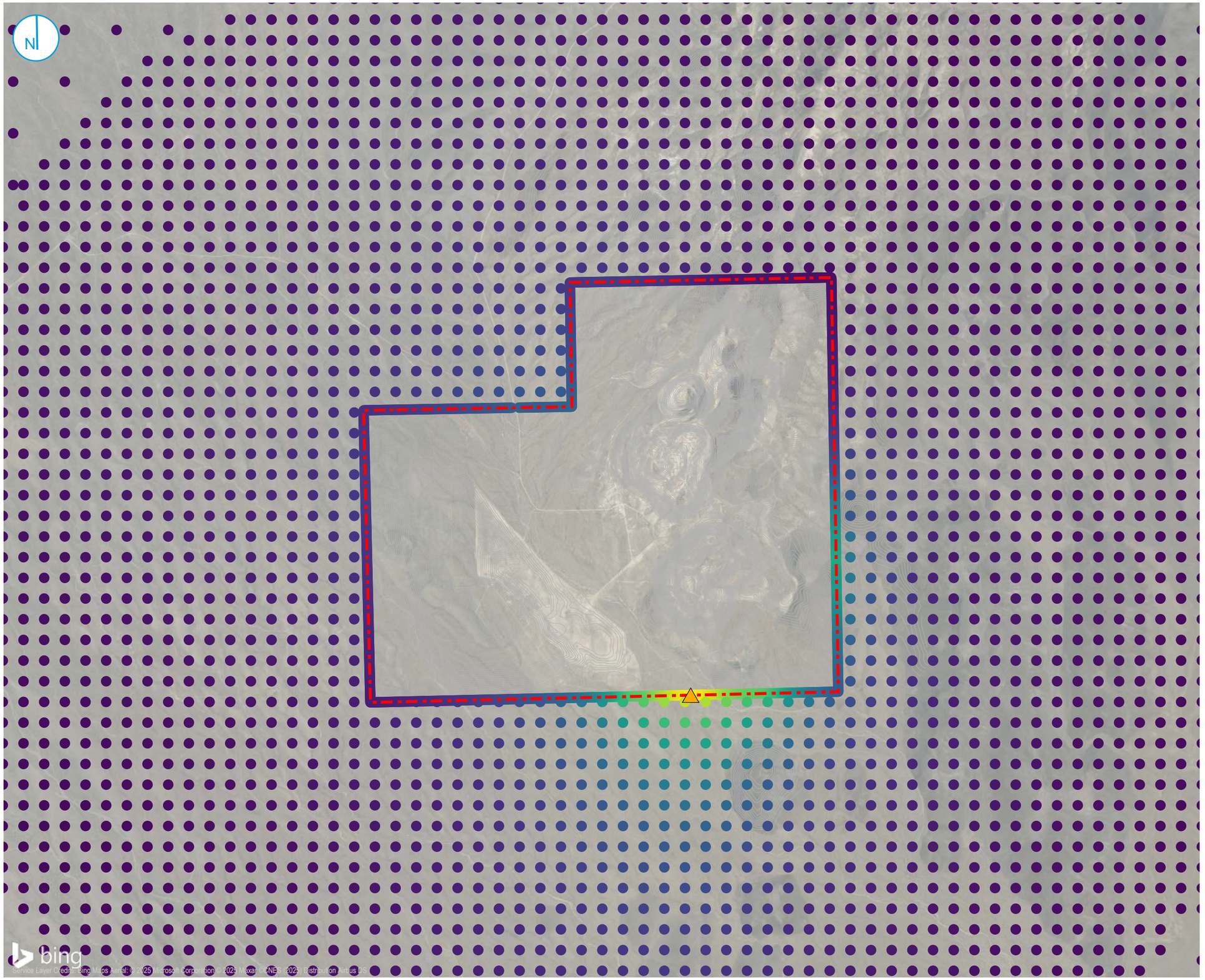
MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
PM_{10}, 24-HR MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 49

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.0095

4.4

0 1,500 3,000 Feet

0 500 1,000 Meters

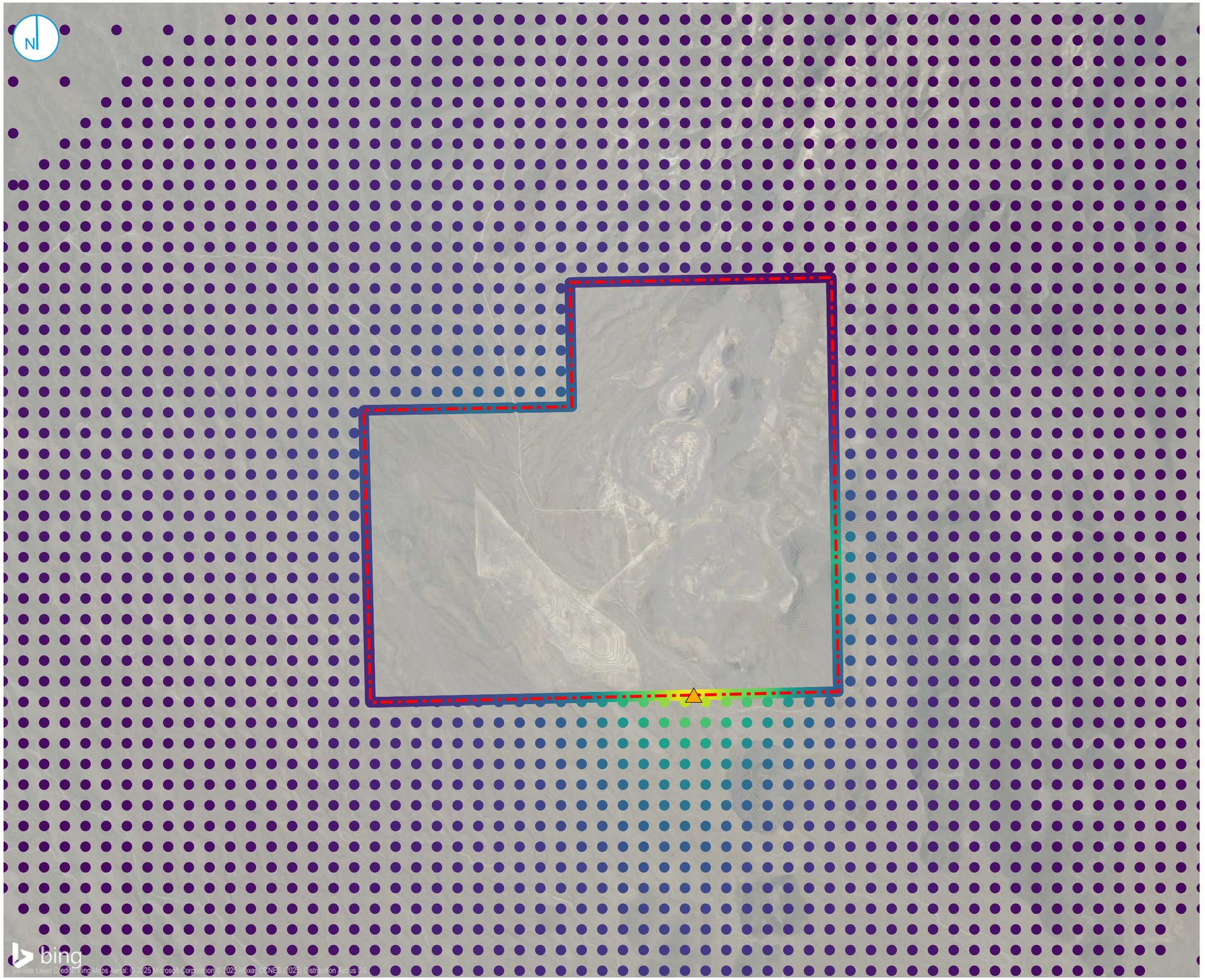
MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
PM_{10}, ANNUAL, MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 50

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL



Site Boundary

Maximum Modeled Concentration (Design Value)

Modeled Concentrations (Design Values)

0.0014

0.58

0 1,500 3,000 Feet

0 500 1,000 Meters

MAXIMUM EMISSIONS SCENARIO
ASSUMED SOUTH OPERATIONS
$PM_{2.5}$, ANNUAL, MAXIMUM (CAAQS)

Castle Mountain Mine 2022 Plan Amendment
San Bernardino County, California

ATTACHMENT 3
FIGURE 51

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL

EIR APPENDIX 5

Right of Way Emissions Inventory (Ramboll 2025)

Prepared for
Castle Mountain Venture
Castle Mountain Mine
Ivanpah, California

Prepared by
Ramboll Americas Engineering Solutions, Inc

Date
May 29, 2025

CASTLE MOUNTAIN MINE RIGHT OF WAY EMISSIONS INVENTORY

CASTLE MOUNTAIN VENTURE
CASTLE MOUNTAIN MINE

RAMBOLL

CONTENTS

1. INTRODUCTION 1

2. METHODOLOGY 1

3. EMISSION ESTIMATES 3

FIGURES

Figure 1: Proposed Powerline and Water Pipeline Installation Routes

TABLES

ROW Construction Emissions Inventory, Summary Tables

Table C-1: ROW Construction Emissions Summary, CAP Emissions

Table C-2: ROW Construction Emissions Summary, HAP Emissions

Table C-3: ROW Construction Emissions Summary, GHG Emissions

ROW Construction Emissions Inventory, Detailed Tables

Table C-4: Fugitive Dust Emissions from Bulldozing, Scraping and Grading Activity, Offroad Construction Equipment

Table C-5: Offroad Equipment, Exhaust CAP Emissions

Table C-6: Offroad Equipment, Exhaust GHG Emissions

Table C-7: Watering Assumptions for Disturbed Construction Areas, Construction Vehicles

Table C-8: Construction Mobile Vehicle Fleet Mix, Onroad Vehicles

Table C-9: Onroad Mobile Vehicles, Exhaust Emission Factors

Table C-10: Onroad Mobile Vehicles, Trip Rates

Table C-11: Onroad Mobile Vehicles, Exhaust CAP Emissions

Table C-12: Onroad Mobile Vehicles, Exhaust GHG Emissions

Table C-13: Fugitive Dust Emissions from Onroad Mobile Vehicles, Paved Roads

Table C-14: Fugitive Dust Emissions from Onroad Mobile Vehicles, Unpaved Roads

Table C-15: Disturbed Construction Area Emissions, Wind Erosion

Table C-16: Hazardous Air Pollutant Emissions, Fugitive Dust Sources

Table C-17: Hazardous Air Pollutant Emissions, Mobile Exhaust Sources – Inorganic HAPs

Table C-18: Hazardous Air Pollutant Emissions, Mobile Exhaust Sources – Organic HAPs

1. INTRODUCTION

Background

Castle Mountain Venture (CMV) is proposing to revise the Castle Mountain Mine (CMM) Mine Plan and Reclamation Plan to expand mining operations to include increased blasting, ore hauling, overburden stockpiling, crushing, conveying, heap leaching, and final gold recovery activities (referred to as Phase 2 Mine operations).

In support of proposed Phase 2 Mine operations, CMM will need to re-install the former 69 kilovolt (kV) powerline from Walking Box Ranch to the Mine site along with a water pipeline from Nipton, California to Walking Box Ranch, then similarly along the access road to the mine site.

Figure 1 shows the proposed powerline and water pipeline installation routes.

CMM has applied to the Bureau of Land Management (BLM) for a Right-of-Way (ROW) lease agreement to install the above proposed utility lines in support of proposed Phase 2 Mine operations. This is herein referred to as the proposed action.

Scope of Emissions Inventory

Due to the nature of the proposed action, potential air emissions during routine operation following line installations would be limited to as-needed maintenance activities. Such emissions would be de minimis and will not be quantified here.

Direct and indirect emissions during construction will include criteria air pollutants (CAPs), hazardous air pollutants (HAPs), and greenhouse gas (GHG) emissions from the following types of activities and emission sources:

- Offroad equipment operation;
- Worker, vendor, and hauling trips to the construction site, including commuting, material deliveries and soil movement, as applicable; and
- Fugitive dust from disturbed areas.

Construction of the powerline and water pipeline are estimated to occur over periods less than 1 year. As such, total emissions are expressed on a tons per year basis, or on a metric tons (MT) per year basis for GHGs. Construction was conservatively estimated to start as early as 2026. Construction may commence after this time and thus the emission estimates presented here are conservative due to improvements to exhaust emissions controls over time.

Emissions presented in this report are intended to be conservative and are subject to further refinement should more accurate data or methodologies be deemed appropriate.

2. METHODOLOGY

The construction emissions inventory prepared utilizes anticipated construction activity, including worker and vendor travel to and from the site, off-road equipment use, and fugitive dust disturbance details. Emission factors and methodologies were selected for each activity utilizing applicable local, state, and federal guidance as appropriate. The selected emission

methodologies and emission factors used to prepare the construction emissions inventory are listed below and are detailed in supporting tables.

- BAAQMD. 2004. CARB Emission Factors for CI Diesel Engines - Percent HC in Relation to NMHC + NO_x.
- Bureau of Land Management. 1997. Castle Mountain Mine Expansion Project Final Environmental Impact Statement/Environmental Impact Report. October.
- CAPCOA. User Guide for CalEEMod Version 2022.1. Available online at: http://www.aqmd.gov/caleemod/user-guide
- CARB. CARB and USEPA Off-Road Compression-Ignition (Diesel) Engine Standards. Available online at: https://ww2.arb.ca.gov/sites/default/files/2020-03/Tier_Color_Chart_Off_Road_Diesel_Stds_R.pdf
- CARB. Off-Road Diesel New Engine Emissions Standards. Available online at: https://ww3.arb.ca.gov/msei/ordiesel/ordieselstandards.xlsx
- CARB. Speciation Profiles Used in CARB Modeling. Available at: https://ww2.arb.ca.gov/speciation-profiles-used-carb-modeling
- CARB. 2017. 2017 Off-road Diesel Emission Factors. Available online at: https://ww2.arb.ca.gov/sites/default/files/classic/msei/ordiesel/ordas_ef_fcf_2017.xlsx
- CARB. 2021a. EMFAC2021. Available online at: https://arb.ca.gov/emfac/emissions-inventory/c5552d9169627de8742c9889c2de6e6b045ec250
- CARB. 2021b. Miscellaneous Process Methodology 7.9, Entrained Road Travel, Paved Road Dust. March. Available online at: https://ww3.arb.ca.gov/ei/areasrc/fullpdf/2021_paved_roads_7_9.pdf
- CARB. 2022a. In-Use Off-Road Diesel-Fueled Fleets regulation. Available online at: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/off-roaddiesel/appa-1.pdf
- CARB. 2022b. Renewable Diesel Joint Statement. Available online at: https://ww2.arb.ca.gov/our-work/programs/alternative-diesel-fuels/biodiesel-renewable-diesel
- Code of Federal Regulations. Title 40 Chapter I Subchapter C Part 98. Available at: Available online at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1
- Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007. Available at: https://www.ipcc.ch/assessment-report/ar4/
- MDAQMD. 2005. Default Emission Factors for Desert Soils
- MDAQMD. 2013. Emissions Inventory Guidance: Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768.
- USEPA. 2006. AP-42, Section 13.2.2, Unpaved Roads. November. Available online at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0202.pdf.

- USEPA. 2010. Conversion Factors for Hydrocarbon Emission Components, NR-002d. EPA-420-R-10-015. July. Available online at: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10081RP.pdf
- USEPA. 2011. AP-42, Section 13.2.1, Paved Roads. Available online at: http://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0201.pdf
- USEPA. 2021. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019. Available at: https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-annexes.pdf
- USEPA. 2025. AP-42 Chapter 3.4 Large Stationary Diesel and Stationary Dual-fuel Engines. Available at: https://www.epa.gov/system/files/documents/2025-04/c03s04_april2025.pdf

In cases where meteorological data inputs are required for emission estimates, site-specific meteorological measurements were utilized from the Mine and are assumed to be representative of the surrounding offsite areas where construction will occur.

Emission factors for on-road mobile units conservatively utilize the year 2026 even though construction may commence after this year when corresponding emission factors will continue to decrease due to improved technology and vehicle regulation.

Due to uncertainty in contractor selection during construction, the emissions inventory conservatively assumes Tier 3 emission standards for all off-road equipment. When Tier 3 standards do not apply to a given size, Tier 2 standards were conservatively used. Due to state and federal regulations, fleet turnover, and continuing improvement in emissions control technology, it is expected that many, if not all, off-road units will meet emission standards higher than this (Tier 4 Interim or Tier 4 Final). Thus, emissions presented here are conservative.

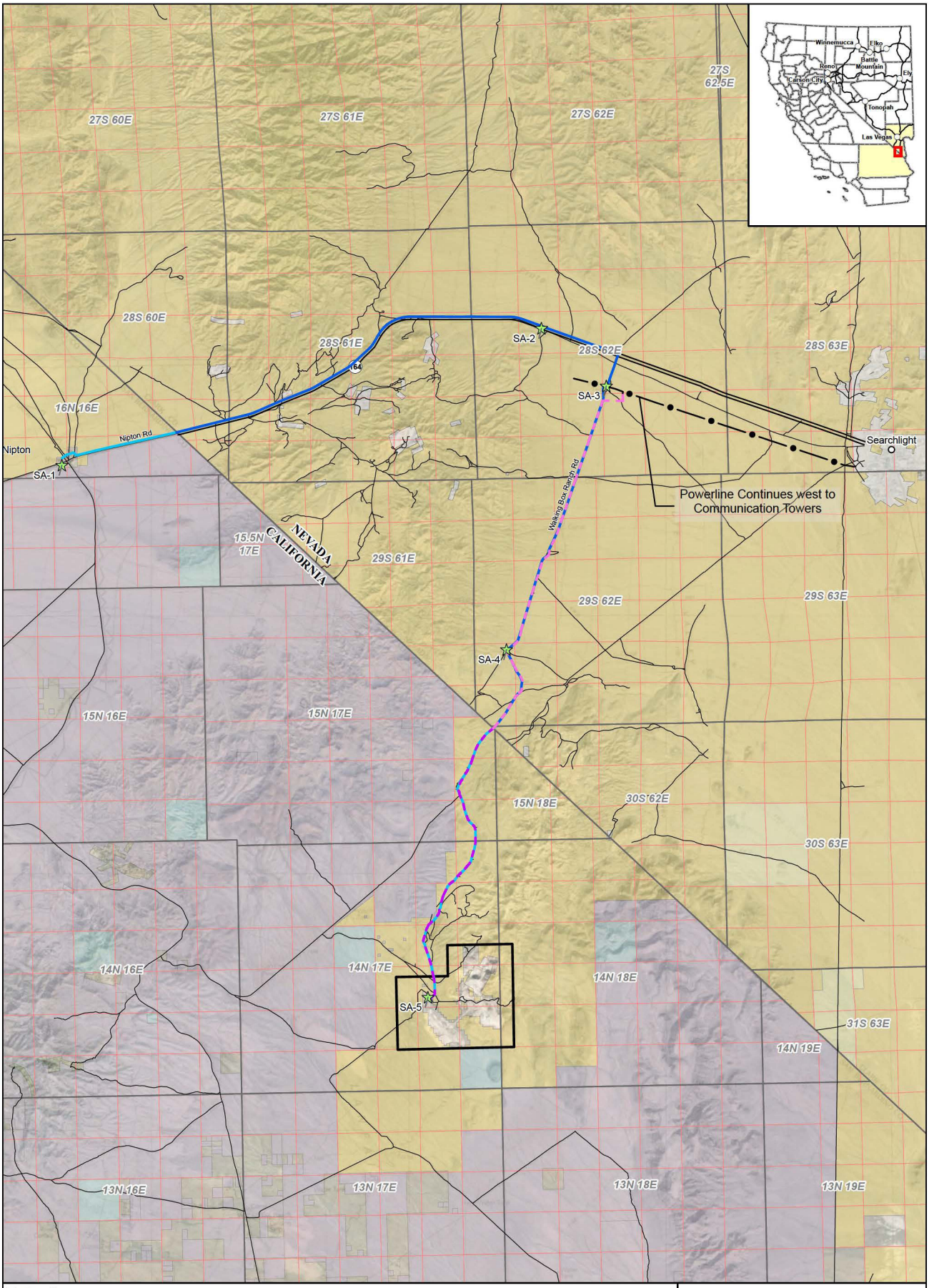
Construction off-road equipment will use renewable diesel fuel (when available from suppliers), consistent with regulatory requirements under the CARB In-Use Off-Road Diesel-Fueled Fleets Regulation and CMV commitments. Associated CO_2 emissions from renewable diesel use have conservatively been quantified and are categorized as biogenic emissions.

The mine access road, along which construction vehicles will need to travel, will be controlled with watering, graveling surface, and treatment with chemical stabilizers. Additional construction surfaces and disturbed areas will be controlled with watering and speed control, where applicable.

3. EMISSION ESTIMATES

Emission estimates for total annual construction activity are summarized in **Table C-1 through Table C-3**. Detailed emission tables which document activity data, emission factors, and emissions methodologies are included as **Tables C-4 through C-18**.

FIGURES



Explanation

- Castle Mountain Mine Boundary
- Existing Road
- State Highway
- Existing NV Energy Power Line
- Staging Area (5)

Proposed Water Line Route

- California (54,178 feet)
- Nevada (114,077 feet)

Proposed Power Line Route

- California (38,956 feet)
- Nevada (49,499 feet)

Land Status

- Bureau of Land Management
- Bureau of Reclamation
- Private

0 1.5 3 Miles N

CASTLE MOUNTAIN VENTURE

IVANPAH WATER AND POWER LINE RIGHTS-OF-WAY PROJECT

Proposed Water and Power Line Routes

Label: Figure 1	Drawn By: TJC
Date: 04/14/2025	Project No.: 2268.01
Base Map: USGS 100k Quads: Ivanpah, Mesquite Lake	
File Name: 10102_Ivanpah_working.mxd	

WestLand

TABLES

Table C-1
ROW Construction Emissions Summary
CAP Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

ROW Utility	Source Type	Total Construction Emissions[1,2] (tpy)					
		NO_x	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$
Both Utility Lines	Vehicle Travel	0.59	0.010	1.5	0.059	12	1.2
	Construction Equipment	6.4	0.011	6.1	0.36	3.2	1.2
	Disturbed Areas	--	--	--	--	3.4	1.3
	Total - Both Utility Lines	**7.0**	**0.021**	**7.6**	**0.42**	**18**	**3.8**

ROW Utility	Source Type	Sub-Type	Total Construction Emissions[1,2] (tpy)					
			NO_x	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$
Powerline	Vehicle Travel	Commuters	0.0034	1.0E-04	0.042	0.0063	0.0097	0.0015
		Single-Axle Vehicles/Vans	0.018	5.9E-04	0.094	0.0040	0.94	0.096
		Double-Axle Vehicles	0.086	7.9E-04	0.0081	0.0011	1.2	0.13
	Construction Equipment	Dozers	0.061	1.1E-04	0.055	0.0034	0.015	0.0068
		Loaders	0.11	1.1E-04	0.079	0.0064	0.045	0.018
		Skid Steers	0.14	2.5E-04	0.19	0.0081	0.069	0.029
		Air Compressors	0.074	6.8E-05	0.051	0.0042	0.0042	0.0042
		Other	2.1	0.0037	1.9	0.12	0.11	0.11
	Disturbed Areas	Construction Disturbed Areas	--	--	--	--	0.0019	7.7E-04
	Total - Powerline		**2.6**	**0.0057**	**2.5**	**0.15**	**2.4**	**0.40**

ROW Utility	Source Type	Sub-Type	Total Construction Emissions[1,2] (tpy)					
			NO_x	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$
Water Pipeline	Vehicle Travel	Commuters	0.079	0.0037	1.0	0.034	0.89	0.11
		Single-Axle Vehicles/Vans	0.056	0.0019	0.29	0.0099	2.2	0.22
		Double-Axle Vehicles	0.34	0.0032	0.031	0.0043	6.6	0.67
	Construction Equipment	Dozers	1.6	0.0028	1.5	0.090	1.5	0.51
		Loaders	0.12	1.8E-04	0.14	0.0070	0.29	0.097
		Motor-Graders	0.15	2.7E-04	0.14	0.0086	0.15	0.053
		Aerial Lifts	0.18	3.0E-04	0.23	0.0099	0.014	0.014
		Pipe Layers	0.39	6.8E-04	0.51	0.022	0.030	0.030
		Skid Steers	0.14	2.1E-04	0.16	0.0080	0.31	0.10
		Air Compressors	0.36	5.0E-04	0.30	0.020	0.019	0.019
		Other	0.94	0.0015	0.86	0.053	0.65	0.23
	Disturbed Areas	Construction Disturbed Areas	--	--	--	--	3.4	1.3
	Total - Water Pipeline		**4.4**	**0.015**	**5.1**	**0.27**	**16**	**3.4**

Notes:

1. Details of the construction CAP emission calculations are presented in Table C-4 through Table C-5, Table C-7 through Table C-11, and Table C-13 through Table C-15.
2. Construction of both the powerline and water pipeline are expected to occur over a duration less than one year, therefore total emissions are presented as tons per year.

Abbreviations:

CAP - criteria air pollutant
CO - carbon monoxide
lb - pound
NO_x - nitrogen oxides
PM - particulate matter
ROW - Right of Way
SO_x - sulfur oxides
tpy - ton per year
VOC - volatile organic compounds

Table C-2
ROW Construction Emissions Summary
HAP Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source		Powerline Construction[1,2]		Water Pipeline Construction[1,2]		Total Construction Emissions[1,2]
		Fugitive Dust	Exhaust	Fugitive Dust	Exhaust	
Annual Emissions (lb/yr)	Antimony	0.059	0.010	0.42	0.017	0.51
	Arsenic	0.26	0.0014	1.7	0.0024	2.0
	Cadmium	0.058	0.011	0.39	0.019	0.48
	Chlorine	--	0.12	--	0.41	0.53
	Chromium	0.59	0.0035	4.0	0.0075	4.6
	Cobalt	0.37	0.0032	2.5	0.0071	2.9
	Lead	0.23	0.012	1.6	0.020	1.8
	Manganese	3.5	0.011	24	0.021	28
	Mercury	0.075	0.0084	0.51	0.014	0.61
	Nickel	0.17	0.0054	1.2	0.011	1.3
	Phosphorus	2.2	0.035	16	0.061	18
	Selenium	0.0095	0.0028	0.064	0.0048	0.082
	1,3-Butadiene	--	0.70	--	1.5	2.2
	2,2,4-Trimethylpentane	--	1.2	--	3.0	4.2
	Acetaldehyde	--	21	--	34	55
	Acrolein	--	0.033	--	0.14	0.18
	Benzene	--	6.4	--	12	18
	Cumene	--	0.067	--	0.13	0.20
	Ethyl Benzene	--	1.2	--	2.6	3.8
	Formaldehyde	--	43	--	69	112
	Hexane	--	0.70	--	1.8	2.5
	Methanol	--	0.22	--	0.70	0.91
	Methyl Tert-Butyl Ether	--	0.34	--	1.5	1.8
	M-Xylene	--	2.6	--	6.3	8.9
	Naphthalene	--	0.28	--	0.51	0.80
	o-Xylene	--	1.3	--	2.8	4.1
	Propionaldehyde	--	2.8	--	4.5	7.3
	p-Xylene	--	0.29	--	0.45	0.74
	Styrene	--	0.20	--	0.38	0.57
	Toluene	--	5.5	--	12	18
	Total HAPs	**7.6**	**88**	**52**	**154**	**302**

Notes:

1. Details of the construction HAP emission calculations are presented in Table C-16 through Table C-18.
2. Construction of both the powerline and water pipeline are expected to occur over a duration less than one year, therefore total emissions are presented as pounds per year.

Abbreviations:

HAP - hazardous air pollutant
lb - pounds
ROW - Right of Way
yr - year

Table C-3
ROW Construction Emissions Summary
GHG Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

ROW Utility	Source Type	Total Construction Emissions[1,2] (MT/yr)				
		CO_2	CH_4	N_2O	Biogenic CO_2e	Non-biogenic CO_2e
Both Utility Lines	Vehicle Travel	959	0.0069	0.087	--	985
	Construction Equipment	1,024	0.094	0.087	1,024	28
	Total - Both Utility Lines	**1,983**	**0.10**	**0.17**	**1,024**	**1,013**

ROW Utility	Source Type	Sub-Type	Total Construction Emissions[1,2] (MT/yr)				
			CO_2	CH_4	N_2O	Biogenic CO_2e	Non-biogenic CO_2e
Powerline	Vehicle Travel	Commuters	9.2	4.5E-04	3.3E-04	--	9.3
		Single-Axle Vehicles/Vans	55	4.2E-04	0.0050	--	57
		Double-Axle Vehicles	75	4.6E-05	0.012	--	79
	Construction Equipment	Dozers	10	9.3E-04	8.6E-04	10	0.28
		Loaders	10	9.3E-04	8.6E-04	10	0.28
		Skid Steers	24	0.0022	0.0020	24	0.66
		Air Compressors	6.6	6.1E-04	5.6E-04	6.6	0.18
		Other	353	0.033	0.030	353	9.8
	Total - Powerline		**544**	**0.038**	**0.052**	**404**	**156**

ROW Utility	Source Type	Sub-Type	Total Construction Emissions[1,2] (MT/yr)				
			CO_2	CH_4	N_2O	Biogenic CO_2e	Non-biogenic CO_2e
Water Pipeline	Vehicle Travel	Commuters	340	0.0046	0.0068	--	342
		Single-Axle Vehicles/Vans	177	0.0012	0.016	--	181
		Double-Axle Vehicles	302	1.8E-04	0.048	--	317
	Construction Equipment	Dozers	267	0.025	0.023	267	7.4
		Loaders	18	0.0016	0.0015	18	0.49
		Motor-Graders	25	0.0023	0.0022	25	0.71
		Aerial Lifts	29	0.0027	0.0025	29	0.81
		Pipe Layers	65	0.0060	0.0056	65	1.8
		Skid Steers	20	0.0019	0.0017	20	0.56
		Air Compressors	48	0.0044	0.0041	48	1.34
		Other	148	0.014	0.013	148	4.1
	Total - Water Pipeline		**1,439**	**0.063**	**0.12**	**620**	**857**

Notes:

1. Details of the construction GHG emission calculations are presented in Table C-6 and Table C-12.
2. Construction of both the powerline and water pipeline are expected to occur over a duration less than one year, therefore total emissions are presented as metric tons per year.

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
MT - metric ton
N_2O - nitrous oxide
ROW - Right of Way

Table C-4
Fugitive Dust Emissions from Bulldozing, Scraping and Grading Activity
Offroad Construction Equipment
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

ROW Utility	Equipment Type[1,2]	Equipment Details	Quantity[2]	Operating Days during Construction[2] (per quantity)	Operating Hours per Day[2]	Utilization Rate	Operating Hours during Construction[3] (per quantity)	Control Efficiency[4] (%)	Emission Factors[5,6] (lb/hr)		Total Emissions[7] (tpy)	
									PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Powerline	Dozers	Cat D6	1	150	10	15%	225	98%	0.10	0.032	0.012	0.0036
	Loaders	Backhoe Loader	1	150	10	50%	750	98%	0.10	0.032	0.039	0.012
	Skid Steers	Skid Steer	1	150	10	75%	1,125	98%	0.10	0.032	0.058	0.018
									Total - Powerline		**0.11**	**0.033**

ROW Utility	Equipment Type[1]	Equipment Details	Quantity[2]	Operating Days during Construction[2] (per quantity)	Operating Hours per Day[2]	Utilization Rate	Operating Hours during Construction[3] (per quantity)	Control Efficiency[4] (%)	Emission Factors[5,6] (lb/hr)		Total Emissions[7] (tpy)	
									PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Water Pipeline	Dozers	Cat D6	2	38	10	70%	266	87%	0.55	0.17	0.15	0.045
		Cat 330	19	34	10	70%	236	87%	0.55	0.17	1.2	0.38
	Loaders	Cat 420	1	146	10	70%	1,022	87%	0.55	0.17	0.28	0.086
	Motor-Graders	Cat 160	2	38	10	70%	266	87%	0.55	0.17	0.15	0.045
	Skid Steers	JD 331	2	77	10	70%	536	87%	0.55	0.17	0.30	0.090
	Other	Cat D7R	8	39	10	70%	270	87%	0.55	0.17	0.60	0.18
									Total - Water Pipeline		**2.7**	**0.83**
									Total - Both Utility Lines		**2.8**	**0.86**

Notes:

1. Aerial lifts, cranes, air compressors, and telehandlers are assumed to have no fugitive emissions, as they are either portable sources that would be towed when moved, travel at such a low speed that emissions generation is unlikely, or are stationary. Thus, emissions would either be accounted for in the vehicle that transports the equipment or are de minimis.
2. Equipment quantity, operating hours per day, and operating days during construction provided by Castle Mountain Venture and supporting contractors.
3. Operating hours during construction were calculated per equipment quantity based on operating days during construction, operating hours per day, and utilization rate.
4. Control efficiency calculated based on MDAQMD guidance for Dust Entrainment from Unpaved Roads as presented in Table C-7.
5. Emission factors are derived from the Mojave Desert Air Quality Management District's Emissions Inventory Guidance for Mineral Handling and Processing Industries, using the "Most Complex" method.
6. A roadway moisture content of 2% and a surface silt content of 5% were used, consistent with data provided by Castle Mountain Venture.
7. Construction of both the powerline and water pipeline are expected to occur over a duration less than one year, therefore total emissions are presented as tons per year.

Abbreviations:

hr - hour
lb- pounds
PM - particulate matter
ROW - Right of Way
tpy - ton per year
TSP - total suspended particles
VMT - vehicle miles traveled

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance Mineral Handling and Processing Industries. Available online at: https://www.mdaqmd.ca.gov/home/showdocument?id=768

Table C-5
Offroad Equipment
Exhaust CAP Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

ROW Utility	Equipment Type	Equipment Details	Quantity[1]	Engine Tier Level[2]	Engine[3] (hp)	Equipment Load Factor[4]	Fuel Type	Operating Days during Construction[1] (per quantity)	Operating Hours per Day[1]	Utilization Rate	Operating Hours during Construction[5] (per quantity)	Emission Factors[6] (g/hp-hr)						Total Emissions[7] (tpy)					
												NO_x	SO_x	CO	ROG	PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	ROG[8]	PM_{10}	$PM_{2.5}$
Powerline	Dozers	Cat D6	1	Tier 3	215	40%	Renewable Diesel	150	10	15%	225	2.9	0.0049	2.6	0.16	0.15	0.15	0.061	1.1E-04	0.055	0.0034	0.0032	0.0032
	Loaders	Backhoe Loader	1	Tier 2	70	37%	Renewable Diesel	150	10	50%	750	5.3	0.0049	3.7	0.30	0.30	0.30	0.11	1.1E-04	0.079	0.0064	0.0064	0.0064
	Skid Steers	Cat 299	1	Tier 3	110	37%	Renewable Diesel	150	10	75%	1,125	2.9	0.0049	3.7	0.16	0.22	0.22	0.14	2.5E-04	0.19	0.0081	0.011	0.011
	Air Compressors	Air Compressor	1	Tier 2	35	48%	Renewable Diesel	150	10	50%	750	5.3	0.0049	3.7	0.30	0.30	0.30	0.074	6.8E-05	0.051	0.0042	0.0042	0.0042
	Other	Terex 6060	2	Tier 3	250	43%	Renewable Diesel	150	10	75%	1,125	2.9	0.0049	2.6	0.16	0.15	0.15	0.76	0.0013	0.69	0.043	0.040	0.040
		Track Bucket	3	Tier 3	300	43%	Renewable Diesel	150	10	75%	1,125	2.9	0.0049	2.6	0.16	0.15	0.15	1.4	0.0024	1.2	0.077	0.072	0.072
																	Total - Powerline	**2.5**	**0.0042**	**2.3**	**0.14**	**0.14**	**0.14**

ROW Utility	Equipment Type	Equipment Details	Quantity[1]	Engine Tier Level[2]	Engine[3] (hp)	Equipment Load Factor[4]	Fuel Type	Operating Days during Construction (per quantity)[1]	Operating Hours per Day[1]	Utilization Rate	Operating Hours during Construction[5] (per quantity)	Emission Factors[6] (g/hp-hr)						Total Emissions[7] (tpy)					
												NO_x	SO_x	CO	ROG	PM_{10}	$PM_{2.5}$	NO_x	SO_x	CO	ROG[8]	PM_{10}	$PM_{2.5}$
Water Pipeline	Dozers	Cat D6	2	Tier 3	215	40%	Renewable Diesel	38	10	70%	266	2.9	0.0049	2.6	0.16	0.15	0.15	0.14	2.5E-04	0.13	0.0081	0.0076	0.0076
		Cat 330	19	Tier 3	273	38%	Renewable Diesel	34	10	70%	236	2.9	0.0049	2.6	0.16	0.15	0.15	1.5	0.0025	1.3	0.082	0.077	0.077
	Loaders	Cat 420	1	Tier 3	92	36%	Renewable Diesel	146	10	70%	1,022	3.3	0.0049	3.7	0.19	0.30	0.30	0.12	1.8E-04	0.14	0.0070	0.011	0.011
	Motor-Graders	Cat 160	2	Tier 3	224	41%	Renewable Diesel	38	10	70%	266	2.9	0.0049	2.6	0.16	0.15	0.15	0.15	2.7E-04	0.14	0.0086	0.0081	0.0081
	Aerial Lifts	1055 Telehandler	1	Tier 3	130	42%	Renewable Diesel	146	10	70%	1,022	2.9	0.0049	3.7	0.16	0.22	0.22	0.18	3.0E-04	0.23	0.0099	0.014	0.014
	Pipe Layers	Cat 561	4	Tier 3	132	42%	Renewable Diesel	40	10	70%	280	2.9	0.0049	3.7	0.16	0.22	0.22	0.20	3.4E-04	0.25	0.011	0.015	0.015
		Cat 571	4	Tier 3	132	42%	Renewable Diesel	41	10	70%	284	2.9	0.0049	3.7	0.16	0.22	0.22	0.20	3.4E-04	0.26	0.011	0.015	0.015
	Skid Steers	JD 331	2	Tier 3	98	37%	Renewable Diesel	77	10	70%	536	3.3	0.0049	3.7	0.19	0.30	0.30	0.14	2.1E-04	0.16	0.0080	0.013	0.013
	Air Compressors	185 Doosan	3	Tier 2	62	48%	Renewable Diesel	40	10	70%	278	5.3	0.0049	3.7	0.30	0.30	0.30	0.15	1.3E-04	0.10	0.0082	0.0082	0.0082
		Doosan 1600	6	Tier 3	560	48%	Renewable Diesel	6.0	10	70%	42	2.9	0.0049	2.6	0.16	0.15	0.15	0.21	3.7E-04	0.19	0.012	0.011	0.011
	Other	Light Tower	4	Tier 2	13.8	42%	Renewable Diesel	6.0	10	70%	42	5.3	0.0049	3.7	0.30	0.30	0.30	0.0057	5.3E-06	0.0040	3.2E-04	3.2E-04	3.2E-04
		Pump	2	Tier 3	173	74%	Renewable Diesel	6.0	10	70%	42	2.9	0.0049	3.7	0.16	0.22	0.22	0.034	5.8E-05	0.044	0.0019	0.0026	0.0026
		Bending Machine	2	Tier 2	67	42%	Renewable Diesel	43	10	70%	298	5.3	0.0049	3.7	0.30	0.30	0.30	0.098	9.1E-05	0.068	0.0055	0.0055	0.0055
		Cat D7R	8	Tier 3	258	44%	Renewable Diesel	39	10	70%	270	2.9	0.0049	2.6	0.16	0.15	0.15	0.77	0.0013	0.70	0.043	0.041	0.041
		JD 6130M	1	Tier 3	171	44%	Renewable Diesel	19	10	70%	133	2.9	0.0049	3.7	0.16	0.22	0.22	0.031	5.4E-05	0.041	0.0018	0.0024	0.0024
																	Total - Water Pipeline	**3.9**	**0.0065**	**3.8**	**0.22**	**0.23**	**0.23**
																	Total - Both Utility Lines	**6.4**	**0.011**	**6.1**	**0.36**	**0.37**	**0.37**

Notes:

1. Equipment quantity, operating hours per day, and operating days during construction provided by Castle Mountain Venture and supporting contractors.
2. All off-road equipment used during construction was conservatively assumed to be Tier 3. Tier 2 standards were conservatively assumed for equipment less than 75 hp because Tier 3 standards do not exist for equipment under 75 hp.
3. Equipment specific horsepower ratings were utilized where equipment model numbers were provided by Castle Mountain Venture and supporting contractors. In the absence of equipment model numbers, engine horsepower rating were estimated based on default values in Appendix G of the CalEEMod® User's Guide (CAPCOA 2022).
4. Load factors for off-road equipment were selected from default values from OFFROAD2017 as provided in Appendix G of the CalEEMod® User's Guide (CAPCOA 2022).
5. Operating hours during construction were calculated per equipment quantity based on operating days during construction, operating hours per day, and utilization rate.
6. PM, CO, NO_x, and VOC engine emission factors based on ARB Tier 3 or Tier 2 diesel engine standards. Emission factors for ROG and NO_x were converted from NMHC values provided in the Tier standards using EPA hydrocarbon conversion factors. When applicable, the NMHC/NO_x combined Tier standard was split into NMHC and NO_x per BAAQMD guidance (assumed 5% NMHC, 95% NO_x). Emission factors for SO_x from diesel fuel are calculated from the California standard for diesel fuel of 15 ppm (http://www.arb.ca.gov/fuels/diesel/081404dslregs.pdf). Emission factor calculations assume a diesel fuel density of 7.1 lb/gal, heating value of 19,300 BTU/lb, BSFC of 7,000 BTU/hp-hr (USEPA 2025), and that all sulfur is converted to SO_2.
7. Construction of both the powerline and water pipeline are expected to occur over a duration less than one year, therefore total emissions are presented as tons per year.
8. ROG is assumed to equal VOC.

Abbreviations:

BSFC - brake specific fuel consumption
BTU - British thermal units
CO - carbon monoxide
g - gram
gal - gallon
hp - horsepower
hr - hour
lb - pound
NMHC - non-methane hydrocarbons
NO_x - nitrogen oxides
PM - particulate matter
ppm - parts per million
ROG - reactive organic gases
ROW - Right of Way
SO_x - sulfur oxides
tpy - ton per year
VOC - volatile organic compounds
yr - year

References:

Bay Area Air Quality Management District (BAAQMD). 2004. CARB Emission Factors for CI Diesel Engines - Percent HC in Relation to NMHC + NO_x.

California Air Pollution Control Officers Association (CAPCOA). 2022. User's Guide of CalEEMod® Version 2022.1. April. Available online at: https://www.caleemod.com/user-guide

California Air Resources Board (CARB). CARB and United States Environmental Protection Agency (USEPA) Off-Road Compression-Ignition (Diesel) Engine Standards. Available online at: https://ww2.arb.ca.gov/sites/default/files/2020-

CARB. Off-Road Diesel New Engine Emissions Standards. Available online at: https://ww3.arb.ca.gov/msei/ordiesel/ordieselstandards.xlsx

CARB. In-Use Off-Road Diesel-Fueled Fleets regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/off-roaddiesel/appa-1.pdf

CARB. 2022. Renewable Diesel Joint Statement. Available online at: https://ww2.arb.ca.gov/our-work/programs/alternative-diesel-fuels/biodiesel-renewable-diesel

CARB. 2017. 2017 Off-road Diesel Emission Factors. Available online at: https://ww2.arb.ca.gov/sites/default/files/2022-05/Off-road_CI_engine_standards_chart_04212022.pdf.

Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1

USEPA. 2010. Conversion Factors for Hydrocarbon Emission Components, NR-002d. EPA-420-R-10-015. July. Available online at: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10081RP.pdf

USEPA. 2025. AP-42 Chapter 3.4 Large Stationary Diesel And Stationary Dual-fuel Engines. Available at: https://www.epa.gov/system/files/documents/2025-04/c03s04_april2025.pdf

Table C-6
Offroad Equipment
Exhaust GHG Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

ROW Utility	Equipment Type	Equipment Details	Quantity[1]	Engine[2] (hp)	Load Factor[3]	Fuel Type	Operating Hours During Construction[1,4] (per quantity)	Total Fuel Usage[5] (gal/yr)	Emission Factors[6] (kg/gal)			Total Emissions[7] (MT/yr)				
									CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Biogenic CO_2e[8]	Non-biogenic CO_2e[8]
Powerline	Dozers	Cat D6	1	215	40%	Renewable Diesel	225	988	10.21	9.4E-04	8.7E-04	10	9.3E-04	8.6E-04	10	0.28
	Loaders	Backhoe Loader	1	70	37%	Renewable Diesel	750	992	10.21	9.4E-04	8.7E-04	10	9.3E-04	8.6E-04	10	0.28
	Skid Steers	Cat 299	1	110	37%	Renewable Diesel	1,125	2,339	10.21	9.4E-04	8.7E-04	24	0.0022	0.0020	24	0.66
	Air Compressors	Air Compressor	1	35	48%	Renewable Diesel	750	644	10.21	9.4E-04	8.7E-04	6.6	6.1E-04	5.6E-04	6.6	0.18
	Other	Terex 6060	2	250	43%	Renewable Diesel	1,125	12,356	10.21	9.4E-04	8.7E-04	126	0.012	0.011	126	3.5
		Track Bucket	3	300	43%	Renewable Diesel	1,125	22,241	10.21	9.4E-04	8.7E-04	227	0.021	0.019	227	6.3
											Total - Powerline	**404**	**0.037**	**0.034**	**404**	**11**

ROW Utility	Equipment Type	Equipment Details	Quantity[1]	Engine[2] (hp)	Load Factor[3]	Fuel Type	Operating Hours During Construction[1,4] (per quantity)	Total Fuel Usage[5] (gal/yr)	Emission Factors[6] (kg/gal)			Total Emissions[7] (MT/yr)				
									CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Biogenic CO_2e[8]	Non-biogenic CO_2e[8]
Water Pipeline	Dozers	Cat D6	2	215	40%	Renewable Diesel	266	2,337	10.21	9.4E-04	8.7E-04	24	0.0022	0.0020	24	0.66
		Cat 330	19	273	38%	Renewable Diesel	236	23,779	10.21	9.4E-04	8.7E-04	243	0.022	0.021	243	6.7
	Loaders	Cat 420	1	92	36%	Renewable Diesel	1,022	1,729	10.21	9.4E-04	8.7E-04	18	0.0016	0.0015	18	0.49
	Motor-Graders	Cat 160	2	224	41%	Renewable Diesel	266	2,496	10.21	9.4E-04	8.7E-04	25	0.0023	0.0022	25	0.71
	Aerial Lifts	1055 Telehandler	1	130	42%	Renewable Diesel	1,022	2,851	10.21	9.4E-04	8.7E-04	29	0.0027	0.0025	29	0.81
	Pipe Layers	Cat 561	4	132	42%	Renewable Diesel	280	3,172	10.21	9.4E-04	8.7E-04	32	0.0030	0.0028	32	0.90
		Cat 571	4	132	42%	Renewable Diesel	284	3,212	10.21	9.4E-04	8.7E-04	33	0.0030	0.0028	33	0.91
	Skid Steers	JD 331	2	98	37%	Renewable Diesel	536	1,984	10.21	9.4E-04	8.7E-04	20	0.0019	0.0017	20	0.56
	Air Compressors	185 Doosan	3	62	48%	Renewable Diesel	278	1,266	10.21	9.4E-04	8.7E-04	13	0.0012	0.0011	13	0.36
		Doosan 1600	6	560	48%	Renewable Diesel	42	3,460	10.21	9.4E-04	8.7E-04	35	0.0033	0.0030	35	0.98
	Other	Light Tower	4	13.8	42%	Renewable Diesel	42	50	10.21	9.4E-04	8.7E-04	0.51	4.7E-05	4.3E-05	0.51	0.014
		Pump	2	173	74%	Renewable Diesel	42	549	10.21	9.4E-04	8.7E-04	5.6	5.2E-04	4.8E-04	5.6	0.16
		Bending Machine	2	67	42%	Renewable Diesel	298	855	10.21	9.4E-04	8.7E-04	8.7	8.0E-04	7.4E-04	9	0.24
		Cat D7R	8	258	44%	Renewable Diesel	270	12,543	10.21	9.4E-04	8.7E-04	128	0.012	0.011	128	3.5
		JD 6130M	1	171	44%	Renewable Diesel	133	511	10.21	9.4E-04	8.7E-04	5.2	4.8E-04	4.4E-04	5.2	0.14
											Total - Water Pipeline	**620**	**0.057**	**0.053**	**620**	**17**
											Total - Both Utility Lines	**1,024**	**0.094**	**0.087**	**1024**	**28**

Notes:

1. Equipment quantity and operating days during construction provided by Castle Mountain Venture and supporting contractors.
2. Equipment specific horsepower ratings were utilized where equipment model numbers were provided by Castle Mountain Venture and supporting contractors. In the absence of equipment model numbers, engine horsepower rating were estimated based on default values in Appendix G of the CalEEMod® User's Guide (CAPCOA 2022).
3. Load factors for off-road equipment were selected from default values from OFFROAD2017 as provided in Appendix G of the CalEEMod® User's Guide (CAPCOA 2022).
4. Operating hours during construction were calculated per equipment quantity based on operating days during construction, operating hours per day, and utilization rate.
5. Fuel usage is calculated by taking the horsepower-hours for each piece of equipment (calculated as horsepower * usage hours * load factor) and multiplying it by the gallons of diesel consumption per horsepower-hour consistent with USEPA AP-42 diesel fuel data in Table 3.4.1, which cites an average brake-specific fuel consumption (BSFC) of 7,000 BTU/hp-hr, a heating value of 19,300 BTU/lb, and density of 7.1 lb/gal. Consistent with ARB guidelines, renewable diesel is treated the same as conventional diesel (CARB 2022).
6. CO_2 emission factor is from 40 CFR Part 98, Subpart C, Table C-1. CH_4 and N_2O emission factors are from the EPA Center for Corporate Climate Leadership (2022, April 1) Emission Factors for Greenhouse Gas Inventories, Table 5 (available at https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf) which are calculated from the USEPA Inventory of U.S. Greenhouse Gas Emission and Sinks: 1990-2019. Emission factors for CO_2e were estimated by multiplying the CO_2, CH_4, and N_2O emission factors by their global warming potentials from the IPCC 4th Assessment Report on Climate Change (AR4).
7. Construction of both the powerline and water pipeline are expected to occur over a duration less than one year, therefore total emissions are presented as metric tons per year.
8. Emissions for CO_2e were estimated by multiplying the CO_2, CH_4, and N_2O emissions by their global warming potentials from the IPCC 4th Assessment Report on Climate Change (AR4). CO_2 emissions are assumed to be 100% biogenic based on the assumption of the use of 100% renewable diesel fuel in off-road equipment, consistent with regulatory requirements under the CARB In-Use Off-Road Diesel-Fueled Fleets Regulation and CMV commitments.

Abbreviations:

BSFC - brake specific fuel consumption
BTU - British thermal units
CO_2e - carbon dioxide equivalent
CH_4 - methane
gal - gallon
hp - horsepower
kg - kilogram
MT - metric ton
N_2O - nitrous oxide
ROW - Right of Way
yr - year

References:

CARB. In-Use Off-Road Diesel-Fueled Fleets regulation. Available at: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/off-roaddiesel/appa-1.pdf
CARB. 2022. Renewable Diesel Joint Statement. Available online at: https://ww2.arb.ca.gov/our-work/programs/alternative-diesel-fuels/biodiesel-renewable-diesel
CARB. 2017. 2017 Off-road Diesel Emission Factors. Available online at: https://ww2.arb.ca.gov/sites/default/files/2022-05/Off-road_CI_engine_standards_chart_04212022.pdf.
Code of Federal Regulations. Title 40, Chapter I, Subchapter C, Part 98. Available at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98?toc=1
Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007. Available at: https://www.ipcc.ch/assessment-report/ar4/
USEPA. 2021. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019. Available at: https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-annexes.pdf
USEPA. 2025. AP-42 Chapter 3.4 Large Stationary Diesel And Stationary Dual-fuel Engines. Available at: https://www.epa.gov/system/files/documents/2025-04/c03s04_april2025.pdf

Table C-7
Watering Assumptions for Disturbed Construction Areas
Construction Vehicles
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Parameter[1]	Value	Units	Data Source
Powerline Average Hourly Traffic Rate	3	vehicles/hr	It is assumed that only 25% of total operating equipment would operate over the same area in a given hour. Given the total operating equipment amounts to 9 vehicles, it is expected that 3 vehicles will operate per hour.
Water Pipeline Average Hourly Traffic Rate	16	vehicles/hr	It is assumed that only 25% of total operating equipment would operate over the same area in a given hour. Given the total operating equipment amounts to 61 vehicles, it is expected that 16 vehicles will operate per hour.
Time Between Water Applications	1	hour	Per Castle Mountain Venture, watering occurs approximately once per hour.
Average Annual Class A Pan Evaporation	75	inches	MDAQMD Mineral Guidance, conservative default, Pg. 26
Water Application Intensity	0.11	gal/yd^2	MDAQMD Mineral Guidance, conservative default, Pg. 26
Powerline Control Efficiency	98	%	MDAQMD Mineral Guidance, Pg. 26
Water Pipeline Control Efficiency	87	%	MDAQMD Mineral Guidance, Pg. 26

Notes:

1. Watering control efficiencies calculated consistent with MDAQMD guidance for Dust Entrainment from Unpaved Roads.

Abbreviations:

hr - hour
gal - gallons
yd^2 - square yard

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance Mineral Handling and Processing Industries. Available online at: https://www.mdaqmd.ca.gov/home/showdocument?id=768

Table C-8
Construction Mobile Vehicle Fleet Mix
Onroad Vehicles
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Fleet Mix Assumption[1]	Vehicle Type	Percentage of Fleet Mix[2,3]	Percentage by Fuel Type[2]				
			Gas	Diesel	Natural Gas	Electric	Plug-in Hybrid
Commuters	LDA	55.3%	90%	0.20%	0%	6.3%	3.3%
	LDT1	4.0%	99%	0.017%	0%	0.40%	0.34%
	LDT2	23.7%	98%	0.34%	0%	0.82%	1.2%
	MCY	0.4%	100%	0%	0%	0%	0%
	MDV	16.7%	96%	1.6%	0%	1.3%	1.1%
Single-Axle Vehicles/Vans	MDV	100%	50%	50%	0%	0%	0%
Double-Axle Vehicles	HHDT	100%	0%	100%	0%	0%	0%

Notes:

1. The following types of trips are expected to occur during construction: commuters to vanpool pick-up, vanpooling trips (vanpool to construction site), and single and double axle vehicle trips in support of
2. Fleet mixes and percentages by fuel type are calculated based on EMFAC2021 v1.0.1 vehicle miles traveled projections for MDAQMD. EMFAC2021 v1.0.1 was run in Emission Rates mode for calendar year 2026 in the annual season.
3. Construction of both the powerline and water pipeline are expected to occur over a duration less than 1 year. Year 2026 was conservatively used as the earliest possible year of construction.

Abbreviations:

EMFAC2021 - California Air Resources Board EMission FACtor model

References:

California Air Resources Board (ARB) 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory

Table C-9
Onroad Mobile Vehicles
Exhaust Emission Factors
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Year[1]	Fleet	Emission Factor Units	Mobile Emission Factors[2,3]									
			CAPs						GHGs			
			ROG	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x	CO_2	CH_4	N_2O	CO_2e[4]
2026	Commuters	g/mile	0.015	0.062	0.015	0.0051	0.81	0.0030	306	0.0033	0.0058	308
		g/trip	1.1	0.28	0.0020	0.0018	3.2	7.5E-04	76	0.073	0.033	87
	Single-Axle Vehicles/Vans	g/mile	0.016	0.12	0.019	0.0089	0.63	0.0042	431	0.0025	0.038	442
		g/trip	0.73	0.21	0.0011	0.0010	2.0	5.3E-04	53	0.051	0.021	61
	Double-Axle Vehicles	g/mile	0.012	1.4	0.14	0.066	0.037	0.014	1,478	5.7E-04	0.23	1,548
		g/trip	0.48	8.1	0.0021	0.0020	7.0	0.010	1,051	0.022	0.17	1,101

Notes:

1. Construction of both the powerline and water pipeline are expected to occur over a duration less than one year. Year 2026 was conservatively used as the earliest possible year of construction.
2. Emission factors were estimated using EMFAC2021 for MDAQMD. EMFAC2021 was run in Emission Rates mode for calendar year 2026 in the annual season. The following processes have units of g/trip: DIURN, HOTSOAK, RESTLOSS, STREX, and IDLEX. The following processes have units of g/mile: PMBW, PMTW, RUNEX, and RUNLOSS. Processes with units of g/vehicle/day were converted to g/trip using the population and trip rate values given in the EMFAC2021 run.
3. Emission factors from EMFAC with units of g/vehicle/day were converted to g/trip by scaling by the ratio of the total number of vehicles divided by the total number of trips for each vehicle class, fuel type, and year.
4. Emission factors for CO_2e were estimated by multiplying the CO_2, CH_4, and N_2O emission factors by their global warming potentials from the IPCC 4th Assessment Report on Climate Change (AR4).

Abbreviations:

CAP - Criteria Air Pollutant
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
DIURN - diurnal evaporative hydrocarbon emissions
EMFAC2017 - California Air Resources Board EMission FACtor model
g - grams
GHG - greenhouse gas
HOTSOAK - hot soak evaporative hydrocarbon emissions
IDLEX - idle exhaust emissions
IPCC - Intergovernmental Panel on Climate Change
MDAQMD - Mojave Desert Air Quality Management District
N_2O - nitrous oxide
NO_x - nitrogen oxides
PM - particulate matter
PMBW - break wear particulate matter emissions
PMTW - tire wear particulate matter emissions
RESTLOSS - resting evaporative losses
ROG - reactive organic gases
RUNEX - running exhaust emissions
RUNLOSS - running loss evaporative hydrocarbon emissions
STREX - start exhaust tailpipe emissions
SO_x - sulfur oxides

References:

California Air Resources Board (ARB) 2021. EMFAC2021. Available at: https://arb.ca.gov/emfac/emissions-inventory
Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007. Available at: https://www.ipcc.ch/assessment-report/ar4/

Table C-10
Onroad Mobile Vehicles
Trip Rates
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

ROW Utility	Vehicle Description	Fleet Mix Classification[1]	Total Trips[2] (trips/yr)	Total VMT[2] (VMT/yr)	Unpaved VMT[3] (VMT/yr)
Powerline	On-Site Pickup Trucks	Single-Axle Vehicles/Vans	1,200	56,250	56,250
	On-Site Semi Truck	Double-Axle Vehicles	640	25,500	25,500
	Vanpool to Site	Single-Axle Vehicles/Vans	600	45,600	5,400
	Commuters to Vanpool Pickup	Commuters	4,800	28,800	--
	Pickup Trucks to Site (Superintendent, Contractors, Site Inspectors)	Single-Axle Vehicles/Vans	328	26,200	2,952
	Material Deliveries, Garbage Hauling	Double-Axle Vehicles	146	25,000	1,314

ROW Utility	Vehicle Description	Fleet Mix Classification[1]	Total Trips[2] (trips/yr)	Total VMT[2] (VMT/yr)	Unpaved VMT[3] (VMT/yr)
Water Pipeline	On-site Pickup Trucks	Single-Axle Vehicles/Vans	2,154	113,085	113,085
	On-site Tool Van	Single-Axle Vehicles/Vans	584	30,660	30,660
	Commuters to Site	Commuters	8,266	1,080,200	37,197
	Vanpool to Site	Single-Axle Vehicles/Vans	439	265,595	1,976
	Commuters to Vanpool Pickup	Commuters	4,390	26,340	--
	On-site Semi-Trucks (Water, Fuel, etc.)	Double-Axle Vehicles	2,688	141,120	141,120
	Vendor Trips to Site	Double-Axle Vehicles	292	61,320	1,314

Notes:

1. Fleet mixes are defined in Table C-8.
2. Trip rates and distances/origins were provided by Castle Mountain Venture and supporting contractors. For the powerline construction, vanpools were assumed to originate from Las Vegas, NV, Henderson, NV, and/or Bullhead City/Laughlin, NV. For the water pipeline construction, vanpools were assumed to originate from Jean, NV.
3. Unpaved VMT represents the portion of travel that will occur on the unpaved mine access road (from Joshua Tree Highway to the Mine) when construction will be occurring along that route.

Abbreviations:

ROW - Right of Way

VMT - vehicle miles travelled

yr - year

Table C-11
Onroad Mobile Vehicles
Exhaust CAP Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

ROW Utility	Vehicle Description	Fleet Mix Classification[1]	Total Trips (trips/yr)	Total VMT (VMT/yr)	Total Emissions[4] (tpy)					
					NO_x	SO_x	CO	ROG[2]	PM_{10}[3]	$PM_{2.5}$[3]
Powerline	On-Site Pickup Trucks	Single-Axle Vehicles/Vans	1,200	56,250	0.0079	2.6E-04	0.042	0.0020	0.0012	5.6E-04
	On-Site Semi Truck	Double-Axle Vehicles	640	25,500	0.046	4.0E-04	0.0060	6.8E-04	0.0040	0.0019
	Vanpool to Site	Single-Axle Vehicles/Vans	600	45,600	0.0063	2.1E-04	0.033	0.0013	9.8E-04	4.5E-04
	Commuters to Vanpool Pickup	Commuters	4,800	28,800	0.0034	1.0E-04	0.042	0.0063	4.9E-04	1.7E-04
	Pickup Trucks to Site (Superintendent, Contractors, Site Inspectors)	Single-Axle Vehicles/Vans	328	26,200	0.0036	1.2E-04	0.019	7.3E-04	5.6E-04	2.6E-04
	Material Deliveries, Garbage Hauling	Double-Axle Vehicles	146	25,000	0.040	3.9E-04	0.0021	4.1E-04	0.0039	0.0018
				Total - Powerline	**0.11**	**0.0015**	**0.14**	**0.011**	**0.011**	**0.0051**

ROW Utility	Vehicle Description	Fleet Mix Classification[1]	Total Trips (trips/yr)	Total VMT (VMT/yr)	Total Emissions[4] (tpy)					
					NO_x	SO_x	CO	ROG[2]	PM_{10}[3]	$PM_{2.5}$[3]
Water Pipeline	On-site Pickup Trucks	Single-Axle Vehicles/Vans	2,154	113,085	0.016	5.2E-04	0.083	0.0037	0.0024	0.0011
	On-site Tool Van	Single-Axle Vehicles/Vans	584	30,660	0.0043	1.4E-04	0.023	0.0010	6.6E-04	3.0E-04
	Commuters to Site	Commuters	8,266	1,080,200	0.076	0.0036	0.99	0.028	0.018	0.0061
	Vanpool to Site	Single-Axle Vehicles/Vans	439	265,595	0.036	0.0012	0.19	0.0051	0.0057	0.0026
	Commuters to Vanpool Pickup	Commuters	4,390	26,340	0.0031	9.1E-05	0.039	0.0058	4.4E-04	1.6E-04
	On-site Semi-Trucks (Water, Fuel, etc.)	Double-Axle Vehicles	2,688	141,120	0.24	0.0022	0.027	0.0033	0.022	0.010
	Vendor Trips to Site	Double-Axle Vehicles	292	61,320	0.098	9.5E-04	0.0047	9.8E-04	0.0095	0.0045
				Total - Water Pipeline	**0.48**	**0.0087**	**1.4**	**0.048**	**0.059**	**0.025**
				Total - Both Utility Lines	**0.59**	**0.010**	**1.5**	**0.059**	**0.070**	**0.030**

Notes:

1. Trip generation rates and emission factors used in emissions calculations are shown in Table C-10 and Table C-9, respectively.
2. ROG is assumed to equal VOC.
3. PM_{10} and $PM_{2.5}$ emissions include tire wear and brake wear.
4. Construction of both the powerline and water pipeline are expected to occur over a duration less than one year, therefore total emissions are presented as tons per year.

Abbreviations:

CO - carbon monoxide
lb - pound
NO_x - nitrogen oxides
PM - particulate matter
ROG - reactive organic gases
ROW - Right of Way
SO_x - sulfur oxides
tpy - tons per year
VMT - vehicle miles traveled
VOC - volatile organic compounds
yr - year

Table C-12
Onroad Mobile Vehicles
Exhaust GHG Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

ROW Utility	Vehicle Description	Fleet Mix Classification	Total Trips[1]	Total VMT[1]	Total Emissions[1,2,3] (MT/yr)			
			(trips/yr)	(VMT/yr)	CO_2	CH_4	N_2O	Non-biogenic CO_2e
Powerline	On-Site Pickup Trucks	Single-Axle Vehicles/Vans	1,200	56,250	24	2.0E-04	0.0022	25
	On-Site Semi Truck	Double-Axle Vehicles	640	25,500	38	2.9E-05	0.0060	40
	Vanpool to Site	Single-Axle Vehicles/Vans	600	45,600	20	1.4E-04	0.0018	20
	Commuters to Vanpool Pickup	Commuters	4,800	28,800	9.2	4.5E-04	3.3E-04	9.3
	Pickup Trucks to Site (Superintendent, Contractors, Site Inspectors)	Single-Axle Vehicles/Vans	328	26,200	11	8.1E-05	0.0010	12
	Material Deliveries, Garbage Hauling	Double-Axle Vehicles	146	25,000	37	1.7E-05	0.0058	39
				Total - Powerline	**140**	**9.2E-04**	**0.017**	**145**

ROW Utility	Vehicle Description	Fleet Mix Classification	Total Trips[1]	Total VMT[1]	Total Emissions[1,2,3] (MT/yr)			
			(trips/yr)	(VMT/yr)	CO_2	CH_4	N_2O	Non-biogenic CO_2e
Water Pipeline	On-site Pickup Trucks	Single-Axle Vehicles/Vans	2,154	113,085	49	3.9E-04	0.0044	50
	On-site Tool Van	Single-Axle Vehicles/Vans	584	30,660	13	1.1E-04	0.0012	14
	Commuters to Site	Commuters	8,266	1,080,200	331	0.0042	0.0065	333
	Vanpool to Site	Single-Axle Vehicles/Vans	439	265,595	114	6.8E-04	0.010	118
	Commuters to Vanpool Pickup	Commuters	4390	26,340	8.4	4.1E-04	3.0E-04	8.5
	On-site Semi-Trucks (Water, Fuel, etc.)	Double-Axle Vehicles	2,688	141,120	211	1.4E-04	0.033	221
	Vendor Trips to Site	Double-Axle Vehicles	292	61,320	91	4.1E-05	0.014	95
				Total - Water Pipeline	**819**	**0.0060**	**0.070**	**840**
				Total - Both Utility Lines	**959**	**0.0069**	**0.087**	**985**

Notes:

1. Trip generation rates and emission factors used in emissions calculations are shown in Table C-10 and Table C-9, respectively.
2. Emissions for CO_2e were estimated by multiplying the CO_2, CH_4, and N_2O emissions by their global warming potentials from the IPCC 4th Assessment Report on Climate Change (AR4).
3. Construction of both the powerline and water pipeline are expected to occur over a duration less than one year, therefore total emissions are presented as metric tons per year.

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
GHG - greenhouse gas
MT - metric ton
N_2O - nitrous oxide
VMT - vehicle miles traveled
yr - year

References:

Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007. Available at: https://www.ipcc.ch/assessment-report/ar4/

Table C-13
Fugitive Dust Emissions from Onroad Mobile Vehicles
Paved Roads
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Road Dust Equation[1]

E = k*(sL)^0.91 * (W)^1.02 * (1-P/4N)

Parameter[2,3]	Value
E = annual average emission factor in the same units as k	[calculated]
k = particle size multiplier for particle size range and units of interest	
PM_{10} (lb/VMT)	0.0022
$PM_{2.5}$ (lb/VMT)	3.3E-04
sL = road surface silt loading (grams per square meter) (g/m^2)	0.099
W = average weight (tons) of all the vehicles traveling the road	2.4
P = number of "wet" days with at least 0.01 in of precipitation during averaging period	45
N number of days in the averaging period	365

Entrained Roadway Dust Constants for San Bernardino County (MDAQMD)		
Roadway Category	**Silt Loading[4] (g/m^2)**	**Travel Fraction[4]**
Freeway	0.015	52%
Major	0.08	32%
Collector	0.08	9.0%
Local	0.84	7.0%
Weighted Silt Loading Factor	**0.099**	**100%**

Parameter	Fugitive PM_{10}	Fugitive $PM_{2.5}$	Units
Emission Factor	6.4E-04	9.6E-05	lb/VMT

Powerline Paved Fugitive Dust Emissions

Vehicle Description	Paved VMT[5] (VMT/yr)	Total Emissions[6] (tpy)	
		PM_{10}	$PM_{2.5}$
Vanpool to Site	40,200	0.013	0.0019
Commuters to Vanpool Pickup	28,800	0.0092	0.0014
Pickup Trucks to Site (Superintendent, Contractors, Site Inspectors)	23,248	0.0074	0.0011
Material Deliveries, Garbage Hauling	23,686	0.0075	0.0011
Total - Powerline		**0.037**	**0.0055**

Water Pipeline Paved Fugitive Dust Emissions

Vehicle Description	Paved VMT[5] (VMT/yr)	Total Emissions[6] (tpy)	
		PM_{10}	$PM_{2.5}$
Commuters to Site	1,043,003	0.33	0.050
Vanpool to Site	263,620	0.084	0.013
Commuters to Vanpool Pickup	26,340	0.0084	0.0013
Vendor Trips to Site	60,006	0.019	0.0029
Total - Water Pipeline		**0.44**	**0.067**
Total - Both Utility Lines		**0.48**	**0.072**

Notes:

1. The road dust equation for paved roads is from the ARB's March 2021 update to Entrained Road Travel Emission Inventory Source Methodology.
2. The number of "wet" days for San Bernardino County (MDAQMD) from Table 5 of the ARB's March 2021 update to Entrained Road Travel Emission Inventory Source Methodology.
3. $PM_{2.5}$ is assumed to be 15% of PM_{10} based on paved road dust sampling in California (ARB Speciation Profile #471), consistent with guidance in ARB 2021 (page 17).
4. Travel fraction by roadway category and silt loading are from the ARB's March 2021 update to Entrained Road Travel Emission Inventory Source Methodology, Tables 2 and 4, respectively.
5. Vehicle miles traveled from Table C-10.
6. Construction of both the powerline and water pipeline are expected to occur over a duration less than one year, therefore total emissions are presented as tons per year.

Abbreviations:

ARB - Air Resources Board
CalEEMod® - California Emissions Estimator Model
g - gram(s)
lb - pounds
m - meter
PM - particulate matter
tpy - tons per year
VMT - vehicle miles traveled

References:

California Air Resources Board. 2021. Miscellaneous Process Methodology 7.9, Entrained Road Travel, Paved Road Dust. March. Available online at: https://ww3.arb.ca.gov/ei/areasrc/fullpdf/2021_paved_roads_7_9.pdf

USEPA. 2011. AP 42. Compilation of Air Pollutant Emission Factors, Volume 1. Fifth Edition. Chapter 13.2.1, Paved Roads. Available online at: http://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0201.pdf.

Table C-14
Fugitive Dust Emissions from Onroad Mobile Vehicles
Unpaved Roads
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

ROW Utility	Vehicle Description[1]	Average Vehicle Weight[2] (tons)	Unpaved VMT[3,4] (VMT/yr)	PM_{10} EF[5] (lb/VMT)	$PM_{2.5}$ EF[5] (lb/VMT)	Control Efficiency[6] (%)	Number of Days with >0.01 Inches Precipitation[7] (day/yr)	Total Emissions[8] (tpy)	
								PM_{10}	$PM_{2.5}$
Powerline	On-Site Pickup Trucks	2.4	56,250	0.62	0.062	95%	27	0.80	0.080
	On-Site Semi Truck	32	25,500	2.0	0.20	95%	27	1.2	0.12
	Vanpool to Site	2.4	5,400	0.62	0.062	95%	27	0.077	0.0077
	Pickup Trucks to Site (Superintendent, Contractors, Site Inspectors)	2.4	2,952	0.62	0.062	95%	27	0.042	0.0042
	Material Deliveries, Garbage Hauling	32	1,314	2.0	0.20	95%	27	0.060	0.0060
							Total - Powerline	2.1	0.21

ROW Utility	Vehicle Description[1]	Average Vehicle Weight[2] (tons)	Unpaved VMT[3,4] (VMT/yr)	PM_{10} EF[5] (lb/VMT)	$PM_{2.5}$ EF[5] (lb/VMT)	Control Efficiency[6] (%)	Number of Days with >0.01 Inches Precipitation[7] (day/yr)	Total Emissions[8] (tpy)	
								PM_{10}	$PM_{2.5}$
Water Pipeline	On-site Pickup Trucks	2.4	113,085	0.62	0.062	95%	27	1.6	0.16
	On-site Tool Van	2.4	30,660	0.62	0.062	95%	27	0.44	0.044
	Commuters to Site	2.4	37,197	0.62	0.062	95%	27	0.53	0.053
	Vanpool to Site	2.4	1,976	0.62	0.062	95%	27	0.028	0.0028
	On-site Semi-Trucks (Water, Fuel, etc.)	32	141,120	2.0	0.20	95%	27	6.5	0.65
	Vendor Trips to Site	32	1,314	2.0	0.20	95%	27	0.060	0.0060
							Total - Water Pipeline	9.1	0.91
							Total - Both Utility Lines	11	1.1

Notes:

1. The following types of trips are expected to travel on unpaved roads during construction: single commuters, vanpooling trips (vanpool to construction site), and various single and double axle vehicle trips in support of construction work.
2. Vehicle weights estimated based off of typical vehicle size for the types of trips listed. Where multiple types of vehicles may be used within a given grouping, weights of heavier vehicle models were conservatively used.
3. Unpaved VMT represents the portion of travel that will occur on the unpaved mine access road (from Joshua Tree Highway to the Mine) when construction will be occuring along that route.
4. VMT and trip rates shown in Table C-10.

[5] Fugitive dust emission factors calculated following MDAQMD's "most complex" Unpaved Roads methodology from the Emissions Inventory Guidance: Mineral Handling and Processing Industries, with updates to account for the latest AP-42 correlations for industrial roads (Equation 1a, Table 13.2.2-2, AP-42 Section 13.2.2) at the time of inventory preparation. A surface silt content of 5% was used, consistent with data provided by Castle Mountain Venture.

[6] A control efficiency of 95% was used consistent with assumptions for watering, graveling surface, treatment with chemical stabilizers, and speed control from the 1997 Castle Mountain Mine Expansion Project EIS/EIR, and the understanding that chemical suppressants will be applied to all unpaved roadways.

[7] Consistent with the AP-42 Section 13.2.2 unpaved roads methodology for industrial sites, Ramboll applied a precipitation reduction based on the average number of days per year with greater than 0.01 inches precipitation per year based on site-specific meteorological measurements between January 2022 and December 2024.

[8] Construction of both the powerline and water pipeline are expected to occur over a duration less than one year, therefore total emissions are presented as tons per year.

Abbreviations:

lb - pounds
PM - particulate matter
tpy - tons per year
VMT - vehicle miles traveled
yr - year

References:

USEPA. 2006. AP 42. Compilation of Air Pollutant Emission Factors, Volume 1. Fifth Edition. Chapter 13.2.2, Unpaved Roads. Available online at: https://www.epa.gov/sites/default/files/2020-10/documents/13.2.2_unpaved_roads.pdf.

Bureau of Land Management. 1997. Castle Mountain Mine Expansion Project Final Environmental Impact Statement/Environmental Impact Report. October.

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance Mineral Handling and Processing Industries. Available online at: https://www.mdaqmd.ca.gov/home/showdocument?id=768

Table C-15
Disturbed Construction Area Emissions
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

Source Name[1]	Mean Wind Speed[2] (m/s)	Fraction of Vegetative Cover[3]	Threshold Friction Velocity[4] (m/s)	Ratio of Wind Speed to Friction Velocity[5]	Threshold Value of Wind Speed[1] (m/s)	x Value for Correction Factor Selection	Correction Factor[1]	Emission Factors[1] (ton/acre)		Daily Disturbed Surface Area (acres)[6]	Control Efficiency[7] (%)	Total Emissions (tpy)	
								PM_{10}	$PM_{2.5}$			PM_{10}	$PM_{2.5}$
Powerline Disturbed Areas	3.9	0	0.26	15	3.9	0.89	1.7	2.4	0.94	0.033	98%	0.0019	7.7E-04
Water Pipeline Disturbed Areas	3.9	0	0.26	15	3.9	0.89	1.7	2.4	0.94	11	87%	3.4	1.3
											Total - Both Utility Lines	**3.4**	**1.3**

Notes:

1. Windblown dust from construction disturbed areas assumed to be a "unlimited" reservoir consistent with MDAQMD definitions due to the fact that significant crusting would not occur on construction areas. Emissions were estimated using the intermediate complexity Wind Erosion from Unpaved Operational Areas and Roads methodology in MDAQMD Emissions Inventory Guidance, Section VI.L.
2. Mean wind speed based on 3-year average of site-specific meteorological measurements for the period of January 2022 through December 2024.
3. Vegetative cover fraction assumed to be zero which provides a conservative estimate of emissions from disturbed construction areas.
4. Threshold friction velocity selected from the MDAQMD guidance based on an area use of "disturbed desert".
5. Ratio of wind speed to friction velocity selected from the MDAQMD guidance based on an area use of "open space".
6. Disturbed surface area based on information provided by Castle Mountain Venture and supporting contractors. This area represents the surface area expected to be disturbed on a daily basis for the duration of the construction period. Per MDAQMD Guidance, "actively disturbed is defined as being disturbed by man's activity at least once per day". The total area to be disturbed during construction was divided by the construction duration and then multiplied by the number of construction workdays per week (assuming any given area may be disturbed daily for up to 1 week of construction) to provide a conservative estimate of the average surface area disturbed at any time.
7. Control efficiency accounts for watering of disturbed areas and is estimated in Table C-7. Watering control efficiency is calculated consistent with MDAQMD guidance for Dust Entrainment from Unpaved Roads as shown in Table C-7.

Abbreviations:

m/s - meters per second
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
tpy - tons per year

References:

Mojave Desert Air Quality Management District. 2013. Emissions Inventory Guidance Mineral Handling and Processing Industries. Available online at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

Table C-16
Hazardous Air Pollutant Emissions
Fugitive Dust Sources
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

HAP	CAS #	Metal Weight Fraction			
		Desert Soil[1]	Paved Road Dust[2]	Tire Wear[3]	Brake Wear[4]
Antimony	7440360	1.2E-05	6.8E-05		
Arsenic	7440382	5.7E-05	1.3E-05		1.0E-05
Cadmium	7440439	1.3E-05	3.0E-06		
Chromium (total)	7440473	1.3E-04	1.7E-05	3.0E-05	0.0012
Cobalt	7440484	8.3E-05	2.3E-05		
Lead	7439921	4.8E-05	1.2E-04	1.6E-04	5.0E-05
Manganese	7439965	7.6E-04	8.0E-04	1.0E-04	0.0017
Mercury	7439976	1.7E-05	9.0E-06		
Nickel	7440020	3.7E-05	1.2E-05	5.0E-05	6.6E-04
Phosphorus	7723140	4.5E-04	0.0027	0.0013	
Selenium	7782492	2.0E-06	2.0E-06	2.0E-05	2.0E-05

Source		Powerline Construction						
		Off-Road Fugitive Dust	Onroad Paved Fugitive Dust	Onroad Unpaved Fugitive Dust	Tire Wear Fugitive Dust	Brake Wear Fugitive Dust	Disturbed Areas	Total Emissions[6]
Material Profile		Desert Soil	Paved Road	Desert Soil	Tire Wear	Brake Wear	Desert Soil	--
Annual PM_{10} Emissions (lb/yr)[5]		217	74	4,299	6.8	10	3.9	**4,610**
Annual Emissions (lb/yr)	Antimony	0.0026	0.0050	0.052	--	--	4.6E-05	**0.059**
	Arsenic	0.012	9.6E-04	0.24	--	1.0E-04	2.2E-04	**0.26**
	Cadmium	0.0028	2.2E-04	0.055	--	--	4.9E-05	**0.058**
	Chromium (total)	0.028	0.0013	0.55	2.0E-04	0.012	4.9E-04	**0.59**
	Cobalt	0.018	0.0017	0.35	--	--	3.2E-04	**0.37**
	Lead	0.010	0.0092	0.21	0.0011	5.1E-04	1.9E-04	**0.23**
	Manganese	0.17	0.059	3.3	6.8E-04	0.017	0.0029	**3.5**
	Mercury	0.0036	6.6E-04	0.071	--	--	6.4E-05	**0.075**
	Nickel	0.0079	8.9E-04	0.16	3.4E-04	0.0067	1.4E-04	**0.17**
	Phosphorus	0.10	0.20	1.9	0.0085	--	0.0017	**2.2**
	Selenium	4.3E-04	1.5E-04	0.0086	1.4E-04	2.0E-04	7.7E-06	**0.0095**
	Total HAPs	**0.35**	**0.28**	**6.9**	**0.011**	**0.037**	**0.0062**	**7.6**

Source		Water Pipeline Construction						
		Off-Road Fugitive Dust	Onroad Paved Fugitive Dust	Onroad Unpaved Fugitive Dust	Tire Wear Fugitive Dust	Brake Wear Fugitive Dust	Disturbed Areas	Total Emissions[6]
Material Profile		Desert Soil	Paved Road	Desert Soil	Tire Wear	Brake Wear	Desert Soil	--
Annual PM_{10} Emissions (lb/yr)		5,404	888	18,261	43	52	6,722	**31,369**
Annual Emissions (lb/yr)	Antimony	0.065	0.060	0.22	--	--	0.081	**0.42**
	Arsenic	0.31	0.012	1.0	--	5.2E-04	0.38	**1.7**
	Cadmium	0.069	0.0027	0.23	--	--	0.086	**0.39**
	Chromium (total)	0.69	0.015	2.3	0.0013	0.062	0.86	**4.0**
	Cobalt	0.45	0.020	1.5	--	--	0.55	**2.5**
	Lead	0.26	0.11	0.88	0.0068	0.0026	0.32	**1.6**
	Manganese	4.1	0.71	14	0.0043	0.088	5.1	**24**
	Mercury	0.089	0.0080	0.30	--	--	0.11	**0.51**
	Nickel	0.20	0.011	0.67	0.0021	0.034	0.25	**1.2**
	Phosphorus	2.4	2.4	8.1	0.053	--	3.0	**16**
	Selenium	0.011	0.0018	0.037	8.5E-04	0.0010	0.013	**0.064**
	Total HAPs	**8.7**	**3.4**	**29**	**0.069**	**0.19**	**11**	**52**
Total - Both Utility Lines		**9.0**	**3.6**	**36**	**0.080**	**0.22**	**11**	**60**

Notes:

1. Desert soil PM weight fractions from MDAQMD.

2. Paved road dust PM weight fractions are based on ARB particulate matter chemical profile 471 from ARB speciation profiles. Profile selection based on ARB reference numbers for PM profiles.

3. Tire wear PM weight fractions are based on ARB particulate matter chemical profile 472 from ARB speciation profiles. Profile selection based on ARB reference numbers for PM profiles.
4. Brake wear PM weight fractions are based on ARB particulate matter chemical profile 473 from ARB speciation profiles. Profile selection based on ARB reference numbers for PM profiles.
5. PM10 emissions for each source category are based on emissions from Table C-4, Table C-11, Table C-13, Table C-14, and Table C-15. Tire wear and brake wear PM10 emissions from onroad sources are separated here for purposes of applying corresponding chemical profiles.
6. Construction of both the powerline and water pipeline are expected to occur over a duration less than one year, therefore total emissions are presented as tons per year.

Reference:

California Air Resources Board (ARB). *Speciation Profiles Used in CARB Modeling.* Available at: https://ww2.arb.ca.gov/speciation-profiles-used-carb-modeling

California Air Resources Board (ARB). Particulate Matter chemical speciation profiles for source categories. Available at: https://ww2.arb.ca.gov/sites/default/files/2025-05/pmchemprofile29apr25.xlsx

California Air Resources Board (ARB). Particulate Matter reference number for particulate matter profiles. Available at: https://ww2.arb.ca.gov/sites/default/files/2025-05/pmprof_ref29apr25.xlsx

Mojave Desert Air Quality Management District (MDAQMD). 2005. *Default Emission Factors for Desert Soils.*

Abbreviations:

ARB - California Air Resources Board
lb - pounds
HAP - hazardous air pollutant
MDAQMD - Mojave Desert Air Quality Management District
PM - particulate matter
yr - year

Table C-17
Hazardous Air Pollutant Emissions
Mobile Exhaust Sources - Inorganic HAPs
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

PM Speciation	PM_{10} Weight Fractions[1,2]		Total Emissions (lb/yr)						
			Powerline Construction			Water Pipeline Construction			Total - Both Utility Lines
	Mobile Source Diesel Combustion	Mobile Source Gasoline Combustion	Mobile Diesel Equipment Exhaust		Mobile Gasoline Equipment Exhaust	Mobile Diesel Equipment Exhaust		Mobile Gasoline Equipment Exhaust	
			Offroad	Onroad	Onroad	Offroad	Onroad	Onroad	
Total PM_{10} Emissions[3]			**274**	**5.0**	**0.28**	**463**	**19**	**3.5**	
Antimony	3.6E-05		0.0099	1.8E-04		0.017	6.9E-04		**0.027**
Arsenic	5.0E-06		0.0014	2.5E-05		0.0023	9.6E-05		**0.0038**
Cadmium	4.0E-05		0.011	2.0E-04		0.019	7.7E-04		**0.030**
Chlorine	3.4E-04	0.070	0.094	0.0017	0.020	0.16	0.0066	0.25	**0.53**
Chromium	1.2E-05	5.0E-04	0.0033	6.0E-05	1.4E-04	0.0056	2.3E-04	0.0018	**0.011**
Cobalt	1.1E-05	5.0E-04	0.0030	5.5E-05	1.4E-04	0.0051	2.1E-04	0.0018	**0.010**
Lead	4.2E-05		0.011	2.1E-04		0.019	8.1E-04		**0.032**
Manganese	4.0E-05	5.0E-04	0.011	2.0E-04	1.4E-04	0.019	7.7E-04	0.0018	**0.032**
Mercury	3.0E-05		0.0082	1.5E-04		0.014	5.8E-04		**0.023**
Nickel	1.9E-05	5.0E-04	0.0052	9.5E-05	1.4E-04	0.0088	3.6E-04	0.0018	**0.016**
Phosphorus	1.3E-04		0.035	6.4E-04		0.059	0.0024		**0.097**
Selenium	1.0E-05		0.0027	5.0E-05		0.0046	1.9E-04		**0.0076**
Total HAPs			**0.20**	**0.0036**	**0.020**	**0.33**	**0.014**	**0.25**	**0.82**

Notes:

1. Diesel combustion PM weight fractions are based on ARB particulate matter chemical profile 425 from ARB speciation profiles. Profile selection based on ARB reference numbers for PM profiles.
2. Gasoline combustion PM weight fractions are based on ARB particulate matter chemical profile 115/399/400 from ARB speciation profiles. Profile selection based on ARB reference numbers for PM profiles.
3. PM10 emissions for each source category are based on emissions from Table C-5 and Table C-11. PM10 emissions from onroad mobile sources represent exhaust emissions only and are split by diesel and gasoline fuel sources for purposes of applying corresponding chemical profiles.

Reference:

California Air Resources Board (ARB). *Speciation Profiles Used in CARB Modeling.* Available at: https://ww2.arb.ca.gov/speciation-profiles-used-

California Air Resources Board (ARB). Particulate Matter chemical speciation profiles for source categories. Available at: https://ww2.arb.ca.gov/sites/default/files/2025-05/pmchemprofile29apr25.xlsx

California Air Resources Board (ARB). Particulate Matter reference number for particulate matter profiles. Available at: https://ww2.arb.ca.gov/sites/default/files/2025-05/pmprof_ref29apr25.xlsx

Abbreviations:

ARB - California Air Resources Board
lb - pounds
HAP - hazardous air pollutant
PM - particulate matter
yr - year

Table C-18
Hazardous Air Pollutant Emissions
Mobile Exhaust Sources - Organic HAPs
Castle Mountain Venture
Castle Mountain Mine, Ivanpah, CA

VOC Speciation	CAS Number	VOC Weight Fractions[1,2]		Total Emissions (lb/yr)						
				Powerline Construction			Water Pipeline Construction			Total - Both Utility Lines
		Mobile Source Diesel Combustion	Mobile Source Gasoline Combustion	Mobile Diesel Equipment Exhaust		Mobile Gasoline Equipment Exhaust	Mobile Diesel Equipment Exhaust		Mobile Gasoline Equipment Exhaust	
				Offroad	Onroad	Onroad	Offroad	Onroad	Onroad	
			Total VOC[3]	**284**	**4.3**	**19**	**438**	**15**	**80**	
1,3-Butadiene	106-99-0	0.0019	0.0083	0.54	0.0081	0.15	0.83	0.029	0.67	**2.2**
2,2,4-Trimethylpentane	540-84-1	0.0030	0.020	0.85	0.013	0.37	1.3	0.046	1.6	**4.2**
Acetaldehyde	75-07-0	0.074	0.0075	21	0.31	0.14	32	1.1	0.60	**55**
Acrolein	107-02-8		0.0018			0.033			0.14	**0.18**
Benzene	71-43-2	0.020	0.034	5.7	0.086	0.64	8.8	0.31	2.8	**18**
Cumene	98-82-8	2.0E-04	5.0E-04	0.057	8.6E-04	0.0093	0.088	0.0031	0.040	**0.20**
Ethyl Benzene	100-41-4	0.0031	0.015	0.88	0.013	0.28	1.4	0.048	1.2	**3.8**
Formaldehyde	50-00-0	0.15	0.031	42	0.63	0.58	64	2.3	2.5	**112**
Hexane	110-54-3	0.0016	0.013	0.45	0.0068	0.24	0.70	0.025	1.1	**2.5**
Methanol	67-56-1	3.0E-04	0.0070	0.085	0.0013	0.13	0.13	0.0046	0.56	**0.91**
Methyl Tert-Butyl Ether	1634-04-4		0.019			0.34			1.5	**1.8**
M-Xylene	108-38-3	0.0061	0.045	1.7	0.026	0.83	2.7	0.094	3.6	**8.9**
Naphthalene	91-20-3	9.0E-04	0.0013	0.26	0.0038	0.024	0.39	0.014	0.10	**0.80**
o-Xylene	95-47-6	0.0034	0.016	0.97	0.015	0.29	1.5	0.052	1.2	**4.1**
Propionaldehyde	123-38-6	0.0097	0.0013	2.8	0.041	0.024	4.3	0.15	0.10	**7.3**
p-Xylene	106-42-3	0.0010		0.28	0.0043		0.44	0.015		**0.74**
Styrene	100-42-5	6.0E-04	0.0013	0.17	0.0026	0.024	0.26	0.0093	0.10	**0.57**
Toluene	108-88-3	0.015	0.068	4.2	0.063	1.3	6.4	0.23	5.5	**18**
			Total HAPs	**81**	**1.23**	**5.4**	**126**	**4.4**	**23**	**242**

Notes:

1. Diesel combustion VOC weight fractions are based on ARB organic chemical profile 818 from https://ww2.arb.ca.gov/sites/default/files/2024-10/orgprofile20sep24.xlsx. Profile selection based on https://ww2.arb.ca.gov/sites/default/files/2024-10/orgprof_ref20sep24.xlsx.
2. Gasoline combustion VOC weight fractions are based on ARB organic chemical profile 401 from https://ww2.arb.ca.gov/sites/default/files/2024-10/orgprofile20sep24.xlsx. Profile selection based on https://ww2.arb.ca.gov/sites/default/files/2024-10/orgprof_ref20sep24.xlsx.
3. VOC emissions for each source category are based on emissions from Table C-5 and Table C-11. VOC emissions from onroad mobile sources are split by diesel and gasoline fuel sources for purposes of applying corresponding chemical profiles.

Abbreviations:

ARB - California Air Resources Board
lb - pounds
HAP - hazardous air pollutant
VOC - volatile organic compound
yr - year

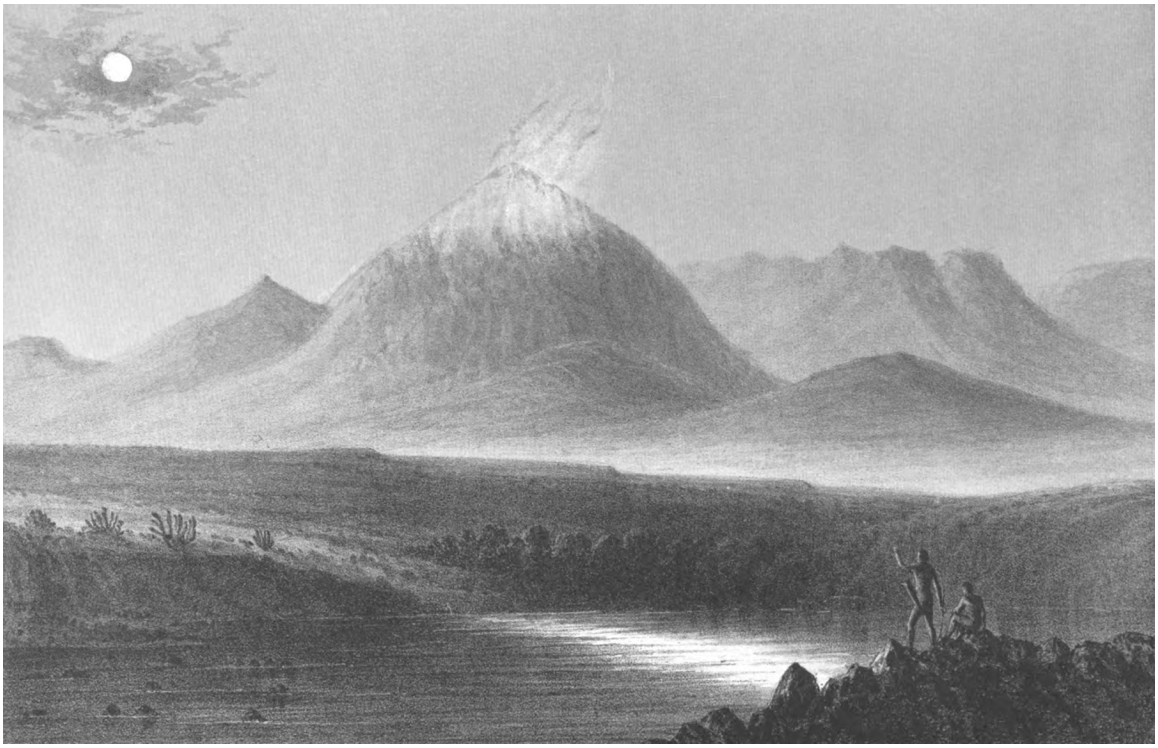
EIR APPENDIX 6

Avi Kwa Ame National Monument Cultural and Historical Overview (Wright 2022)

Under the Halo of Spirit Mountain:

A Cultural and Historical Overview of the Proposed Avi Kwa Ame National Monument, Southern Clark County, Nevada

Aaron M. Wright, Ph.D. RPA



Archaeology Southwest

Technical Report No. 2022-102

300 North Ash Alley, Tucson, Arizona • September 2022

Note: The Fort Mojave Tribe has its own origins and it is not bound by any findings in this report.

Under the Halo of Spirit Mountain:

A Cultural and Historical Overview of the Proposed Avi Kwa Ame National Monument, Southern Clark County, Nevada

BLM Report No. 5-2905

Aaron M. Wright, Ph.D. RPA



Archaeology Southwest

Technical Report No. 2022-102

300 North Ash Alley, Tucson, Arizona • September 2022

STATEMENT OF PURPOSE AND AUTHORITY

This report was prepared at the request of the Nevada Avi Kwa Ame Coalition, a non-governmental organization. Its express purpose is to provide the U.S. Department of the Interior, elected representatives and officials, and other interested parties with: (a) a descriptive account of all known historic properties, cultural resources, and other objects of historic or scientific interest within the proposed Avi Kwa Ame National Monument; (b) an overview of Tribal connections to and affinities with those objects, as well as the land and water within the proposed monument; (c) an assessment of the objects' historic and scientific value and significance; and (d) an evaluation of the objects' ecological, geological, and archaeological contexts to inform assessments of the smallest area compatible with the proper care and management of those objects so as to preserve their integrity and the integrity of the interactions and relationships among them.

In accord with these purposes, previously developed archaeological, ethnographic, and ethnohistoric information available in the public domain or curated in repositories for which permitted access was granted is synthesized here. This report was reviewed by authorized representatives, agents, and/or consultants of the Fort Mojave Indian Tribe, Chemehuevi Indian Tribe, Moapa Band of Paiute Indians, and Las Vegas Tribe of Paiute Indians. The purpose of Tribal review was to safeguard against unnecessary and inadvertent disclosure of sensitive, harmful, inaccurate, or inappropriate information pertaining to Tribal heritage. The collection of new archaeological and ethnographic information was beyond the scope and aim of this study. Because new or privileged information might contradict or otherwise discredit that which is reported here, this report should not be regarded as an authoritative account of the history and Tribal heritage associated with the land, water, and objects within the proposed Avi Kwa Ame National Monument or other areas referenced herein.

Because this report was not prepared in response to a federal undertaking or at the behest of a governmental entity, Tribal involvement and review was entirely voluntary. This report was not produced pursuant to the Tribal coordination or consultation requirements of Executive Order 13175 of November 6, 2000 ("Consultation and Coordination with Indian Tribal Governments"), of George W. Bush's Presidential Memorandum of September 23, 2004 ("Government-to-Government Relationship with Tribal Governments"), of Barack Obama's Presidential Memorandum of November 5, 2009 ("Tribal Consultation"), or of Joseph R. Biden's Presidential Memorandum of January 26, 2021 ("Tribal Consultation and Strengthening Nation-to-Nation Relationships").

Likewise, this report is not released to meet Tribal consultation guidelines enumerated in Department of the Interior Secretarial Order No. 3215 of April 28, 2000 ("Principles for the Discharge of the Secretary's Trust Responsibility"), Order No. 3317 of December 1, 2011 ("Department of the Interior Policy on Consultation with Tribes"), or Order No. 3403 of November 15, 2021 ("Joint Secretarial Order on Fulfilling the Trust Responsibility to Indian Tribes in the Stewardship of Federal Lands and Waters"). Accordingly, this document and the information reported herein do not satisfy Tribal consultation responsibilities of any federal or state agency. Furthermore, while this report presents a compilation and synthesis of other sources, it does not replace or otherwise represent them for purposes of compliance with any federal or state law or rule pertaining to cultural resources, including the Archaeological Resources Protection Act, National Historic Preservation Act, National Environmental Policy Act, Native American Graves Protection and Repatriation Act, American Indian Religious Freedom Act, Executive Order 13007 ("Indian Sacred Sites"), Nevada Revised Statue 381.195.227 ("Preservation of Prehistoric and Historic Sites"), Nevada Revised Statute 383.180 ("Protection of Indian Burial Sites"), and Nevada Revised Statue 383.383.345 ("Protection of Historic and Prehistoric Sites").

EXECUTIVE SUMMARY

This report details the findings of a Class I archaeological and ethnographic survey of the proposed Avi Kwa Ame National Monument in southern Clark County, Nevada. This area of public land lies within the traditional homelands of the Aha Macav (i.e., Mojave) and Nuwuvi (i.e., Southern Paiute and Chemehuevi), and their ancestors. The survey consisted of a thorough and exhaustive review of: (1) records for historic, archaeological, and cultural properties identified to date within the proposed monument; (2) corresponding reports and publications; and (3) published or otherwise publically available ethnographic information pertaining to Avi Kwa Ame, or Spirit Mountain, and the surrounding landscape. The findings offer a synthesis of existing information, as no new archaeological or ethnographic fieldwork was conducted in the course of this survey.

The Class I survey established that information is available for 125 prior cultural resources and historic property inventories within, intersecting, or overlapping the proposed monument. While each topographic region has experienced some level of investigation, the combined area of coverage constitutes less than 5 percent of the proposed monument, indicating most of the region has yet to be systematically and professionally surveyed. Despite the small proportion of land inventoried to date, records exist for 350 documented historic, archaeological, and cultural properties throughout the proposed monument. Properties of Indigenous origin and use include petroglyphs and pictographs, rockshelters, quarries, trails, rock features, artifact scatters, and Traditional Cultural Places (TCPs), specifically the Spirit Mountain TCP that was included in the National Register of Historic Places in 1999. Properties of Euro-American origin and use include mines and mining settlements, military training areas, transportation facilities, energy and utility conduits, rock features, refuse areas, and homesteading and ranching sites, the best known being the Walking Box Ranch, which was included in the National Register of Historic Places in 2009.

In addition to tangible cultural resources, Avi Kwa Ame and the landscape in which it lies, much of which is encompassed by the proposed monument, undergird the intangible cultural resources of numerous associated Indigenous communities. In the cosmologies of the Yuman Tribes, including the Aha Macav, Avi Kwa Ame is the place of Creation. The mountain is a place people visit in person and in spirit when seeking wisdom and knowledge. It persists as a pilgrimage destination and remains central to Yuman mourning ceremonies; further, it and the surrounding landscape feature prominently in traditional Yuman songs. To the Nuwuvi, the proposed monument lies within Puaxant Tuvip, a holy land given to them at the time of Creation. The landscape and the topographic features within it feature in traditional Nuwuvi songs, such as those of the Mountain Sheep Song Cycle. Importantly, the Nuwuvi Salt Song Cycle—which is essentially a map of Nuwuvi holy land and a route for the spirits of recently departed to follow on their way to the afterlife—circumnavigates the proposed monument, underscoring the landscape's centrality to Nuwuvi cultural identity, spirituality, and persistence.

While the Aha Macav and Nuwuvi perspectives on Avi Kwa Ame are best known, additional ethnographic work is needed to more fully understand the significance of the mountain to other Tribal communities. This is especially the case for Tribes who supported the original Spirit Mountain TCP but for whom relevant ethnographic information is lacking, particularly the Hopi, Havasupai, and Yavapai. Pertinent ethnographic information is also lacking for more distant Yuman communities (the PaiPai and Kiliwa in Baja, Mexico) and for neighboring non-Yuman Tribes who were not involved in the TCP outreach and for whom ethnographic information is also lacking, such as the Cahuilla, Kawaiisu, and Koso.

TABLE OF CONTENTS

Statement of Purpose and Authority iii

Executive Summary v

List of Figures xi

List of Tables xiii

Acknowledgments xv

1. INTRODUCTION 1

    Outline of the Avi Kwa Ame Study Area 1
    Organization of the Report 3

2. PHYSICAL SETTING 5

    Topography 5
        McCullough Range 5
        Highland Range 7
        Lucy Gray Mountains 7
        New York Mountains 7
        Castle Mountains 8
        Piute Range 8
        Chiquita Hills 9
        Dead Mountains 9
        Newberry Mountains 9
        Ireteba Parks 10
    Hydrogeography 10
        Colorado River Valley 10
        Piute Valley 12
        Eldorado Valley 12
        Ivanpah Valley 12
        Jean Lake Valley 12
    Surface Water 13
    Environment and Climate 14
        Current Ecosystems 15
    Past Ecosystems 17
        Terminal Pleistocene 18
        Early Holocene 18
        Middle Holocene 18
        Late Holocene 19

3. CULTURAL SETTING....21

Aha Macav....23
Nuwuvi....27

4. HISTORICAL SETTING....35

Pre-Projectile Era....35
Paleoarchaic Era....36
Paleoindian Period....37
Early Archaic Period....37
Archaic Era....38
Middle Archaic Period....38
Late Archaic Period....39
Formative Era....41
Early Formative Period....42
Late Formative Period....44
Ethnohistoric Era....45
Spanish Provincial Period....45
Mexican Territorial Period....48
U.S. Territorial Period....49
Early Statehood Period....53

5. CULTURAL RESOURCES INVENTORY....55

Methodology....56
Databases....56
History of Research....57
Early Investigations....57
Cultural Resources Management Era....58
Inventory by Region....62
Inventory by Agency....62
Inventory by Industry....62
Representativeness of the Sample....66

6. SUMMARY OF FINDINGS....69

Indigenous Properties....73
Artifact Scatters....73
Miscellaneous Rock Feature....75
Petroglyphs and Pictographs....76
Quarries....79
Rockshelters....81
Traditional Cultural Properties....84
Trails....88
Euro-American Properties....89
Energy and Utility Conduits....89
Homesteading and Ranching Sites....90

Military and Training Areas 91
Mining Localities and Features 91
Miscellaneous Rock Features 93
Refuse Scatters 93
Settlements 93
Transportation Facilities 94

7. THE INTANGIBLE CULTURAL HERITAGE SIGNIFICANCE OF AVI KWA AME AND THE SURROUNDING LANDSCAPE 97

Spiritual Power in Numic and Yuman Ontology 98
Avi Kwa Ame in Yuman Ontology 99
Aha Macav 101
Kwatsáan 102
Cocopah 103
Piipaash 104
Kumeyaay 105
Hualapai 107
Yuman "Dreaming" 108
Yuman Songs 109
Yuman Ceremonies 110
The Nuwuvi Holy Land 111
Nuwuvi Songs 112

8. SCIENTIFIC AND RESEARCH POTENTIAL 117

Indigenous History Research Themes 118
Chronology 118
Settlement Patterns and Settlement Systems 118
Subsistence and Diet 119
Technology 120
Religion and Ritualism 121
Contact and Trade 122
Archaeological Cultures, Ethnicity, and Ethnogenesis 123
Landscape as Scale, Context, and Strategy 124

APPENDIX A: INVENTORY OF PRIOR CULTURAL RESOURCES AND HISTORIC PROPERTIES INVENTORIES 127

APPENDIX B: INVENTORY OF DOCUMENTED CULTURAL RESOURCES AND HISTORIC PROPERTIES 135

REFERENCES CITED 151

LIST OF FIGURES

1.1. Location of the proposed Avi Kwa Ame National Monument 2

2.1. Landforms in and around the study area 6

2.2. Watersheds in and around the study area 11

2.3. Ecosystems within the study area 16

3.1. Current reservations overlaying areas of traditional tribal occupancy in and around the study area 22

3.2. Traditional Nuwuvi lands, by regional group 30

4.1. Wood cut of Beale's Pass in 1860, by J. J. Young 51

4.2. Euro-American roads and settlements as of 1865 52

5.1. Surveyed/inventoried area, by topographic region 60

5.2. Inventory data, by topographic region 63

5.3. Inventory data, by agency 64

5.4. Inventory data, by industry 65

6.1. Rudolph d'Heureuse's photograph of Lewis Holes in 1863 85

7.1. Routes of the Salt Songs around the Nuwuvi Holy Land and the proposed Avi Kwa Ame National Monument 114

LIST OF TABLES

2.1. Springs within the study area 13

3.1. Nuwuvi regional groups 28

3.2. Contemporary Nuwuvi Tribes and Tribes with recognized Nuwuvi contingencies 29

3.3. Nineteenth century Nuwuvi Bands of the Las Vegas and Chemenhuevi Groups 31

4.1. Culture-historical chronology for the study area 36

4.2. Timeline of events of historic significance relevant to the study area 46

5.1. Surveyed/inventoried lands, by topographic region 59

5.2. Cultural resources inventory project data, by agency 61

5.3. Cultural resources inventory project data, by industry 61

6.1. Historic property classes within the study area and their National Register of Historic Places status 71

6.2. Historic property classes, by topographic region 72

A.1. Inventory of prior cultural resources and historic property inventories 129

B.1. Inventory of documented cultural resources and historic properties 137

ACKNOWLEDGMENTS

This culture historical overview of southern Clark County, Nevada, and specifically the proposed Avi Kwa Ame National Monument, was sponsored by the Nevada Avi Kwa Ame Coalition (www.honorspiritmountain.org). The preparation of this report required the assistance of many people familiar with the study area, as well as the individuals and institutions vested with managing the land and the records pertaining to the archaeological and historical properties on that land. Alan O'Neill, former superintendent of the Lake Mead National Recreation Area, and Linda Otero, director of the Pipa Aha Macav Cultural Center at Fort Mojave, were instrumental in providing background for the current conservation effort. Assistance with permitting was provided by Anna Camp from the Nevada State Museum, Karyn de Dufour with the Nevada Cultural Resource Information System (NVCRIS), and Bryan Hockett and Jennifer Durk with the Nevada Bureau of Land Management. Relevant cultural resources records and reports were identified at repositories and archives in Arizona, Nevada, and California. In Nevada, access was facilitated by Jeff Wedding with the Southern Nevada Archaeological Archive at the Desert Research Institute, Karyn de Dufour, Anna Camp, and Jennifer Durk. In California, Kara Vetter with the Museum of Us, Paolo Pellegatti at the Phoebe A. Hearst Museum of Anthropology, Isabela Kott with the South Central Coastal Information Center of the California Historical Resources Information System, and Tamara Serrao-Leiva with the San Bernardino County Museum granted access to records not available in the NVCRIS. In Arizona, Chris Caseldine at the Center for Archaeology and Society at Arizona State University shared information also not available in the NVCRIS. Mike Chodoronek with the cultural resources program at Nellis Air Force Base and Michael Baksh with Tierra Environmental Services granted access to reports that aided in contextualizing the proposed monument area in the wider landscape. Finally, Don Christensen, a long-time and well-respected researcher of petroglyphs and pictographs in the Mojave Desert, provided advice and copies of relevant publications. I thank all the individuals listed above for their patience and assistance.

CHAPTER 1

INTRODUCTION

This report is a synthesis of information about the cultural history and heritage value of the landscape encompassed by the proposed Avi Kwa Ame National Monument in southern Clark County, Nevada. This overview was prepared from previously generated data and literature that is either available in the public domain or accessible via appropriate permits from the agencies that curate relevant records and data sources. Information pertaining to specific cultural resources, historic properties, and archaeological sites was accessed through repositories in Nevada, Arizona, and California; no new archaeological survey, excavation, or research in any other regard was conducted. Similarly, all ethnographic information was garnered from previously published literature, and no new ethnographic research or formal Tribal consultation was conducted in the course of this study.

OUTLINE OF THE AVI KWA AME STUDY AREA

The proposed Avi Kwa Ame National Monument (hereafter "study area") consists of approximately 446,223 acres (or 1,805.8 km^2) of federal public land administered by the Bureau of Land Management (BLM) (440,632 acres) and Bureau of Reclamation (Reclamation) (5,591 acres) situated along the southern boundary of Clark County, in the southernmost reach of Nevada (Figure 1.1). This area lies generally north, south, and west of the town of Searchlight. The small communities of Cal-Nev-Ari and Palm Garden are on inholdings within the study area. The southern boundary of the study area is the California-Nevada state line, placing this area opposite a large swath of protected lands in California, which includes the Mojave National Preserve, Mojave Trails National Monument, Castle Mountains National Monument, and Dead Mountains Wilderness Area. South of Searchlight, the eastern boundary of the study area is largely coterminous with the boundary of Lake Mead National Recreation Area, while to the east and north, it is coterminous with that of the Piute-Eldorado Valley Area of Environmental Concern (ACEC). Finally, the western boundary is defined largely by those of the South McCullough Wilderness Area and the Ivanpah ACEC.

Topographically, the study area includes portions of a series of north-south trending mountain ranges, including the Lucy Gray Mountains, New York Mountains, Castle Mountains, Dead Mountains, Newberry Mountains, Highland Range, Ireteba Peaks, Piute Range, McCullough Range, and Chiquita Hills. These uplifts are interspersed by valleys of variable breadth, with the study area including portions of the Piute, Cottonwood, and Mohave Valleys that drain into the Colorado River, as well as portions of the centripetal drainages of the Jean Lake, Ivanpah, and Eldorado Valleys. In all, approximately 60 percent of the study area lies within the Colorado River Basin with the remainder in the hydrographic Great Basin.

Regarding current land management status, the study area fully encompasses the South McCullough Wilderness Area (43,996 acres), the Wee Thump Joshua Tree Wilderness Area (6,489 acres), and the Highland Range Crucial Bighorn Habitat (14,069 acres), as well as part of the Ireteba Peaks Wilderness Area (1,560 acres)—all managed by the BLM. The study area also includes a portion of the Spirit Mountain Wilderness Area located on BLM-administered land (553 acres), with the remainder of that

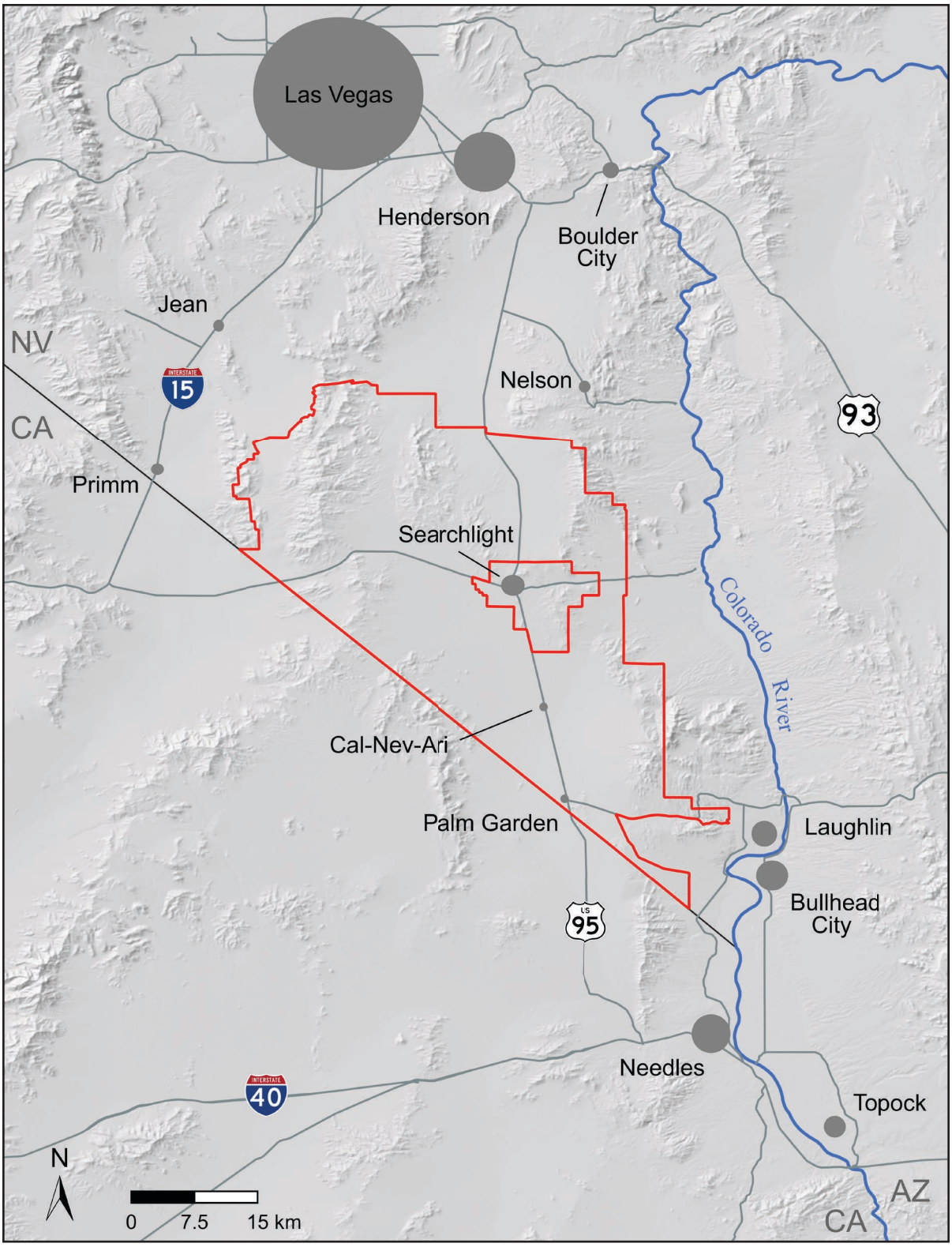


Figure 1.1. Location of the proposed Avi Kwa Ame National Monument.

wilderness area lying east of the proposed monument, within Lake Mead National Recreation Area. Wilderness areas, established only through an act of Congress, are parcels of federal land where authorized human activity is limited to non-mechanized recreation and scientific study.

The study area also encompasses the Crescent Townsite ACEC (436 acres) and the Piute-Eldorado Valley ACEC (319,300 acres), as well as a small portion of the Ivanpah ACEC (314 acres). ACECs, established and managed by the BLM, are parcels of federal public land requiring some degree of special management to protect important cultural, historical, natural, ecological, and/or scenic values and resources.

ORGANIZATION OF THE REPORT

This report is organized into eight chapters, including this introduction. In the next, Chapter 2, the physical setting of the study area is explained, with specific focus on landforms, hydrogeography, climate, and ecosystems. That chapter also reviews current understanding of changing climatic conditions in the past, as they seemingly presaged major transitions in material culture and, by inference, human practice, observed in the archaeological record. The cultural setting of the study area is described in Chapter 3, with brief overviews of the Aha Macav (i.e., Mojave) and Nuwuvi (i.e., Southern Paiute and Chemehuevi), the Indigenous communities whose traditional territories intersect and overlap the study area. In Chapter 4, 10,000 years of regional history is summarized, as gleaned from the archaeological and ethnohistoric records, which sets the stage for the cultural resources inventory and assessment in the remainder of the report.

Chapter 5 accomplishes two related aspects of the present study. It begins with an outline of the methodology utilized to build a comprehensive and exhaustive inventory of records on 328 cultural resources and historic properties documented in the study area, as well as the 115 projects through which those properties were inventoried. The second part of Chapter 5 reviews the history of archaeological work and research in the study area and how that history influences the known composition and distribution of historic properties. Those properties are subsequently summarized in Chapter 6. Based on information in the cultural resources records, the 328 documented properties are distinguished as Indigenous or Euro-American in origin and then classified into a range of property types, or "classes." The spatial distribution of the different properties, as well as their significance to archaeological research, as proxied by eligibility for inclusion in the National Register of Historic Places, is also discussed. Some of the *intangible* cultural resources of the Nuwuvi, Aha Macav, and other Yuman Tribes that relate specifically to the Avi Kwa Ame landscape are reviewed in Chapter 7. Some of the better known ways this landscape and the natural and archaeological material within it factor into Nuwuvi and Yuman cosmology and ritualism are outlined. In the final chapter of the report, Chapter 8, the general composition of known archaeological and historical properties is assessed regarding their potential to address scientific and historical research questions relevant to southern Nevada.

CHAPTER 2

PHYSICAL SETTING

The study area is situated exclusively within the Basin and Range physiographic province (Fenneman 1931). This province, which includes most of the arid and semiarid regions of western North America, is a landscape characterized by isolated and linear north-south oriented mountain ranges running roughly parallel and interspersed with detritus-filled valleys and basins. In a generalized sense, the Basin and Range country resulted from extensive stretching of the Earth's upper mantle, or crust. Extension led to thinning and cracking of the crust, which created faults along which the mountains and valleys formed.

This greater physiographic province is bound on the west by the Sierra Nevada, the Salton Trough, and the Gulf of California and on the east by the Wasatch Range, the Colorado Plateau, the Rio Grande Rift, and Sierra Madre Oriental; it is bound to the north by the Columbia Plateau and to the south by the Trans-Mexican Volcanic Belt. The study area lies within the northern Colorado River extensional corridor, the southeastern portion of the central Basin and Range that experienced one of the most recent phases of widespread volcanism and large-scale extension in the province (Faulds et al. 2001).

TOPOGRAPHY

Most of the mountain ranges within the Basin and Range province are bordered by low gradient piedmont slopes that trend toward the intervening valley floors (Figure 2.1). The piedmont slopes are generally comprised of a body of eroded bedrock immediately adjacent to the corresponding range (i.e., the pediment) that grades into fan-shaped deposits of alluvium toward the valley floors (i.e., bajadas) (Peterson 1981). The study area includes portions of 10 such ranges and associated piedmont slopes, described below.

McCullough Range

The McCullough Range extends from the foot of the New York Mountains in the south to the city of Henderson in the north. Following Smith et al. (2010), the range can be conceptualized in three parts: (1) the central McCullough Range centered on McCullough Pass; (2) the north McCullough Range from the pass to Henderson; and (3) the south McCullough Range south of the pass. The study area encompasses a portion of the central McCullough Range and the entirety of the south McCullough Range. Elevation within these portions vary from about 760 m above sea level (asl) to 2,142 m atop McCullough Mountain, the highest point in the entire range.

Geologically, those portions of the McCullough Range within the study area consist of metamorphosed Precambrian basement rock overlaid and juxtaposed with various felsic igneous rocks associated with Middle Miocene-era volcanism,and include formations of tuff, andesite, rhyolite, basalt, dacite, and dacite breccia (Smith et al. 2010:Figure 4). Precipitation falling on the portions of the McCullough Range within the study area flow into the Jean Lake Valley to the west, Ivanpah Valley to the southwest, Eldorado Valley to the northeast, and Piute Valley to the southeast. Thus, the McCullough Range lies

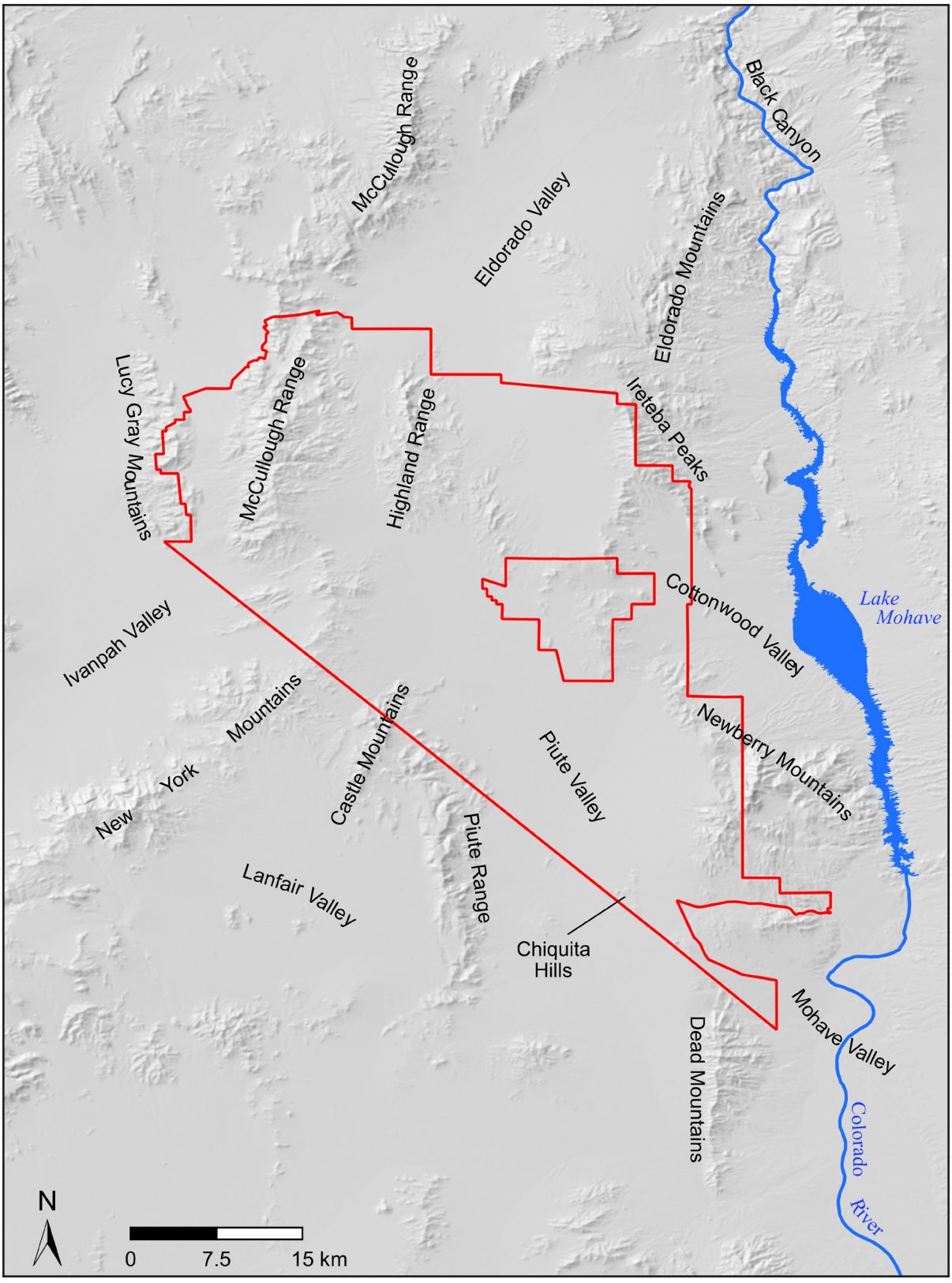


Figure 2.1. Landforms in and around the study area.

along the Great Basin Divide, as the Jean, Ivanpah, and Eldorado Valleys are endorheic, or internally draining basins, while the Piute Valley drains into the Colorado River.

Highland Range

The study area encompasses nearly the full breadth of the Highland Range, with just a small section at the northern terminus of the range lying within the Boulder City Conservation Easement just outside the northern boundary of the proposed Avi Kwa Ame National Monument. This relatively low range, whose elevation rises from approximate 820 m asl to 1,487 m atop Castle Tower, is set off from the south McCullough Range by a narrow, unnamed valley of about 5 km width.

The lithology of the Highland Range is similar to that of the adjacent south McCullough Range, with Middle Miocene felsic volcanic rocks such as tuff, andesite, dacite, rhyolite, basalt, and megabreccia proliferating. Unlike the neighboring range, though, the Highland Range includes relatively large exposures of Middle Miocene sedimentary rocks such as conglomerate and sandstone (Faulds et al. 2002). Precipitation runoff from the Highland Range flows north into the Eldorado Valley and south into the Piute Valley, placing the range along the Great Basin Divide with the adjacent McCullough Range.

Lucy Gray Mountains

The Lucy Gray Mountains sit along the northeastern boundary of the Ivanpah Valley. They run parallel to the McCullough Range, from which they are set off by an unnamed valley with a width of approximately 10 km. The study area includes about one-third of the range.

The geology of the Lucy Gray Mountains is similar to that of the adjacent McCullough Range, with Middle Miocene volcanic rocks such as basalt, rhyolite, andesite, dacite, and breccia overlying a Precambrian basement of metamorphosed rock (Hewett 1956). Elevation ranges from roughly 950 m asl to 1,542 m, with the high point located within the study area. Precipitation falling on the Lucy Gray Mountains drains into either the Jean Lake Valley to the north or the Ivanpah Valley to the west and south.

New York Mountains

The New York Mountains are a northeast-southwest oriented landform whose northern terminus abuts the southern end of McCullough Range. Big Tiger Wash cuts through the pass between the two ranges and serves as the dividing line. The New York Mountains are known traditionally among the Nuwuvi as Kaivaya Amanti and as Avi Watha among the Aha Macav (Bean et al. 1979:Map D; Kroeber 1925:760). Most of this 48-km-long range lies within California and, thus, beyond the study area. The portion on the Nevada side and within the study area is the site of the Crescent Mining District, which was the focus of intensive turquoise mining by Euro-American settlers and Indigenous communities before them (Morrissey 1968:6–8).

The geology of the New York Mountains is representative of the broader south-central Basin and Range, with Precambrian basement rock underlying mostly Middle Miocene sedimentary and volcanic rocks,

although exposures of the sedimentary strata lie largely outside the project area (Miller and Wooden 1993). Near the center of the range but outside the study area are exposures of granite associated with the Teutonia Batholith, a Mesozoic-era metamorphic complex that intruded into Precambrian basement (Beckerman et al. 1982). Further, the north end of the New York Mountains, within the study area, is the likely parent dome for a fan of alluvially deposited obsidian nodules at the northern foot of the Castle Mountains (Wilke 1988). Elevation within that portion of the New York Mountains in the study area ranges from around 1,200 m asl to 1,828 m atop Crescent Peak. Precipitation in the New York Mountains drains west and into the Ivanpah Valley and east into the Lanfair Valley, the latter of which drains into the Colorado River, thereby situating this range along the Great Basin Divide with the McCullough and Highland Ranges.

Castle Mountains

The Castle Mountains span the California-Nevada border, with most of the range lying on the California side within Castle Mountains National Monument and, thus, outside the study area. The landform trends northeast-southwest, with its northern end intersecting with the north-south trending Piute Range. At 1,689.5 m asl, Hart Peak is the highest point in the Castle Mountains, alhough this peak lies just over 1 km south of the state border. Elevation within the study area ranges from approximately 1,100 m asl to 1,510 m at the California-Nevada border.

The Castle Mountains are composed of a Precambrian basement of metamorphic and plutonic rock overlaid by a series of regionally extensive Middle Miocene volcanic formations, including tuff, basalt, rhyolite, andesite, dacite, breccia, and obsidian. Perhaps unique to the Castle Mountains, and situated in the study area, is a small exposure of Precambrian limestone overlying the Precambrian basement (Capp and Moore 1997). Precipitation runoff from the portion of the Castle Mountains within the study area drains north and northeast into the Piute Valley. Outside the study area, the runoff drains south and southeast into the Lanfair Valley.

Piute Range

The Piute Range is a north-south trending landform whose northernmost section abuts that of the northeast-southwest oriented Castle Mountains. Among the Nuwuvi, it is traditionally known as Pas-Kaiv, "farm mountain" (Kroeber 1959a:298). As with the Castle and New York Mountains to the northwest, most of the Piute Range lies within the state of California, with just the northern terminus situated in the project area. The Piute Range is approximately 22.5 km long and 3 km wide, and elevation throughout the landform ranges from approximately 800 m asl to 1,496 m; within the study area, however, it is a narrower range of 850 to 1,254 m. The range is sometimes referred to as a table mountain, due to its relatively wide, level, mesa-like apex. It is a basalt cap that gives the range its mesa-like character.

As with most of the other ranges in the study area, the Piute Range consists of a Precambrian basement overlaid by Middle-Miocene sedimentary rocks and volcanic formations such as rhyolite, andesite, dacite, basalt, breccia, obsidian, and tuff (Hewett 1956; Nielson et al. 1987), although unlike the other ranges, volcanism in the Piute Range continued into the Late Miocene (Nielson 1998). Similar to the New York Mountains, granite and related rocks of the Teutonia Batholith are exposure in the central portion of the range, outside the study area. Precipitation runoff from that portion of the Piute Range within the study area drains east into the Piute Valley. Outside the study area, the runoff along

the western slopes drains into the Lanfair Valley and that on the eastern slopes drains into the Piute Valley.

Chiquita Hills

The Chiquita Hills are a relatively low, small, north-south oriented landform within the Piute Valley, between the Piute Range and Dead Mountains. The hills are approximately 5 km long and 1.5 km wide, with elevations ranging from 800 m asl to 919 m. Most of the landform lies within the study area, with just the southernmost tip extending into California.

The Chiquita Hills consist entirely of exposed Precambrian basement rock, lacking the overlying Middle Miocene volcanic formations of most the surrounding mountain ranges (Ludington et al. 2006).

Dead Mountains

Dividing the southern end of the Piute Valley from the Mohave Valley along the lower Colorado River, the Dead Mountains are a north-south trending range that rises from an elevation of approximately 400 m asl near the river to 2,097 m atop Mount Manchester. Most of the Dead Mountains lie in California and outside the study area. Elevations within the study area, around the northernmost reach of the landform, range from 430 m asl to 670 m.

Like the Chiquita Hills, that portion of the Dead Mountains within the study area consists of Precambrian basement rock without overlying Middle Miocene volcanic formations (Jennings 1961). Precipitation falling on the portion of the Dead Mountains within the study area drains directly into the Colorado River via numerous unnamed washes. Along the western front of the range, the runoff flows into Piute Wash, in the southern end of the Piute Valley, which turns east around the southern end of the Dead Mountains to flow into the Colorado River.

Newberry Mountains

Defining the southeastern boundary of the study area, the Newberry Mountains are the parent range for Spirit Mountain, or Avi Kwa Ame, the namesake of the proposed national monument. This range separates most of the Piute Valley from the Colorado River, with elevations ranging from about 240 m asl near the Colorado River to 1,719 m at the apex of Spirit Mountain, just east of the study area boundary. Spirit Mountain is known as Avi Kwa Ame among the Aha Macav and other traditional Yuman-speaking communities, and it is known as Aagah among the Nuwuvi (Bean et al. 1979:Map D). Elevation within the portion of the Newberry Mountains within the study area ranges from around 850 m asl to approximately 1,425 m just below the summit of Spirit Mountain.

Geologically, the Newberry Mountains are comprised of several Middle Miocene intrusions, including the Spirit Mountain and Mirage Plutons, which comprise the Spirit Mountain Batholith (Walker 2006). These intrusions, represented by various granites, intruded a Precambrian basement that is represented by exposures of gneiss along the northern foot of the Newberry Mountains. The landform lacks the Middle Miocene volcanic formations characteristic of ranges west, on the opposite side of the Piute Valley. Precipitation falling onto the Newberry Mountains drains into the Colorado River, either

directly by any number of washes along the eastern front of the range or via Piute Wash that drains the western slopes.

Ireteba Peaks

The Ireteba Peaks serve as the northeastern boundary of the study area. Named after a nineteenth century leader of the Aha Macav, these jagged spires are the southernmost extension of the Eldorado Mountains. These peaks, which are occasionally called the Opal Mountains, include Copper Mountain and Fourth of July Mountain east of Searchlight. While Ireteba Peak sits just beyond the study area boundary, the highest point, Central Peak at 468 m asl, lies within the proposed monument.

The geology is akin to the ranges along the eastern flank of the Piute Valley, with Precambrian basement rock of schist, gneiss, and granite and intrusions of several Middle Miocene-aged granitic plutons, including the Aztec Wash and Ireteba Plutons and the Eldorado Dike Swarm, but lacking any overlying Middle Miocene volcanic formations (Conrad et al. 1991; Hinz et al. 2012). Precipitation falling on the portion of the Ireteba Peaks in the study area drains into the endorphic Eldorado Valley or the Colorado River, depending on latitude. Thus, this landform sits along the Great Basin Divide.

HYDROGEOGRAPHY

Southern Nevada, specifically the study area, straddles the Great Basin Divide, a topographic line that dictates if surface water flows into the Pacific Ocean or any number of contiguous endorheic basins within the western United States that collectively comprise the hydrographic Great Basin. The study area encompasses the watersheds of five valleys (Figure 2.2), three of which are endorheic and part of the Great Basin and two of which drain into the Pacific Ocean via the Colorado River. These valleys are filled with geologic detritus that has eroded from the landforms within their watersheds, although the depths of their fill vary. Each of the five valleys is detailed below.

Colorado River Valley

The Colorado River Valley extends from the vicinity of Black Canyon, at present-day Hoover Dam, to the river's delta. This valley is actually comprised of a chain of basins that formed as a result of crustal extension during the Miocene. These basins were later linked into a river corridor during the early Pliocene as water, newly diverted through the Grand Canyon, filled the basins with sediment. Lakes formed within the basins and subsequently overflowed, with the out-spilling water eroding the bedrock divides between the basins and effectively carving a river corridor (Howard et al. 2019; Pearthree and House 2014). Mountain ranges approach in multiple places and seemingly pinch the Colorado River Valley into smaller, more local hydrographic units such as the Chemehuevi, Palo Verde, Mohave, Parker, and Cottonwood Valleys. These valleys are the surfaces of the detritus-filled basins through which the Colorado River carved its path.

The eastern slopes of the Newberry and Dead Mountains and the southern half of the Ireteba Peaks along the eastern reach of the study area drain directly into the Colorado River Valley, and specifically

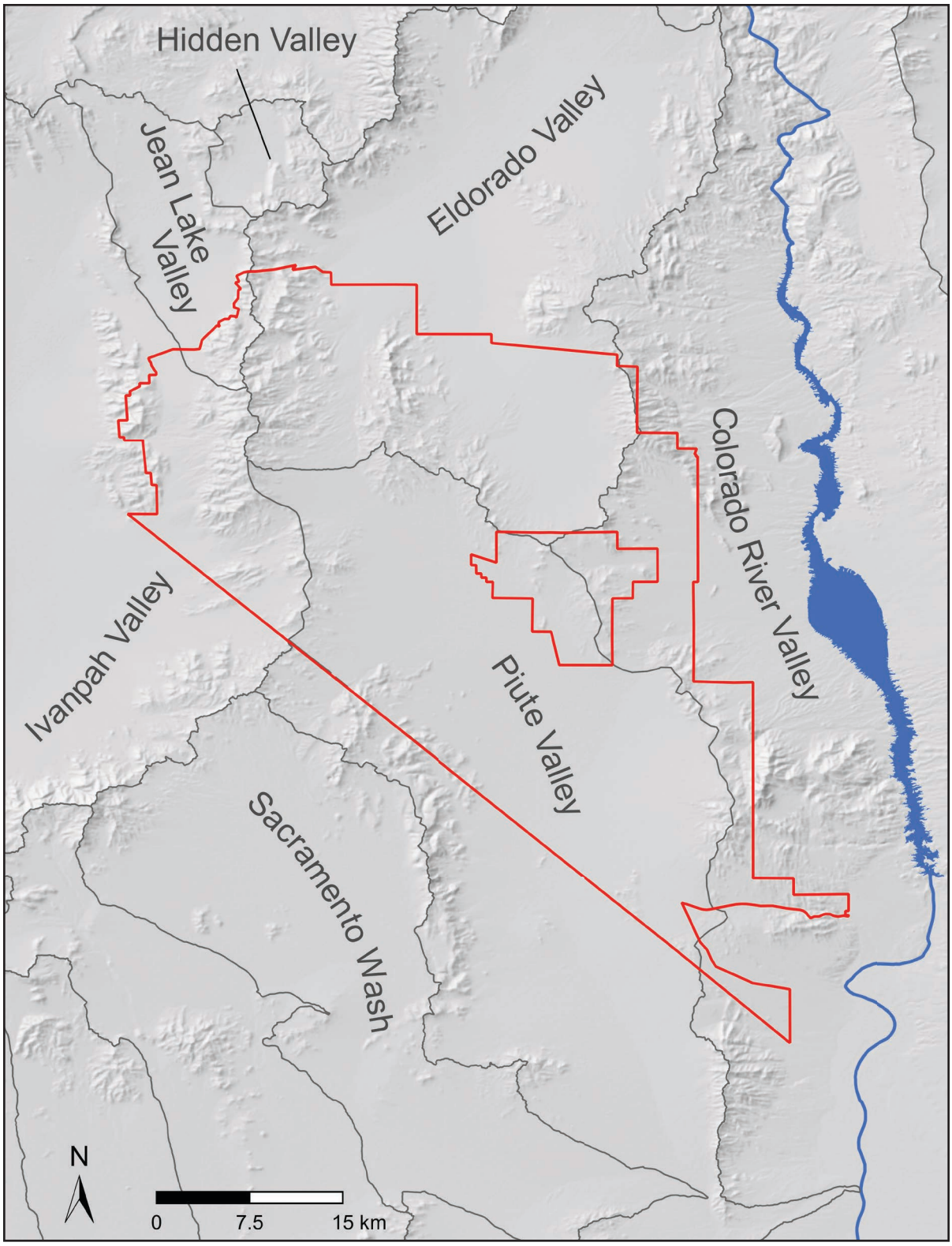


Figure 2.2. Watersheds in and around the study area.

Cottonwood and Mohave Valleys, via numerous washes of variable breadth. The study area includes the headwaters of most of these ephemeral drainages, including Nellis and Empire Washes and Grapevine and Bridge Canyons in the Newberry Mountains. In all, about 62,237 acres (13.8 percent) of the study area drains directly into the Colorado River Valley.

Piute Valley

The Piute Valley is a 72-km-long, roughly north-south trending valley, that spans the California-Nevada border. It is bordered on the east by the Newberry and Dead Mountains, on the west by the Piute Range and Castle and New York Mountains, on the north by Fourth of July Mountain and the Highland and McCullough Ranges, and on the south by the Sacramento Mountains (California). The valley is drained by the seasonally flowing Piute Wash. This tributary flows into the Colorado River near Needles after turning east around the southern end of the Dead Mountains. The watershed of Piute Wash constitutes approximately 198,172 acres (44.0 percent) of the study area.

Eldorado Valley

The Eldorado Valley is an endorheic basin immediately north of the Piute Valley. It measures approximately 56 km north-south and 29 km east-west. A dry lake—represented today by a salt pan and variably called the Eldorado Dry Lake or Eldorado Playa—occupies the lowest portion of this centripetal drainage near the north edge of the valley and outside the study area. The Eldorado Valley is bordered to the south by the Highland Range and Fourth of July Mountain, to the east by the Ireteba Peaks and Eldorado Mountains, to the west by the McCullough Range, and to the north by the River Mountains. Approximately 128,056 acres (28.5 percent) of the study area is within the centripetal drainage of the Eldorado Valley.

Ivanpah Valley

Like the Piute, the Ivanpah Valley is an elongated, north-south oriented valley that spans the California-Nevada border. Unlike the Piute Valley, the Ivanpah Valley is internally draining, as evidenced by the dry beds of Ivanpah and Roach Lakes at the two lowest points in the valley. The Ivanpah Valley is bordered on the south by the New York Mountains, on the west by the Ivanpah, Clark, and Spring Mountains, on the east by the Lucy Gray Mountains and Sheep Mountain, and on the north by Bird Spring Mountains. Big Tiger Wash, the headwaters of which lie in the pass between the New York Mountains and McCullough Range, drains into Ivanpah Lake. Around 51,602 acres (11.5 percent) of the study area drains into the Ivanpah Valley.

Jean Lake Valley

The Jean Lake Valley is a small endorphic basin immediately northeast of the Ivanpah Valley. It is bound to the south by the Lucy Gray Mountains, to the east by the McCullough Range, to the west by Sheep Mountain, and to the north by the Bird Spring Mountains. A small portion of the study area, some 10,040 acres (2.2 percent) in the northwest corner, drains into the (dry) Jean Lake near the center of the valley.

SURFACE WATER

All streams within the study area are intermittent and only convey water following episodes of precipitation, usually after winter storms, with most precipitation falling in the mountainous zones (Bedinger et al. 1989; Rush and Huxel 1966). When the streams flow, most of the water moves subsurface within the bodies of alluvium in the streambeds and the piedmont slopes of the surrounding ranges. The Colorado River, situated about 7 km east of the study area, is the closest perennial stream. While generally an unreliable source of surface water, ephemeral streams are critical to the regional ecosystem in many ways (Levick et al. 2008). The relatively higher level of moisture contained within and around them promotes a greater abundance and diversity of wildlife and vegetation relative to much of the surrounding landscape.

In light of the intermittent and ephemeral nature of streams within the study area, springs also maintain a critical place within the region's ecosystem. They are the principal means by which groundwater reaches the surface in and around the study area (Belcher et al. 2013). They can form pools and wetlands that, while relatively small in aerial extent, promote some of the greatest biodiversity across the region, especially among aquatic and riparian species (Myers and Resh 1999; Sada et al. 2005). Prior to the drilling of wells, the presence and location of springs in large part conditioned how people moved through the study area, where they stayed, and the duration of their stays.

Table 2.1. Springs within the study area.

Castle Mountains	*New York Mountains*
Lewis Holes	Bullion Spring
	Burro Springs a
	Burro Springs b
	Crescent Spring
	Crossman Spring
	Surveyor's Spring
Eldorado Valley	*Newberry Mountains*
Ten Mile Spring	Hiko Springs a
	Hiko Springs b
	Indian Spring
	Juniper Spring
	Newberry unnamed a
	Old Roman Spring
	Rats Nest Spring
	Rattlesnake Spring[a]
	Roman Spring a
	Roman Spring b
	Yellowstone Spring
Highland Range	*Piute Valley*
Bell No. 2 Spring	Battle Axe Spring
Cow Spring a	Lewis Spring
Cow Spring b	New Spring
Highland Spring	
Ora Hanna Spring	
Ireteba Peaks	
Grasshopper Spring	
Tip Top Spring	
Tule Spring a	
Tule Spring b	
Tule Spring c	
Wesselhoff Spring	
McCullough Range	
Bird Spring	
McClanahan Spring	
McCullough Spring a	
McCullough Spring b	
McCullough Spring c	
McCullough unnamed a	
McCullough unnamed b	
McCullough unnamed c	
McCullough unnamed d	
McCullough unnamed e	
McCullough unnamed f	
McCullough unnamed g	
McCullum's Spring	
Pine Spring	
Railroad Spring	

[a]This spring lies just outside the boundary, but its surrounding microhabitat extends into the study area.

At least 47 springs are reported from the study area (Table 2.1). This inventory of springs derives largely from the National Hydrography Dataset (U.S. Geological Survey [USGS] 2018–2019). Seven springs

(Battle Axe, Bell No. 2, Bird, Juniper, Lewis, New, and Ten Mile Springs) were added to that dataset from the Bureau of Land Management's (BLM) spring dataset (Bureau of Land Management [BLM] 1999a). Also added was a third McCullough Spring in the McCullough Range depicted on an old topographic map (U.S. Geological Survey 1912) that has since been excluded from regional spring inventories. Rattlesnake Spring, in the Newberry Mountains just below the summit of Spirit Mountain, is included in Table 2.1 because, although it sits about 80 m beyond the study area boundary, the microhabitat surrounding it extends into the study area.

Accurate data on spring discharge rates, periodicity of flow, water quality, differential response to surrounding environmental disturbances, and related attributes for these springs are not presently available (Belcher et al. 2013), making objective and measurable comparisons among them and assessment of their potential relevance to human use not presently possible. A century ago, Thompson (1921) provided second-hand observations that both the Crescent waterhole (i.e., spring) and Railroad Spring yielded about one gallon/minute. Available contemporary studies (e.g., Bradford et al. 2003; Desert Conservation Program 2008) indicate most springs in and around the study area dry frequently, and less than half can be considered persistent sources of surface water. However, this characterization may not accurately reflect past conditions under different climatic patterns and prior to widespread groundwater pumping and extensive ranching-related landscape alterations. Recent assessments of the most productive springs in southern Nevada determined that most have been highly disturbed by, in order of ubiquity: diversion, use by non-native ungulates, invasion by non-native aquatic species, flooding, and recreation (Desert Conservation Program 2008:Table 6).

ENVIRONMENT AND CLIMATE

Southern Nevada lies within a broad transition zone between the Sonoran, Mojave, and Great Basin Deserts, three of the four primary deserts of North America (the other being the Chihuahuan Desert) (Shreve 1942). As Smith and colleagues (1997) explain, the historical delineation of North America's deserts has tended to rely on multiple defining factors, including climate, floristic composition, vegetation physiognomy, and physiography. While these factors are somewhat correlated, adherence to just one, or emphasis on one over the others, yields different boundaries.

Climatically, North America's deserts can be demarcated longitudinally (i.e., precipitation) and latitudinally (i.e., temperature). While the Great Basin Desert is centered on the Great Basin hydrographic province, the desert extends farther north and east and does not extend as far south. The Great Basin Desert is regarded as a cold desert, partly due to its relatively higher latitude and elevation. Mean annual temperature across the Great Basin Desert is 9°C, and winter (December–February) temperatures commonly drop below freezing. An abrupt north to south drop in elevation across southern Nevada and interior south-central California, and the concomitant increase in temperature and decrease in precipitation, effectively charts the boundary between the Great Basin and Mohave Deserts (Beatley 1975).

The Mojave, Sonoran, and Chihuahuan Deserts are considered warm deserts, with mean annual temperatures ranging from 19°C in the Chihuahuan to 22°C in the Mojave and Sonoran. Seasonal patterns in precipitation are the principal distinguishing climatic factor among these three deserts. There is a general west to east, or Mojave to Chihuahuan, transition from a winter-dominant precipitation regime to a summer-dominant regime. In order of dominance, winter (November–February) precipitation accounts for 44 percent of the annual sum in the Mojave Desert, 28 percent in the Sonoran Desert, and 18

percent in the Chihuahuan Desert. Conversely, summer (June–September) rains account for 59 percent of the annual total in the Chihuahuan Desert, 53 percent in the Sonoran Desert, and 27 percent in the Mojave Desert.

Seasonal trends are less extreme in the Great Basin Desert, with winter precipitation at 38 percent and summer rains 25 percent of the annual sum (Smith et al. 1997:13). The markedly higher contribution of summer precipitation in the Chihuahuan and Sonoran Deserts is due to the summer monsoon (Sheppard et al. 2002), a near-annual climatic phenomenon initiated by a heat-induced shift in atmospheric circulation that brings more moisture-laden air from the Pacific Ocean into the southwest regions of North America (Adams and Comrie 1997). This is most pronounced in northwest Mexico and the states of Arizona, New Mexico, and west Texas. The Mojave and Great Basin Deserts lie largely outside the typical zone of high atmospheric pressure that presages the monsoon, and thus, they are minimally affected by monsoonal activity.

Current Ecosystems

Each of the four North American deserts are associated with certain flora. While specific plants are seemingly iconic of their corresponding deserts, such as the Mojave's Joshua tree (*Yucca brevifolia*), the Great Basin's sagebush (*Artemesia* spp.), the Sonoran's saguaro (*Carnegiea gigantea*), and the Chihuahuan's lechuguilla (*Agave lechugilla*), floristic parameters around these four deserts can be more effectively delineated through *assemblages* of species (Smith et al. 1997). For the Great Basin Desert, shrublands of sagebrush (*Artemsia* spp.) and shadescale (*Artiplex confertifolia*) proliferate. With the transition to the warm deserts, the sagebrush-dominated landscape gives way to ones populated by creosote (*Larrea tridentata*) shrub communities. Seemingly distinctive assemblages for the warm deserts are Joshua tree, indigo bush (*Dalea fremontii*), and Mexican bladdersage (*Salazaria mexicana*) for the Mojave Desert, palo verde (*Cercidium* spp.) and ironwood (*Olneya tesota*) for the Sonoran Desert, and lecheguilla, mariola (*Parthenium incanum*), and tarbush (*Flourensia cernua*) for the Chihuahuan Desert (MacMahon and Wagner 1985).

Being situated within a broad zone between the Mojave, Sonoran, and Great Basin Deserts makes ascribing the study area to any one of them problematic. Large-scale distributional maps tend to show these deserts with discrete boundaries, but those boundaries are not so abrupt and better reflect the defining variable(s) under consideration, the availability of ecological data, and a familiarity with local ecosystems. As a result, the region in and around the study area is commonly shown either entirely within the Mojave Desert (e.g., MacMahon and Wager 1985) or split between it and the Sonoran Desert (e.g., Benson and Darrow 1981). Neither accurately visualizes the ecological complexity of this transition zone, although the split version is arguably more precise because obvious Sonoran "influences" such as ironwood, palo verde, and mesquite are present in the Piute Valley and coexist with characteristic Mojave taxa such as Joshua tree and indigo bush (Nielson et al. 1987:C3). Regarding the Great Basin Desert, the study area lies just beyond its direct influence, with the present southern extension of sagebrush communities terminating in the Spring Mountains opposite the Jean Lake Valley (RECON 2000; West et al. 1978).

Rather than assess climatic variability, ecological structure, and diversity on such a broad scale, it is perhaps more informative to examine more local ecosystems associated with the landforms and elevational gradient within the study area. As for climate, the Nevada Division of Forestry (2020:42) situates the study area within the Extreme Southern Nevada Division, the hottest and driest division

in the state. Average annual rainfall is just 18 cm, and average summer (June–September) temperatures exceed 32.2°C, with summer highs often above 37.7°C. Precipitation is winter dominant, but there is a subtle bimodal trend as average monthly rainfall slightly increases in July and August followed by a slight drop in September.

Regarding ecology, the Clark County Multiple Species Habitat Conservation Plan (MSHCP) (Desert Conservation Program 2008; RECON 2000) recognizes 11 tentative ecosystems within their jurisdiction, five of which are present in the study area: Pinyon-Juniper, Mojave Desert Scrub, Mesquite-Catclaw-Acacia, Blackbrush, and Springs (Figure 2.3). These ecosystems are conceptual models that group species whose habitats share abiotic qualities that dictate their co-association and distribution such as soil, climate, and elevation.

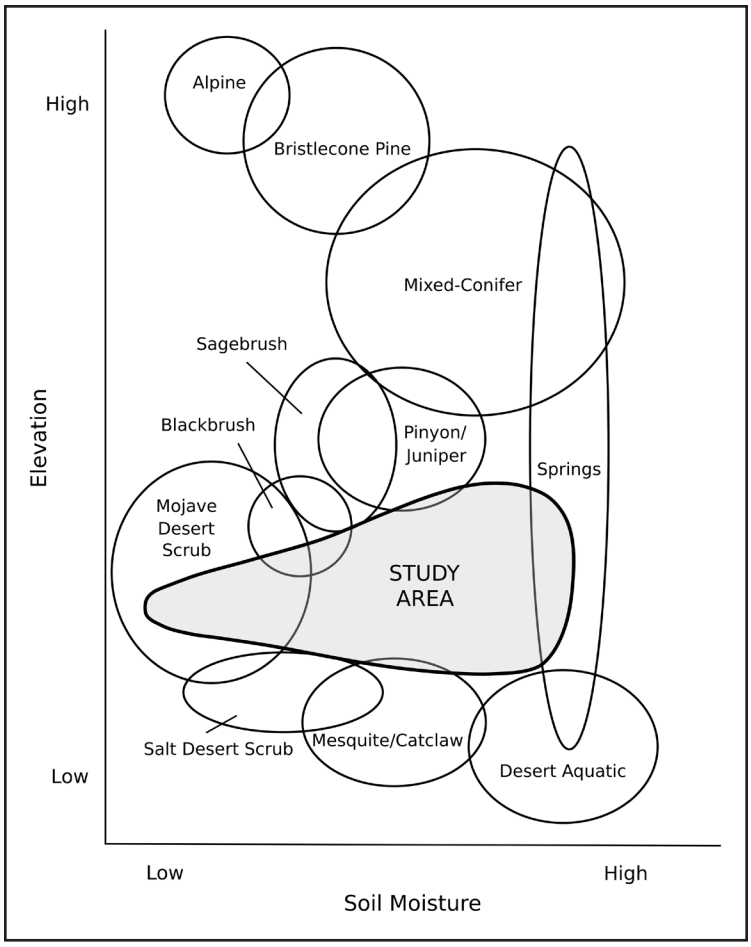


Figure 2.3. Ecosystems within the study area (adapted from Desert Conservation Program 2008:Figure 8).

Situated between about 1,500 and 2,500 m asl, the Pinyon-Juniper ecosystem is the highest elevation ecosystem within the study area. It consists of a relatively open woodland composed of round, bushy evergreen trees with shrubs and grasses located in open settings. Woody species include single-leaf pinyon pine (*Pinus monophylla*), Utah juniper (*Juniperus osteosperma*), Rocky Mountain juniper (*J. scopulorum*), western juniper (*J. occidentalis*), and mountain mahogany (*Cercocarpus edifolius*). Primary associated shrubs include alderleaf mountain mahogany (*C. montanus*), littleleaf mountain mahogany (*C. intricatus*), oak (*Quercus gambelii*), rabbitbrush (*Chrysothamnus* spp.), bitterbrush (*Purshia tridenta*), blackbrush (*Coleogyne ramosissima*), and cliffrose (*Cowania mexicana*). An island of the Pinyon-Juniper ecosystem occurs within the higher limits of the south McCullough Range (RECON 2000:A-117).

Below the Pinyon-Juniper ecosystem is the Blackbrush ecosystem. This ecosystem ranges from approximately 1,200 to 1,800 m asl and is generally regarded as a transitional habitat between other Mojave and Great Basin ecosystems (RECON 2000). It consists of a shrubland dominated by blackbrush, but with primary contributions from Utah juniper, Joshua tree, yucca (*Yucca* spp.), shadescale, creosote, spiny hopsage (*Grayia spinosa*), mormon tea (*Ephedra* spp.), desert thorn (*Lycium* spp.), and snakeweed (*Gutierrezia sarothrae*). Within the study area, this ecosystem is present within the south and central portions of the McCullough Range, the Highland Range, the New York Mountains, Lucy Gray Mountain, and the Newberry Mountains.

The Mojave Desert Scrub ecosystem is the most widespread within the study area. It lies below 1200m asl and extends from valley floors to the lower reaches, or pediments of the higher hills and mountains. This ecosystem is dominated by creosote and white bursage (*Ambrosia dumosa*), with primary associations with shadescale, blackbrush, indigo bush, mormon tea, hopsage, desert thorn, ratany (*Krameria erecta*), burro bush (*Hymenoclea salsola*), honey mesquite (*Prosopis glandulosa*), brittlebush (*Encelia farinosa*), bebbia (*Bebbia juncea*), desert saltbush (*Atriplex polycarpa*), and desert holly (*A. hymenelytra*). Lesser associations include Joshua tree, yucca, beavertail prickly pear (*Opuntia basilaris*), teddybear cholla (*O. bigelovii*), and hedgehog cacti (*Echinocereus* spp). This ecosystem is found within those portions of the Ivanpah, Jean Lake, Piute, Mohave, Cottonwood, and Eldorado Valleys covered by the study area, as well as on the slopes of all the mountainous landforms.

The Mesquite-Catclaw-Acacia ecosystem has a limited presence within the study area. It is restricted to elevations below 1,200 m asl and localized to sandy wash bottoms draining the eastern front of the Newberry Mountains, the northern slopes of the south McCullough and Highland Ranges as they drain into the Eldorado Valley, and along Piute Wash and its larger tributaries in the Piute Valley. It manifests as isolated linear swaths lining the larger drainages that cut through a landscape otherwise characterized by a Mojave Deserrt Scrub ecosystem. These locations are dominated by catclaw (*Acacia greggii*) with lesser amounts of honey mesquite. Common associated plants include burro bush, bebbia, and sandpaper plant (*Petalonyx nitidus*).

The fifth and final MSHCP-recognized ecosystem within the study area are the habitats surrounding springs, as reviewed in the section on hydrogeography. These occur as localized contexts within the other ecosystems.

As with sources of surface water, ecosystem distributions have been a major factor in how people moved about and lived within the study area, especially for those communities whose subsistence was largely or entirely reliant on the biotic resources within this transitional desert region. This, of course, is relevant to understanding the long history of human engagement with this landscape. It is therefore imperative to place the archaeological and historical records within their contemporary ecological contexts, which were not always—perhaps rarely, if ever were—what they are today. Archaeologists and geologists working in the region recognized long ago that North America's deserts experienced profound fluctuations in climate, environment, geomorphology, and ecology throughout the late Pleistocene and Holocene, which elicited concomitant human responses as resource distributions realigned (Antevs 1929; Campbell et al. 1937; Merriam 1939; Rogers 1929, 1939; Sayles and Antevs 1941). Current understanding of the broad, enduring, and measurable shifts in climatic and ecological conditions that likely had some bearing on human presence and interaction within the study area are reviewed in the final section of this chapter.

PAST ECOSYSTEMS

Information about past ecological dynamics is not as resolute with regard to time, space, and process as it is for current and recently past conditions, because such information derives largely from proxy rather than direct observation and records. Nevertheless, a variety of proxy records of past climatic and environmental conditions have been studied for nearly a century, and there is general agreement on broad patterns and trends, but debate remains on the amplitude, intensity, impact, and thus significance of changes observed in the proxy records. While very long records of reconstructed paleoclimatic, paleo-

ecological, paleoenvironmental, and paleohydrological conditions for the North American deserts exist, the following review initiates with the terminal Pleistocene, since that is the period for which there is widespread agreement on the presence of material human signatures in the local archaeological record (Chapter 6, this volume).

Terminal Pleistocene (circa 13,000–11,500 BP)

The terminal Pleistocene represents the final phase of the Last Glacial Maximum, a period of deglaciation that marks a transition to increasingly drier and warmer conditions that stabilized in the following Holocene. The period considered here, 13,000–11,500 BP, is roughly congruent with an abrupt and final cycle of cooling known as the Younger Dryas (Young 2009). During this period, two massive, inland pluvial lakes existed north of the study area and centered on what is now northwest Nevada (Lake Lahontan) and northern Utah (Lake Bonneville). Smaller pluvial lakes and spring-fed wetlands had also formed in valleys closer to the study area (Enzel et al. 2003; Haynes 2008; Honke et al. 2019; Morrison 1991; Quade et al. 1998). While much cooler than today, the Younger Dryas was also a period of relative aridity in the Northern Hemisphere (Carlson 2013; Haynes 1991; Pigati et al. 2009; Quade et al. 1998).

Plant macrofossils suggest a pygmy conifer woodland of juniper, pinyon, and oak thrived in and around the study area at elevations between 600 and 1200 m lower than today (Koehler et al. 2005; Spaulding 1990; Spaulding and Graumlich 1986; Thompson and Anderson 2000). While presently located only at the highest elevations in the McCullough Range, a pinyon-juniper ecosystem covered much of the study area during the terminal Pleistocene.

Early Holocene (circa 11,500–8000 BP)

The onset of the Holocene is marked by a turn to higher temperatures and increased moisture availability following the Younger Dryas. Formerly drying lakes stabilized or witnessed slight rebounds (Benson et al. 1990; Davis and Sellers 1994; Enzel et al. 2003), streams flowed more often (Huckleberry et al. 2001), and extreme rainstorms occurred more frequently (Enzel et al. 2003). Multiple lines of evidence suggest a strengthening of the monsoon and increased contribution of summer precipitation across the Sonoran and Mojave Deserts (Hockett 2000; Spaulding and Graumlich 1986; Wigand and Rhode 2002).

With warming conditions, pinyon seemingly climbed to higher elevations, but a juniper scrubland persisted over much of its terrain during the terminal Pleistocene. This suggests the early Holocene may have witnessed episodic periods of cooler and/or wetter conditions that enabled juniper ecosystems to persist in place, albeit altered, while pinyon distributions changed dramatically (Wigand and Rhode 2002). By 8000 BP, juniper had also receded to higher elevations, and parameters around current conceptions of the Sonoran and Mojave Deserts were in place, although compositions continued to shift well into the middle Holocene (Anderson and Van Devender 1995; Cole 1990; Thompson and Anderson 2000).

Middle Holocene (8000–4000 BP)

The middle Holocene is regarded as an extended period of exceptionally high temperature and low effective moisture (Lachniet et al. 2020). Biotic proxies for this period are sparse, which may well

demonstrate the severity of the matter (Wigand and Rhode 2002). Once conceptualized as a "Long Drought" (Antevs 1955), conditions were far from stable, and the timing and intensity of fluctuations varied across space (Grayson 2011; Wriston 2009). Importantly, the period between 5800 and 5200 BP—Wriston's (2009) "Middle Holocene Gap"—was one of relatively cooler and wetter conditions, as evidenced by a brief return of mesophilic plants around springs in the McCullough Range (Spaulding 1991). Nearest the study area, a thermal maximum seems to have occurred around 6800 BP (Feng and Epstein 1994) followed by several centuries of peak aridity (Spaulding 1991). By 6000 BP, proxies for spring discharge all but disappeared for the subsequent three millennia, attesting to the severity and duration of aridification (Quade et al. 1998).

Extreme xeric conditions seem to have induced reduced faunal species richness as well, at least among small mammals in select places (Grayson 2000). Juniper had receded from the valleys and off the lower elevation landforms and was effectively supplanted by a northern expansion of creosote that reconfigured local ecosystems (Steinberg 2014). By 4000 BP, the desert ecosystems we know today had been fully established.

Late Holocene (circa 4000–100 BP)

In and around the study area, the onset of the late Holocene is marked by an expansion of a pinyon-juniper woodland, signaling cooler and/or wetter conditions than during preceding centuries (Wigand et al. 1995). This period of more mesic conditions persisted for nearly two millennia and is evidenced in multiple proxies from across the Great Basin (Benson et al. 2002; LaMarche 1973; Mehringer 1985; Reinemann et al. 2009; Thompson 1992; Wigand and Rhode 2002). Spring discharge increased (Quade et al. 1998), and pluvial lake levels rose (Benson et al. 1990, 2002; Broughton et al. 2000; Lindström 1990; Oviatt 1988) or, in some instances, refilled after millennia of dessication (Enzel et al. 1992). This first half of the late Holocene has been referred to as the "Neoglacial" (Porter and Denton 1967), as the cooling likewise induced a re-advance of glaciers in North America (Burke and Birkeland 1983; Davis 1988).

The Neoglacial ended around 2000 BP with a reversal to generally warmer and drier conditions (Wigand and Rhode 2002). While effectively drier, the contribution of summer moisture to annual trends seems to have increased in and around the study area. High resolution proxy records for the post-Neoglacial period from near the study area evidence multiple fluctuations between wetter and drier and cooler and warmer conditions at decadal and centurial scales (Benson et al. 2002; Leavitt 1994; Thiessen et al. 2019). One of these, known variably as the "Medieval Warm Epoch" (Lamb 1965) or the "Medieval Climatic Anomaly" (Stine 1994), was seemingly global in scale (Mann et al. 2009) but probably not uniform in expression (Hughes and Diaz 1994; Young et al. 2015). The Mojave Desert experienced this perturbation as a relatively warmer and drier climate from approximately 1150 to 600 BP interrupted by a century of cooler and wetter conditions between 838 and 741 BP (Millar and Wolfenden 1999; Miller et al. 2010; Stine 1994).

Subsequent to the Medieval Climatic Anomaly was a prolonged period of modest cooling in the Northern Hemisphere often called the "Little Ice Age" that persisted into the nineteenth century (Mann 2003), although the timing of its onset varied across regions (Matthews and Briffa 2005). In and around the study area, this cooler epoch was apparently accompanied by increased precipitation (Hunter 1991) and streamflow (Enzel et al. 1989; Miller et al. 2010) that allowed blackbrush to establish itself within the Mojave Desert Scrub ecosystem (Cole and Webb 1985; Hunter and McAuliffe 1994).

CHAPTER 3

CULTURAL SETTING

The region encompassed by the proposed Avi Kwa Ame National Monument subsumes the aboriginal territories and traditional use-areas of several Indigenous communities. In straddling the Great Basin Divide (Chapter 2, this volume), much of the area lies within the ancestral homeland of the Nuwuvi, a people generally referred to as the Southern Paiute and Chemehuevi and often conceptualized as being of a Great Basin culture (Kelly and Fowler 1986). Nuwuvi is better regarded as an ethnic affiliation for Numic-speaking people in the southern Great Basin and adjoining regions, most of whose traditional lifestyle was one of hunting, gathering, and horticulture supported by a relatively flexible mode of residential mobility. Nuwuvi aboriginal lands extend north, west, and east of the Colorado River to include a contiguous zone of occupation across present-day northern Arizona, southwestern Utah, southern Nevada, and southeastern California (Kelly 1934).

The reach of the proposed monument closest to the Colorado River subsumes portions of the traditional territory of the Aha Macav, a Yuman-speaking people usually referred to as the Mojave. Rather than a Great Basin culture or people, the Aha Macav are typically conceptualized as Southwestern in affiliation, or intermediate between Southwestern and Californian Indigenous cultural provinces (Kroeber 1902, 1939; Wissler 1914). Aha Macav traditional lands extend the length of the Colorado River between Black Canyon to the Chemehuevi Valley (Kroeber 1925:726–727).

Historically, the Aha Macav had exclusive domain over the length of the Colorado River from Black Canyon to the Chemehuevi Valley (Kroeber 1925:726-727), although their traditional territory covers a much larger land area. From there, present reservation lands in the Mohave and Parker Valleys, Aha Macav traditional lands extend north to the Las Vegas Valley, south to the Palo Verde Valley, and west to the Pacific Coast Ranges to encompass the entire Mojave Desert. They also extend east include a swath of land in Arizona that is approximately 25 miles wide and that extends between Black Canyon and the Palo Verde Valley (Kroeber 1974:132–133). Traditional Aha Macav songs, epic narratives, and oral history establish cultural and historical ties and affinities to an even larger landscape that extends east to the vicinity of Flagstaff, southeast to the Great Bend of the Gila River, south into Baja, California, and northwest to the Sierra Nevada (Hatzenbuehler 1994; Kroeber 1948, 1951a, 1972; Stone 2006).

The original ownership, authority, or sovereignty over lands encompassed by the proposed monument by the Aha Macav and Nuwuvi was adjudicated through the Indian Claims Commission (ICC). Their findings, reproduced in Figure 3.1, divide the area almost equally between the Mojave, the Chemehuevi, and the Southern Paiute, the Tribal names recognized by the U.S. government and for which the legal suites were prosecuted (Indian Claims Commission [ICC] 1978:130n34). The ICC's findings are reflective of the U.S. doctrine of Indian title, and are solely a creation of the U.S. courts based on legal prejudices on the concept of land ownership and the basis of any such ownership (ICC 1978:128).

The ICC has been rightly criticized for, among many things, favoring "narrow construals and parsimonious settlements" (Oestreich Lurie 1978:97). It is clear from their own summation that the ICC struggled with the fact that some tracts of land were essentially shared among Tribes. They found it particularly troublesome to reconcile shared landscapes with Indian title, as the latter legal framework

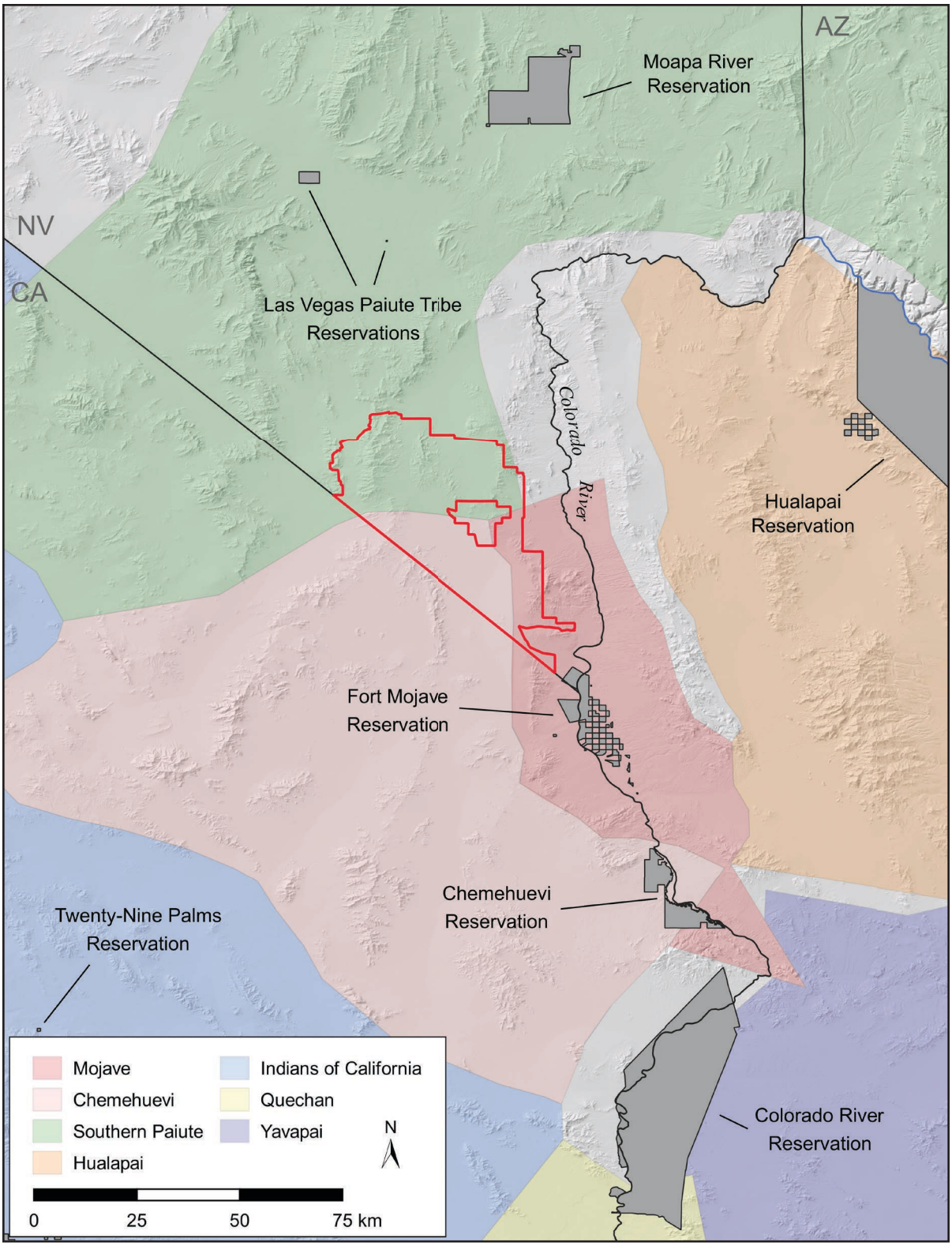


Figure 3.1. Current reservations overlaying areas of traditional tribal occupancy (variegated shades) in and around the study area. Areas of traditional tribal occupancy were adjudicated through the Indian Claims Commission.

necessitates "exclusive use" by the Tribe asserting title (ICC 1978:128). As a result, their findings established hard lines around aboriginal territories when, in reality, the boundaries were less concrete and were certainly subject to fluctuation and negotiation throughout the past. Further, areas of contestation, joint use, or otherwise common lands were often left untitled to any claimant and, therefore, appear as "buffer zones" or "no-man's lands" when that could not be further from reality. Such is the case with the findings for much of the lower Colorado River Valley adjacent to the proposed monument (see Figure 3.1), which represents not a lack of occupancy by any Tribes but the incompatibility of Indigenous land stewardship and U.S. jurisprudence.

While fallible, the ICC's findings derived from a great deal of historical and anthropological research and are grounded in some essence of past reality. The placement, abruptness, and appropriateness of boundaries are debatable, but the Indigenous relationship with the broader landscape beyond the reach of the present reservations is clear and compelling. The remainder of this chapter offers a brief sketch of the Nuwuvi and Aha Macav to allow contextualization of the archaeological landscape around Avi Kwa Ame and its significance to contemporary descendant communities.

AHA MACAV

The Aha Macav reside below and at the riverside foot of Avi Kwa Ame and have done so since "time immemorial" (Bean et al. 1979:7–24). The Aha Macav language is of the River Branch of the Yuman language family, with the closest languages being those of Piipaash and Kwatsáan (Campbell 1997:127). Aha Macav, the Tribal name, translates loosely as "the people who live along the water." Hodge (1907:921) provides more than 50 various names used historically, but Mojave was popularized in the first half of the nineteenth century by trappers along the Colorado River, such as James Ohio Pattie, George Yount, and Kit Carson (Chapter 4, this volume). The source of "Mojave" as a name, however, remains unclear (Gudde 1948; Sherer 1967:2; Stewart 1983:69).

The Aha Macav homeland lies at the center of two major axes of trade and transportation—the north to south flowing Colorado River and the 35th parallel that the U.S. government set as an appropriate east-west oriented road to open California for commerce and settlement. The road corridor later begat the railroad, U.S. Route 66, and Interstate 40, all of which led to incredible exposure of the Aha Macav to travelers. As a result, the Aha Macav have long been the subject of popular and academic writing, and the works are numerous. The more substantial anthropological works include those of Bourke (1889), Curtis (1908:45–60), A. Kroeber (1902, 1925:726–795, 1948, 1951a, 1951b, 1957, 1972; also Kroeber and Harner 1955; Kroeber and Kroeber 1973), C. Kroeber (1965), Devereaux (1937, 1948, 1949, 1950, 1951, 1956, 1957), Wallace (1947a, 1947b, 1948, 1953, 1955), Stewart (1947a, 1947b, 1947c, 1957, 1965, 1966a, 1966b, 1966c, 1968a, 1969a, 1969b, 1969c, 1973, 1974a, 1974b, 1977, 1983), Taylor and Wallace (1947), Fathauer (1951a, 1951b, 1954), Spier (1953, 1955), Sherer (1965, 1966; also Sherer and Stillman 1994), Smith (1966), Gorman (1981), and Munro and Crawford (1984).

When first visited in late 1604 by Juan de Oñate y Salazar, the then-governor of the Spanish Province of Santa Fe de Nuevo México, and an entourage of nearly three dozen men, the Aha Macav were living in the Chemehuevi and Parker Valleys along the Colorado River, north and south of the mouth of the Bill Williams River (Bolton 1919:28–29; Zárate Salmerón 1916 [1626]:271–273). After Oñate, the Aha Macav evaded direct contact with the Spanish and other colonial bodies until visited in 1776 by

Francisco Hermenegildo Tomás Garcés, a Franciscan priest in search of a northern route between Santa Fe and the missions around Monterey Bay, California (see Chapter 4).

Garcés found the Aha Macav living only north of the Bill Williams River, in the Chemehuevi and Mohave Valleys, indicating they had contracted northward at some point after 1605 (Coues 1900:413–422). That was probably no later than 1699, as the Xalychidom (i.e., Piipaash) had migrated into the Parker Valley from the Gila-Colorado confluence by 1700 (Dobyns et al. 1963:113; Ezell 1963:9). The Aha Macav and allies, principally the Kwatsáan, eventually ran the Xalychidom from the region in the late 1820s, after which some Aha Macav began to move back into the Parker Valley.

Following a series of skirmishes with trappers and wagon trains, Aha Macav leader Ireteba (Woodward 1953) and a band of followers split from the rest of the community in 1859 and settled in the Parker Valley. Most, however, remained in the Mohave Valley under the leadership of Homoseh. This division persists today (Stewart 1969a, 1983), with the southern group associated with the Colorado River Indian Tribes in the Parker Valley and the northern group being the Fort Mojave Indian Tribe in the Mohave Valley. Many Aha Macav also live off the two reservations. The Colorado River Indian Tribes and the Fort Mojave Indian Tribe were federally recognized in 1865 and 1870, respectively.

Traditional Aha Macav social organization has been described as nationalistic (Kroeber 1965). While local communities exist, the Aha Macav see themselves as one large nation (Kroeber 1925:727; Stewart 1983:55). This sense of unity, despite regional divisions, was once a major factor in the Aha Macav's success in warfare (Stewart 1947b, 1983:62). Their oneness as a people established a well-defined Aha Macav territory, as the social and cultural allegiances were clear to themselves and to others. Still, regional distinctions once existed, as evidenced by the three regional bands known historically. The Mathalyadoma occupied the northern Mohave and Cottonwood Valleys, from Piute Wash to Black Canyon. The Hutopa held central Aha Macav territory, from Piute Wash south to the Needles. Land south of the Mohave Valley was home to the Kavilyadoma. Within each band were multiple settlements, each with their own leaders (Kroeber 1925:746; Sherer 1965:80; Stewart 1983:62).

At the National level, traditional Aha Macav leadership was one of hereditary male chieftainship (*hamidhala*) (Kroeber 1925:745; Stewart 1983:62), although the position was more symbolic than actual. The head person was most responsible for promoting Tribal morale. The regional bands also had leaders, and the prominent men of settlements were local heads. Outside of politics, important social positions include those of war leaders (*kwanami*), religious leaders (*kohota*), and spiritual doctors (*kwaidai*). As public offices, leaders' tenures were contingent upon the faith and disposition of their followers, not on any authority inherent in the social role. Thus, these leaders were expected to be exceptional orators and organizers. Dreaming (see Chapter 7) was the avenue to leadership, and the validity of any such dreams was determined through consensus of the community. While National chieftainship was hereditary, the heir was expected to have dreamed their power (Stewart 1983:62).

As is the norm among most Yuman Tribes (Gifford 1918), traditional Aha Macav social organization ascribes to a system of exogamous, patrilineal, totemic *címuls*, or clans (Bourke 1889:180–181; Kroeber 1925:741–744; Sherer 1965; Spier 1953; Stewart 1983:65). While Kroeber (1925:742–743) documented 22 Aha Macav clans at the beginning of the twentieth century, at least two had dissolved 50 years later (Sherer 1965:28). Clan names were given by Matevilya at the time of creation (see Chapter 7), and totems include plants, animals, insects, weather phenomena, and celestial bodies. Totems are not venerated, and there are no proscriptions on killing or eating one's totem.

Rancherías, or loose arrangements of houses and associated buildings (i.e., *ranchos*), typified traditional Aha Macav settlement structure. Ranchos were spread throughout the valleys and situated near farmlands, with house clusters separated by up to 2 km (Castetter and Bell 1951:45). For most of the year, traditional Aha Macav life was spent outdoors. Residences consisted of flat-topped ramadas, storage platforms and granaries, and domestic work areas in the river's floodplain and near a family's fields. During the coldest months, families relocated to higher ground just beyond the floodplain, where they maintained more substantial and durable residential facilities. Aha Macav winter houses were framed with logs and wooden posts covered in a waddle-and-daub superstructure of arrowweed and grasses. The structure, semisubterranean and rectangular in plan, was further insulated by layers of sand and earth piled over it (Bourke 1889:177; Kroeber 1925:731–735).

Traditional Aha Macav agriculture was one of floodwater farming, where they took advantage of the seasonal inundations of the Colorado River's floodplain. Floodwaters renewed fields by depositing new, organic-rich silts, and floodwater was channelized in shallow ditches and retained in sloughs where it could be controlled. Corn was the principal cultivar, although the Aha Macav also grew varieties of beans, melons, and squashes (Castetter and Bell 1951; Kroeber 1925:735–736; Stewart 1966c). Their traditional diet was supplemented by an abundance of wild produce, most notably mesquite pods, wild seeds, and cactus fruits (Kroeber 1925:736–737; Stewart 1965). Fish was readily abundant and consumed regularly (Stewart 1957; Wallace 1955), and wild game was an important but less reliable element of the diet (Kroeber 1925:736; Stewart 1947a).

Aha Macav territory is centered on the Mohave and Chemehuevi Valleys (Stewart 1969b, 1983:55), which is roughly the same as what the ICC adjudicated (see Figure 3.1). This region was the exclusive domain of the Aha Macav for much of the past 500 years, as there are no historical records of any other Tribes living in these two valleys other than the Chemehuevi beginning in the 1800s, who came at the invitation of the Aha Macav (see below). Nevertheless, Aha Macav settlements extended both north and south at different points in the past, with periods of residence in the Parker and Cottonwood Valleys at times, which was intermittently shared and contested by that of the Chemehuevi, the Southern Paiute, and the Xalychidom.

The Aha Macav were also intimately familiar with the deserts east and west of the Colorado River, such that portions of this greater expanse could be considered Aha Macav territory, though not theirs exclusively. As Kroeber (1948, 1951a, 1972) illustrated, the Aha Macav maintain historical epics that describe temporary residence at places throughout western Arizona, as far east as Date Creek and the Great Bend of the Gila River (cf. Stone 2006). Their reasons for being in those regions concerned matters of travel, trade, war, marriage, and migration. The Aha Macav made regular forays west of the river through the desert to reach the Pacific Coast and places between. This history is materialized by a network of trails over which early explorers and travelers were led, often by Aha Macav guides (see Chapter 4).

Regarding the western extent of Aha Macav territory, there are conflicting perspectives on whether a contingent was once in residence deep within the Mojave Desert. As Kroeber (1959a:306) asserts, "An actual tribe of Mohave speech and customs in the western mountain desert is of course definitely fictitious within our historic knowledge." By this, though, he means any such group cannot be accounted for in Euro-American documentary records. So, if it were true, their existence and demise either predates Garcés' 1776 expedition through the region, or it was too short-lived to have been encountered by any Euro-American chroniclers since. While conclusive documentary evidence is lacking, Indigenous oral history and archaeology suggest the case is not closed.

Eisen (1898), Harrington (n.d.), Kelly (2016), Kroeber (1959a), and Laird (1976) detail the accounts of multiple Nuwuvi who described a people they called Turat Aiyet, "Desert Mojave," living between the New York Mountains and Soda Lake in the Mojave Sink. More recent ethnographic work among the Chemehuevi has expanded on the subject (Earle 2005:6–7). The Turat Aiyet spoke like the Aha Macav and cremated their dead, as is customary among other Yuman Tribes, but they lived like Chemehuevi. According to the Nuwuvi informants, the Chemehuevi killed off these Desert Mojave and took possession of their lands, which included the New York Mountains and Piute Range.

Aha Macav historical epics do describe some having once lived for short periods of time along the Mojave River and in the Providence Mountains (Kroeber 1948:24, 28, 1951a:74, 77, 1972:49). Further, in 1844, John C. Fremont met a group of vagabond Aha Macav near the Mojave Sink, one of whom—a Spanish-speaking mission survivor of unspecified cultural affiliation who took up residence with his Aha Macav companions in the 1830s—said a group of Aha Macav once lived along the Mojave River, where they grew various types of melons (Fremont 1845:260).

Aside from pure fancy, Kroeber (1925) presents two possibilities to explain the Desert Mojave. One is that, according to Serrano and Aha Macav informants, there was once a group of people in the Mojave Desert who were almost identical to the Aha Macav in language and cultural practice. The Serrano called them Kitanemuk or Alliklik, while the Aha Macav called them Kwiahta Hamakhava, "like Mojaves" (Kroeber 1925:612). While inconclusive, Kroeber (1925) concluded that this group, if real, were not Aha Macav, but most likely a Serrano band, as suggested by Gifford (1918:179). In his other scenario, Kroeber (1925) suggests that, once the Vanyume Serrano left the area for the coastal missions beginning around 1790, a small group of Aha Macav may have moved into the area and made an unsuccessful effort at farming. Such an ephemeral and short tenure in a difficult to reach and relatively isolated place could easily go unnoticed in the documentary record (between Garcés in 1776 and American trappers in the 1820s) and survive only as a batch of legends, if at all.

Rogers (1929, 1939) first drew attention to archaeological evidence for a possible western manifestation of Aha Macav within the Mojave Sink region of the central interior of the Mojave Desert. He noted the recurrence of a material culture assemblage of Lower Colorado Buff Ware pottery, cobble hearths, intentionally broken metates, and cremations in sand dune settings around mesquite thickets, which he interpreted as early Aha Macav mesquite camps (Rogers 1929:8–9). He suggested these western Aha Macav vacated the area in the 1600s, with Numic-speaking groups (i.e., Nuwuvi) moving in to take their place (Rogers 1939:73). His dating of events, however, relied on a fairly crude understanding of ceramic chronologies that have not stood the test of time (Wright 2021). In fact, some of the supposed Aha Macav ceramics he reported bear relatively late attributes, including folded rims, stuccoed exteriors, and painted-and-incised decorative patterns (Rogers 1929:9–10, Plate III) and, therefore, could date as late as the nineteenth century (Wright 2020, 2021).

Reconciling the archaeological record with oral history to fully understand what the Desert Mojave expression represented remains a challenge in regional research (Earle 2005; Sutton 1996). Most recent thinking postulates that the central Mojave Desert was an area of joint resource use with little to no year-round residence by any one social or cultural group (Sutton 2017). Regardless of whether some Aha Macav lived in the central portion of the Mojave Desert in the past, that it is even a question of research indicates the area falls within a broader ancestral Aha Macav territory, even if it may not have been used exclusively by them.

NUWUVI

The Nuwuvi, or Nuwu, include multiple Indigenous groups otherwise known as the Southern Paiute and Chemehuevi. Nuwuvi is a Numic word that translates closely into English as "the people." According to Campbell (1997:134) and Stoffle and Zedeño (2001a), the Nuwuvi language is of the Southern Numic Branch of the Uto-Aztecan language family, of which the language of the neighboring Ute is also a part. Major primary and secondary ethnographic works on the Nuwuvi include those of Sapir (1912, 2010), Kroeber (1925:593–600), Kelly (1934, 1936, 1964, 2016; also Kelly and Fowler 1986), Stewart (1942), Stuart (1945), Euler (1966), Miller and Miller (1967), Stewart (1967, 1968b), C. Fowler and D. Fowler (1971), D. Fowler and C. Fowler (1971), Van Valkenburgh (1976), Laird (1974, 1976, 1977, 1980, 1984), Roth (1976), Inter-Tribal Council of Nevada (1976), Knack (2002), Trafzer (2015; also Trafzer et al. 1997), as well as the many contributions of Spoon and his students at Portland State University (Lahoff 2013; Lefler 2014; Spoon and Arnold 2012; Spoon et al. 2015; Spoon et al. 2011, 2012a, 2012b, 2014; Wendel 2014) and Stoffle and colleagues at the University of Arizona (Stoffle, Carroll et al. 2004; Stoffle, Chmara-Huff et al. 2004; Stoffle et al. 1994, 1997, 1998, 2000, 2001, 2005, 2017; Van Vlack 2012a, 2012b).

The first documented direct engagements between the Nuwuvi and Euro-American colonial powers took place in 1776. On Garcés' trek to find a route from Santa Fe to Monterey, before reaching the Aha Macav in the Mohave Valley, he met some 40 Chembet (i.e., Chemehuevi) in the interior desert west of the Colorado River (Coues 1900:219–225). They told Garcés their Nation was bordered on the west by the Beñemé (i.e., Vanyume Serrano) and followed the right-side (west and north) of the Colorado to the territory of the Yuta (i.e., Ute). Later that year, two other Franciscan priests, Atanasio Domínguez and Silvestre Vélez de Escalante, who were on a separate exploration for an overland route between Santa Fe and Monterey, met people using ditches to irrigate fields of maize and squashes and who called themselves Parussi (Bolton 1950:95). These were Nuwuvi living along the Virgin River below Ash Creek in southwestern Utah. According to Tony Tillohash, a Nuwuvi originally from the Kaibab Indian Reservation renowned for his work with linguist Edward Sapir (Pezzati 2013), the Nuwuvi name for the Virgin River is Pa-roos, "white foaming river," and the people there were known as the Pa-roos-itsn (Presnall 1936:5; see also Palmer 1928:43–44).

As an ethnic group, Nuwuvi identity derives from shared language, culture, history, and ancestry. They maintain they have been in their homeland since the time of creation (Stoffle and Zedeño 2001a; Stoffle et al. 1998:18). While one people, the Nuwuvi have never been politically organized as one Nation. In fact, some groups were, at times, antagonistic toward each other, with accusations of slave raiding levied among them (Kelly and Fowler 1986:368). Traditional Nuwuvi social organization is best characterized as a series of regional groups of extended families, or bands (*newavi*), with associated territorial ranges.

The fluidity of Nuwuvi social organization is reflected in discrepancies between the numbers of Nuwuvi bands and tribes reported among ethnographers (Steward 1938:181). For example, Powell and Ingalls (as reported in D. Fowler and C. Fowler 1971) enumerated 31 Nuwuvi "tribes," not including any Chemehuevi groups, while Kelly (1934) described 15 Nuwuvi "subgroups, bands, or tribes," including the Chemehuevi. As Kelly (1934:557) explained, such discrepancies arise from the custom of Nuwuvi social groups identifying with local landforms or places. However, as Steward (1938:181) contends, this is also due to the loose nature of Nuwuvi political organization, so much so that concepts of bands and tribes are possible misnomers.

The Nuwuvi regional divisions described by Kelly and Fowler (1986) to have been organized during the nineteenth century are listed in Table 3.1. Kelly (1934) regarded these as discrete dialect groups whose members were, in most cases, self-sufficient within their own territories. Within them existed smaller groups, or families, with smaller territories but who were dialectically identical to their neighbors and reliant on them to some extent. These smaller groups are what Powell called "tribes," Lowie (1924:193) regarded as "bands," and Kelly (1964:22) considered "economic clusters." Kelly and Fowler (1986:380) describe them further as "assemblages of individual households and gathering trips, returning to the same spring or the same agricultural site." This underscores how aspects of the landscape, particularly waters sources and resource zones, are integral to Nuwuvi identity.

Today, the Nuwuvi are represented among 12 federally recognized Tribes in Utah, Arizona, Nevada, and California (Table 3.2), as well as the Pahrump Band of Southern Paiute who have been engaged in a decades-long effort to have their sovereignty recognized by the United States (Chmara-Huff 2006). The distribution of Nuwuvi traditional lands, including those of the Pahrump Band, are shown in Figure 3.2.

As noted, the proposed Avi Kwa Ame National Monument encompasses Indigenous territories recognized by the ICC as once belonging to the Chemehuevi and Southern Paiute. However, according to Kelly's (1934; also Kelly and Fowler 1986) research, the area falls exclusively within the territory of the Las Vegas division of the Nuwuvi, with Chemehuevi territory situated just south (see Figure 3.2). Any such boundary between Las Vegas and Chemehuevi groups and their territories is nebulous for two reasons.

One is that, by both group's admissions, the Chemehuevi are a "recent offshoot" of the Las Vegas group (Kelly 1934:556). Euler's (1966:105) Las Vegas confidants told him they saw no difference between themselves and the Chemehuevi. In fact, the Chemehuevi were likely indistinguishable from their Las Vegas counterparts prior to the 1820s when they began residing along the lower Colorado River and in so doing assumed a "veneer of Yuman culture" (Euler 1966:110; cf. Kelly and Fowler 1986:370; Kroeber

Table 3.1. Nuwuvi Regional Groups (after Kelly and Fowler 1986).

Common Name	Nuwuvi Name	English Gloss
Antarianunts	Yantarii	–
Beaver	Kwiumpacimi	People of the Red Stream
Cedar	Ankappanukkicicimi	People of the Monument Plant
Chemehuevi	Tantawait	People of the South
Gunlock	Matisati	–
Kaibab	Kaipapicicimi	People of the Mountain Lying Down
Kaiparowits	Kaiparowits	Mountain Home of the People
Las Vegas	Nipakanticimi	People of Charleston Mountain
Moapa	Moapats	People of Muddy Creek
Pahranagat	Patanikici	People Who Put Feet in the Water
Panaca	Matisabits	–
Panguitch	Pakiucimi	People of the Fish
Saint George	Uainuints	–
San Juan	Kwaiantikowkets	People on the Opposite Side
Shivwits	Sipicimi	People of the East
Uinkaret	Yipinkatiticimi	People of Mount Trumbull

1925:597–600, 1959b:261–263). That any distinction between the Las Vegas and Chemehuevi groups is superficial, and likely more a product of U.S. Indian policies than anything, is also witnessed in the assignment of bands to one or the other. In particular, Kelly (1934:Table 1) situated 11 of Powell's Nuwuvi "tribes"—regarded here as bands—within the Las Vegas group, with none specified for the Chemehuevi. Kroeber (1925:595) regarded five of these, however, as being Chemehuevi (Table 3.3). Importantly, Laird (1976) regards the Las Vegas group as northern Chemehuevi, a sentiment shared by Roth (1976).

The second reason any boundary line between Chemehuevi and Las Vegas group aboriginal territory is nebulous is because there is general agreement that, over time, the Chemehuevi gradually moved south and into the territory in which they were met by early chroniclers in the late eighteenth and nineteenth centuries (Kelly 1934:556). Kelly's (1934) regional divisions are an approximation of Nuwuvi organization and territorial extent at the middle of the nineteenth century, after the Chemehuevi had assumed what would be the southernmost reach of the expansion. Kroeber (1955, cited in Euler 1966:110) disagreed with where Kelly (1934) had drawn the boundary line, largely because several of his Chemehuevi consultants were born at places north of that line, including the southern Piute Valley.

In fact, Bean et al. (1979:6–18) learned from consultants that the last Nuwuvi living near Searchlight, Nevada in the 1950s moved to the Colorado River Indian Reservation. Understandably, Kroeber (1959a:294) felt that any "sharp distinction between the Las Vegas and Chemehuevi [groups] is difficult to find or maintain." Because Kroeber was an expert witness on behalf of the Chemehuevi during the ICC hearings, his view that Chemehuevi territory extended into southern Nevada helps explain the discrepancy between the ICC's findings (see Figure 3.1) and Kelly's (1934) work (see Figure 3.2).

Because the proposed national monument lies within the aboriginal territories of the Las Vegas and Chemehuevi groups, these two divisions of the Nuwuvi are the most relevant to the current study. While Nuwuvi can be considered one ethnic group, there are important traditional cultural aspects shared by the Las Vegas and Chemehuevi groups not present among other Nuwuvi. These are elements of the Yuman "veneer" as described by Euler (1966:110), which is attributed to these two groups' adjacencies to and histories with the Aha Macav. As reviewed by Kelly and Fowler (1986), such distinctions

Table 3.2. Contemporary Nuwuvi Tribes and Tribes with recognized Nuwuvi contingencies.

Southern Paiute
Kaibab Band of Paiute Indians
Las Vegas Tribe of Paiute Indians of the Las Vegas Indian Colony
Moapa Band of Paiute Indians of the Moapa River Indian Reservation
Pahrump Band of Southern Paiutes[a]
Paiute Indian Tribe of Utah (Cedar, Indian Peaks, Kanosh, Koosharem, and Shivwits Bands)
San Juan Southern Paiute Tribe of Arizona
Chemehuevi
Agua Caliente Band of Cahuilla Indians
Cabazon Band of Mission Indians
Chemehuevi Tribe of the Chemehuevi Reservation
Colorado River Indian Tribes
Morongo Band of Mission Indians
Torres-Martinez Desert Cahuilla Indians
Twenty-Nine Palms Band of Mission Indians of California

[a]Presently not recognized by the U.S. government as a sovereign Tribe or Nation.

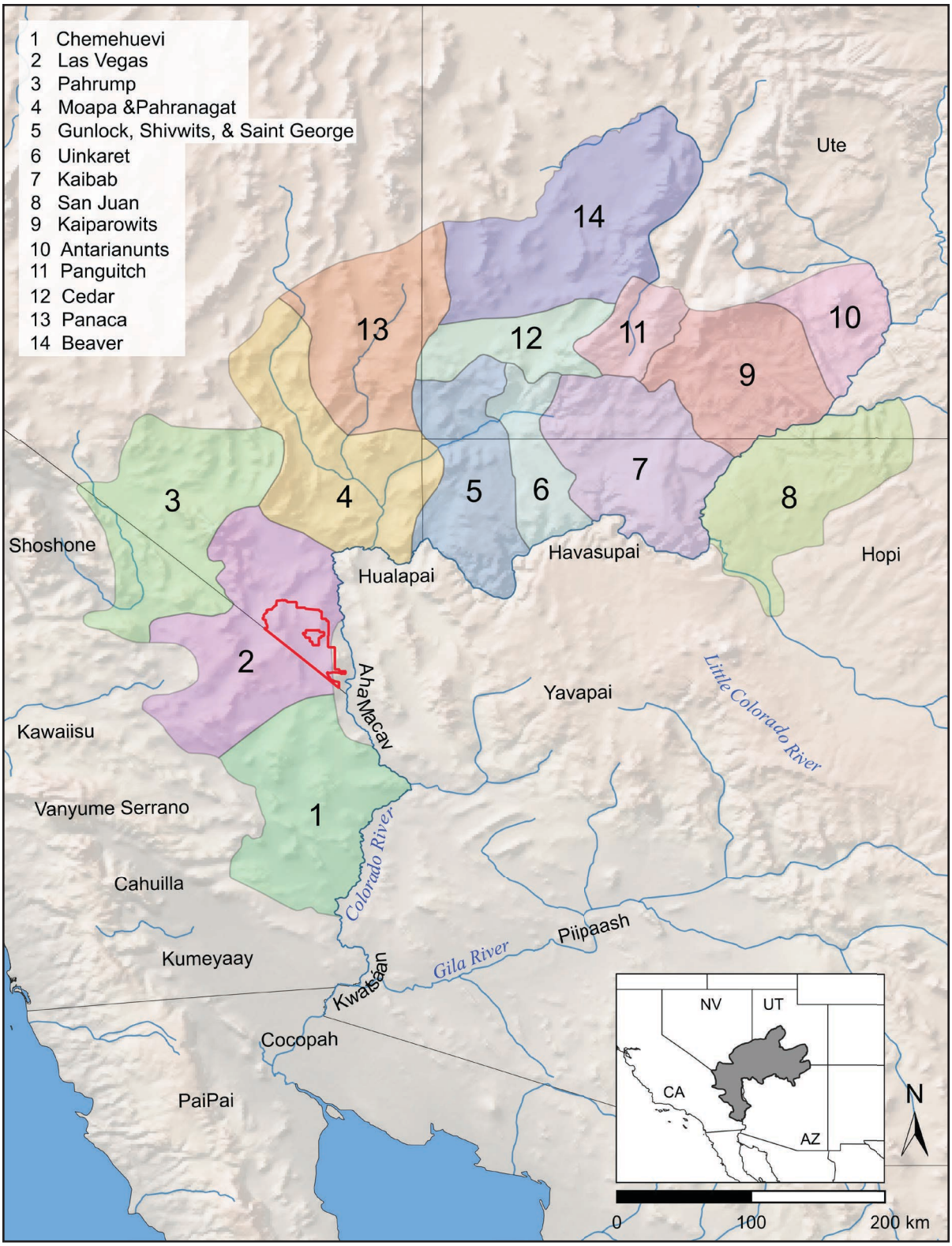


Figure 3.2. Traditional Nuwuvi lands, by regional group. (Information adapted from Kelly and Fowler 1986:Figure 1 and Stoffle et al. 2017:Figure 2).

Table 3.3. Nineteenth century Nuwuvi Bands of the Las Vegas and Chemehuevi Groups.

		Regional Division	
Name	Locality	Kroeber (1925)	Kelly (1934)
Ho-kwaits	Ivanpah Valley (California-Nevada)	Chemehuevi	Las Vegas
Kau-yai-chits	Ash Meadows (California)	Chemehuevi	Las Vegas
Kwi-en-go-mats	Indian Springs (Nevada)	–	Las Vegas
Mo-quats	Kingston Mountains (California)	Chemehuevi	Las Vegas
Mo-vwi-ats	Cottonwood Island (Nevada)	Chemehuevi	Las Vegas
No-gwats	Spring Mountains (Nevada)	–	Las Vegas
Nu-a-gun-tits	Las Vegas Valley (Nevada)	–	Las Vegas
Pa-ga-its	Callville Wash (Nevada)	–	Las Vegas
Pa-roo-pats	Pahrump Springs (Nevada)	–	Las Vegas
Shi-va-wats	Chemehuevi Valley (California)	Chemehuevi	–
Tim-pa-shau-wa-got-sits	Providence Mountains (California)	Chemehuevi	Las Vegas
Ya-gats	Amargosa Valley (California)	Chemehuevi	Las Vegas

include dimensions of material culture, subsistence, vocabulary, song, ceremony, personal adornment, and political organization that resemble those of the Aha Macav or that are definite adoptions from them. Where relevant, such distinctions are provided below.

Traditional Nuwuvi political organization lacked strong hierarchy and positions with ascribed power. The basic social and political unit was the nuclear family, and it was often the case that such a unit consisted of a male and his offspring or his mother, a childless couple, two or more siblings, or even a single individual. More often, households were part of larger social groups consisting of the households of relatives and friends, each of which had a separate but nearby camp and whom shared in economic pursuits. The number of households ranged from one to as many as 20 (Kelly and Fowler 1986:380).

Most such bands had a head person (*niavi*) who was more of an advisor or administrator than an authority (Kelly and Fowler 1986:380). There was a tendency for such positions to be associated with particular families, but among most groups, the role did not automatically move from father to son. Most often, it transitioned to a nephew (Kelly 1964:28), but the ultimate decision rested with the elders of the band. For the Las Vegas and Chemehuevi groups, however, headmanship was inherited by a son, usually the eldest if there was more than one (Laird 1976). This element of male hereditary leadership may be due to Aha Macav influence.

Springs were usually associated with specific individuals and their extended families, so much so that there was a sense of ownership recognized within and outside the family units (Kelly 1964:7). These socially recognized and respected associations formed through repeated occupation of the area around the spring that instilled a sense of responsibility, or control over it. The "ownership" association of springs was inheritable by relatives who continued to live at the site and maintained usage of the spring. Springs were clearly integral to traditional Nuwuvi economic organization, and that the names of many bands referenced their associated springs shows that these landscape features were also a basis of social identity. Still today, the Nuwuvi regard themselves as stewards of water resources within their aboriginal territory, even if that territory lies outside their current jurisdiction (Wendel 2014).

Traditional Nuwuvi subsistence entailed a system of hunting, gathering, and collecting wild resources characteristic of Great Basin Indigenous practices broadly, but they combined that with horticulture, or small-scale agriculture, in places where it was feasible. Regardless of location, seeds were a staple of the Nuwuvi diet (Kelly and Fowler 1986:370). Edible roots, berries, and nuts (pine nuts and acorns) were available at higher elevations, while mesquite and agave were important foodstuffs at lower elevations and in canyon country nearer the Colorado River. Excess foodstuffs were stored in baskets and sacks, were cached in caves and crevices, and were sometimes buried in the ground, all to be available at later times (D. Fowler and C. Fowler 1971:49).

Nuwuvi residential mobility followed an annual cycle tuned to the seasonal availability of these and other resources. According to Kelly and Fowler (1986:371), the annual cycle of camp movement and resource acquisition differed little between those who also engaged in farming. Horticulture was simply integrated into the cycle and did not intervene with other subsistence pursuits (Steward 1938:180). Traditional Nuwuvi farming practices took advantage of whatever water resource availed them. Crops were planted along the margins of lakes and watered by hand as those lakes subsided. Irrigation ditches were used along streams and springs to convey water to small gardens. It was customary for people to plant their gardens near springs, leave for a period of time, and later return to harvest their crops (D. Fowler and C. Fowler 1971:47-49).

For the Chemehuevi living along the Colorado, floodplain farming like that of Aha Macav was available (Kelly and Fowler 1986:371). Important cultivars included maize (*ah-weaph*), wheat (*atsito*), beans (*mu-rih*), squashes, melons, sunflowers, and amaranth. While the availability of water at springs within the interior of the desert fluctuated through time in response to climatic changes (see Chapter 2), there was apparently enough in at least select places to irrigate gardens. In the first days of March 1854, members of the transcontinental railroad survey remarked at seeing the remains cultivated maize, wheat, melons, and gourds at a recently vacated Chemehuevi ranchería at a spring in the southern Piute Valley, just south of the Nevada/California border (Möllhausen 1858:287; Whipple 1856:121).

Regarding the Chemehuevi, they were relatively latecomers to the Colorado River. Kroeber's (1925:594) Aha Macav consultants said they invited the Chemehuevi to live near them in the Cottonwood and Chemehuevi Valleys. Their movement into the Parker and Chemehuevi Valleys began in the early 1830s to fill the void left by the Xalychidom once they moved east and into the Phoenix Basin (Kelly 1934:556; Kroeber 1925:593–594). There is some indication some Chemehuevi were living among the Xalychidom prior to the latter's departure (Trafzer et al. 1997). According to Roth (1976:81), some Chemehuevi and Xalychidom shared a village at the south end of the Parker Valley during the 1820s. According to that account, the Chemehuevi, having learned of an impending attack by the Aha Macav, tipped off the Xalychidom who then fled. The Chemehuevi were left with the Parker Valley to themselves, but were later joined in 1859 by the splinter group of Aha Macav under Irataba, as discussed prevoiusly.

Relations between the Chemehuevi and Aha Macav were amicable until the mid-1860s when myriad pressures culminated to the point at which the former allies turned on each other (Stewart 1968b:19–25). A period of inter-Tribal warfare between 1864 and 1867 (Woodward 1955) prompted many Chemehuevi to seek refuge to the west in the Mojave Desert and Coachella Valley (Kroeber 1925:595–595; Kroeber and Kroeber 1973:33–46; Trafzer 2015:12; Trafzer et al. 1997:62–67). Some stayed, however, and once a truce was brokered, they were permitted to live on the west side of the river, opposite the Aha Macav (Dent 1868:18).

With the peace, some of the refugee Chemehuevi chose to return to the Colorado River, with some settling at the Fort Mojave and Colorado River Indian Reservations and others joining off-reservation Chemehuevi communities. Still others moved into new territories, including the Mohave Valley opposite Fort Mojave and along the lower stretch of the Bill Williams River (Bean et al. 1979:5–21). Some never returned to the lower Colorado River, choosing instead to reside among Tribes on reservations bordering traditional Chemehuevi territory or to settle in newly formed desert towns such as Coachella, Banning, India, Las Vegas, and Palm Springs (Trafzer 2015:12). This explains why the Chemehuevi have a presence among Tribes otherwise affiliated with the Cahuilla and Serrano (see Table 3.2) (Krober 1908a; Sutton and Earle 2017; Trafzer et al. 1997; see also Deur and Confer 2012:162).

Although resettled along the Colorado, Chemehuevi relations with the Aha Macav were permanently altered. Eventually, some Chemehuevi at the Fort Mojave and Colorado River Indian Reservations began to petition the federal government to establish a reservation exclusively for them in their former territory, specifically in the Chemehuevi Valley. By 1885, several hundred Chemehuevi were resident in the Chemehuevi Valley (Roth 1976:125; Stewart 1968b:25), and in 1907, the government established the Chemehuevi Valley Reservation (Sanchez-Barnett 2006:133). However, through a Congressional act in 1935, the government reacquired the reservation land in anticipation of it being flooded by Parker Dam. With completion of the dam in 1938 and the subsequent filling of Lake Havasu, most residents in the Chemehuevi Valley had to relocate; many moved to the Colorado River Reservation. Chemehuevi desire for self-sufficiency persisted, and the 1960s saw revived efforts to establish an exclusive Chemehuevi reservation. The movement prevailed. In 1970, the federal government formally recognized the Chemehuevi Tribe, and the current Chemehuevi Indian Reservation was established by an Executive Order in 1971.

Regarding the Las Vegas group of Nuwuvi, they are perhaps best represented today by descendants affiliated with the Las Vegas Tribe of Paiute Indians, the Moapa Band of Paiute Indians, and the Pahrump Band of Southern Paiutes. The Las Vegas Tribe represents descendants from the Moapa and Chemehuevi groups, in addition to those of the Las Vegas group. By the latter decades of the nineteenth century, many Nuwuvi in southern Nevada who had not settled at either the Fort Mojave, Colorado River, or Moapa Reservations (established in 1873) had coalesced into small colonies around the Las Vegas Valley. These included local Nuwuvi (the Pa-ga-its) as well as those from the south, including Chemehuevi, and those of the Moapa group to the east. These Nuwuvi came in search of employment, which was available at the ranches, mines, and businesses of fledging Las Vegas (Inter-Tribal Council of Nevada 1976:119–120).

As the mines throughout the eastern Mojave Desert began to shutter in the early years of the twentieth century, the Nuwuvi working them were left without work, and many headed to the Nuwuvi colonies around Las Vegas. By that time, though, available land and water were scarce. The local entrepreneurs exploited the cheap labor but were otherwise reluctant to accommodate the Nuwuvi. In 1911, a local resident sold a 10-acre plot of land, just outside of town, to the federal government to provide a place for the reservation-less Las Vegas Nuwuvi to live. Aside from the purchase of land to be held in trust for the Nuwuvi, the federal government essentially left this colony to fend for itself over the following decades.

During that time, the community there established roots, and when, beginning in 1958, the federal government initiated a campaign to sell the land and relocate its Nuwuvi residents, they resisted. That campaign acquired renewed energy following the Indian Claims Commission's resolution to the South-

ern Paiute and Chemehuevi's suites, which shed light on the murky legal status of the Las Vegas colony (Inter-Tribal Council of Nevada 1976:126–127). In 1970, facing the threat of removal, the community organized a government and penned and ratified a constitution and by-laws. Approval of the plan by the Secretary of the Interior established them as a sovereign Nation in the eyes of the federal government (Alley 1977). Since that time, the Tribe's land holdings have expanded to include a separate and much larger Snow Mountain Reservation northwest of Las Vegas.

The social history of the Pahrump Band of Southern Paiutes is closely aligned with that of the Las Vegas Tribe. While Powell (D. Fowler and C. Fowler 1971:105) identified a Pa-room-pats band of Nuwuvi, tethered closely to the Pahrump Spring on the west side of the Spring Mountains, and Kelly (1934:559) associated them with the Las Vegas group, the contemporary Pahrump Band's connection to that ancestral band is unclear. This is largely due to the fact that the Pahrump Band of Southern Paiutes has been largely ignored by the federal government, and sadly, social and historical research has followed in consonance (Chmara-Huff 2006).

According to Bean et al. (1979:5–32), the Nuwuvi at Pahrump splintered from the Las Vegas colony in the early twentieth century to alleviate themselves from the generally deplorable conditions of the overcrowded and neglected 10-acre parcel to which the Las Vegas Nuwuvi were relegated. It is unclear, however, if they joined other Nuwuvi already living in the Pahrump Valley or if they established a new colony. Regardless, their historical connection to the Las Vegas colony suggests the Pahrump Band of Southern Paiutes are likewise an amalgam of descendants from bands of the Chemehuevi, Las Vegas, and Moapa groups, among others. According to Stoffle and Dobyns (1983:29), Pahrump Nuwuvi interviewed in the late 1970s "said they traditionally had stronger ties with the Moapa than the Las Vegas bands but had clear connections with both." The Pahrump Band of Southern Paiutes has been seeking federal recognition since at least 1978 (Bean et al. 1979:6–18).

CHAPTER 4

HISTORICAL SETTING

A historic context for the proposed Avi Kwa Ame National Monument in southern Clark County, Nevada is presented in this chapter. Just as this region is situated at the interface of the Sonoran, Mojave, and Great Basin Deserts (Chapter 2, this volume), it is also within a landscape in which cultural traditions tailored to those different climatic and ecological contexts intermixed in complex ways. While culture historical trajectories for each of those desert regions have been defined, debated, and continually refined, the location of the study area at the nexus among them underscores that none alone can fully capture the unique record of the region, and all are relevant. To address this, Roberts and Ahlstrom (2012:Table 1.1) devised a culture historical framework specific to southern Nevada that melds broad regional patterns better known from surrounding areas and reworks them to suit the local setting.

The culture historical framework followed in this study (Table 4.1) borrows Roberts and Ahlstrom's (2012) outline for southern Nevada but with two key divergences. One is the acknowledgement of a "Pre-Projectile Point Period" that leaves open the possibility of a pre-Clovis human presence in the study area. The second is a de-emphasis of the relevance of Ancestral Puebloan culture history. While pertinent to the region of southern Nevada east of Las Vegas Wash, there is presently little to no evidence of a substantial Ancestral Pueblo presence south of the wash, including in and around the study area. Instead, this period when farming became commonplace along major tributaries, such as the nearby Colorado River, is simply referred to as the Formative era. Major hinge points in the following chronological framework align closely with those identified in the paleoecological records (see Chapter 2), underscoring the close, and arguably essential, relationship between humans and their environments.

PRE-PROJECTILE ERA (?–13,100 BP)

The length of a human presence in North America during the Pleistocene has long been a point of contentious debate. Most archaeologists have ascribed to a "Clovis-first" model, a position that contends the continent's first inhabitants were essentially big-game hunters who somehow migrated into North America near the end of the Pleistocene, circa 13,100 BP (see below). This model is based on the premise that the earliest stone tools of convincingly human manufacture are projectile points that have been found in direct association with extinct Pleistocene megafauna, most notably at the Blackwater Locality No. 1 type-site near Clovis, New Mexico.

Rivaling the Clovis-first model has been a series of idiosyncratic "discoveries" of older stone artifacts that evidence some sort of "pre-projectile" lithic assemblage (Wallace 1962:174), many of which have been found in the Mojave and Sonoran Deserts and are, thus, relevant to the study area. These include places such as Manly Terraces in Death Valley (Clements and Clements 1953), Lake Manix (Simpson 1958), China Lake (Davis 1978), Calico Hills (Simpson et al. 1986), and Coyote Gulch (Simpson 1961), as well as the Yuha Desert (Childers and Minshall 1978) and Sierra Pinacate near the delta of the Colorado River (Hayden 1976).

Table 4.1. Culture-historical chronology for the study area.

Era	Date Range	Period	Date Range
Ethnohistoric	500–100 BP	Early Statehood	154–100 BP
		U.S. Territorial	173–154 BP
		Mexican Territorial	200–173 BP
		Spanish Provincial	500–200 BP
Formative	1500–500 BP	Late Formative	800–500 BP
		Early Formative	1500–800 BP
Archaic	7500–1500 BP	Late Archaic	4000–1500 BP
		Middle Archaic	7500–4000 BP
Paleoarchaic	13,100–7500 BP	Early Archaic	11,000–7500 BP
		Paleoindian	13,100–11,000 BP
Pre-Projectile	???? –13,100 BP	–	???? –13,100 BP

For one reason or another, each of the above-reference discoveries has been largely discredited as a convincing material expression of a pre-Clovis human presence in the Desert West. Nevertheless, the recent findings of fossilized footprints in southern New Mexico that pre-date Clovis stone technology by about 10,000 years seemingly confirms a human presence in western North America much earlier than Clovis-first models claim (Bennett et al. 2021). It also indicates that evidence of human antiquity need not be restricted to lithic technologies and may, in fact, be pre-projectile. Although there is presently no evidence of a Pre-Projectile human presence reported from the study area, absence of evidence is not evidence of absence. Descendant communities with ancestral ties to study area, including the Aha Macav and Nuwuvi, assert they have been on this landscape since time immemorial, and the New Mexico footprints give added credence to their claims.

PALEOARCHAIC ERA (13,100–7500 BP)

Willig and Aikens (1988) defined the Paleoarchaic era as a time of cultural practice associated with the terminal Pleistocene and early Holocene, particularly the complex cultural response to the changing climate and environment of that time. The Paleoindian and Early Archaic periods are usually associated with the terminal Pleistocene and early Holocene, respectively. The Paleoarchaic recognizes that the shift between the two was quite prolonged, that cultural response was similarly prolonged and perhaps punctuated and non-uniform across the Desert West, and that researchers in various places often have difficulty placing material of this era into either period (Graf and Schmitt 2007).

The Paleoarchaic concept is, in many ways, an effort to circumvent unresolved debate on the temporal, and perhaps cultural relationship between Clovis (fluted projectile technology) and Lake Mojave (stemmed projectile technology) complexes in the Mojave Desert, the southern Great Basin, and surrounding regions (see Sutton 1996:228–229). Most information about Paleoarchaic lifeways in and around southern Nevada derives from research around the Pleistocene lakes of the Mojave Desert southwest of the study area and the Forty Mile Wash region northwest of it (Roth 2012:87–91). Collectively, the data suggest people were highly mobile and subsisted on a wide range of terrestrial, aquatic, and avian resources (Beck and Jones 1997; Madsen 2007).

Paleoindian Period (13,100–11,000 BP)

In light of the controversial nature of "pre-projectile point" sites referenced above, the Paleoindian period is traditionally regarded as the dawn of humanity within the North American deserts. While the perspective that this period began circa 13,100 years ago is no longer tenable in light of mounting and convincing evidence for a much earlier human presence in the Americas, including the Southwest, Clovis material (which defines this period) remains the hallmark and most widespread sign of early humans in North America. Clovis projectile points have been found directly associated with now-extinct Pleistocene megafauna, which has fueled a characterization of Clovis-using communities as highly mobile big-game hunters.

While no Clovis material has been reported to date from within the study area, sporadic finds of fluted projectile points have been found nearby, including one from the McCullough Range (Roth 2012:Figure 5.1). As Roth (2012:87–90) observes, this material is rare in southern Nevada and seemingly localized to lowland valleys and the shores of now-dessicated lakes, and none have been found associated with megafauna. Finds from across the Great Basin and Mojave Desert are similarly sporadic and from inadequately dated contexts (Beck and Jones 2009).

Such a distribution has led some to suggest it is indicative of relatively small-scale, logistical forays of Clovis hunters following game routes throughout the region (Jones and Edward 1994; Warren and Crabtree 1986). During the terminal Pleistocene when Clovis technology was in vogue, the climate was cooler and wetter and inland lakes dotted the Mojave and Great Basin Deserts. In light of these aquatic resource bases, reliance of big-game hunting may have been less essential to the subsistence base, and lifestyles may have reflected this (Heizer and Baumhoff 1970).

Early Archaic Period (11,000–7500 BP)

The Early Archaic period corresponds with the onset of the Holocene. This transition witnessed a broad shift in the archaeological record of North America that is generally understood as a diversification and generalization over the prior epoch in which it is presumed that most people specialized in big-game hunting. The technological innovations associated with this era are classified as the Lake Mojave Complex in the Mojave Desert (Campbell et al. 1937), the San Dieguito Complex in southern California and the western Sonoran Desert (Rogers 1929, 1939, 1966), and the Sulphur Springs Stage in the Chihuahuan Desert (Sayles and Antevs 1941; Waters 1998).

While the temporal relationship between fluted and stemmed projectile points in the Mojave Desert and Great Basin remains unresolved, archaeologists generally regard the stemmed varieties as indicative of the Early Archaic period. Most stemmed points from dated contexts are in fact younger than 10,000 BP (Roth 2012:91), but they have been recovered from contexts independently dated to the Paleoindian period (Erlandson et al. 2011) and may actually pre-date Clovis material in some settings (Beck and Jones 2010; cf. Goebel and Keene 2014). Stemmed points are most often recovered from the shores of paleolakes and other extant wetland settings (Campbell et al. 1937), suggesting they were part of an Early Archaic lifeway focused on marshes and lacustrine settings (Bedwell 1973; Hester 1973). Varieties of these distinctive points found in and around the study area include Lake Mojave and Silver Lake points (Amsden 1937).

The inception of technologies for the intensive processing of plant foods (i.e., ground stone) is often associated with Archaic lifeways in North America, but very little is known about Early Archaic plant use in and around the study area (Sutton 1996:230). The *absence* of milling stones was once a diagnostic attribute of the Early Archaic period in the Mojave Desert (Campbell et al. 1937), although a few examples have since been found (Sutton 1996:230). The discrepancy may be one of location and resource base more than technological innovation.

The Early Archaic period in the Mojave Desert and Great Basin is best known from lakeshore settings where the intensive processing of seeds and, by proxy, the manufacture and use of milling stones, may not have been needed. The Early Archaic utilization of upland settings and otherwise non-lacustrine environments, where aquatic resources were unavailable but seeds, tree nuts, fruits, and such were plentiful, is lesser known. As Sutton (1996:229) notes, there may be a sample bias of Early Archaic sites, because archaeologists have tended to focus attention on paleolakes at the expense of other settings. Under such a scenario, current understanding of the representation of milling stones in the Early Archaic archaeological record may also be biased.

As Roth (2012:91–93) has summarized, Early Archaic period manifestations are more numerous and widespread in southern Nevada than Paleoindian material, although representation from in and around the study area is poor. Importantly, two Silver Lake points have been reported from one of the previously documented historic properties in the study area (Chapter 6, this volume). These mark the earliest known archaeological material in the study area and one of the earliest archaeological sites in the surrounding landscape.

ARCHAIC ERA (7500–1500 BP)

The Archaic era in southern Nevada spans nearly six millennia and is therefore conventionally differentiated into a number of shorter periods that can generally be subsumed within more broadly defined Middle and Late Archaic periods (Roth 2012). Following conventional terminology for the Mojave Desert, which probably most accurately represents the study area during the Archaic period, the Middle Archaic period is roughly synonymous with the Pinto Complex (Rogers 1939) and the Late Archaic period with the Amargosa-Gypsum Complex (Rogers 1939, 1966).

Middle Archaic Period (7500–4000 BP)

The Middle Archaic period coincides with the complete drying of the Pleistocene lakes dotting the Mojave Desert and Great Basin and marked aridificaton of the Middle Holocene. The major type sites for this period are Pinto Basin (Campbell and Campbell 1935) and the Stahl site (Harrington 1957), both of which contained rich and diverse artifact assemblages of flaked and ground stone implements. This period was once conceptualized as being so arid that populations could not be sustained outside of riverine settings in the Desert West (Antevs 1955). Subsequent research has shown that there was not a complete depopulation of inland deserts, but conditions were so extreme that population levels likely decreased and settlement and mobility patterns shifted so much that there is little evidence of activity away from reliable waters sources such as rivers, streams, and springs (Warren 1984; Warren and Crabtree 1986).

Subsistence pursuits were still invested heavily in hunting, but the regular though spotty occurrence of ground stone indicates plants were a major part of the diet as well. The presence of ground stone was one

of the early distinguishing factors between Pinto (Middle Archaic period) sites and earlier Lake Mojave (Early Archaic period) sites (Campbell and Campbell 1935; Campbell et al. 1937). The diversity of subsistence technologies associated with the Middle Archaic supports inferences that populations engaged in a pattern of general foraging within a broad spectrum economy (Basgall 2000).

When found, Middle Archaic period sites in southern Nevada tend to occur in higher elevation settings or places with reliable water (Roth 2012:96). Pinto projectile points, the most diagnostic artifact of the Middle Archaic, have yet to be reported from the study area. Whether this is emblematic of the broader Middle Archaic shift of landscape use brought about by Middle Holocene aridification, a relic of sampling bias inherent to cultural resources management (Chapter 5, this volume), or an inadequate amount of survey and inventory within the study area has yet to be determined. It is worth noting, however, that a spring in the McCullough Range (Quade et al. 1998) within the study area seemingly ceased during this period (see Chapter 2). If this is a general representation of spring activity throughout the study area, which is likely, it is reasonable to conclude that the study area was seemingly void of any hospitable places during this time and a lack of Middle Archaic period material is a fair proxy of the low intensity of a human presence in the region at that time.

Late Archaic Period (4000–1500 BP)

A sharp increase in the number and/or visibility of archaeological sites in a greater diversity of settings across the landscape over earlier periods characterizes the Late Archaic period in southern Nevada. This change in site density seemingly reflects an elevated population density that coincided with a period of generally cooler and possibly wetter conditions, which has been termed the Neoglacial (see Chapter 2). Subsurface residential architecture became a feature of the domestic landscape, and the prevalence of ground stone continued to increase over earlier times (Warren and Crabtree 1986). This period also marks the advent of mortar and pestle technology and a greater use of valley floors, which likely signals the addition of processed mesquite pods to the diet (Roth 2012:99). Faunal assemblages from Late Archaic sites also register a greater presence of artiodactyl remains, indicating there was in increased reliance on big-game hunting over the Middle Archaic. Whether this was due to an increase in game populations coincident with the favorable climatic and environmental conditions (Broughton and Bayham 2003; Byers and Broughton 2004) or to a shift in the social value of hunting and/or artiodactyl remains (Hildebrandt and McGuire 2002; McGuire and Hildebrandt 2005) has not yet been answered.

The wide distribution of an increasingly diversified range of Late Archaic period sites indicates communities remained highly mobile but involved in a more complex pattern of subsistence and settlement pursuits. Some have suggested the change reflects a shift in logistical mobility, with people residing longer in base camps centered on productive resource patches with smaller groups targeting specific resources in more distant settings (Byrd et al. 2009; Hildebrandt and McGuire 2002; McGuire and Hildebrandt 2005). The diagnostic artifacts of the Late Archaic are Elko, Gypsum, and Humboldt style projectile points (Jennings 1986:Figure 3; Warren and Crabtree 1986:184–189).

Accompanying a broad change in subsistence and settlement patterns during the Late Archaic period was an apparent florescence in ritualism. Strong evidence for this comes from caves and rockshelters, where a range of esoterica and sacral objects has been exhumed from Late Archaic contexts. Firebrand Cave in southern Nevada contained wooden implements described as "prayer" and "spirit" sticks, red-painted cordage, torches, and animal carcasses seemingly left as offerings (Blair and Winslow 2006). Gypsum Cave, just east of Las Vegas, contained decorated atlatl dart fragments, bundled feathers, a rattle, a "gaming" stick, and wooden flutes (Gilreath 2009). From Newberry Cave, in the Newberry

Mountains near Barstow, California, Davis and Smith (1981) excavated 394 pieces of figurines, 11 split-twig figures, bundled features, crystals, and a piece of sinew-wrapped bighorn sheep excrement. Finally, in Pintwater Cave near Indian Springs, Nevada, staff from the Nevada State Museum found painted Late Archaic atlatl darts (Buck and DuBarton 1994).

Petroglyphs and pictographs provide additional evidence for Late Archaic period ritual innovation or intensification. In particular, the incorporation of figurative motifs, especially representational anthropomorphic and artiodactyl imagery at that time (Berg et al. 2013:165–166), has been widely regarded as some sort of change in the religious and ritual relationship between humans and bighorns. Early interpretations regarded this as evidence for hunting magic to assist in big-game hunting pursuits (Heizer and Baumhoff 1962).

Whitley (1992, 1994a, 1994b, 1998, 2000) popularized the view that petroglyph and pictograph sites in the Mojave Desert and Great Basin were loci of vision quests, and the visual portrayal of hunting bighorn sheep were visual metaphors of shamanic trance. Most recently, Garfinkel (2006, 2007; also Garfinkel and Austin 2011; Yohe and Garfinkel 2012) has argued the imagery is evidence for the rise of a bighorn sheep cult, at least in the Coso Range of the western Mojave Desert. Although interpretations on the substance of Late Archaic bighorn ceremonialism vary, ritual deposition of painted hunting implements and bighorn effigies (Coulam and Schroedl 2004) in caves, bighorn shrines, and elaborate and interactive bighorn scenes in petroglyph iconography indicate the increased hunting and consumption of artiodactyls in the Late Archaic was not simply reflective of a change in diet.

The only Late Archaic period projectile points reported from the study area to date are a Humboldt Concave projectile point from the southern edge of the McCullough Range (Young 1990:23–26) and an Elko Eared from Hiko Springs (Beekman n.d.). The Humboldt Concave point, however, was found at a site described as an otherwise Patayan site—designated by the ceramics found there. The presence of a Late Archaic projectile point at this otherwise Formative period site was not explained, but it could be evidence for a multicomponent site or reuse of an Archaic tool by subsequent people. Three other projectile points from that site were left untyped by the field recorders, but they compare favorably to general atlatl points and thus indicate the site probably contains a Late Archaic component. Regarding the basal fragment of an Elko Eared point at Hiko Springs, its presence comports with the Great Basin Abstract style petroglyphs at that location (see Chapter 6) and attests to the great time depth of human connection to those springs.

The final centuries of the Late Archaic period, from roughly 2200 to 1500 BP, was a time of transition as communities in certain locations began farming, or at least encouraging cultivars and incorporating them into existing dietary programs and subsistence systems. This turn toward some degree of agriculture heralded a major change in settlement and subsistence practices, with people investing more heavily in residential architecture as they became increasingly tied to irrigable land (Roberts and Ahlstrom 2016; Sutton 2016).

The continued use of Elko and Humboldt points (and to a lesser extent Gypsum points) indicates atlatl-assisted big-game hunting persisted as a major economic, and possibly religious pursuit during this transitional phase. Along the Muddy and Virgin Rivers, northeast of the study area, these early farming manifestations are referred to as "Basketmaker" (Shutler 1961), and thus tie into Ancestral Pueblo cultural development—although biological data suggest the cultural practices were new to the region and not necessarily the people practicing them (Harry and Watson 2018).

While terminal Archaic sites have not yet been reported from within the study area, they have been identified to the west, north, and northeast (Roth 2012:110). Their lack of representation within the study area may be due to a dearth of excavation work in the region. Because the projectile point technology of the terminal Archaic was identical to that of the Late Archaic more broadly, differentiating terminal Archaic sites requires information from other lines of evidence such as radiocarbon assays. The best expression of terminal Archaic occupation in southern Nevada comes from the Las Vegas Valley where there is conclusive evidence of maize, and, by proxy, some degree of farming, by about 2100 BP (Ahlstrom 2008, 2019; Roberts and Ahlstrom 2016).

Whether the spread of maize farming followed a course from southern Arizona up the Colorado River and into the Las Vegas Valley, or if it moved west from the Colorado Plateau remains in question (Harry and Watson 2018:130–133). Pre-ceramic sites along the Colorado River are sorely underreported, so addressing the timing and direction of the adoption of agricultural practices into and around the study area remains difficult. Excavations at Willow Beach along the Colorado River (and presently inundated by Lake Mead) northeast of the study area exposed probable terminal Archaic material, but the site was interpreted as evidence of a frequently used campsite (Schroeder 1961). Given the water demands, it is unlikely that maize farming was conducted within the study area during the terminal Archaic due to the lack of reliable water sources in the region beyond the few springs in upland settings (see Chapter 2).

FORMATIVE ERA (1500–500 BP)

The Formative denotes the era when agriculture was firmly established along the Colorado River and its tributaries. From this commitment to an agrarian lifestyle followed the development of stable villages along those tributaries and innovations in technology, such as ceramic economies and the adoption of the bow and arrow. Communities in places outside the river valleys were less committed to agriculture and, consequently, were less residentially stable. This variable investment in sedentism and agriculture, especially between river-side and desert dwellers, underscored markedly different lifeways that is well reflected in the archaeological record. Thus, it was during the Formative era when regionally distinct technological traditions, settlement patterns, and subsistence practices were formalized within what was a more materially homogenous Archaic.

As Ahlstrom and Roberts (2012:145) observe, few Formative era archaeological sites in and adjacent to the study area have been intensively studied. Regardless, a general overview can be gleaned from the available information. Bridging riverine and desert environments, the study area lies at the interface between multiple Formative era cultural traditions archaeologists have defined from the various regions surrounding it. These include the Virgin Branch of the Ancestral Pueblo (i.e., Basketmaker and Pueblo) tradition centered on the Moapa Valley to the northeast (Baldwin 1950a; Colton 1939; Shutler 1961), the Yuman, or Patayan, tradition of the Colorado River Valley and the adjacent Arizona Uplands (Baldwin 1950a; Rogers 1945; Schroeder 1952), and the Shoshonean cultural pattern in the interior deserts to the northwest, west, and southwest (Crabtree et al. 1979; Wallace 1962; Warren and Crabtree 1986; Warren et al. 1980).

Each of these traditions is relevant in understanding the history and cultural resources of the study area, yet none alone can fully represent the cultural diversity associated with it. Consequently, this study assumes a general chronology of Early and Late Formative periods, with the divide conforming to major transitions within each of the defined traditions.

Early Formative Period (1500–800 BP)

The Early Formative period approximates Warren's (1984; also Warren and Crabtree 1986) Saratoga Springs period of the southwestern Great Basin, Fowler and Madsen's (1986) Horticultural period of the southeastern Great Basin, Sutton's (1996) Rose Spring period for the Mojave Desert, Shutler's (1961) Basketmaker III through Pueblo II periods in the Moapa Valley, Ahlstrom and Roberts' (2012) Puebloan period in southern Nevada, Wallace's (1962) Amargosa Phase II of the southern California deserts, Rogers' (1945) Yuman/Patayan I period of the lower Colorado River and Colorado Desert regions, and Schroeder's (1961) Roaring Rapids and early Willow Beach phases from Cottonwood Valley.

Aspects of each of these regional culture historical frameworks is pertinent to the study area, but the most salient are those that transcend the regional classifications. The most germane of these is the widespread adoption of bow-and-arrow technology (Yohe 1998), as evidenced by the dominance of Eastgate and Rose Spring projectile points in the Mojave Desert and southern Great Basin. This transition occurred in both the deserts and along the river corridor. Another significant change seen across regions during the Early Formative period was a general population increase accompanied by long-term and in-place aggregation. This is evidenced by architecture and well-developed refuse concentrations with abundant and diverse artifact assemblages along the rivers (Baldwin 1950a; Schroeder 1952; Shutler 1961), as well as in the interior of the Mojave Desert (Sutton 1996:235; cf. Sutton 2017).

The major distinguishing factor between people living in the interior of the Mojave Desert and the Great Basin and those living along rivers during the Early Formative period was their commitment to an agricultural lifestyle and the corollary production and consumption of ceramic vessels. These subsistence and economic activities do not appear to have been practiced by communities in the interior of the Mojave Desert (although some investment in farming, in the absence of ceramics, in the Mojave Sink has long been in question [Rogers 1929:8]). Instead, the subsistence base of people living in the interior of the Mojave Desert and the southern Great Basin shows continuity with the Late Archaic period.

In contrast, communities tethered to reliable streams, such as the Colorado River and its major tributaries such as Las Vegas Wash and the Muddy and Virgin Rivers were fully engaged in agricultural pursuits and had developed culturally distinct ceramic technologies. These include Moapa Gray and White, Shivwits, and Shinarump Red Wares associated with the Virgin Branch of the Ancestral Pueblo tradition of the Moapa Valley (Allison 2008; Colton 1952; Lyneis 2008) and Lower Colorado Buff Ware associated with the Patayan tradition along the lower Colorado River (Schroeder 1952, 1958; Waters 1982; Wright 2021). The archaeological signature of each of these traditions within the study area are considered here.

Signatures of Virgin Branch Ancestral Puebloans and their Basketmaker ancestors, who seem to have been a local population who assumed some practices and traditions from neighboring groups of the Colorado Plateau to the east, persisted in the archaeological record until about AD 1250 (Harry and Watson 2018). Their settlements were concentrated along the Virgin and Muddy Rivers in the Moapa Valley, but their influence and possible presence extend west through the Las Vegas Valley (Ahlstrom and Roberts 2012). Baldwin (1943, 1948) reported Virgin Branch Ancestral Pueblo pottery from sites in Cottonwood Valley along the lower Colorado River, south of the Moapa Valley and just northeast of the study area, although those sites were only superficially studied prior to being flooded by Lake Mohave. The two best studied sites in Cottonwood Valley, Catclaw Cave (Wright 1954) and Willow Beach (Schroeder 1961), contained such pottery but neither was interpreted as a Virgin Branch Ancestral Puebloan residential site.

Evidence of a Virgin Branch Ancestral Puebloan presence within the study area is scant. At Hiko Springs, in 1930, Rogers (n.d.) of the San Diego Museum of Man collected sherds of "intrusive" Deadman's Fugitive Red Ware and Moapa Gray Ware. Rogers (n.d.) suggested the material was associated with passers-through who camped at the springs while traveling through the south end of the Newberry Mountains en route to the southern Piute Valley. If the pottery was brought from travelling Ancestral Puebloans, some of the petroglyphs at Hiko Springs may be attributable to them as well.

Beyond Hiko Springs, the only suggestion of an Ancestral Puebloan presence within the study area is at the Crescent Turquoise Mines. Rogers (n.d.) insinuated the mines had been worked by itinerant Ancestral Puebloans, but he did not report any Puebloan pottery from the mines. Instead, he found intrusive sherds of San Francisco Gray Ware, along with Lower Colorado Buff Ware and Prescott Gray Ware, in a nearby rockshelter. The San Francisco Gray Ware is of Puebloan manufacture, though not from the Moapa Valley.

Rogers' (n.d.) suggestion that Ancestral Puebloans mined the turquoise near Crescent is based on his findings of Ancestral Puebloan pottery at turquoise mines and camp sites throughout the Mojave Sink, southwest of the study area (Rogers 1929; see also Heizer and Treganza 1944; Nelson and Drover 1980). From that pattern, Rogers (1929:12) contended there was an "extensive turquoise mining industry" associated with a "scattered but permanent Puebloan population" in the Mojave Sink. Any further evidence of a residential Ancestral Puebloan population in the Mojave Sink region beyond the pottery has yet to be found, however (Loren-Webb 2003). Thus, it would seem that Ancestral Puebloan activity in the study area was targeted and specific to the turquoise at Crescent or to passing through the region to reach places farther west, including the turquoise mines in the Mojave Sink or possibly even the Pacific Coast.

The Patayan tradition is generally considered an ancestral Yuman material culture manifestation historically connected to contemporary Yuman tribes. Regarding the Patayan tradition in and around the study area, its archaeological signature is almost entirely aligned with the presence of Lower Colorado Buff Ware. Earthen ground figures—variably termed as intaglios, geoglyphs, gravel pictographs, etc.—are another hallmark of the Patayan tradition (Harner 1953; Johnson 1986; Von Werlhof 1987). These have been reported from peripheral regions north, west, and east of the study area (Rafferty 1990, 1991, 2008, 2012), but, to date, none have been found within it.

Lower Colorado Buff Ware has been reported from multiple archaeological sites within the study area, including rockshelters and open-air artifact scatters (see Chapter 6). Lower Colorado Buff Ware was being made by at least the eighth century AD, as determined by its occasional association with better-dated Hohokam ceramics of the Gila Butte phase (Harner 1958; Rogers 1945). Lower Colorado Buff Ware suffers from poor chronological control, and attempts to use it to date archaeological sites is suspect (Wright 2021). Therefore, it is not currently feasible to differentiate Lower Colorado Buff Ware-bearing sites within the study area as dating to either the Early or Late Formative period without additional lines of evidence (Ahlstrom and Roberts 2012:147). Nevertheless, as summarized by Ahlstrom and Roberts (2012:147–149) there is good reason to think the Patayan tradition was in place along the lower Colorado River and in the Las Vegas Valley during the Early Formative period, but how early remains in question.

In addition to Lower Colorado Buff Ware and earthen ground figures, a set of petroglyph motifs distinctive to the eastern Mojave Desert, and found within the study area, are also associated with a local expression of the Patayan tradition. These motifs have been intensively studied by Christensen and

Dickey (2001), who refer to them as the Grapevine Canyon style due to their proliferation at an early reported site in a canyon of the same name at the foot of the Newberry Mountains just outside the study area. Petroglyphs consistent with the Grapevine Canyon style, and most likely Patayan in origin, are present at various places within the study area, including Hiko Springs, Granite Tanks, and Lewis Holes (see Chapter 6). However, as with Patayan ceramics, determining if Patayan petroglyphs date to the Early or Late Formative period based solely on stylistic grounds is presently not possible (Quinlan 2012:223–232).

Late Formative Period (800–500 BP)

The Late Formative period corresponds closely to Warren and Crabtree's (1986) and Fowler and Madsen's (1986) Shoshonean period of the southern Great Basin, Sutton's (1996) Late Prehistoric period for the Mojave Desert, the early portion of Roberts' (2012a) Post-Puebloan period in southern Nevada, Wallace's (1962) Prehistoric Shoshonean and Yuman period of southern California deserts, and Rogers' (1945) Yuman/Patayan II period of the lower Colorado River and Colorado Desert regions. In and around the study area, the Late Formative is generally regarded as the period in which the contours of the cultural landscape witnessed and described first-hand by Europeans several centuries later had taken form (Sutton 1996:238). Marked transitions within the Patayan tradition are difficult to discern. Whether that is because there was strong continuity with the Early Formative or due to a general lack of data is unknown. Although details are sparse, there is little doubt that Patayan communities along the lower Colorado during the Late Formative were directly ancestral to the Yuma Tribes met by Spaniards beginning in the first half of the sixteenth century AD.

While the Patayan tradition appears little changed with the onset of the Late Formative period, the archaeological landscape in the interior deserts and the Moapa Valley underwent profound alterations. The Ancestral Pueblo population in the Moapa Valley peaked in the final decades of the Early Formative and was in decline during the first decades of the Late Formative, such that they were no longer archaeological visible by the fourteenth century AD (Larson 1996; Larson and Michaelsen 1990; Lyneis 1995). This depopulation by Virgin Branch Ancestral Puebloans coincided with an apparent expansion of the Shoshonean, or Numic languages, and a related material culture from the southwestern reach of the Mojave Desert outward and across much of the Great Basin, Mojave Desert, and into surrounding regions.

This seemingly new cultural expression, which is widely regarded as a proxy for ancestors of the Nuwuvi (Warren and Crabtree 1986:192), is evidenced by the appearance of distinctive projectile point forms, including Desert Side-notched and Cottonwood Triangular types, as well as inadequately understood and difficult to distinguish brown ware ceramics, including Owens Valley Brown Ware (Riddell 1951), Great Basin Brown Ware (Bettinger 1986), Death Valley Brown Ware (Eerkens et al. 2002), Intermountain Brown Ware (Pippin 1986), Southern Paiute Utility Ware (Baldwin 1950b), and Shoshoni Ware (Rudy 1953). Whether any such expansion, or spread, actually occurred remains a matter of academic debate, however, with some archaeologists, linguists, and ethnographers arguing that the ancestral Nuwuvi have been living in the Great Basin and across the western Colorado Plateau for several millennia (e.g., Shaul 1986; Stoffle et al. 1990; Torgler 1995; Whitley 1994b, 1994c).

First proposed by Lamb (1958) on linguistic grounds, this supposed Numic Expansion, as it is commonly known, began around 1000 AD (Madsen 1975). There is considerable debate, still unresolved, about when it reached the landscape in and around the study area and its role, if any, in the Ancestral

Puebloan depopulation of the Moapa Valley (Madsen and Rhode 1994). As summarized by Roberts (2012a), the debate centers largely on whether: (a) the Numic Expansion was effectively a model of replacement, in which migrating Numic-speakers seemingly outcompeted residential populations (e.g., Ambler and Sutton 1989; Bettinger 1994; Bettinger and Baumhoff 1982; Young and Bettinger 1992); (b) one of assimilation in which residential populations adopted an otherwise Numic lifestyle (e.g., Gunnerson 1962); or (c) one of cohabitation and mutualism among newly arrived Numic speakers and residential populations through which a new cultural pattern developed over time (Aikens 1994; Aikens and Witherspoon 1986; Lyneis 1994).

As part of this debate, it is critical to note that any such Numic Expansion effectively models the spread of language and material culture, not necessarily people. The Nuwuvi assert that they have been within their aboriginal territory since the time of their Creation (Inter-Tribal Council of Nevada 1976; Knack 2002).

Untyped brown ware ceramics have been reported from the study area, both alone and associated with gray wares that are probably associated with the Patayan tradition (see Chapter 6). As Sutton (1996:239–240) remarked, the archaeology of the Late Formative period in the eastern Mojave Desert is inadequately understood due, in large part, to the lack of a specific research program. The brown wares in the study area probably signal an ancestral Nuwuvi presence, but it is presently impossible to determine if the pottery is Late Formative in origin or if it dates to the subsequent Ethnohistoric era. Comingling with Patayan ceramics complicates interpretations.

ETHNOHISTORIC ERA, (500–100 BP)

The Ethnohistoric era begins with the written accounts by early Spanish colonial agents of the region and its inhabitants. A timeline of significant events related to the study area during this most recent historical epoch is presented in Table 4.2.

Spanish Provincial Period (500–200 BP)

The first to reach the vicinity of the study area (and for which there is a documentary record) was Juan de Oñate, then governor of the Spanish colonial province of Nuevo México, who descended the Bill Williams River in 1604 on a quest to find a coastal port to supply the inland territory (Bolton 1919; Zárate Salmerón 1916 [1626]). At the confluence of the Bill Williams River with the Colorado River, they were met by Aha Macav from valleys immediately north and south. Friar Francisco de Escobar, who accompanied Oñate, described the Aha Macav, whom he called Amacava, as "very friendly" and said they were greeted with "maize, frijoles, and calabashes" (Bolton 1919:10). Escobar's account is the first written description of the Aha Macav. From the confluence, Oñate's party turned south toward the Colorado River's delta.

The first Spanish colonial agent to describe the general study area was Francisco Hermenegildo Tomás Garcés, a Spanish Franciscan priest of considerable renown in the history of Spanish colonialism and Catholic missionization in present-day southern California, Arizona, Sonora, and Baja California. Following the expulsion of the Jesuits from Pimería Alta in 1767, Garcés was one of 14 Franciscan missionaries from the College of Santa Cruz de Querétaro, in the present-day state of the same name in Mexico, to take their places.

Table 4.2. Timeline of events of historic significance relevant to the study area.

Spanish Provincial	1521	Study area encompassed by the Viceroyalty of New Spain
	1604	Juan de Oñate meets the Aha Macav at the mouth of the Bill Williams River
	1767	Study area becomes part of the Province of Las Californias within the Viceroyalty of New Spain
	1776	Francisco Garcés visits Aha Macav villages and travels the Mojave Trail to Pacific Coast and back
	1804	Study area becomes part of the Province of Alta California within the Viceroyalty of New Spain
Mexican Territorial	1821	Study area becomes part of Alta California territory of Mexico
	1826	Aha Macav meet the trapping party of James Ohio Pattie
	1826	Aha Macav meet the trapping part of Jedediah Smith; Smith follows Mojave Trail to the Pacific
	1827	Jedediah Smith returns to Aha Macav villages and flees west on the Mojave Trail
	1829	Ewing Young's trapping party passes by Aha Macav villages while traveling the Mojave Trail
	1846	Outbreak of the Mexican-American War
	1848	Study area becomes part of U.S. Territory of New Mexico following the Treaty of Guadalupe
U.S. Territorial	1851	Lorenzo Sitgreaves visits Aha Macav villages on river survey from Zuni to Fort Yuma
	1852	Study area becomes part of Valencia and Santa Ana Counties of New Mexico Territory
	1852	Aha Macav rescue Olive and Mary Oatman from the Yavapai
	1853	Amiel Weeks Whipple visits Aha Macav villages on 35th parallel railroad survey
	1855	Severe famine besets the Aha Macav and results in many casualties, including Mary Oatman
	1856	Olive Oatman coerced to leave the Aha Macav and returned to Fort Yuma
	1857	Edward Beale visits Aha Macav villages on 35th parallel wagon road survey
	1857	Joseph Ives visits Aha Macav villages on survey of the Colorado River
	1858	Battle of Beale's Crossing between the Aha Macav and Rose party
	1859	Battle of Beaver Lake between Aha Macav and the 6th Cavalry
	1859	Establishment of Camp Colorado/Fort Mojave
	1859	Aha Macav leader Ireteba establishes colony in Parker Valley
	1859	Discovery of gold at Eldorado Canyon
	1860	Completion of Beale's Wagon Road
	1861	Fort Mojave abandoned following outbreak of the Civil War
	1861	Eldorado Canyon gold rush
	1863	Study area becomes part of the U.S. Territory of Arizona
	1863	Fort Mojave regarrisoned
	1864	Study area becomes part of Mohave County, Arizona Territory
	1865	Establishment of Colorado River Indian Reservation
	1865	Study area becomes part of Pah-Ute County, Arizona Territory
Early Statehood	1867	Study area transferred to the State of Nevada, Lincoln County
	1867	Some Chemehuevi move from the Colorado River to Twenty-Nine Palms
	1873	Establishment of the Moapa Indian Reservation
	1876	Establishment of Agua Caliente, Cabezon, Morongo, and Torres Martinez Reservations
	1883	Southern Pacific Railroad between Barstow and Needles completed
	1890	Fort Mojave decommissioned
	1890	Establishment of Fort Mojave Indian Reservation
	1891	Establishment of Shivwits Reservation
	1894	Discovery of turquoise at Crescent
	1894	Establishment of Rock Springs Land and Cattle Company

Table 4.2. Continued.

Early Statehood	1895	Establishment of Twenty-Nine Palms Reservation
	1897	Discovery of gold near Searchlight
	1902	Quartette Mining Company Railroad to Searchlight completed
	1906	Quartette Mining Company Railroad no longer in operation
	1907	Establishment of Chemehuevi Valley Reservation
	1907	Establishment of Paiute Strip Reservation
	1907	Barnwell to Searchlight Railroad completed
	1909	Establishment of Clark County
	1909	Passage of the Enlarged Homestead Act
	1911	Establishment of Las Vegas Indian Colony (reservation)
	1913	Establishment of Kaibab Paiute Reservation
	1915	Establishment of Indian Peaks Reservation
	1922	Paiute Strip Reservation revoked
	1923	Barnwell to Searchlight Railroad damaged and abandoned
	1928	Establishment of Koosharem Reservation
	1929	Establishment of Kanosh Reservation
	1931	Rex Bell and Clara Bow purchase the Walking Box Ranch
	1934	Passage of the Taylor Grazing Act
	1935	Chemehuevi Valley Reservation revoked
	1936	Boulder Dam completed
	1939	Harry Reid born at Searchlight
	1942–1944	World War II Desert Training Center operations in study area
	1953	Davis Dam completed
	1954	Kanosh, Koosharem, Indian Peaks, and Shivwitz Reservations revoked
	1964	Operation Desert Strike in the study area
	1971	Establishment of Chemehuevi Indian Reservation
	1980	Passage of Paiute Indian Tribe of Utah Restoration Act
	1983	Establishment of Snow Mountain Reservation (for Las Vegas Paiute Tribe)
	1984	Establishment of Paiute Indian Tribe of Utah Reservation
	1999	Spirit Mountain Traditional Cultural Place listed on the National Register of Historic Places
	2009	Walking Box Ranch listed on the National Register of Historic Places
	2022	Avi Kwa Ame National Monument Establishment Act (H.R. 6751) introduced into Congress

Assigned to the mission of San Xavier del Bac, a short distance south of present-day Tucson, Arizona, Garcés' missionization agenda led him to some of the the farthest, least charted regions of New Spain. As was the situation with his Jesuit predecessors Eusebio Kino and Jacobo Sedelmayr, Garcés' duty to the Church was part missionization and part exploration and pathfinding. In many cases, his accounts are the first written records about the terrain, ecology, climate, and people of the interior of Alta California (Bolton 1917).

Francisco Garcés is perhaps best known to history for his role in the Anza Expedition of 1775/1776 that led to the founding of a mission and presidio near San Francisco Bay, a colonizing expedition memorialized by the Juan Bautista de Anza National Historic Trail. It was on that expedition when Garcés set out on his own to find a northern route from the Colorado River to Monterey/San Luis Obispo.

Garcés' hope was that, by finding such a route, a direct road from the missions around Monterey Bay along the Pacific Coast to Santa Fe could be established (Bolton 1930:445).

Garcés left the Anza party on February 14, 1776 with translators Sebastian, a Cochimí originally from the California Penninsula, and an unspecified Aha Macav (Bolton 1930:445) and reached the Aha Macav villages on February 29 (Coues 1900:213–233). Garcés and Sebastian left the Aha Macav villages in the Mohave Valley on March 4 with three Aha Macav guides, stopping first at a natural water source Garcés named Pozo de San Casimiro. They travelled a generally westward direction for six days along a set of Indigenous trails stretching between various springs, wells (*pozos*), and tinajas that took them through the southern reach of the Piute Valley (Bolton 1930:447; Coues 1900:235–236).

On the return Garcés was joined by guides Sebastian, Luis (Aha Macav), and Ventura (Aha Macav). They left on May 19 and followed a slightly different route than the previous one to reach the Aha Macav settlements on May 30 (Bolton 1930:490). Importantly, along this route Garcés described visiting three Chemebet (i.e., Chemehuevi) settlements in the interior desert between Pozos de San Juan de Dios (generally thought to be Marl Springs in the Mojave National Preserve) and the Colorado River (Coues 1900:305–308). From there, they returned to Pozo de Casimiro and then followed their tracks back to the Aha Macav villages.

Efforts to retrace Garcés' routes based on his journal entries can be met with mixed results. He regularly provided directional bearings and distances traveled in leagues, and his combination of those measurements with descriptions of the terrain makes reconstructing his travel routes possible. However, in certain landscapes where landforms are generally undifferentiated and where Garcés was short on words, the routes can be ambiguous. His round-trip trek across the Mojave Desert is one of those cases, as most of his stopping points were non-descript watering spots that can be matched to any number of springs and tinajas. That said, multiple scholars have attempted to trace his route (e.g., Bancroft 1884:275n28; Coues 1900; Bolton 1930; Van Dyke 1927; Weaver 1982; Wood 2000).

Garcés wrote that when they left the Aha Macav villages in the Mohave Valley, they traveled southwest for 2.5 leagues to reach Pozo de San Casimiro, and on the return, they entered the Aha Macav nation by traveling about 3 leagues east-southeast from the same water source (Coues 1900:235, 308). Based on this description, there is general agreement that Garcés' party traveled up Piute Wash from its confluence with the Colorado River to the southern end of the Dead Mountains before striking west on their voyage to the ocean (Coues 1900:235n4; Van Dyke 1927:355; Wood 2000:3). Wood (2000:3) places Pozo de San Casimiro at Sacramento Spring, situated at the confluence of Piute and Sacramento Washes near the southern end of the Dead Mountains. This route would have led Garcés close to but south of the study area.

Mexican Territorial Period (200–173 BP)

Following Garcés, the study area continued to be visited solely by passers-through, and their descriptions are more brief than their visits. In March 1826, a party of fur trappers, of whom James Ohio Pattie, George Yount (Camp 1923:7–9), and Ewing Young (Hill 1923a, 1923b:21) were parties, entered the Mohave Valley on an expedition up the Colorado River (Kroeber 1964). They fought with the Aha Macav (who Pattie called "Mohawa") before retreating upriver (Pattie 1831:93–96). Later that year, another party of trappers, led by Jedediah Strong Smith, descended the Colorado after traveling from the Great Salt Lake and through territory of the Pa-Ulches (i.e., Southern Paiute). Below them, on the

Seedskadee (i.e., Colorado River), Smith's party met the Ammuchabas (i.e., Aha Macav). From there, they headed west across the Mojave Desert to visit the San Gabriel Mission near Monterey Bay (Smith 1918[1827]). Smith and companions returned to the Aha Macav villages the following year, but this encounter was less congenial and led to conflict that resulted in multiple casualties. Smith and eight others fled west, closely following the route they had taken in 1826 (Smith 1977:89; Sullivan 1992:32).

The actual western routes Smith followed are not known, but the routes took them around, or possibly through, the Dead Mountains. If they rounded the mountains on the north, they would have entered the study area. If it was to the south, they were following Garcés' route of 50 years prior. Smith's route through the Mojave Desert, or something like it, was probably followed by fellow trapper Ewing Young and his companion, Kit Carson, in 1829 (Camp 1922:114; Cleland 1922:82; Hill 1923b:24). The Aha Macav were also visited in 1829 by Peter Ogden, of the Hudson Bay Company, who was tasked with exploring the viable trapping opportunities south of the Columbia River (Ogden 1853:11–20). As was the fate of Smith's party, of whom Ogden was acquainted, he too skirmished with the Aha Macav before fleeing down river.

Garcés' and Jedediah Smith's east-west travails across the Mojave Desert from the Aha Macav villages along the Colorado River followed a travel corridor that has since been popularly called the Mojave Trail. Details of their routes make clear that this was not a single trail, but rather, a network of Indigenous trails that connected the Aha Macav with the Pacific Coast via various paths that led to intervening places of importance, such as springs and villages in the interior of the Mojave Desert.

While Smith's exploits demonstrate the viability of such a route, some subsequent itinerant Mexican and American travelers over the following couple of decades opted for one of several variations that cut off the Colorado River. Those routes, popularized by the likes of Antonio Armijo (1829), William Wolfskill and George Yount (1830), and John Fremont and Kit Carson (1844), generally led southwest from the Las Vegas Valley and through the Pahrump Valley, thereby skirting the study area to the north and west (Myhrer et al. 1990). Fremont (1845) famously called this the "Spanish Trail," a designation now enshrined as the Old Spanish National Historic Trail (Bureau of Land Management and National Park Service [BLM and NPS] 2017).

U.S. Territorial Period (173–154 BP)

Following the annexation by the United States of much of the West in the wake of the Mexican-American War in 1848, the federal government invested heavily in exploring the new territory and developing transcontinental transportation infrastructure, such as wagon roads and railroads. The first such survey to touch upon the study area was that of Lorenzo Sitgreaves, a Brevet Captain with the Corps of Topographical Engineers, who was instructed in 1851 to explore the navigability of rivers between the Pueblo of Zuni in New Mexico Territory and the Gulf of California. Sitgreaves was joined on the survey by, among others, fellow Topographic Engineer Brevet Second Lieutenant John Parke and guide Antoine Leroux. From the Little Colorado River, the crew veered west and traveled overland, through the territory of the Yavapai, to reach the Colorado River in the Mohave Valley where they met several hundred Aha Macav eager to trade (Sitgreaves 1853:17–19). The surveyors camped for the night then turned south and followed the river to Fort Yuma.

In 1853, at the behest of then-Secretary of War Jefferson Davis, the Army commissioned Lieutenant Amiel Weeks Whipple to survey a possible route along the 35th parallel that would extend between

Fort Smith, Arkansas and Los Angeles, California. Whipple's team reached the Mohave Valley in February 1854, where they were met with great affair by the Aha Macav. Whipple enlisted the aid of Irataba and Cai-rook, two Aha Macav leaders, to lead them across the Mojave Desert from the Aha Macav villages. Upon ascending the west bank of the Colorado, Whipple (1856:19) described climbing the "mouth of a dry arroyo" and finding 10 miles away from the river "several small springs of good water." Whipple's description compares favorably with Garcés' route up what was likely the mouth Piute Wash to the Sacramento Spring at the southern end of the Dead Mountains.

Whipple's railroad survey of the 35th parallel was soon followed by a wagon road survey of the same latitude from Fort Defiance, New Mexico to the Colorado River by Edward Beale in 1857. Although Beale's survey terminated at the Aha Macav villages in the Mohave Valley along the Colorado River, he observed a "regularly travelled road" leading west from the river toward Los Angeles (Beale 1912 [1857]:214). Although the survey was complete, Beale followed that road, which he described as the "United States surveyor's trail," to Los Angeles (Beale 1858:76).

Unlike the Indigenous trails followed by Garcés and Whipple, the informal road, or "surveyor's trail," on the west bank of the Colorado River most certainly skirted the north side of the Dead Mountains, and in so doing passed through the study area. Ives' 1858 maps of the Colorado River, made less than a year after Beale's survey, show "Beales trail" passing around the north end of an unnamed range immediately south of "Dead Mountain," his name for Avi Kwa Ame (Ives 1861:Maps 1–2). Those maps also show "Whipple's trail, 1853-'54" passing around the south end of the same unnamed landform. The unnamed landform is the Dead Mountains, with Beale's trail ascending between that range and the Newberry Mountains—a corridor Ives (1861:74) called "Beale's Pass" (Figure 4.1). This is the pass through which Nevada State Route 163 runs today.

"Beale's Wagon Road" was completed in 1860. While it officially terminated at the Colorado River, a crossing of the river seamlessly linked it to the informal road through Beale's Pass that ultimately connected to the Mormon Road, or Old Spanish Trail, at Fork of the Road along the Mojave River (Figure 4.2). This new thoroughfare quickly became a major east-west artery across the Southwest. The influx of travelers into the Mohave Valley led to heightened tensions with the resident Aha Macav. Consequently, in 1859 the Sixth Infantry, led by Lieutenant Colonel William Hoffman, arrived to establish a military outpost adjacent to "Beale's Crossing," just north of the Aha Macav villages.

Camp Colorado, renamed Fort Mohave just nine days after its founding, was strategically placed along the north-south artery of the Colorado and was the principal east-west artery across the Mojave Desert. For the next 25 years, this "Mojave Road," as it came to be known (Casebier 1975), was a major supply route for Fort Mohave and Beale's Wagon Road, the mail route between California and Prescott, a major mining center and the first capital of the newly established Arizona Territory.

The Mojave Road enabled Euro-American exploration and settlement within the interior of the Mojave Desert, but at great and grave expense to the Nuwuvi bands who lived there. Small settlements and military posts sprang up along the road, and soon, roads began to fork off the main route and lead into previously unmolested regions. Near the center of the Lanfair Valley, a spur branching north off the Mojave Road quickly formed. The road cut across the Piute and Eldorado Valleys to reach Eldorado Canyon, at the north end of the Eldorado Mountains, northeast of Searchlight. Von Till Warren and Roske (1981:29) call this the "Eldorado Canyon Cut-Off." It was likely established shortly after the discovery of gold and silver in Eldorado Canyon in the late 1850s. Vredenburgh (1995:83) places it

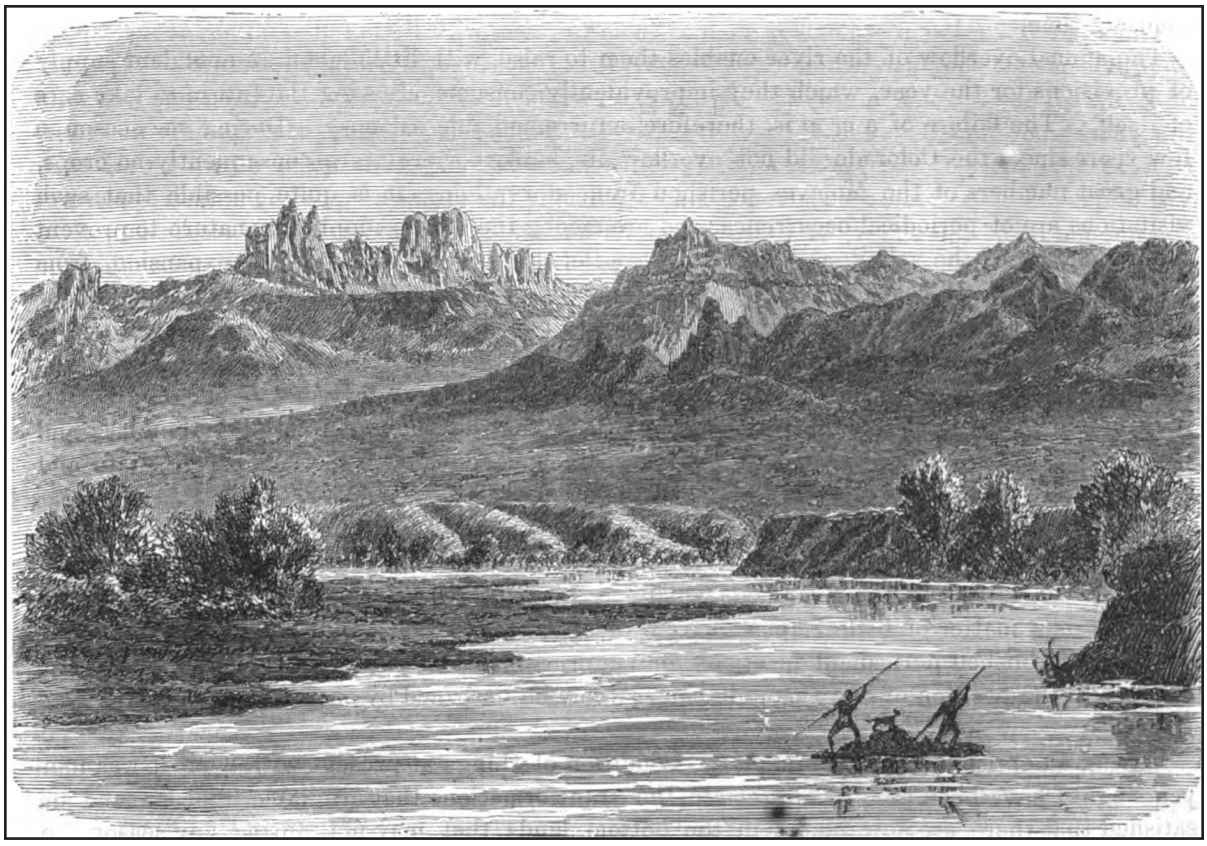


Figure 4.1. Wood cut of Beale's Pass in 1860, by J. J. Young (from Ives 1861:Figure 18).

as early as 1861. This road was followed in 1863 by Rudolph D'Heureuse, who was hired to scout the productivity of the newly formed Eldorado Mining District (Lapides 2018). The road is depicted on various maps beginning in the mid-1860s (e.g., Bancroft 1867; Holdredge 1866).

One of the major waypoints along the Eldorado Canyon Cut-Off was a set of springs at the north end of the Castle Mountains, called Lewis Holes (see Chapter 6). Both Lewis Holes and a long stretch of the Eldorado Canyon Cut-Off are within the study area. Von Till Warren and Roske (1981) describe the Mojave Road between Los Angeles and Needles and the Eldorado Canyon Cut-Off as sections of the South Fork of the Old Spanish Trail. The National Park Service (NPS) recognizes a "Mojave Route" of the Old Spanish Trail (Figure 4.2). This route includes the section of the Mojave Road between Fork of the Road and the center of the Piute Valley, where it turns north to connect with the Armijo Route in the Las Vegas Valley.

Importantly, this north-south route between the Las Vegas Valley and the Piute Valley is not based in any specific historical record and is unconfirmed on the ground (labeled "speculative" on Figure 4.2). The NPS lists it as a "tentative high potential segment" of the Old Spanish National Historic Trail (BLM and NPS 2017:Table 5), meaning additional research and information is needed to fully assess its relevance and significance. A recent survey for a proposed gas pipeline crossed the Congressionally designated alignment of this Mojave Route segment in four places around the town of Searchlight, but no evidence of a nineteenth century road or mule trail was identified despite deliberately searching for it (Arcadis 2020).

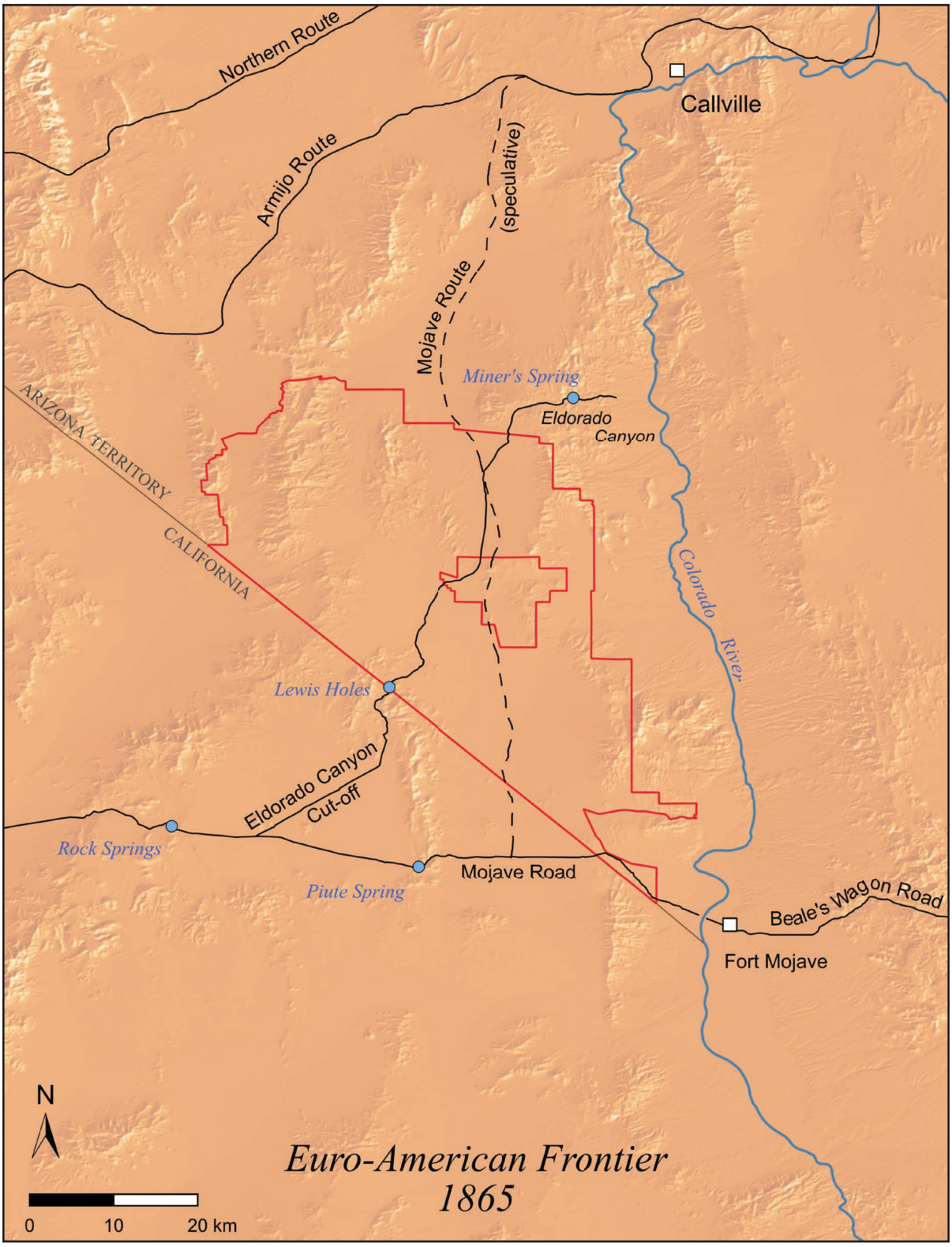


Figure 4.2. Euro-American roads and settlements as of 1865. The Northern, Armijo, and speculative Mojave Routes are recognized elements of the Old Spanish National Historic Trail.

Early Statehood Period (154–100 BP)

Completion of the section of Southern Pacific Railroad across the Mojave Desert and the founding of Needles, California—initially a railroad station—in 1883 heralded the beginning of the end for the Mojave Road as a major conduit. Nevertheless, it and its many spurs continued to be used in the following decades by miners and ranchers who came to settle in and around the study area. One such settlement was Searchlight, near where gold and silver were discovered in 1897 (Tingley 1998). The Searchlight Mining District was established in 1898, and mining activity began in earnest in 1902, following the Quartette Mining Company's erection of a 20-stamp mill on the Colorado River (Ransome 1907:64; Vanderburg 1937:68). Searchlight quickly became a boom town, with peak population between 1906 and 1908 that rivaled Las Vegas as southern Nevada's population center and potentially gained the seat of Lincoln County. However, the ore lodes were largely exhausted by 1916, and population soon dwindled.

While Searchlight is an inholding within the proposed Avi Kwa Ame National Monument, numerous old mines and related infrastructure associated with the Searchlight Mining District are located within the study area. These include several mines in the Newberry Mountains, Chiquita Hills, and Ireteba Peaks that are sometimes attributed to a Newberry Mining District (Longwell et al. 1965:141–142). Prior to construction of the Barnwell to Searchlight Railroad in 1907, Searchlight's access to the railroad was provided by two stage lines that ran to either Nipton or Manvel (i.e., Barnwell), each about 25 miles long (Ransome 1907:63).

Crescent, a small mining community near the divide between the McCullough Range and the New York Mountains, formed in the early years of the twentieth century but soon died out. Ransome (1907:79) described it as "consisting of a dozen or more tents and wooden buildings." Turquoise had been found there in 1894, with peak mining activity ending around 1906 (Vanderburg 1937:19). The Crescent turquoise mines were part of the larger Crescent Mining District, most of which focused on metallic ores rather than turquoise. The Crescent Mining District covered the southern McCullough Range and the northern end of the New York Mountains.

Beginning around 1905, coincident with the peak in turquoise mining at Crescent, the mining of gold, silver, copper, and lead began to boom across the district. Peak years of metal extraction around Crescent were 1905–1907, 1911, 1930, and 1934–1941 (Longwell et al. 1965:139; Vanderburg 1937:19–26). Paher (1970) claimed that the first miners to work the region of the Crescent District were Mexicans who had extracted around a half-million dollars in gold between 1863 and 1878. This has yet to be confirmed with primary sources, and it remains unclear if he was referring to miners of Hispanic ethnicity or Mexican citizens who were mining in the United States.

Beyond mining, cattle ranching was the primary Euro-American economic activity in and around the study area until recently. The rise and decline of ranching was closely aligned with that of the region's mining ventures due to the desire for fresh meat to feed the bustling mining camps. The completion of the railroad in 1883 greatly aided local ranching operations as well, as hay from beyond the drought-stricken Mojave Desert could be imported and beef could be exported to larger markets.

The largest early ranching operation in the region was that of the Rock Springs Land and Cattle Company. The company organized in 1894 by combining the holdings of various ranchers who had been running cattle in the Mojave Desert since the mid-1870s (Owens and Provencer 2007). They headquar-

tered at Barnwell, California, which gave them ready access to the newly built Nevada Southern Railroad (later reorganized as the California Eastern Railroad) that connected to the Atchison, Topeka, and Santa Fe Railroad at Blake, California (later renamed as Goffs). This later positioned them to provide beef and other commodities to Searchlight via the Barnwell to Searchlight Railroad in 1907.

At its peak, the Rock Springs Land and Cattle Company grazed a rangeland covering nearly one million acres. This operation spilled over into southern Nevada and within the study area. While the range was primarily public land, the company was aggressive in its efforts to acquire water rights to gain dominion over the land. Their tactics prohibited much of the region from being successfully homesteaded. A severe and prolonged drought beset the Mojave Desert in the 1920s, and with such a negative impact to the viability of ranching, the Rock Springs Land and Cattle Company folded in 1928. The company sold its land, livestock, and water and grazing rights to other outfits. The portion of the company's holdings in Nevada was gifted to long-time employee John Woolf. Woolf then sold the property to George Francis Beldam, better known as the movie star Rex Bell. Bell and his wife, Clara Bow, ran the property as a quasi-ranch and retreat for themselves and their Hollywood friends (Wollan et al. 2008).

CHAPTER 5

CULTURAL RESOURCES INVENTORY

The primary goal of the present study is to establish a baseline understanding of the cultural resources and historic properties within the proposed Avi Kwa Ame National Monument. This chapter is divided into two interrelated parts. The methodology and due diligence by which a comprehensive inventory of documented cultural resources within the study area was obtained are explained in the first section. In the second section, the history of cultural resources investigations within the study area is reviewed to contextualize the inventory and to evaluate its nature and status as a sample of an unknown number of actual cultural resources within the study area. A summation of the results of these investigations—the inventory of cultural resources and historic properties in the project area—is provided in the following chapter.

Cultural resources, as considered here, are indicia of human activity on the landscape, including but not limited to, objects, architecture, landscape alterations, and graphic expressions, that are material and relatively fixed in place. In common parlance, cultural resources are often called "sites," which the Bureau of Land Management (BLM) Nevada defines as "a place where human activity occurred and material remains were deposited" (Bureau of Land Management [BLM] 2019:66). Such places are generally analogous to archaeological and historic *properties*, as defined in law. While any such sign is technically a cultural resource, several federal laws—such as the Antiquities Act (1906), Historic Sites Act (1935), National Historic Preservation Act (NHPA) (1966), and the Archaeological Resources Protection Act (ARPA) (1979)—have effectively established criteria for what constitutes a cultural resource, how to evaluate its "integrity," and ultimately, how to assess its "significance" to local, state, and national history (National Park Service [NPS] 1990). Integrity and significance determine a property's eligibility for inclusion in the National Register of Historic Places (NRHP).

The majority of reported cultural resources within the study area were documented in the course of BLM undertakings in compliance with the NHPA. Section 106 of the NHPA requires the BLM Nevada to evaluate historic properties for eligibility in the NRHP if a "project, activity, or program [i.e., an "undertaking"] funded in whole or in part under the direct or indirect jurisdiction of the BLM…has the potential to cause effects on [said] historic properties" (BLM 2014:4).

A standard principle generally followed by preservationists, cultural heritage and cultural resources managers, public historians, museologists, and related practitioners working in the U.S. is the so-called "50-Year Rule;" that is, cultural resources less than 50 years old are not eligible for inclusion in the NRHP unless they are of exceptional importance (Sprinkle 2007; Yoder 2017). This is due to a generally agreed upon understanding that historical *significance*, a necessary factor for NRHP eligibility, cannot be objectively assessed until some period of time has lapsed. Although NPS historians established this as an arbitrary 50 years prior to passage of the NHPA, this "rule" continued and has since carried over to other federal agencies. The BLM Nevada has adopted this age threshold as a de facto criterion for eligibility in its *Guidelines and Standards for Archaeological Inventory* (BLM 2019:18). As a result, cultural resources less than 50 years old are generally unreported in property inventories triggered by BLM Nevada undertakings. Therefore, any such cultural resources, regardless of their eligibility for the NRHP, are not considered here because they have not been systematically reported and documented.

Another cultural resources caveat pertinent to the present study is that federal laws, guidelines, and regulations recognize Traditional Cultural Properties (TCPs) (hereafter "Traditional Cultural Places") as a class of cultural resources in addition to otherwise archaeological and historic properties. By definition, TCPs are associated "with the cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community," regardless of whether such places exhibit a material signature of such association (NPS 1998). This is relevant to the Spirit Mountain TCP discussed in Chapter 6 (this volume).

METHODOLOGY

Comprehensive inventories of documented cultural resources and previous projects within the study area were compiled from information provided by the following archives and repositories.

- Nevada Cultural Resource Information System (NVCRIS)
- Las Vegas Field Office, Bureau of Land Management (BLM-LV)
- Southern Nevada Archaeological Archive (SNAA)
- South Central Coastal Information Center, California Historical Resources Information System
- San Bernardino County Museum
- Museum of Us (formerly San Diego Museum of Man)
- Office of Cultural Resource Management, Arizona State University (OCRM)
- AZSITE

Queries of all but AZSITE yielded records of cultural resources and/or cultural resources inventories within the study area. Information sought and requested included descriptions of archaeological and historic properties (i.e., site records), reports from previous inventory and excavation projects, and corresponding geospatial data and references for historic properties and inventory projects. Records requests and searches were limited to the study area. Projects that extended beyond the study area were "clipped" so that only information on those portions within the study area are considered. In several cases, documented cultural resources spanned the study area boundary, with places falling both within and outside. In those cases, the entire property is included in the cultural resources inventory.

Databases

Cultural resources information obtained through the records requests was consolidated into two databases, one for prior cultural resources and historic property inventories (Appendix A, this volume) and the other for documented cultural resources (Appendix B, this volume). While there was considerable redundancy in the information provided by the different archives and repositories, each provided some amount of unique information. In cases where historic properties had multiple site records, each place (rather than record) was designated a single "site" in the inventory.

There was also a range of data gaps and errors in the consolidated information that needed to be rectified. For example, some sites were attributed incorrect site numbers in the NVCRIS system but were corrected via reference to the corresponding site reports. In four cases, the geospatial information for inventory projects had to be generated from maps in the corresponding reports because they were not present among the geospatial data provided by any of the archives and repositories. Similarly, geospatial data on a subset of documented cultural properties had to be generated from maps. Most of these are

historic properties that, for one reason or another, are not recognized in the NVCRIS but for which a record was available through a different archive. These include 10 petroglyph and pictograph localities in McLane (2001) that do not have State Historic Preservation Office (SHPO) site records.

HISTORY OF RESEARCH

Roberts (2012b) considers the region in and around the study area to be within the least archaeologically understood reach of southern Nevada. Nevertheless, a general history of research within the study area can be outlined from the information compiled from the various archives and repositories. Perhaps the first published account of cultural resources near the study area is Mallery's (1893:95) relating of Lieutenant Augustus G. Tassin's 1877 drawings and description of "ancient rock-carving at the base and in the recesses of Dead mountain," which is quite likely a reference to petroglyphs in Grapevine Canyon along the eastern front of Avi Kwa Ame, presently situated within Lake Mead National Recreation Area. The first report on cultural resources *within* the study area seems to have been that of A. P. Miller, a railroad engineer and resident of Needles, California, on petroglyphs at Hiko Springs, as shared second-hand by Steward (1929:150).

Early Investigations

Professional investigations within the study area began with the explorations of Malcolm J. Rogers with the Museum of Man (now the Museum of Us) in San Diego. In the 1920s, 1930s, and 1940s, Rogers (1939, 1945, 1966) roamed over much of the desert country of Nevada, California, and Arizona as he worked to craft a broad outline of culture history across this vast region. Undoubtedly led to many places by local informants, Rogers documented dozens of archaeological sites in southern Nevada as part of his Mojave Desert Project. His Nevada site records are divided between those prefaced with an "M" for the Mojave Desert, and those with an "N" presumably for places in Nevada but outside the Mojave Desert. Most of Rogers' Nevada fieldwork was conducted over seven weeks in the final months of 1930, although there are entries in his Mojave Desert and Nevada notebooks dating to 1931, 1932, 1935, and between 1938 and 1941 (Hanna 1982:210–211). The 1930 Nevada fieldwork was funded by a grant from the Smithsonian Institute, and the field crew included Frank Rogers, George Carter, and H. Sharp.

The Mojave Desert Project involved primarily survey and artifact collection, although Rogers and his field crew conducted several small excavations in various caves and rockshelters, the results of which remain unpublished. It is unclear where those excavated caves and rockshelters are in relation to the study area. Regarding Rogers' surveys in and around the study area, available records do not provide much detail on methodology:

> The survey was conducted in as systematic a manner as the terrain permitted, every effort being made to conduct the work so that a definite area would be covered properly and eliminated. U.S.G.S. Water Supply maps were used for locating and recording sites. Much of this desert mountain region is inaccessible to automobiles, and the bulk of the survey had to be done on foot.
>
> As a result of this work we now have a large triangular block of the Mohave Desert well surveyed with the exception of a few minor areas. This block is bounded on the west by the meridian 117° West, on the south by the parallel 35° North, on the east by the Colorado River, and on the north by the Nevada state-line. *The survey was carried over the Nevada state-line into the southern part of Clark County*, and across it to the Colorado River (Rogers 1930:2–3, emphasis added).

Due to the lack of detail on methodology and locations of fieldwork, the exact extent of Rogers' Mojave Desert Project bearing on the study area cannot be fully assessed. Nevertheless, Rogers documented six sites within the study area.

After Rogers, little archaeological investigation was conducted within the study area until passage of the NHPA in 1966, as reviewed in the following section. One exception is the work of Arda Haenszel. Haenszel was a resident of San Bernardino and long-time affiliate of the San Bernardino County Museum with a keen interest in local history. She compiled an extensive collection of material, ephemera, and notes on the archaeology and history of San Bernardino County and surrounding areas, including southern Nevada. Part of her contribution is an assortment of site records, including several from within the study area she prepared in the 1950s and 1960s (Haenszel 1965). Some of Haenszel's information and photographs of petroglyphs at Hiko Springs and Lewis Holes were used in Heizer and Baumhoff's (1962) seminal overview of petroglyphs and pictographs in Nevada and southeastern California.

Cultural Resources Management Era

As reviewed above, the earliest archaeological and historical information about places within the study area were the result of personal interests of researchers, particularly Malcolm Rogers, Arda Haenszel, and several others. Because there were no industry standards at that time, their work was arguably unsystematic and largely unreported. Moreover, because the early researchers were either self-funded, or depended in large degree upon a limited number of grants, the pace of work was relatively slow and the breadth of fieldwork narrow. Consequently, their contributions to the present project are negligible.

The largest amount of cultural resources inventory and documentation within the study area, by far, took place after, and in response to, passage of the NHPA in 1966. Among other provisions, the NHPA requires federal agencies to consider the effects projects could have on historic properties. This law laid the groundwork for the vast majority of archaeological work conducted within the United States over the last half century (McManamon 2018).

The comprehensive inventory of prior cultural resources inventory projects within the study area identified 125 conducted in compliance with NHPA obligations (see Appendix A). Information regarding 123 of these projects was provided through the NVCRIS or BLM-LV. Information about another project, a transmission line survey as part of the Central Arizona Project (CAP), was acquired through reports by the OCRM (Dobbins 1979, 1980). Although the NVCRIS contained records for two sites documented on that project, it did not contain information about the project itself. The NVCRIS also provided geospatial data for another project (for a total of 125); however, due to an apparent error in record keeping it was not possible to connect the geospatial record to a particular project. That project is included here, although pertinent information on which agency carried it, the nature of the undertaking, and the methodology employed is not available. The survey/inventory is assumed to not have identified any historic properties as neither the NVCRIS or BLM-LV have records for any such sites from within that project area.

The project information obtained from the NVCRIS and BLM-LV includes the location and approximate amount of area inventoried, while further details about methodology were extracted from the corresponding reports. From these sources, it was possible to construct a database containing information about the amount of area inventoried, the survey methodology, the agencies who sponsored and carried out the projects, and the agency undertakings that triggered each cultural resources inventory project.

The available information is summarized here to chart a general history of archaeological research within the study area between 1972 and 2020, the first and last years for which data are available.

Based on information provided by the NVCRIS, BLM-LV, and OCRM, the total area inventoried within the study area amounts to approximately 78.80 km^2, or roughly 4.3 percent of the proposed Avi Kwa Ame National Monument (Table 5.1). For comparison, the Nevada SHPO (2020:14) estimates that 9 percent of the state (6.6 million acres) has been inventoried for historic properties and cultural resources, indicating the proportion of surveyed/inventoried land within the study area is about half the state-wide average. The combined area of coverage is shown on Figure 5.1, which parses the total surveyed/inventoried area into topographic units. These topographic units conform to the physiographic contexts discussed in Chapter 2 (this volume), with the addition of the McCullough-Highland and McCullough-Lucy Gray Traverses. These are narrow, unnamed valleys that run parallel and between these ranges, with the McCullough-Highland Traverse draining into the Eldorado Valley and the McCullough-Lucy Gray Traverse draining into the Ivanpah Valley.

Importantly, the total area of surveyed/inventoried lands reported here, 78.80 km^2, is less than the combined project areas discussed below (Tables 5.2–5.3). This is because many project areas overlapped, and surveys in those overlapping areas were therefore redundant. The 78.80 km^2 of total surveyed/inventoried land is the area of land covered by all projects less their portions of overlap, not the sum of the area covered by all the projects. Further, the reported amount of inventoried area is not precise and is probably slightly more than the actual amount of area inventoried. There are several reasons for this.

First, most of the geospatial data for these projects, which include the amount of land surveyed/inventoried, was created by digitizing the perimeters of project areas that had been drawn on traditional

Table 5.1. Surveyed/inventoried lands, by topographic region.

Topographic Region	Area of Region (km^2)	Proportion of Study Area (percent)	Area Inventoried (km^2)	Proportion of Area Inventoried (percent)
Castle Mountains	22.81	1.3	0.54	2.4
Chiquita Hills	5.46	0.3	0.30	5.6
Cottonwood Valley	74.93	4.1	0.41	0.5
Dead Mountains	8.80	0.5	1.22	13.9
Eldorado Valley	200.05	11.0	11.57	5.8
Highland Range	161.73	8.9	2.49	1.5
Ireteba Peaks	67.21	3.7	0.28	0.4
Ivanpah Valley	12.28	0.7	<0.00	<0.1
Lucy Gray Mountains	22.36	1.2	0.22	1.0
McCullough Range	253.57	14.0	4.87	1.9
McCullough-Highlands Traverse	64.40	3.5	5.62	8.7
McCullough-Lucy Gray Traverse	71.38	3.9	2.37	3.3
Mohave Valley	13.56	0.7	2.35	17.3
New York Mountains	67.84	3.7	4.59	6.8
Newberry Mountains	128.59	7.1	4.81	3.7
Piute Range	11.83	0.7	0.03	0.2
Piute Valley	629.25	34.6	37.12	5.9
Study Area	*1,816.08*[a]	*100.0*	*78.80*[a]	*4.3*

[a]Totals are slightly higher than the sum of table figures due to rounding of the latter.

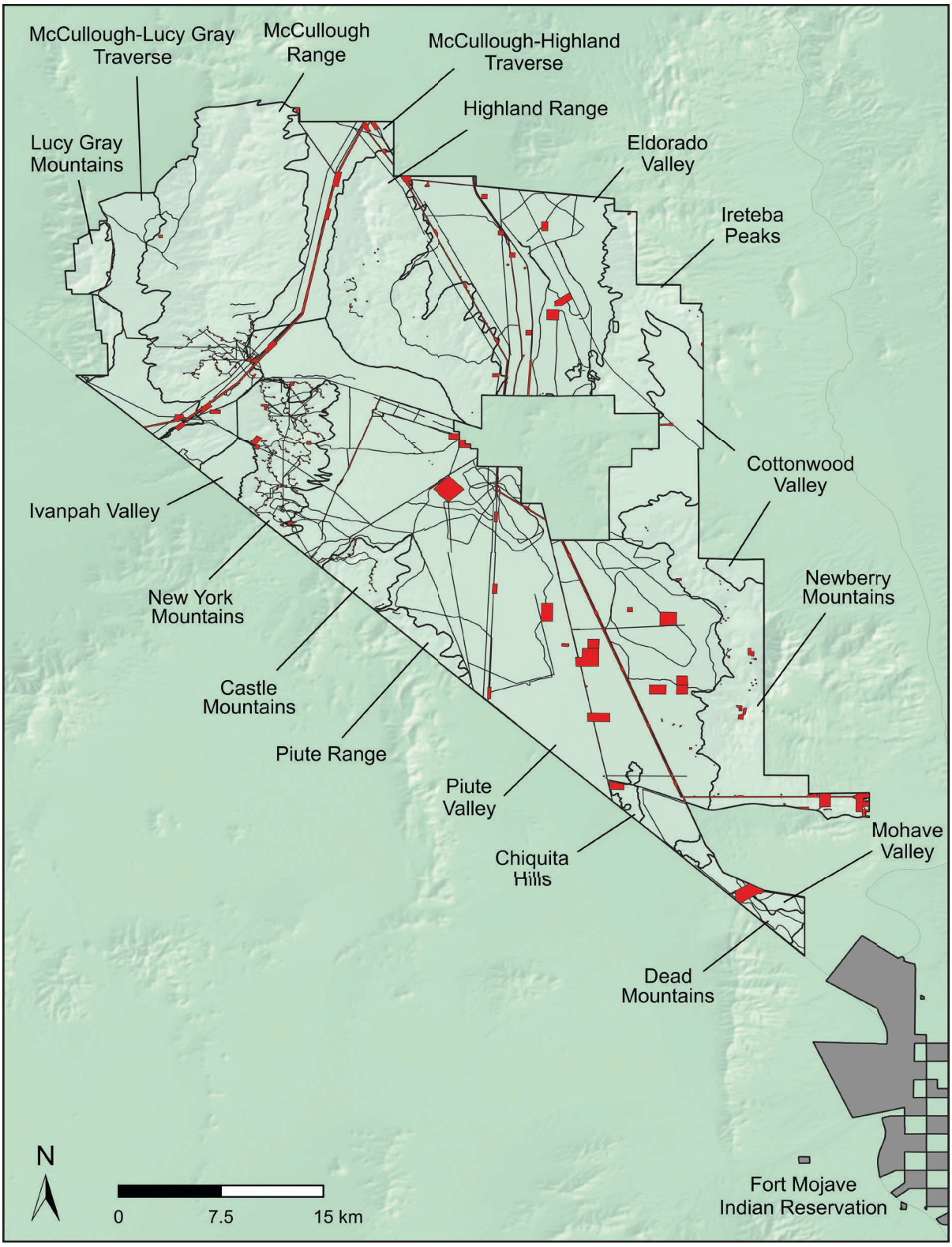


Figure 5.1. Surveyed/inventoried area, by topographic region.

Table 5.2. Cultural resources inventory project data, by agency.

Industry	No. of Projects	Total Area Inventoried (km^2)	Average Area (km^2) per Project
Bureau of Land Management	48	21.94	0.46
Nevada Department of Transportation	24	14.92	0.62
National Park Service	5	0.19	0.04
Army Corps of Engineers	1	0.22	0.22
Contractors	46	54.84	1.19
Total	*124*	*92.12*[a]	*0.74*[a]

[a]Totals are slightly higher than the sum of table figures due to rounding of the latter.

Table 5.3. Cultural resources inventory project data, by industry.

Industry	No. of Projects	Total Area Inventoried (km^2)	Average Area (km^2) per Project
Transportation	27	15.33	0.57
Telecommunication	20	3.22	0.16
Mining	18	6.84	0.38
Energy	20	41.48	2.07
Range management	9	7.12	0.79
Recreation permitting	16	14.80	0.93
Other	14	3.34	0.44
Total	*124*	*92.12*[a]	*0.74*

[a]Totals are slightly less than the sum of table figures due to rounding of the latter.

print maps (usually USGS 7.5-minute maps). A comparison between the amount of land inventoried/surveyed as listed in the project reports versus what was calculated from the geospatial data revealed multiple discrepancies. Many of these were surveys for linear undertakings, such as roads, transmission lines, and so forth. For these types of projects, the lines drawn on the maps were often wider than the actual project corridors, and digitizing the perimeters of the lines drawn on the maps yielded project areas larger than what was reported in the corresponding reports. A simple fix would have been to determine the amount of land surveyed/inventoried from the reports rather than the geospatial data. However, because many of these projects extended beyond the study area, there was no viable way to determine what fraction of the total amount of land surveyed/inventoried listed in the reports is within the study area.

A second factor that skews the amount of inventoried/surveyed land higher than the actual amount is that several projects included parcels for which a Class III pedestrian survey was not conducted. For example, for the survey associated with the proposed Crescent Peak Wind Project (Vicari et al. 2018), an unknown amount of the project area was not subject to pedestrian survey because the terrain was too steep, yet those unsurveyed areas were included in the total project area listed in the report and in the geospatial data.

More common, though, were situations in which the survey/inventory was not conducted on foot, but rather, via "windshield" (i.e., low-speed vehicular survey) or horseback. These projects do not meet the current standard for Class III inventory as set by the BLM Nevada, which requires "*pedestrian* tran-

sects not to exceed 30 meters in separation" (BLM 2019:11, emphasis added; see also BLM 2014:73). However, they do provide some degree of coverage that is worth considering. Rather than omitting them, and due to issues regarding the digitized project boundaries discussed above, it seemed prudent to report the data here as it was reported by the BLM-LV and NVCRIS, but with the expressed caveat that the total area of inventory/survey is skewed upward (i.e., too high), and a fraction of it does not meet current federal standards for Class III inventory. Given these nuances to the database, the proportion of the study area inventoried to current standards is likely closer to 4.0 percent than the 4.3 percent referenced above.

INVENTORY BY REGION

Systematic cultural resources inventories have been conducted in each topographic region within the study area, yet as shown in Figure 5.2, there are clear differences in how extensively each region has been investigated. The relative size of each topographic region ("proportion of study area") is listed in Table 5.1, as are what proportion of that region has been surveyed/inventoried for cultural resources ("proportion of area inventoried"). Although accounting for a small proportion of the study area, the Mohave Valley and Dead Mountains rank highest regarding the proportions of area inventoried. These two adjacent regions are closest to the resort town of Laughlin. As the largest region in the study area, the Piute Valley also contains the most amount of inventoried land (37.12 km^2). This is due to the valley's long history of use as a north-south conduit for roads, transmission lines, and pipelines, undertakings that prompt NHPA obligations on the part of the associated federal agencies.

INVENTORY BY AGENCY

Cultural resources inventory projects within the study area have been conducted by multiple agencies for a range of undertakings. The agencies include the BLM, the Nevada Department of Transportation (NDOT), the NPS, the Army Corps of Engineers (ACOE), and contractors, most of whom were employed by energy or telecommunication firms interested in undertakings on BLM-administered land. The total number of projects and combined area surveyed are listed in Table 5.2, by agency, and these data are shown in Figure 5.3, per year, since 1972.

While the numbers of projects between the BLM and contractors are nearly the same, the total land inventoried by contractors is almost three times that of the BLM. Most of the projects conducted by the BLM were small clearances (0.46 km^2/project) while contractors were sought for larger projects (1.19 km^2/project), most of which were energy related, as reviewed below. Also of note is that the BLM phased out nearly all "in-house" projects by the mid-1990s, with contractors accounting for most of the work thereafter. Importantly, the NDOT also conducted a fair number of projects, most of which were clearances for material pits and rights-of-ways for road improvements. Their projects occurred throughout the time frame covered here, but there was a notable peak in NDOT undertakings during the 1980s.

INVENTORY BY INDUSTRY

A similar analysis can be performed by industry. Here, the projects were assigned to one of seven categories based on the type of undertaking for which they were conducted. Those industries include transpor-

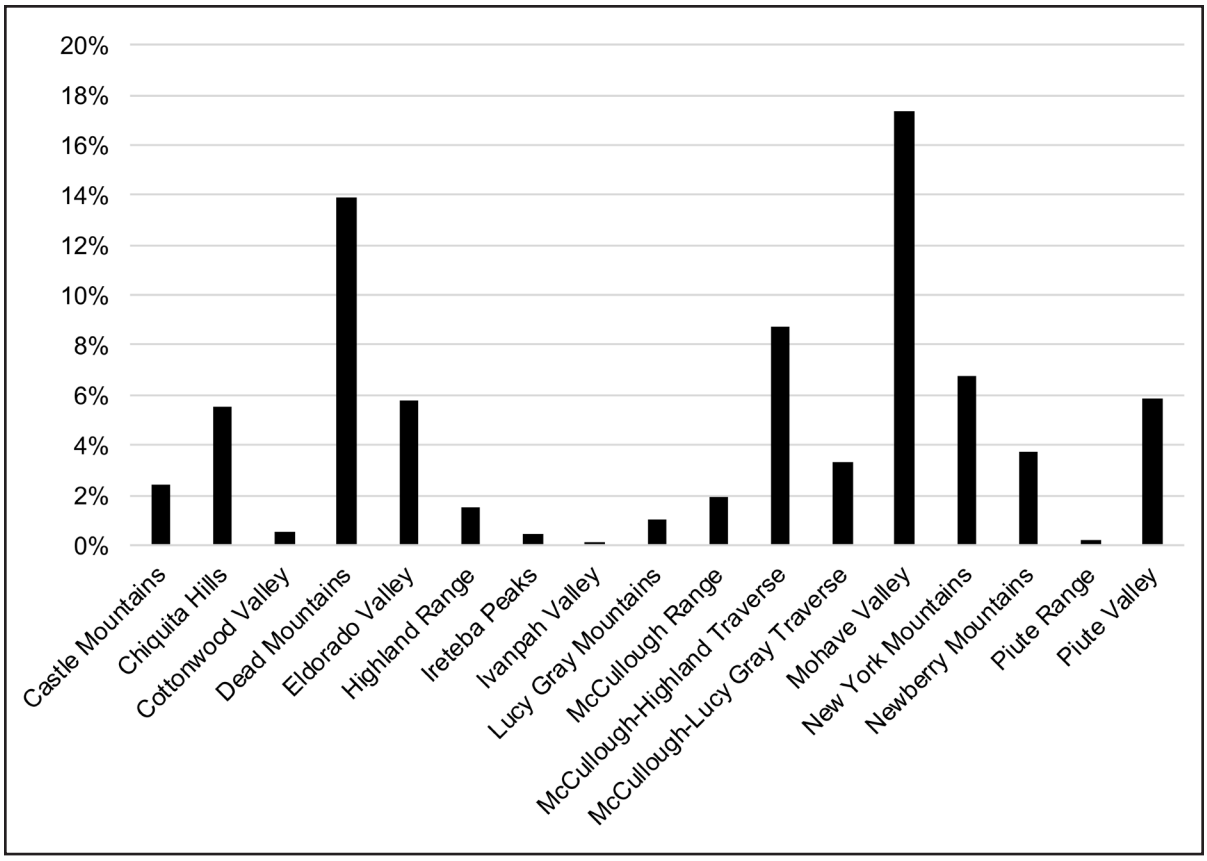


Figure 5.2. Inventory data, by topographic region.

tation, telecommunications, mining, energy, range management, recreation permitting, and other. Most of these are self-explanatory, but several merit further explanation.

The energy industry includes proposed energy developments within the study area as well as energy conveyances through the area. Energy developments include proposed wind energy production centers such as the Crescent Peak Wind Project (Vicari et al. 2018), while energy conveyances are transmission lines and oil and gas pipelines. Recreational permitting is limited to clearances for various off-road vehicle and horseback races in the outskirts of Laughlin and Searchlight. Miscellaneous projects subsumed within the "other" category include undertakings such as groundwater studies, installation of wind-monitoring facilities, building, etc.

The total number of projects and combined area surveyed are listed in Table 5.3, by industry, and these data are shown in Figure 5.4, per year, since 1972. Transportation-related undertakings account for the greatest number of projects, but energy-related undertakings resulted in the largest total amount of inventoried land, with the average project size (2.07 km^2) twice that of the second largest (recreational permitting, 0.93 km^2/project) and nearly four times that of the average transportation-related project (0.57 km^2). Energy-related undertakings account for almost half the total amount of land inventoried for cultural resources within the study area, and more than half the energy-related inventory (21.83 km^2) has occurred since 2009. In fact, 96.6 percent of land inventoried/surveyed for cultural resources since 2009 has been for energy-related undertakings.

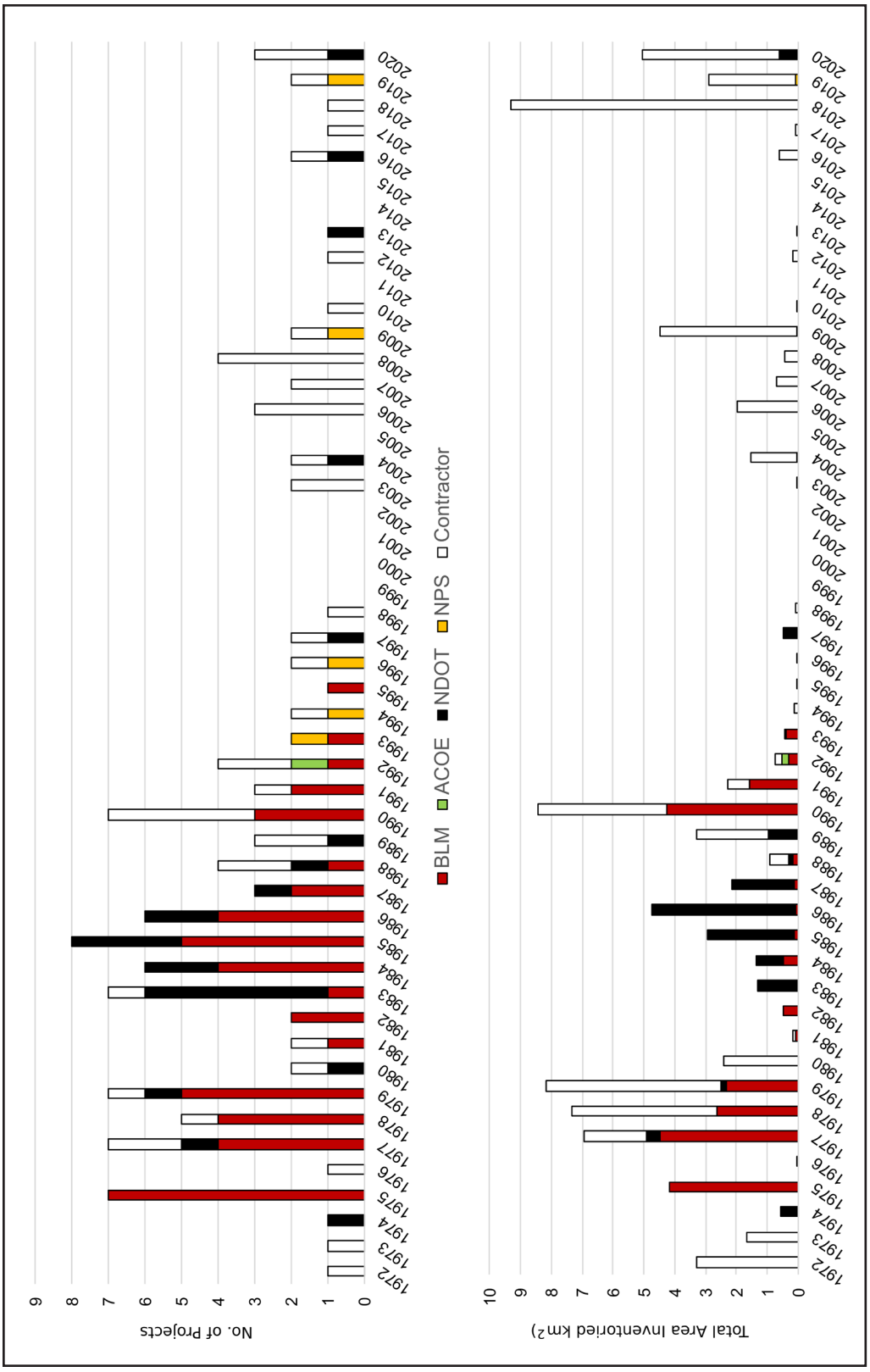


Figure 5.3. Inventory data, by agency.

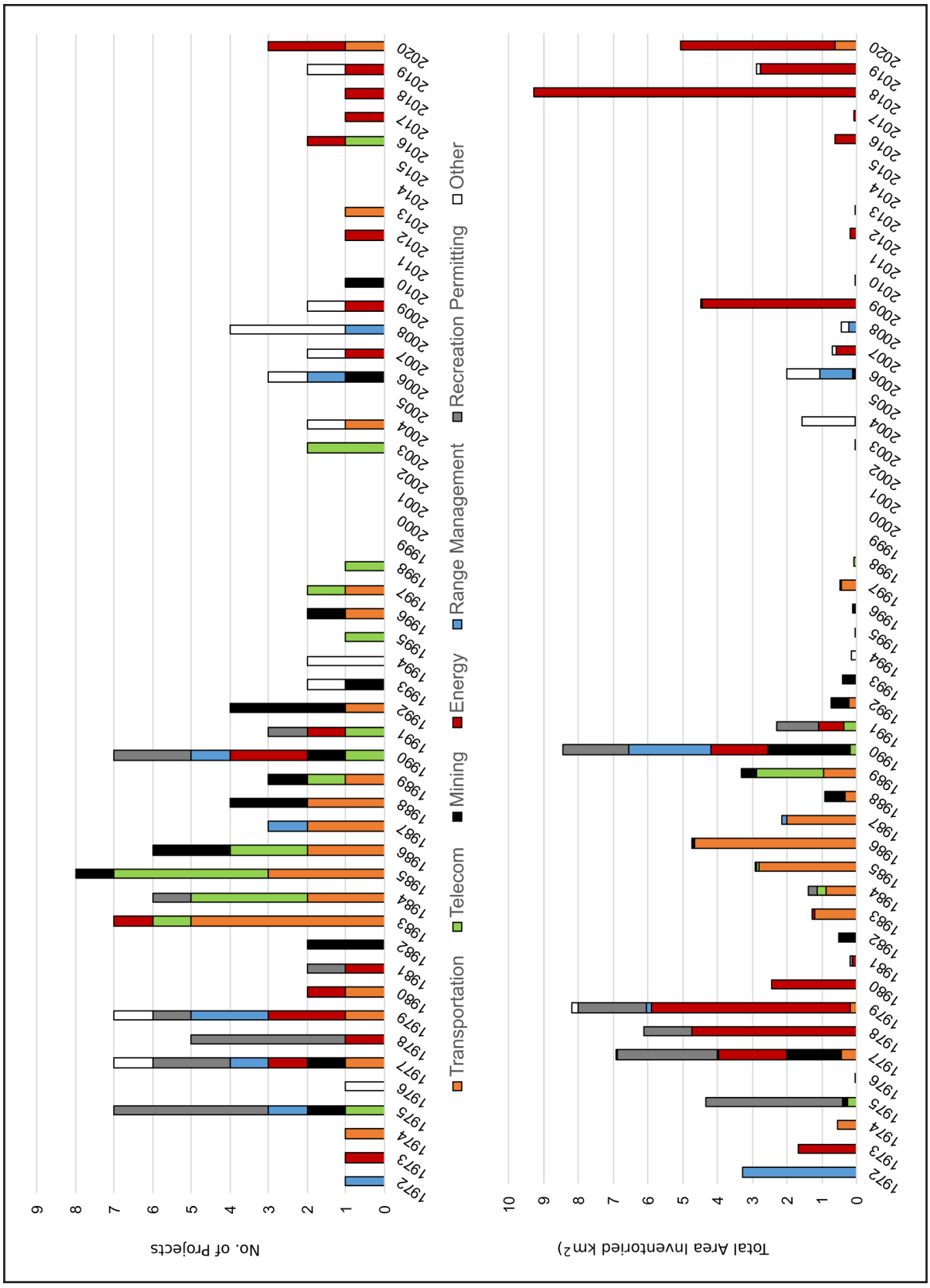


Figure 5.4. Inventory data, by industry.

REPRESENTATIVENESS OF THE SAMPLE

With only about 4 percent of the land surveyed and inventoried, and much of that done decades ago, it is impossible to know the full breadth and range of archaeological and historic properties within the study area. This is not unusual, however, as few landscapes have been completely surveyed, and they rarely need be to understand their cultural and historical significance. Models that consider anthropological theory about human use of the landscapes, the distributions of resources within those landscapes, and the geologic and paleoecological histories of those landscapes can predict the locations of archaeological sites with a good degree of accuracy (Judge and Sebastian 1998; Wescott and Brandon 2000), and they have specifically been shown to do so in Nevada (Zeanah et al. 2004).

Cultural resources inventory project areas are small and incomplete caricatures of the larger regional setting. They are, in effect, a form of sampling that provides a representation of what is likely present across a particular landscape or region. However, because cultural resources inventories are generally not conducted with the sole purpose of being a random and representative sample of the surrounding landscape, consideration of the representativeness of any such "sample" should be taken into account.

The situation with the Piute Valley noted above, in which that topographic region contains most of the surveyed/inventoried land within the study area, underscores that the locations of cultural resources inventory projects, as well as the amount of land inventoried, are not random. Instead, they reflect the types of federal undertakings that have triggered the inventories. Regarding the current study area, there is a notable contrast in the relative proportion of area inventoried between low- and high-relief settings, which exemplifies the nonrandom nature of cultural resources inventory project locations. Low-relief settings, such as the five valleys and two traverses, collectively account for 58.7 percent of the study area, yet they contain 75.4 percent of the inventoried lands. Moreover, 5.6 percent of the 1,065.85 km^2 accounted for by these low-relief contexts have been subject to cultural resources surveys/inventories, but that figure is just 2.6 percent for the 750.22 km^2 situated in upland, high-relief topographic regions.

The valleys within the study area have been the target of more cultural resources inventory work than upland settings. This is understandable based on the types of undertakings that have occurred, or at least been considered, within the study area. With their generally low relief, the valleys have been the preferable landscape settings for travel and transmission corridors. As detailed above, most of the cultural resources inventory projects in this landscape were prompted by transportation undertakings, whereas the largest undertakings (in terms of area surveyed) have been extensive linear surveys for energy-related transmission and pipeline projects.

Projects in high-relief upland settings, in contrast, have most often been related to less expansive and less frequent mining-related undertakings or, most recently, wind energy developments. This has resulted in relatively less cultural resources survey/inventory in the mountainous settings. This lack of coverage is evident is the sparseness of coverage in those regions (see Figure 5.1). For example, the McCullough and Highland Ranges are the second and fourth largest topographic regions within the study area, respectively, yet less than 2 percent of either has been surveyed/inventoried (see Table 5.1).

Although most of the study area has been subject to some degree of cultural resources survey/inventory, the disproportionate representation across topographic regions should be taken into account when considering the number, location, type, diversity, and integrity of historic properties across the study area. Certain types of properties are likely associated with upland and mountainous contexts, and these are therefore probably underrepresented in the cultural resources inventory. For example, rockshelters and

lithic quarries are, by nature, more likely to be present in rocky upland settings. Similarly, the existence of petroglyphs requires rock exposures, which are more prevalent in rocky, upland settings than in valleys.

Of particular note, most of the springs within the study area are situated in the upland and mountains settings (see Chapter 2). As the principal sources of surface water in this landscape, springs are high probability settings for past human activity (Hall 1981), which can be measured by the presence and abundance of cultural resources in their proximity. Indeed, Fowler and colleagues (1978) found in their sample transects across the central Basin and Range, including the study area, that areas centered on springs are one of the most likely to contain archaeological and historic sites, second only to meadows at higher elevations. Thus, it is reasonable to suspect there will be a higher proportion of historic properties around the the 47 springs identified within the study area (see Table 2.1) than in most other contexts; however, only four of these springs are within the investigated areas of prior cultural resources inventory projects.

CHAPTER 6

SUMMARY OF FINDINGS

Inquiry with the various archives and repositories enumerated in the methodology section of Chapter 5 (this volume) yielded 350 documented cultural resources within the study area (Appendix B, this volume). This inventory includes 339 recorded historic properties on file with the Nevada State Historic Preservation Office (SHPO) and available through the Nevada Cultural Resource Information System (NVCRIS), the Las Vegas Field Office, Bureau of Land Management (BLM-LV), or the corresponding project reports. Of those, 336 properties are listed in the NVCRIS archaeological site inventory and three in the rural architectural inventory. Aspects for several of the records within the NVCRIS archaeological site inventory were inaccurate. In all but two cases, it was possible to rectify the errors with information provided in the corresponding project reports. The two sites for which information is not available are included as "indeterminate" sites in the inventory and are omitted from further discussion. Ten additional site records were garnered from a report on petroglyph and pictograph sites in southern Nevada (McLane 2001) on file with the Southern Nevada Archaeological Archive (SNAA) but that do not have corresponding site records in the NVCRIS.

The cultural resources inventory includes archaeological and historic properties for which a record is on file with an archive or repository. In Nevada, cultural resources records are assigned a trinomial number that serves as a unique identifier within the state's cultural resources information system. Numbering systems for records filed with other states are different, but serve the same purpose. Relevant here is the concept of an archaeological or historic site, as defined in Chapter 5, and what constitutes such places on the landscape.

The BLM Nevada recognizes a "site," for purposes of National Historic Preservation Act (NHPA) compliance, as "any location containing two or more artifacts or features that are spaced no more than 30 meters apart" (BLM 2019:66). Such sites are assigned a trinomial number and entered into the NVCRIS. Archaeological and historical properties that do not meet this definition are generally—though not always—regarded as "isolates" or "isolated finds," in contrast to archaeological and historic sites; these are not entered into the NVCRIS. Because such isolated materials do not meet the criteria of a site, they are categorically omitted from evaluations of eligibility for inclusion in the National Register of Historic Places (NRHP), as mandated.

The issue of whether historic properties that do not meet the BLM Nevada's criteria for a site should be considered important or significant under pretexts other than the NRHP—while a debate worth considering—is beyond the scope of the current project. Nonetheless, the matter has bearing on the cultural resources inventory for the study area in several regards. For example, several of the cultural resources records are for what would be, under most circumstances, considered isolated finds. Examples from the inventory include single pieces of historic glass, single cans, and single rock features that cannot be reliably dated, such as cairns.

The current BLM Nevada guidelines are ambiguous on whether such properties should be deemed sites or isolated finds, and the guidelines do not apply to older inventories. In turn, isolated finds have been reported inconsistently across projects and through time. Some were afforded a trinomial and cultural resource record, others merely reported in tables in project reports, and still others left entirely

unreported. Because the purpose of the cultural resources inventory is to collate all documented historic properties within the study area, it includes sites as well as otherwise isolated finds for which cultural resources records were filed. Isolated finds listed solely in project reports are not included because the pertinent data were often lacking.

The remainder of this chapter reviews the types and distribution of cultural resources documented within the study area. It is important to recognize that none of the documented historic properties within the study area have been subject to systemic, professional excavation except several instances of subsurface probing to assess the presence and depth of deposits. As a result, inferences about the origin, antiquity, cultural affiliation, function, and significance of all of them—except Traditional Cultural Places (TCPs)—are therefore drawn almost exclusively from observations of material found on the surfaces of the sites. The inference and opinions of the field recorders, including recommendations regarding eligibility for inclusion in the NRHP and the justifications thereof, were upheld in each case.

The information is organized along two parameters, one cultural and the other thematic. First, the resources were designated as either Indigenous or Euro-American in origin. Indigenous cultural resources are generally analogous to what have been regarded as archaeological sites, while Euro-American cultural resources are otherwise historic sites. It is imperative to note there is temporal and spatial overlap in the Indigenous and Euro-American cultural resources; thus, the historic versus prehistoric nomenclature is avoided. Properties containing both Indigenous and Euro-American cultural resources were designated multicomponent sites; those properties that could not be assigned to either were designated indeterminate.

Following cultural attribution, the cultural resources were grouped thematically based on the nature of the property and the presumed activities for which they were intended or by which they were created. For Indigenous cultural resources, the thematic categories include: artifact scatters, miscellaneous rock features, petroglyphs/pictographs, quarries, rockshelters, TCPs, and trails. Euro-American cultural resources include: energy and utility conduits, homesteading and ranching sites, military training areas, mining localities, miscellaneous rock features, refuse scatters, and transportation facilities. These data, as well as their status regarding NRHP eligibility, are summarized in Table 6.1.

The eligibility *recommendations* reported there, as well as in Appendix B, were made by either the original field recorder or the land management agency, whereas eligibility *determinations* were made by the Nevada SHPO. Only two properties have been formally listed to the NRHP—Walking Box Ranch and Spirit Mountain TCP. Twenty-one other properties (6.0 percent) have been recommended or determined eligible for inclusion, 230 (65.7 percent) have been recommended or determined ineligible for inclusion, and 97 (27.7 percent) have not been adequately assessed for eligibility.

To approximate the spatial distribution of the different types of cultural resources within the study area, Table 6.2 sorts the inventory data by the topographic regions in which the properties are located. There are two reasons why the number of properties reported in Table 6.2 (n = 391) is greater than the total number of documented cultural resources in Table 6.1 (n = 350). First, several of the properties are located in more than one topographic region; as such, they are reported twice in Table 6.2. Most such properties are linear sites, such as roads and transmission lines. The second reason is that in Table 6.2, the multicomponent sites are separated into their constitute components. For example, site CK3, Hiko Springs, in the Newberry Mountains, encompasses Indigenous petroglyphs and Euro-American buildings. Thus, the single site record is split into two site types—one Indigenous petroglyphs/pictographs and one Euro-American homesteading and ranching site.

Table 6.1. Historic property classes within the study area and their National Register of Historic Places status.

	Recommended Eligible	Determined Eligible	Listed	Recommended Ineligible	Determined Ineligible	Unevaluated	Total
Indigenous							
Artifact scatters	1	–	–	17	3	9	30
Miscellaneous rock features	–	–	–	2	1	2	5
Petroglyphs/pictographs	2	–	–	1	–	32	35
Quarries	–	1	–	2	1	8	12
Rockshelters	2	–	–	3	1	17	23
Traditional Cultural Places	–	–	1	–	–	1	2
Trails	–	–	–	–	2	1	3
Euro-American							
Energy and utility conduits	2	–	–	2	2	–	6
Homesteading and ranching sites	1	–	1	7	4	5	18
Military training areas	1	–	–	8	1	–	10
Mining localities and features	4	3	–	55	5	2	69
Miscellaneous rock features	–	–	–	4	4	1	9
Refuse scatters	–	–	–	59	20	11	90
Settlements	–	–	–	–	1	–	1
Transportation facilities	–	2	–	12	4	1	19
Multicomponent Sites	2	–	–	6	1	3	12
Indeterminate Sites	–	–	–	2	–	4	6
Total	*15*	*6*	*2*	*180*	*50*	*97*	*350*

Table 6.2. Historic property classes, by topographic region.

	Castle Mountains	Chiquita Hills	Cottonwood Valley	Dead Mountains	Eldorado Valley	Highland Range	Ireteba Peaks	Ivanpah Valley	Lucy Gray Mountains	McCullough Range	McCullough-Highland Traverse	McCullough-Lucy Gray Traverse	Mohave Valley	New York Mountains	Newberry Mountains	Piute Range	Piute Valley
Indigenous																	
Artifact scatter	3	–	–	–	11	2	–	–	–	4	–	1	–	5	4	–	10
Miscellaneous rock features	–	–	–	–	1	–	–	–	–	–	–	–	–	–	2	2	–
Petroglyphs/pictographs	1	–	1	1	–	14	5	–	–	–	–	–	–	–	7	3	4
Quarries	1	–	–	–	5	4	–	–	–	–	–	–	–	1	1	–	4
Rockshelters	6	–	–	1	–	6	–	–	–	2	–	–	–	1	7	–	–
Traditional Cultural Places	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	–
Trails	–	–	–	–	–	–	–	–	–	1	–	–	–	–	2	–	–
Total	*11*	*0*	*1*	*2*	*17*	*26*	*5*	*0*	*0*	*8*	*0*	*1*	*0*	*7*	*24*	*5*	*18*
Euro-American																	
Energy and utility conduits	–	–	1	–	2	–	1	–	–	1	–	1	2	–	1	–	4
Homesteading and ranching sites	–	–	1	–	1	–	–	–	–	3	–	2	–	3	3	–	8
Military training areas	–	1	–	–	–	–	–	–	–	–	–	–	–	7		–	2
Mining localities and features	1	–	–	–	5	2	4	–	–	10	–	1	1	41	10	–	6
Miscellaneous rock features	–	–	–	–	–	–	–	–	–	5	–	–	–	3	5	–	–
Refuse scatters	1	1	1	–	9	2	–	–	–	15	3	10	2	21	2	–	25
Settlements	1	–	–	–	–	–	–	–	–	1	–	1	–	–	–	–	2
Transportation facilities	1	–	–	–	1	–	–	1	–	–	2	2	–	5	–	–	13
Total	*4*	*2*	*3*	*0*	*18*	*4*	*5*	*1*	*0*	*35*	*5*	*17*	*5*	*80*	*21*	*0*	*60*
Indeterminate Sites	–	–	–	–	1	3	–	–	–	–	–	–	–	2	–	–	–
Total	*15*	*2*	*4*	*2*	*36*	*33*	*10*	*1*	*0*	*43*	*5*	*18*	*5*	*89*	*45*	*5*	*78*

Prior to summarizing the types and distributions of cultural resources, a broad look at their distribution across the study area is noteworthy. Table 6.2 shows that the number of sites is quite variable between topographic regions, although this should be expected given the differential amount of inventory conducted in each and how the nature of the terrain influences the types of historic properties that are possible (see Chapter 5).

For example, the relatively large number of cultural resources documented in the New York Mountains is an obvious outlier from other regions throughout the study area. There are two probable reasons for this. First, this region lies in the heart of the Crescent Mining District, and most of the sites reported from the New York Mountains are mining localities and features (n = 41) and refuse scatters (n = 21), many of which are associated with the mining activity. While mining occurred throughout the study area, the New York Mountains saw the brunt of those ventures. This is reflected in the type and distribution of historic properties in that region. The second reason explaining the atypically elevated site total is that 53 mining sites and refuse scatters in the New York Mountains were reported from the recent Crescent Peak Wind Project (Vicari et al. 2018). Many of those 53 sites date to the mid-twentieth century. Had the region been inventoried earlier, some of these sites would not have met the "50-Year Rule" (see Chapter 5) and, consequently, would not have been reported. This small exercise illustrates how aspects of the undertaking—in this case, the date of the corresponding cultural resource inventory—can influence the types and amounts of cultural resources documented, especially in not so old Euro-American properties.

It is also worth considering the distribution of cultural resources between valley and upland settings as well. Barker et al. (1979) suggested that archaeological sites within the Mojave Desert should be found most often in upland settings, as those areas provide the greatest availability of important resources. These include water at springs, as well as plant and animal subsistence resources. The data provided in Table 6.2 indicate that while Indigenous properties are located throughout the study area, they are disproportionately more numerous in upland settings when the total area surveyed (rounded to the nearest km^2) is considered (χ^2 = 136.9, df = 2, p < .00001, V = .131). This gives credence to Barker and colleagues' (1979) supposition.

Interestingly, the same distinction holds for Euro-American properties, with a disproportionately higher number reported from upland contexts (χ^2 = 11.4, df = 2, p < .001, V = .038). This is understandable given the significance of mining to the region's history. Most of the mining activity in the region occurred in and around mountains, and much of this relationship is driven by the anomalous number of mining-related properties reported from the New York Mountains, as discussed above.

INDIGENOUS PROPERTIES

Artifact Scatters

Artifact scatters are the second-most numerous and ubiquitous class of Indigenous cultural resources documented within the study area. This class includes 30 recorded properties that are exclusively Indigenous artifact scatters and 10 additional artifact scatters otherwise recognized as multicomponent sites. Collectively, these properties have been reported from eight of the 17 topographic regions under study. In terms of size, these properties range from single artifacts, such as a lone projectile point in the Highland Range, to extensive scatters of ceramic, lithic, and ground stone artifacts that evidence some degree of long-term or repeated residence in certain areas of the landscape.

Regarding significance, most of the Indigenous artifact scatters have been recommended ineligible for inclusion in the NRHP (*n* = 17) or have been determined so by the Nevada SHPO (*n* = 3). Another nine sites have yet to be thoroughly evaluated, and just one is recommended eligible for inclusion by the recording field personnel when it was inventoried in 1990. Regarding the artifact scatters at multicomponent sites, 2 of those sites are recommended eligible for inclusion in the NRHP, 6 are recommended ineligible, 1 is unevaluated, and 1 has been determined ineligible by the Nevada SHPO.

Without excavation data, inferences about the nature of the human activity that created the various Indigenous artifact scatters are drawn from size, diversity, composition, and density of material present on the ground surface. Most of the 40 artifact scatters consist solely of flaked stone items (*n* = 29, or 72.5 percent). Many of these are relatively small in terms of number of artifacts and aerial extent, and several are single artifacts. When the field recorders provided interpretations, these simple lithic scatters were described variably as small camps, chipping stations, single-episode reduction loci, and so forth. These sites occasionally contain expedient flaked stone tools, which gives credence to the notion that some are small, short-term, or single-use camps. A general lack of diagnostic artifacts precludes attributing any of these lithic scatters to any archaeological or ethnographic cultural traditions; consequently none are recommended eligible for inclusion in the NRHP under the presumption that they have limited data potential.

Two of the artifact scatters (5.0 percent) consist of only a few ceramic sherds, perhaps remnants of incidental breakage of pots. Four of the artifact scatters (10.0 percent) are a combination of flaked stone and ceramic artifacts. While the greater diversity in material might suggest these properties have greater research potential than simple lithic scatters, they are still quite small and relative sparse. The presence of ceramics may be more a factor of chronology than site function. The occurrence of ceramics suggests these sites date to the Formative era, while simple lithic scatters usually cannot be placed in a temporal context without a robust and careful analysis of the material.

The ceramics reported from the artifact scatters in the study area are variably described as gray, buff, brown, red, and orange in color. Although the field recorders usually did not assign the ceramics to particular types and wares, the buff and gray ceramics, some of which were described as being painted, are likely specimens of Lower Colorado Buff Ware associated with Yuman tribal technologies, and in this case, most likely the Aha Macav (Rogers 1936, 1945; Schroeder 1952, 1958; Waters 1982; Wright 2021). In contrast, the red and brown pottery, so colored by the use of iron-rich clay and firing in an oxidizing environment, are likely associated with the Nuwuvi (Harrington 1926:71), including the Chemehuevi prior to their settling along the lower Colorado River south of the study area. This pottery is variably called Southern Paiute Utility Ware (Baldwin 1950b) and Intermountain Brown Ware (Betenson 2005). Importantly, Nuwuvi pottery was thinned by both the paddle-and-anvil and coil-and-scrape techniques. The technological difference may have relevance to band identity (Baldwin 1950b:53), although this has not yet been fully explored.

Three of the artifact scatters (7.5 percent) documented within the study area are combinations of flaked stone and ground stone artifacts. The ground stone in these contexts adds support that they may be short-term settlements, and the absence of ceramics might indicate an Archaic association. Two of these properties are recommended as eligible for inclusion in the NRHP, although the justification for one is based on its Euro-American component (the Crescent townsite) rather than its Indigenous one.

The other is a large but mostly diffuse lithic scatter in the Piute Valley at the foot of the northeastern extent of the Castle Mountains. The site area stretches for approximately 2.2 km along the margin of a

wash that bends around the mountains, and shovel probes identified buried deposits almost 0.5 m below the surface. Three loci of greater artifact density were noted, and several metates were observed. Importantly, two Silver Lake projectile points were identified, as were more than 50 bifacial and 20 unifacial flake tools. The points are associated with the Lake Mojave period and represent some of the earliest material evidence of human presence in the Mojave Desert. The co-presence of these Paleoindian points and ground stone, the later of which is typically associated with the onset of Archaic lifeways, makes this site relevant for studying human adaptation to changing climatic and environmental conditions during the Pleistocene to Holocene transition.

Lastly, two artifact scatters (5.0 percent) are combinations of lithic, ceramic, and ground stone material. One is situated along the western bajada of the New York Mountains, overlooking the Ivanpah Valley. The material there is concentrated around the confluence of two ephemeral washes, and shovel probes revealed material buried up to 30 cm below the surface. The observed ground stone included a two-sided mano and a fragment of a metate. The pottery was predominantly gray and brown in color and represents at least three vessels. It was tentatively identified as a combination of Pyramid Gray and Tizon Brown Ware, both associated with Yuman tribes and their Patayan ancestors. The flaked stone assemblage included unifacially and bifacially retouched flakes, as well as four projectile points. Some burned bone was found, one piece of which appeared to be a possible portion of human cranium. If so, that would signal the possible presence of cremated human remains interred at the site. The field recorders, who ascribed the site as Yuman based on the ceramics present, recommended it as eligible for inclusion in the NRHP based on its potential to address questions of regional culture history.

The other documented scatter of lithic, ceramic, and ground stone material in the study area is situated on a low ridge above an ephemeral wash emanating from the southern end of the McCullough Range. The site measures approximately 100 m by 50 m, and the central portion was described as a midden-like setting with dark gray soil. A wide range of flaked stone tool types were noted, including scrapers, choppers, hammers, cores, and a corner-notched Rose Spring projectile point made of obsidian. The ceramic assemblage was limited to a single piece of a brown bowl-like vessel. The ceramic and point suggest the site dates to the Early Formative period. This is the only documented historic property within the study area field recorders suggested as being a possible village, and the low quantity of brown ware indicates it may be associated with the Nuwuvi. The field recorders further suggested there may be more than 0.5 m of deposition in and around the central midden-like area. Based on the possibility of such buried material, as well as the apparent habitation that occurred, the recorders recommended the site as potentially eligible for inclusion in the NRHP, suggesting a program of subsurface testing is necessary to verify the presence and nature of any buried material.

Miscellaneous Rock Features

Five documented cultural resources within the study area can be classified as miscellaneous rock features of Indigenous origin and use. This category includes two boulder grinding features at the northern terminus of the Piute Range, each of which was designated as a distinct archaeological site. They are located in a wash, about 100 m apart, and neither was found to have associated material. They were interpreted as probable single-use milling slicks for the processing of locally available seeds (Wilke 1992). Both sites are recommended as ineligible for inclusion in the NRHP.

The category of Indigenous miscellaneous rock features also includes various rock circle features. One documented site consists of a single rock circle slightly embedded in the desert pavement of the Eldo-

rado Valley with a lone orange metate on the edge of an arroyo some 45 m away. Another site, situated on a terrace above an arroyo in a canyon in the Newberry Mountains, consists of three rock circles with internal diameters ranging from 2 to 4 m. No additional features or artifacts were found in association with these rock circles, but they were interpreted as sleeping circles, a perspective undoubtedly influenced by Rogers' (1939:7, 1966:45–47) take on such contexts. Neither of these rock circle sites have been evaluated for the NRHP.

The fifth documented cultural resource within this category is a place where five rock walls have been constructed atop a bluff overlooking Bridge Canyon along the southeastern flank of the Newberry Mountains. The walls were placed in gaps between natural bedrock exposures to effectively enclose the summit and create an area of about 150 m^2 where one could move about undetected. Although additional features and artifacts were not observed, the site is suggested to be a look-out of some kind, perhaps for defense or hunting as it provides expansive views across the valley below. Despite its unique character within the study area, the Nevada SHPO determined this property as ineligible for inclusion in the NRHP.

Petroglyphs and Pictographs

Sites with petroglyphs and/or pictographs are the most reported type of Indigenous property in the study area (n = 35, plus another from a multicomponent site and seven more from rockshelter sites). However, because rock exposures are essential for such sites to exist, they are not evenly distributed across the landscape. To date, they have only been found in eight of the 17 topographic settings within the study area, all but two of which are mountainous contexts. In Cottonwood and Piute Valleys, the exceptions, the petroglyphs are on low, rocky hills.

Petroglyph and pictograph sites are perhaps the earliest reported historic properties in and around the study area. Important sites both within and adjacent to the study area were described in regional studies on the subject by Mallery (1893) and Steward (1929). Their information was provided to them by area residents and passers-through, as those works were in print before any professional archaeological attention had reached the area. One of these was Hiko Springs, a multicomponent site in a canyon at the foot of the Newberry Mountains and lying within the study area.

Additional petroglyph sites in the study area were visited and rudimentarily documented by Rogers (n.d.) on his brief foray to the area in 1930, and later by Haenszel (1953, 1965). Haenszel's photographs and notes proved instrumental in Heizer and Baumhoff's (1962) seminal study of Great Basin petroglyphs and pictographs, summarized below.

While numerous and long of interest, petroglyph and pictograph sites are perhaps the least understood type of cultural property in the study area. A general inability to assign these sites to a time period with much confidence complicates correlating them with other historical dimensions of the cultural landscape. Moreover, when reported, these types of sites are rarely documented to the extent necessary to permit comparative studies. Of the 43 reported sites in the study area exhibiting either petroglyphs or pictographs (including the rockshelters), only two (4.7 percent) have been carefully inventoried to provide a reliable approximation on the number images present, their type of manufacture, and their graphic nature. As noted, 10 of these sites are not reported in the NVCRIS but were identified in a report submitted to the Harry Reid Center at the University of Nevada, Las Vegas (and now curated by the SNAA) by an avocationalist with a strong interest in petroglyphs and pictographs (McLane 2001).

Despite the lack of detail in site documentation and hindrances to developing robust chronologies, the frequent attention devoted to petroglyphs and pictographs in and around the study area has fostered multiple stylistic schemes in an effort to describe, organize, and study them with some degree of acumen. The most consequential work on the matter to date has been that of Heizer and Baumhoff (1962), who defined a number of "styles" and provided some hypotheses on how petroglyphs and pictographs factored into the cultural landscape. They situate the study area squarely within the ranges of what they defined as the Great Basin Curvilinear Abstract, Great Basin Rectilinear Abstract, and Great Basin Representational petroglyph styles. Despite recognizing problems in Heizer and Baumhoff's (1962) framework, both Rector (1981) and Schaafsma (1986) reiterated it in their regional overviews of the eastern Mojave Desert and Great Basin, respectively.

More recent overviews have been more critical of this foundational work (e.g., Quinlan 2012), but a suitable alternative has not been proposed. The most significant revision to the Heizer and Baumhoff (1962) framework has been the recognition of Formative era styles, including the Grapevine Canyon Style attributed to the Patayan tradition (Christensen and Dickey 2001) and the Paiute Rock Art Style associated with the Nuwuvi and their ancestrors (Halmo 1995). Examples of the Grapevine Canyon Style have been reported from sites in the study area (Christensen and Dickey 2001:Figure 1), while those of a Paiute Rock Art Style have not. A summary of the petroglyph and pictograph sites in the study area follows.

Five petroglyph and pictograph sites are reported from the Castle Mountains, all associated with rockshelters. One of these is Lewis Holes, a noted stopping point along a historic wagon road described as the Eldorado Canyon Cut-Off (see Chapter 5). This site, for which Heizer and Baumhoff (1962:32) provide a brief description, has not yet been systematically inventoried or studied, but based on sketches and photographs, the petroglyphs are consistent with Great Basin Curvilinear and Rectilinear styles, as well as the Grapevine Canyon Style. Rector (1981:Chart 1) estimated there were more than 100 petroglyphs around Lewis Holes.

Three additional rockshelter sites with petroglyphs and pictographs in the Castle Mountains are described in more detail in the section on rockshelters later in this chapter. The fifth site is reported by McLane (2001) and for which a NVCRIS site record does not exist. He described it as a small rockshelter with faint red-painted motifs inside, including a handprint and circles. A single star-like petroglyph is on a boulder below the shelter, and a small alcove nearby has more than 50 red-painted finger dots.

One petroglyph site has been reported from the small portion of the Dead Mountains within the study area. Described variably as Granite Springs and Granite Tanks, it is one of just two petroglyph and pictograph sites in the study area to have been fully inventoried (the other is a pictograph-filled rockshelter in the Castle Mountains described in the rockshelters section). The inventory identified 177 petroglyphs, representing a combination of Great Basin Abstract and Grapevine Canyon styles. Some of the motifs at this site are featured in Christensen and Dickey (2001). A bedrock grinding feature was noted in association with the petroglyphs, and a series of utilized rockshelters—considered a separate site and described in the rockshelters section—are situated nearby.

The Highland Range contains the greatest number of reported petroglyph and pictograph sites from the study area. The information on them is quite cursory, however, as most were reported by avocationalists. Five are sites reported by McLane (2001) that are not listed in the NVCRIS. Nonetheless, the available information permits a loose outline. At Cow Spring, Rogers (n.d.) described 30–40 highly weathered petroglyphs on basalt outcrops. His rough illustrations of some of the images suggest the petroglyphs

conform to the Great Basin Curvilinear Abstract Style, yet his record notes a trace presence of Yuman (i.e., Patayan) and Chemehuevi pottery in the vicinity.

Near Highland Spring, Rogers (n.d.) found a cluster of petroglyphs he described as Yuman and Chemehuevi. He further noted the presence of a Chemehuevi camp in the vicinity. A more recent recording did not relocate the camp site, but found what was described as a hunting blind associated with some of the petroglyphs. The documentation for the other petroglyph and pictograph sites in the Highland Range lacks detail, but most are described as relatively small sites with the motifs consisting of abstract and representational forms. Site records for petroglyph and pictographs sites in the Piute Range (n = 3), Piute Valley (n = 4), and Cottonwood Valley (n = 1) are also too cursory to provide much information.

The petroglyph and pictograph sites reported from the Newberry Mountains include Hiko Springs. While this site has yet to be fully inventoried, it is one of the better known petroglyph localities in the region because it often appears on maps and it is easily accessible. The site was first described by Steward (1929:150) and was visited by Rogers (n.d.) in 1930. Rogers (n.d.) described it as a large petroglyph site with Archaic and Formative elements, some of which have been "refreshed" (i.e., repecked) and others superimposed. The petroglyphs illustrated by Rogers (n.d.) are consistent with the Great Basin Abstract and Grapevine Canyon styles. The variety of ceramics found in association with the petroglyphs suggested to Rogers that the site lies along a former travel corridor that led between the Mohave and Piute Valleys. The site was also described briefly by Heizer and Baumhoff (1962:29), and the San Bernardino County Museum collected some flaked stone artifacts from the site including the base of an Elko Corner-notched projectile point.

The six other petroglyph sites reported from the Newberry Mountains are smaller and less well known. All are described as consisting of just a couple of petroglyph panels each. Three are sites mentioned by McLane (2001) and do not have corresponding NVCRIS records. One site, consisting of three panels across two boulders, was severely disturbed by an expansion to State Route (SR) 163. The Nevada Department of Transportation (NDOT) apparently pushed the boulders into an adjacent ravine to make room for the expanded road.

Petroglyphs sites are the only type of Indigenous property reported from the Ireteba Peaks to date. Four of these sites were reported by avocationalists and, as such, lack enough detail other than to remark that they are all relatively small sites, with one to two panels of petroglyphs at each. The professionally documented site is also quite small, with just three panels reported. The petroglyphs were described as a combination of geometric and figurative motifs, with a total estimate of 23 individual petroglyphs. None of the glyphs exhibit any significant degree of varnish accumulation, which suggests they are of the Formative era. The field recorder suggested they were likely of Aha Macav origin (White 2006).

In summary, petroglyph and pictograph sites are well represented in the study area, but unfortunately they are inadequately documented and little is known about them. The available information suggests they date from the Archaic through the Ethnohistoric era and tend to be associated with trails, springs, camps, and rockshelters, a relationship not lost on others (e.g., Christensen and Dickey 1998; Rector 1981). Indeed, Heizer and Baumhoff (1962:32) remarked that the association of petroglyphs with springs and tanks is a "common southern Nevada situation." Regarding their significance, most of these sites (n = 32) have not been evaluated for eligibility to the NRHP. This is because they were reported by avocationalists during surveys unrelated to federal undertakings. Two, including Highland Spring, have been recommended eligible for inclusion, while the one disturbed during road expansion was recommended as ineligible.

Quarries

The volcanic landscape of southern Nevada provides a range of lithic sources suitable for the manufacture of flaked stone artifacts. Twelve quarries of varying material and intensity of utilization have been documented within the study area, with several sites containing additional types of features and artifacts associated with the tool stone sourcing. Four additional quarries have been reported from multicomponent sites. Thus, quarrying is represented at 16 sites in the study area.

Four such quarries are reported from the Highland Range, all along the eastern piedmont that defines the southwestern edge of the Eldorado Valley. One of the four is so extensive that it stretches for more than 2.5 km and extends from the Highland Range's piedmont down into the Eldorado Valley. The material quarried at these sites was primarily rhyolite, although smaller proportions of basalt and andesite were also worked. The density of flaked stone debris from quarrying activity ranges from 1–3 pieces per m^2 to 10–20 pieces per m^2. In-field analyses of the debris suggest most of the quarrying was focused on tool stone acquisition, in which desirable pieces were taken elsewhere for further reduction.

There was some evidence for on-site tool manufacture, however, suggesting visitation to and use of these quarries factored into different mobility and resource acquisition practices. Two of these sites are recommended as ineligible for inclusion in the NRHP, one remains to be evaluated, and another was determined to be eligible by the Nevada SHPO. Its significance is based on the potential to chemically source fine-grained rhyolite (Coffman and Rasic 2015; Scharlotta 2010) and thereby study patterns of use and exchange in ways not possible from in-field analysis alone.

Four quarry sites have been documented within the Eldorado Valley region of the study area. All are situated atop desert pavement-covered, low terraces overlooking the south end of the valley's main drainage. The records are unclear about the stone material, but some of it is described as rhyolitic and some as semi-silicious. The material is likely volcanic colluvium from the nearby Highland Range. All four sites are similar in topographic setting and composition, suggesting they may be temporally related and constituent elements of a larger landscape of quarrying. The flaked stone artifacts are described as heavily patinated and embedded in the desert pavement, indicating they are quite old.

Based on these factors, as well as the presence of several rock circles and the total absence of ceramic artifacts and projectile points, the field recorders suggested these quarries and related materials may be associated with Rogers' (1966) San Dieguito complex. Importantly, a number of ground stone artifacts were found among these quarries, indicating that use of this part of the landscape was not limited to tool stone acquisition and stone tool manufacture. The four sites were documented almost 50 years ago and have not been revisited. They were never evaluated for eligibility to the NRHP, but the field recorders highly recommended additional study, probably due to their presumed great antiquity.

Another quarry is documented in the Newberry Mountains. It was described as a broad area of rhyolite procurement, with numerous reduction loci present within a general scattering of primary reduction debris. The other three documented quarries within the study area are located in the Piute Valley. One consists of two isolated boulders of rhyolite that have been lightly flaked. These appear to have simply been tested, as only a few decortication flakes were noted. Another quarry is on several patches of desert pavement on a ridge near the western foot of the Newberry Mountains. The worked material includes cobbles of chalcedony and chert quarried from the desert pavement. The other quarry is the Juan obsidian source, the only known obsidian source in the study area. This property is in the small part of the Piute Valley that divides the Castle and New York Mountains. This source is most commonly known

as Castle Mountains obsidian (Northwest Research 2019), even though the apparent source is from a dome in the New York Mountains (Wilke 1988).

Obsidian artifacts have been found at several of the artifact scatters and rockshelters documented within the study area, and this may be the source for some, or perhaps all of it. Specimens of Juan, or Castle Mountain obsidian, are relatively uncommon in archaeological assemblages outside the study area. For example, in a database of approximately 1,000 sourced obsidian artifacts from Clark County, Nevada, just one was from the Juan source (Ahlstrom 2012). Another was found in a cave along the northwest edge of the Ivanpah Valley (Rose et al. 2002). It appears to be a relatively minor obsidian source, although it is presumably more abundant in more localized archaeological contexts, a question that could be answered through sourcing from known sites in the study area.

One of the multicomponent sites is also a quarry below Crescent Peak at the north end of the New York Mountains. Unlike the other quarries, this one was for turquoise rather than some sort of tool stone. Rogers (1929, 1930) called this property the Crescent Turquoise Mines. It was commercially mined for about a decade beginning in the 1890s, at which time it was known as the Crescent Peak Mine, or the Toltec and Smithson Phillips Mines (see below). At the time of his visit in 1930, Rogers (1930) found that most of the Indigenous workings had been destroyed by the historic mining activity. He suggested the site was mined during the Amargosa III and Pueblo II periods, as those are the periods of turquoise mining he observed at other places farther west. Morrissey (1968) describes how George Simmons, the mine's purported discoverer, found stone hammers, chisels, and wedges laying around the mine along with large pieces of mined turquoise. He continues:

> Below the mine workings Simmons found a leveled terrace on which there had apparently been workshops and quarters for [Indigenous] miners. Remains were found of rude dugouts with collapsed roofs of logs and brush. At one end of the site was a kitchen midden of broken pottery, at the other end was evidence of a lapidary shop with rubbing and polishing stones and a huge quantity of tiny turquoise fragments. From a study of the growth rings in the logs found in the fallen roofs, and a study of the implements, archaeologists estimated the mine must have been worked and abandoned 200 years before Columbus reached America (Morrissey 1968:7).

The basis of Morrissey's (1968) account is not clear, as he failed to cite the source of his information, so it cannot currently be verified. In the forward to Morrissey's (1968) book, Vernon Scheid, the then-Director of the Nevada Bureau of Mines, writes:

> During his many visits to Nevada, Mr. Morrissey become acquainted with most of the turquoise miners, and from them, learned the locations and history of virtually every turquoise deposit in the State that had produced. Much of the information on the history, production, and previous ownership of the turquoise deposits was acquired by Mr. Morrissey through personal interviews and correspondence and is not a matter of published record. Mr. Lee Hand of Tonopah, Nev., and Mr. Ted Johnson of Tonopah and Fernley, Nev., in particular, contributed much information. Because many of the persons who supplied information to Mr. Morrissey have since died, the Nevada Bureau of Mines has been unable to check certain data (Scheid, in Morrissey 1968:3).

It would seem that an archaeological study of tree rings at such an early phase of Southwest archaeology would have been published, or at least better known, but that does not appear to be the case. During Rogers' site visit, all he observed around the mines was a metate and a couple flakes of jasper. He reported that a resident of Searchlight had found several stone mauls as well. Nevertheless, lithic and ceramic artifacts have been reported for the general area around the mines as recently as 15 years ago (Yoder and Brosman 2007). The Crescent Turquoise Mines have not yet been evaluated for eligibility for inclusion in the NRHP. That withstanding, with the recent breakthrough in chemical sourcing of turquoise, and specifically specimens from the Crescent Peak deposits (Thibodeau et al. 2015), additional research could lead to a much better understanding of the importance of these turquoise quarries in the past.

Rockshelters

Rockshelters are some of the most important contexts for archaeological research in the Southwest and Great Basin due to several factors, one being that they are an ideal setting for habitation given their sheltering nature. They are features of the natural landscape that attract human utilization by their very nature, a quality shared by springs (Chapter 2, this volume). Although the use of such shelters was embedded in specific modes of landscape interaction and systems of settlement and resource acquisition, their general appeal as places of refuge from the elements transcends cultural and social distinctions.

The use of rockshelters tracks from the Paleoindian period through the present, which is often traceable in the stratigraphic relationship of archaeological deposits in such contexts. This quality—the stratigraphic structure and integrity of time-sensitive material culture—is another reason research in rockshelters has been so productive. Finally, due to the dry depositional contexts of rockshelters, they can preserve organic material (e.g., woven objects, wooden implements, foodstuffs, feces) that would otherwise decompose if left in other settings.

Twenty-three of the historic properties documented in the study area contain rockshelters with some amount of human utilization. Any property with a utilized rockshelter is included in this category, even if the property contains material that conforms to another property type, such as petroglyphs. The Newberry Mountains contain seven such sites, the Castle Mountains and Highland Range each contain six, the southern McCullough Range has two, and the Dead Mountains and New York Mountains each have one. The site in the Dead Mountains is a separate record for the Granite Springs, as reviewed in the petroglyphs section. At least six rockshelters have been identified at Granite Springs with some evidence of human utilization, such as smoke-blackened ceilings or artifacts in or eroding from them. Observed artifacts include red- and buff-colored ceramics and utilized river cobbles.

Bedrock grinding features are situated on outcrops in the wash near the rockshelters. As with the petroglyphs at Granite Springs, the rockshelters and associated material have not been evaluated for inclusion in the NRHP. The rockshelter documented in the New York Mountains was described in 1981 as about 4.5 m in length, 1.5 m high, and 1.5 m deep, and pottery and flaked stone artifacts were observed inside. An effort to relocate the site in 2007 was unsuccessful, and it was never evaluated for the NRHP.

The two rockshelter sites in the southern McCullough Range were reported by Rogers (1930). He described one as a set of rockshelters on the south fork of Crescent Wash, presumably a reference to Big Tiger Wash. They contained pottery and had dense middens eroding down the talus below. He observed a pendant or atlatl weight in one and at least three metates among the debris on the talus. Rogers (1930) suggested these shelters were utilized only periodically and by people working the nearby turquoise mines. The other property he described was a single large cave on the north fork of Crescent Wash, again presumably Big Tiger Wash. Rogers (1930) partially excavated this rockshelter and described it as containing ceramics consistent with Lower Colorado Buff Ware, San Francisco Mountain Gray Ware, and Prescott Gray Ware. Neither of the rockshelter localities in the New York Mountains reported by Rogers (1930) have been evaluated for inclusion in the NRHP, and an effort in 2007 to relocate the rockshelter on the south fork was unsuccessful.

The six rockshelter sites reported from the Highland Range are situated along the its eastern front. These shelters overlook the Eldorado Valley below. At least eight rockshelters are present among a cluster of five sites, all of which are located within a 500-m-radius area. All the shelters show evidence of use, and most have some combination of pottery, flaked stone, and ground stone implements within them. At least one contains burned bone. The ground stone assemblage includes slab metates and/or

manos within seven of the shelters, indicating on-site processing of foodstuffs occurred. Nearly all the rockshelters have accumulations of refuse, or "middens," outside them that attest to their intensity and duration of use.

One of the rockshelters, a particularly large one measuring approximately 21.0 m long and 4.5 m deep, contains some 170 forked sticks of varying sizes inside and near the back wall. With only a few exceptions, the forked ends of the wooden implements point toward the back wall, and the sticks are laid out parallel to the wall. The purpose of the forked-stick arrangement is not clear, but the recorders postulated it could have been the support for a large rabbit net (Barker et al. 1979:v–4). The same shelter contains a pointed wooden implement as well, a further testament to the uniqueness of the site and the fine preservation of otherwise perishable objects in these settings.

The sixth documented rockshelter site in the Highland Range is some 7.5 km northwest of the cluster just described. Little is known about it, and a formal report was never prepared. It was described as a series of rockshelters with a midden eroding from it and down the talus. The midden contains a metate and mano, Lower Colorado Buff Ware pottery, and flaked stone debris. Four panels of petroglyphs adorn a cliff face below the rockshelters (Burkholder 1987).

Regarding the significance and integrity of the rockshelter localities in the Highland Range, the one with the associated petroglyphs awaits evaluation. As for the cluster of five sites around the prominent protuberance, the field recorders suggested two of the rockshelter sites were potentially eligible for inclusion in the NRHP and that the other three required test excavations to adequately evaluate their eligibility. Nonetheless, the recorders noted the potential for all five sites to be possibly eligible for the NRHP as an archaeological district, a suggestion with which the then-acting BLM archaeologist concurred by remarking that their research value amplifies when considered collectively.

The portion of the Newberry Mountains within the study area contains an additional seven documented historic properties centered on rockshelters. Two are along Christmas Tree Pass Road, but little is documented about them. A formal report was never prepared and the site record for one was missing from the NVCRIS system at the time of this study. The other is a small rockshelter created by the overhang of a large boulder. Fire-blackened rocks were noted inside, but it had been repurposed in the twentieth century as a stock-related feature, perhaps a holding pin, as evidenced by a set of axe-cut juniper posts around it and its proximity to a corral.

Three other rockshelter localities in the Newberry Mountains consist of single shelters, each with a single ground stone slab within them without additional artifacts or features. Two of these are near the northern end of the range overlooking the Piute Valley, while the other is near the mouth of a canyon along the southeastern foot of the mountains.

A sixth documented rockshelter locality in the Newberry Mountains is not officially recognized in the NVCRIS system, but was reported by McLane (2001), who described a rock-walled enclosure containing a ground stone slab and situated above a dry waterfall on the northern reach of the Newberry Mountains. The site overlooks the Piute Valley, and several boulders adorned with hard to see curvilinear petroglyphs are below the walled shelter.

The seventh rockshelter site reported from the Newberry Mountains is in a canyon on the northeastern flank of the mountain. The rockshelter contains ceramic, lithic, and burned faunal artifacts, as well as several overturned metates. The ceramics were described as both gray and orange in color, and one was

observed with black paint on a buff exterior. The shelter is also partially enclosed by a low rock wall. This rockshelter is above a tank in the canyon floor, and numerous, though inadequately, documented petroglyphs are scattered about. A rock feature in the form of connected circles, or rings, was noted on a small promontory above the rockshelter.

Regarding the significance of the documented Newberry Mountains rockshelter sites, only one has been evaluated for inclusion in the NRHP; it is recommended as ineligible because a shovel probe proved negative for subsurface deposits within it.

The Castle Mountains are the other landform within the study area where utilized rockshelters have been reported. All six documented sites are situated amid outcrops between the Castle Mountains and the Piute Range, opposite the Castle Mountains of the noted Juan obsidian source and the historic mining settlement of Juan. Three of the records were generated by non-archaeologists, and a final report was never prepared. Consequently, observations may not be as thorough as would be otherwise. The researchers were concerned primarily with the location of petroglyphs and pictographs, and the rockshelters were reported in the course of that effort.

One of these localities included a rockshelter with a petroglyph on a boulder in front, with at least five areas of faint red pictographs on the cliff face above the rockshelter and in two alcoves in the same general area. Aspects of the rockshelter were not reported other than it had been dug at some point in the past, presumably illegally. Another locality consists of two rockshelters with a concentration of faint red pictographs and a petroglyph below. The designs are reported as being abstract. Pottery and flaked stone artifacts were reported across the general area, and the presence of ground stone slabs and manos was also noted. A revisit in 2007 found burned bone but the ceramics could not be relocated. A shallow excavation hole was observed in one of the shelters. Another shelter was reported as being above a wash containing naturally occurring obsidian nodules, undoubtedly another exposure of the Juan obsidian source. This particular rockshelter was described as having a considerable amount of refuse scattered across the slope below the shelter. The refuse contains numerous ceramic and lithic artifacts, many of which are pieces of worked obsidian. Because these rockshelters were not formally recorded as part of an undertaking, they were never evaluated for eligibility to the NRHP.

Another rockshelter in the Castle Mountains, recorded during the Crescent Peak Wind Project, is described as exhibiting "significance evidence of prehistoric use" (Vicari et al. 2018:113). The shelter at this site contains internal thermal features and a smoke-blackened interior. The associated refuse is extensive and includes an abundance of complete and broken ground stone implements, flaked stone artifacts comprised primarily of locally quarried rhyolite with a lesser amount of obsidian, and dozens of gray ware and buff ware ceramics. The recording team recommended the site eligible for inclusion in the NRHP, as it has good potential to elucidate on Indigenous technology, subsistence, and history in the region due to its integrity as an unlooted and unexcavated rockshelter with rich deposits.

Another rockshelter in this topographic region contains a similar assortment of material, including rhyolite and obsidian lithics and Lower Colorado Buff Ware, but is notably different by the presence of more than 200 pictographs lining its back wall. The pictographs, which were featured in Christensen and Dickey (1996), are described as Great Basin Abstract and are in shades of red, red-orange, orange, white, yellow, dark red, black, gray, brown-orange, brown-yellow, and polychrome. Also inside the shelter and below the pictographs are a range of bedrock grinding features, including 92 cupules, 8 slicks, 7 basin metates, and 4 mortars. Among the cupules are three petroglyphs, two of which incorporate cupules into their patterns. One of the petroglyphs has red pigment within, indicating it had also been

painted. Although the team that documented the site were not professional archaeologists, and the project was not part of an undertaking, they recommend the rockshelter as eligible to the NRHP. The significance is due to the rich deposits in the shelter, but more so, the quality and quantity of the pictographs. Of particular note is the well-preserved nature of the red pictographs, as these are usually highly weathered in other settings, and the ability to distinguish finger-painted versus brush-painted motifs. Further, polychrome pictographs and painted petroglyphs such as these are rare in the Mojave Desert.

Lewis Holes, the sixth documented rockshelter locality in the Castle Mountains, is best known for the petroglyphs found there (Heizer and Baumhoff 1962:32). Two small rockshelters are high on a ridge above a cluster of petroglyphs. The petroglyphs are concentrated on a knife-like dike of granite that runs from the top of the ridge to its base. Additional petroglyphs are scattered about the surrounding boulders and smaller outcroppings of bedrock. Although the petroglyphs have never been formally documented and inventoried, they conform to the Great Basin Curvilinear, Great Basin Rectilinear, and Grapevine Canyon styles. The shelters are reported to contain ceramic and lithic artifacts, including pieces of obsidian. On the valley floor below the petroglyphs is an area Haenszel (1965) called a "campsite." That portion of the site area was reported to have pottery, although a 2007 site update only noted flaked stone in that zone. The camp site may be just across the state line and in California. Blair (1995) reported several sites there, with Indigenous ceramic and lithic artifacts, as well as nineteenth century artifacts associated with the Eldorado Road (see below).

While the site has not yet been evaluated for eligibility to the NRHP, Lewis Holes is a more notable and historically significant place than the available site documentation conveys. It is the site of a set of springs, hence the name. The nearby Stray Cow Well and Windmill tap into this groundwater source. The place is designated "Lewis Spring" on an early map (Rand McNally and Company 1889:252). The place was photographed in 1863 by Rudolph D'Heureuse, who evidently visited while scouting for precious metals at Eldorado Canyon and places throughout the Mojave Desert (Lapides 2018). D'Heureuse's image shows a set of covered wagons, men, and horses huddled around a fire, with one person apparently fetching water from the spring (Figure 6.1).

Traditional Cultural Places

As explained in Chapter 5, TCPs are a unique type of historic property because they are not necessarily associated with an anthropogenic material record, such as artifacts, buildings, or other features of the built environment. TCPs are places associated "with the cultural practices or beliefs of a living community that are: (a) rooted in that community's history; and (b) important in maintaining the continuing cultural identity of the community" (National Park Service [NPS] 1998). Such places can be elements of the built environment, or otherwise recognized as archaeological or historic sites, but they need not be. Unmodified landforms, bodies of water, sites of significant events, places where important plant and animal resources are gathered, and so forth can all be considered TCPs regardless of the presence or absence of artifacts and anthropogenic features (i.e., "tangible resources") emblematic of the significance of the site. By their nature, any inventory and evaluation of TCPs requires the involvement of extant communities (Bureua of Land Management [BLM] 2016:X–4).

Spirit Mountain is the only NRHP-listed TCP within the study area, and it was the first in the state of Nevada. As an administrative unit, the Spirit Mountain TCP covers 2,214 acres of land centered on the top of the mountain, with 1,532 acres (69 percent) located within the Lake Mead National Recreation Area (and thus outside the study area) and 682 acres (31 percent) on BLM-managed land. The property



Figure 6.1. Rudolph d'Heureuse's photograph of Lewis Holes in 1863 (courtesy of the Bancroft Library, University of California, Berkeley).

was listed to the NRHP in 1999 via a joint nomination by the BLM and the National Park Service (NPS) (Ellis-Pinto and Rolf 1999). The successful nomination was based on Criterion A, "association with events that have made a significant contribution to the broad patterns of our history," and Criterion B, "association with the lives of persons significant in our history" (see NPS 1990:11).

The mountain, Avi Kwa Ame in the Yuman language, is the spiritual birthplace of all Yuman Tribes (Criterion A), and it is closely tied to Mustamho, a spiritual culture hero of several Yuman Tribes who took them to the top of Spirit Mountain before sending them off to settle in their traditional homelands (Criterion B). Thus, the period of significance for the site extends from creation to the present, and its historic and current functions revolve around the landform's role as a ceremonial site and its place in Yuman religion (greater detail is provided in Chapter 7, this volume).

While the entirety of Spirit Mountain is considered sacred—it is the Avi Kwa Ame of Yuman cosmology and ontology—the administrative boundary of the Spirit Mountain TCP is restricted to the highest reaches of the mountain. For the Aha Macav, however, Avi Kwa Ame is the whole mountain mass, not just the peak (Kroeber 1972:22n1). This disjunction between the size and location of the TCP and the actual extent of land that constitutes Avi Kwa Ame has a complicated history. In the early 1990s, the NPS began developing a program of research and management regarding that portion of Avi Kwa Ame within the boundary of the Lake Mead National Recreation Area. The agency was exploring the possibility of nominating a portion of Avi Kwa Ame to the NRHP as a TCP, but at the time, they simply referred to it as a "study area." Their program involved archaeological survey and site assessment

on NPS-administered lands flanking the mountain, but not the mountain itself (Fox 1993, 1994). It also entailed development of a Native American research plan to address issues important to associated Tribes (Baksh 1995).

A pertinent recommendation that arose from both the archaeological and ethnographic initiatives was that the preliminary boundary of the NPS's study area for a potential Spirit Mountain TCP was too small. The archaeologists suggested the boundary be expanded to include cultural resources associated with Avi Kwa Ame, while Tribal advisors wanted to have the entire mountain recognized as a TCP regardless of the administrative boundary between BLM and Lake Mead National Recreation Area that essentially runs down the center of the mountain.

Around the time the NPS was exploring the TCP designation for the portion of Avi Kwa Ame within Lake Mead National Recreation Area, the BLM was similarly engaged in an initiative to recognize a Spirit Mountain TCP. BLM archaeologists recorded the Spirit Mountain TCP in 1994 (Myhrer 1994), but at that time, the TCP was limited to BLM-administered lands—its eastern boundary was simultaneously the boundary with the adjacent Lake Mead National Recreation Area. From there, the BLM extended the TCP boundary south to Christmas Tree Pass Road and west to a road associated with the Roman Mine. The rest of the boundary was defined by a set of washes that intersect the Roman Mine road to create a bounded area atop the mountain.

The boundary of the Spirit Mountain TCP was so narrowly and arbitrarily designated in an effort to establish the integrity of the property's condition, an essential element of an NRHP recommendation. The reason for defining the boundary of the TCP in such a way was to exclude portions of the mountain for which its physical integrity had been comprised through either disturbance or development. Consequently, a notable spire of Ava Kwa Ame was excluded from the TCP because a communications facility was erected atop it in 1960 and was still in operation.

That the narrowly bounded Spirit Mountain TCP did not encompass the full extent of the landscape for which the TCP is significant to living communities was not lost on the BLM. To recognize the continued and ongoing importance of this mountain to contemporary Tribal communities, the BLM proposed to establish a Spirit Mountain Traditional Lifeway Area (TLA) to cover the BLM-administrated portion of the landform outside of but encompassing the Spirit Mountain TCP (BLM 1994).

The TLA concept was developed by BLM Nevada to provide administrative protection for relatively large landscapes associated with traditional values and cultural practices. As originally conceived, they were to be "treated as properties eligible for nomination to the National Register of Historic Places and subject to consultation under Section 106 of the National Historic Preservation Act" (BLM 1994:2–23, emphasis omitted). The purposed of the proposed TLA was to direct future undertakings on and around Avi Kwa Ame that, while outside the TCP, was still of extreme traditional, cultural, and spiritual value to living communities, principally the Yuman Tribes. The Spirit Mountain TLA proposal was an attempt to alleviate increasing Tribal concern regarding the expansion of the communication facility atop Avi Kwa Ame since 1960 and the pending review of permits for related undertakings (Blair 1996a:13–14). It was implemented in 1995 by the BLM in the Stateline Resource Management Plan.

Following site recording and delineation of a boundary around the Spirit Mountain TCP, the BLM began a program of Tribal consultation and outreach in advance of submitting a formal nomination to the Keeper of the NRHP. The first planning meeting involving Tribes was held in 1995 and included representatives of the Fort Mojave Indian Tribe, Colorado River Indian Tribes, Hopi Tribe, Hualapai

Tribe, Yavapai (tribe unspecified), Quechan Tribe of the Fort Yuma Reservation, and Chemehuevi Tribe. Letters inviting comment were also solicited from the Salt River Pima-Maricopa Indian Tribe, Cocopah Indian Tribe, Havasupai Tribe, Pueblo of Zuni, and the Moapa, Las Vegas, Pahrump, and Shivwits Bands of the Nuwuvi. Respondents and participants were unanimous in their support for the TCP nomination.

With Tribal support secured, BLM convened with the NPS in 1996 to begin consideration of an interagency nomination of the Spirit Mountain TCP to the NRHP. The NPS had previously voiced interest in developing a cooperative arrangement with the BLM to more effectively manage and protect Avi Kwa Ame (Baksh 1995). Rather than designate an Avi Kwa Ame TCP, the agencies opted to name it the Spirit Mountain TCP at the request of Aha Macav elders who did not want the Tribal name appropriated in such a manner. Under the joint nomination, the TCP boundary remained unchanged on BLM-administered land but was expanded to include a portion of the mountain within the Lake Mead National Recreation Area that was part of the NPS's original study area. However, despite the archaeologists' recommendation to expand the boundary to include certain cultural resources associated with Avi Kwa Ame, the ultimate boundary expansion into the Lake Mead National Recreation Area was based in large part on the *absence* of archaeological sites and artifacts around the peak of the mountain.

That determination was based on observations that such properties are found around the base of the mountain but not in higher elevations. Their absence at the higher reaches signals that secular activities were not conducted there, and this zone of non-secular activity around the summit of Avi Kwa Ame was taken as a de facto boundary around the mostly religiously significant portion of the mountain, as well as its exclusive use by the Aha Macav. The boundary of the Spirit Mountain TCP was ultimately based primarily on the perspectives and concerns of the federal land agencies. The associated Tribes have always maintained that the boundary was inadequate in size and the legal protections lacking in power and effect to properly protect the most sacred place in their traditional landscape and the center of their spirituality. Indeed, there have been several Tribally informed recommendations to reassess and revise the boundary of the Spirit Mountain TCP (Deur 2014; Deur and the AhaMakav Cultural Society 2018; Deur and Confer 2012). To date, there has been no action to do so.

While Spirt Mountain is the only TCP within the study area listed on the NRHP, the region has not been systemically inventoried for additional places that might also qualify as TCPs. Associated living communities may regard any number of natural features, landscapes, and archaeological properties within the study area as integral to their cultural practices and beliefs or as otherwise important to the maintenance of their cultural identity. For example, the Fort Mojave Indian Tribe has identified the Mojave Road (see below), the Dead Mountains, and spiritually significant corridors and viewsheds between Avi Kwa Ame and the Mohave Valley as potential TCPs, or as contributing properties to a TCP district (Deur and the Aha Makav Cultural Society 2018). While that endeavor awaits future fieldwork and government to government consultation between the BLM, other federal agencies, and Tribes, one of the documented historic properties within the study area may be another place of interest in that regard.

Haenszel (1965) provided a cultural resources record for the site of a battle between Southern Paiutes (the Las Vegas group?) and Chemehuevi near the Crescent townsite. Her source of information about the site and the battle was apparently Mrs. M. A. Peters of Boulder City, who is likely now deceased. The information about the site and the event derives from oral history rather than the material record. Haenszel's (1965) record does not provide any specifics on the battle or details on how such a place is recognizable today. In this context, it is worth noting that Malcolm Rogers reported, on his site record

for a rockshelter along the south fork of Crescent Wash (see above), that miners informed him in 1930 that a "Paiute" camp was once located in the vicinity of the Crescent townsite in the 1880s. Inquiry with traditional cultural knowledge holders and historians from the various Nuwuvi bands and Chemehuevi may well provide additional detail on this place and its significance.

Trails

Despite the Piute Valley being a natural corridor, only three Indigenous trail sites have been documented within the study area. One is a trail segment that follows the edge of a wash into the southern end of the McCullough Range. No artifacts were found in association with it. Two more trail segments were documented along the eastern foot of the Newberry Mountains. One is about 200 m long and the other 600 m long; both are 30–40 cm wide. Both trails lead upslope and into washes draining the mountains, at which point they are no longer evident on the ground surface. One of the trails leads into the canyon with Hiko Springs and may have been one of the access routes to that important place. It is unclear where the other trail leads, but an unmodified quartz crystal was found along it. The trail in the McCullough Range has not yet been evaluated for inclusion in the NRHP, but the two trail segments in the Newberry Mountains have both been determined ineligible by the Nevada SHPO.

Indigenous trails are likely an underreported dimension of the cultural landscape within the study area. Difficulty in distinguishing anthropogenic trails versus game trails is likely one reason, and that many roads probably repurposed older trails, and thus obfuscate or obliterate them, is another. There are clues, however, to the general locations and orientations of several Indigenous trails that cross the study area but have not yet been identified on the ground. For example, in Rogers' (n.d.) record for the Hiko Springs petroglyph site, he wrote: "A trail from the [Colorado] river and another from the southwest up Chemehuevi Canyon come together here and go as one to the west and M-75 [Piute Spring]." Thus, it would seem that Rogers (n.d.) identified an Indigenous trail that stretched between the Aha Macav villages in the north end of the Mohave Valley to Piute Spring, in the portion of the Piute Valley between the Dead Mountains and Piute Range. This trail would have passed around the north end of the Dead Mountains and through the southeastern portion of the study area. At Piute Spring, it would have fed into a larger network of trails that comprise the Mojave Trail system.

Rogers (n.d.) made another important observation about an undocumented Indigenous trail within the study area. In his record for the Cow Spring petroglyph site in the Highland Range, Rogers (n.d.) wrote: "A strong Indian trail which comes down from the north by Cow Spring bends off to the southwest into Crescent Pass and merges with the Ivanpah-Colorado River Trail which runs east-west. The latter goes down Searchlight Wash." Searchlight Wash is an apparent reference to an unnamed, west to east drainage wash that extends between Searchlight and the Colorado River via a pass between Fourth of July Mountain and the main ridge of the Ireteba Peaks. Rogers' (n.d.) observation indicates trails leading to discrete sites of importance within the mountain ranges, such as springs, connected them into large trail networks. Archaeological sites, while bounded by the presence and absence of artifacts and anthropogenic modifications to the landscape, are actually part of a web of cultural practice spread across the study area.

The route of present-day Cottonwood Cove Road may approximate the route of the section of Rogers' (n.d.) Ivanpah-Colorado River Trail between Searchlight and the Colorado River. An additional observation of a major east-west Indigenous trail extending from the Ivanpah Valley, through the vicinity of Searchlight, and on to the Colorado River comes from the Army Corps of Engineers' geographical

surveys west of the 100th meridian, under the direction of Lieutenant George Wheeler. In 1875, Eric Bergland, First Lieutenant of Engineers in Party No. 3 of the California Section, traveled from Los Angeles, California to the vicinity of Needles, California to assess the viability of redirecting the Colorado River west to irrigate farms in southern California.

Bergland (1876:111) reported that from the mining camp of Ivanpah, in the Ivanpah Valley, the party followed an "Indian trail" eastward across a large dry basin and over a range of mountains before descending down "a gradual slope to the Colorado River at Cottonwood Island." He added: "From Ivanpah to the summit of the river range, [the trail is] practicable for riding and pack animals. From the summit to the river there is a gradual slope, the trail which follows the bed of the wash being practicable for wagons" (Bergland 1876:111). Bergland's (1876) description suggests this well-defined Indigenous trail passed east from the Ivanpah Valley, across the Piute Valley, through the divide between the Newberry Mountains and Ireteba Peaks, and down Cottonwood Valley to reach Cottonwood Island (presently submerged under Lake Mohave). Importantly, Bergland's (1876) description of the trail west of Ivanpah indicates it continued southwest to Fork of the Roads, a major junction along the Mojave Trail. This route was probably another branch in this important east-west corridor, just as the one Rogers (n.d.) described for Hiko Springs. Davidson (2009) suggests trails leading west from Cottonwood Valley and connecting to the Mojave Trail enabled travelers to circumvent the Aha Macav villages in the Mohave Valley to the south.

EURO-AMERICAN PROPERTIES

Energy and Utility Conduits

The study area has been the target of multiple pipeline and transmission projects, undoubtedly due to the favorable relief afforded by the Piute Valley (see Chapter 5). The infrastructure associated with some of those projects is now old enough that it merits evaluation for eligibility to the NRHP. Six historic energy- and utility-related historic properties have been documented within or passing through the study area. These include the Eldorado-Lugo and Eldorado-Mohave 500kV transmission lines and associated 220kV circuits, which are different lines of Southern California Edison's Eldorado 500kV Transmission Line system designed to deliver electricity from Hoover Dam to various regions. The Eldorado-Lugo line was raised in 1968–1969 to support suburban expansion in southern California following World War II. The Eldorado-Mohave line was also built in the late 1960s but as part of the Pacific Northwest-Pacific Southwest Intertie that conveyed hydroelectric power from the Pacific Northwest to southern California.

A third historic electricity conduit, the Davis-Hoover Transmission Line (also known as the Hoover-Mead Transmission Line), passes through the Eldorado Valley portion of the study area. It was raised in 1951 to connect the generating and transmission systems at the Hoover Dam with those at Davis Dam, near Laughlin. The historic Southwest Gas Pipeline also passes through the Piute Valley on its course between Laughlin and Las Vegas. The original line was laid in 1953 with additional parallel lines added in 1956 and 1968. The Eldorado-Lugo and Eldorado-Mohave Transmission Lines are recommended as eligible for inclusion in the NRHP, while the Davis-Hoover Transmission Line natural gas pipeline are recommended as ineligible.

In addition to energy conduits, the study area contains the remnants of two documented historic utility lines. One is a telephone line between Searchlight and Nipton, California built in 1906 by the Search-

light Telephone, Telegraph, and Electric Company. The other is a powerline that delivered electricity from Searchlight to Walking Box Ranch, and possibly places beyond. The Nevada SHPO has deemed both historic utility lines as ineligible for inclusion in the NRHP.

Homesteading and Ranching Sites

Outside of mining, the principal economic venture in southern Nevada has been cattle ranching (Young and Sparks 2002). Homesteading and ranching were closely entwined, in part by the passage of the Enlarged Homestead Act in 1909 and the Stock Raising Homestead Act in 1916 that promoted the settlement of regions in which irrigation farming was not feasible (Layton 1988). Ranching operations spread out across the broader landscape were tethered to smaller, individual homesteads. It was the Taylor Grazing Act of 1934, however, that led to a formalize ranching landscape. The law required ranchers to develop multiple water sources so as to not have too much impact on any one place. It also compelled them to delineate their range lands with fences, corrals, and the sort.

Several of the 21 properties with homesteading and ranching related cultural resources within the study area are a product, in some fashion, of the Taylor Grazing Act. Eleven should be regarding as ranching complexes, as they consist of multiple features and often include some combination of corrals, wells, troughs, fences, outbuildings, and roads. Many of these are depicted as corrals or wells on USGS maps from the mid-twentieth century, and all apparently date to the twentieth century based on the field recorders' assessments of construction styles, associated artifact, and other indicators.

Ten other properties in this group are better considered as homesteads, or related to homesteads or other historic residential activities. Six are dilapidated structures with associated residential debris that have not yet been attributed to a specific individual but that date to the first half of the twentieth century. Another property is a possible historic grave, while another is the Searchlight Memorial Cemetery. A wooden cabin built in 1903 in Manville, California was moved and refurbished around Crescent in the late 1970s, although that property was not located during a recent survey. Another property in the Newberry Mountains is the homestead of Rosie McDonald, who settled there around 1930 following the death of her husband. Of those just described, one is recommended eligible for inclusion in the NRHP, seven were recommended ineligible, and four are deemed ineligible by the Nevada SHPO.

Perhaps the best known historic property in the study area is the Walking Box Ranch (Wollan et al. 2008). This ranch was originally part of the Rock Springs Land and Cattle Company that operated across a broad region of southern Nevada and adjacent portions of California. The property was bought in 1931 by Rex Bell and Clara Bow, who proceeded to improve the property as a residence. The couple, of Hollywood status, built a ranch house and guest house in the Spanish Colonial style. The property includes a multiplicity of other structures and facilities. While owned by Bell and Bow, the ranch was a popular vacation destination for their Hollywood associates, with visitors including Lionel Barrymore, Carole Lombard, and Clark Gable.

The couple sold the property to Karl Weikel in 1952, who continued to operate it as a cattle ranch until he sold it to the Viceroy Gold Corporation in 1990. Following a period of use as a corporate retreat, the ranch changed hands several times before the University of Nevada, Las Vegas and the BLM took control in 2005. The 160-acre core of the ranch was listed on the NRHP in 2009.

Military Training Areas

The study area is situated within the areas of disturbance of two mid-twentieth century military training operations (Prose 1986). The first took place from 1942 to 1944 to ready armored vehicles divisions for combat in North Africa during World War II. Under the command of General George S. Patton, the Desert Training Center, California-Arizona Maneuver Area witnessed more than one million troops accompanied by thousands of trucks, jeeps, tanks, and planes carry out simulated battles and war games (Bischoff 2000; Meller 1946). Operations stretched across 17,500 mi^2 of the Mojave and Sonoran Deserts in California, Nevada, and Arizona.

The second operation was the Cold War-era Operation Desert Strike (also known as Joint Exercise Desert Strike) that took place over two weeks in May 1964 (Gantz et al. 1964). Nearly 100,000 soldiers and hundreds of tanks and aircraft took part in the mock conflict to assess the joint-strike capabilities of active and reserve Army units in the context of nuclear-age tactics and technology.

Ten historic military training areas have been identified within the study area. Nine of these are concentrated in the New York Mountains and the adjacent portion of the Piute Valley, while the other is in the Chiquita Hills. The nine in and around the New York Mountains are areas of refuse associated with military training exercises, such as spent ammunition cartridges, machine gun belt links, P-38 opened ration cans, plastic ration spoons, and other miscellaneous artifacts. The site in the Chiquita Hills includes similar refuse but shows additional evidence of training operations, such as foxholes, low rock walls, and gun turrets.

Based largely on the dimensions of ration cans (Wedding et al. 2012) and diagnostics of the munitions cartridges, the nine sites in and around the New York Mountains were dated to 1958–1984 and are, thus, almost certainly associated with Operation Desert Strike. None of those are recommended as eligible for inclusion in the NRHP. The site in the Chiquita Hills contains a mixture of ration cans and munitions that suggest it was involved in both the Desert Training Center maneuvers in the early 1940s and Operation Desert Strike. The original site record for this property recommended it as eligible for inclusion in the NRHP; however, a subsequent update suggested further investigation is needed to appropriately evaluate the property's NRHP eligibility (Gruis and Switalski 2008).

Mining Localities and Features

Considered here, mining localities and features include an assortment of properties, such as adits, shafts, prospecting pits, tailings piles, and so forth. Mining-related cultural resources are the second-most numerous type of historic property documented within the study area. This strong representation is due, in part, to the significant role mining has played in the history of southern Nevada, and in other part, to a multi-agency initiative to document and close several hundred known hazardous mining features in Clark County (White et al. 2008). Their identification and recordation has been less random and circumstantial than the other types of cultural resources within the study area.

Mining began in earnest in the 1890s with the discovery of valuable mineral and metal commodities such as turquoise, gold, silver, copper, lead, and molybdenum in and around the Searchlight, Crescent, and Newberry Mining Districts (Chapter 4, this volume). Most of the mining localities and features

within the study area are in the New York Mountains and south McCullough Range and are therefore part of the Crescent Mining District. Notable documented historic properties associated with the Crescent Mining District within the study area include Morgan's Mill and the Crescent Peak, Silver Bell, Luck Lode, and Marlboro Mines.

The historic Crescent Peak Mine is actually two mines, the Toltec and Smithson-Phillips Mines, on the southern slope of Crescent Peak at the northern terminus of the New York Mountains (Longwell et al. 1965:167; Morrissey 1968:6; Vanderburg 1937:24). It is the same property described as the Crescent Turquoise Mines that has a long history of Indigenous utilization (Rogers 1930). The Euro-American exploitation of this mine began circa 1894. The "discovery" of these mines has been attributed to two different people.

According to Lincoln (1923:19), a Native American known as Prospector Johnnie found the turquoise deposits in 1894. Another account, provided by Morrissey (1968:7), relates the discovery in 1889 or 1890 by George Simmons, who sold the mine to J. R. Woods in 1896. Morgan's Mine, another turquoise extract operation located about 5 km west of Crescent Peak and south of the Crescent townsite, lies within the study area but does not have a corresponding cultural resource record. Its operation was roughly contemporaneous with that of the Crescent Peak Mine, with peak activity subsiding around 1906 (Vanderburg 1937:25). While Morgan's Mine has yet to be documented and reported, remains of the associated stamp mill ("Morgan's Mill") and additional facilities nearer the Crescent town site have been.

Turquoise aside, the Crescent Mining District is best known for its metal deposits, with Euro-American extraction beginning in earnest around 1905 (Vanderburg 1937:19–26). Chief production occurred in 1905–1907, 1911, 1930, and 1934–1941 (Longwell et al. 1965:139). Precious metals were also the principal draw to the Searchlight and Newberry Mining Districts, and mining operations in those regions were most productive in the early twentieth century as well. Notable mines of the Searchlight District that lie either wholely or partly within the proposed Avi Kwa Ame National Monument include the St. Louis, Rockefeller, and Copper Mountain Mines, all positioned in or near the Ireteba Peaks east of Searchlight. Of those, only properties located near the Rockefeller Mine have been inventoried and professionally documented to date. One prominent mine of the Eldorado District, the Belmont-Phoenix Mine, is situated northeast of Searchlight at the northern end of the Ireteba Peaks, but it too lacks any corresponding cultural resource records.

Most of the historic mining localities and features in the study area are associated with a period of intensive metal extraction during the first half of the twentieth century. Unique properties include an early twentieth century arrastra, or ore grinder, at the Luck Lode Mine. That property, which lies within in the Crescent Mining District, and two others in the Searchlight Mining District, have been deemed eligible for inclusion in the NRHP by the Nevada SHPO. Four others, two in the Searchlight and one each in the Crescent and Newberry Mining Districts, are recommended eligible.

The remainder of the documented historic mining localities and features are either recommended ineligible (n = 55), determined to be ineligible (n = 5), or have not yet been evaluated (n = 2) for inclusion in the NRHP. However, descriptions of the mining operations associated with the three mining districts within the study area, and comparison with USGS topographic maps, makes clear that many mining localities and features have yet to be documented.

Miscellaneous Rock Features

Thirteen properties with miscellaneous rock features of Euro-American origin have been documented within the study area, all of them in upland or mountainous settings. Nearly all of these are described as piles of rock, or cairns, some of which have twentieth century artifacts associated with them. One of the cairns is associated with a walking trail in the New York Mountains. This class of Euro-American cultural resources also includes a rock ring in the New York Mountains with early twentieth century artifacts associated. Another is a set of three dry-laid rock walls in the New York Mountains, evidently the remains of an ephemeral structure of unknown purpose. None of these are recommended eligible for inclusion in the NRHP, and the Nevada SHPO deemed four as ineligible.

Refuse Scatters

Much like the artifact scatters discussed under Indigenous properties, historic Euro-American refuse scatters are the most numerous type of historic property within the study area, as well as the most ubiquitous, having been documented within 12 of the 17 topographic regions. These properties range from single artifacts, such as a can or the base of a bottle, to dense concentrations of discarded glass, ceramic, metal, and even plastic items. The ages are equally broad, with some material possibly dating to the late nineteenth century but most to the early and mid-twentieth century. Some date as late as the 1960s.

Regarding significance, BLM Nevada and the Nevada SHPO have jointly agreed that historic artifact scatters that cannot be definitely linked to a specific historic context or theme outlined in the state's preservation plan (Nevada State Historic Preservation Office 2020) and that are not depicted on certain maps, are categorically ineligible for inclusion in the NRHP (BLM 2014:18). None of the Euro-American refuse scatters within the study area have been definitely associated with a significant person, event, or historic theme, and consequently, none are recommended or have been determined eligible for the NRHP. Based on a preliminary assessment, however, Deur and the Aha Makav Cultural Society (2018) suggested the Mojave Road, including the yet to be formally documented section in Nevada and within the proposed national monument, could merit treatment as a TCP given the road's prior existence as an important Indigenous trail tied to Creation narratives.

Settlements

No current settlements are located within the study area, although the communities of Cal-Nev-Ari, Palm Gardens, and Searchlight are surrounded by it. However, portions of three historic and now-defunct settlements on BLM-administered land are within the study area. Juan was a small mining camp adjacent to the Barnwell to Searchlight Railroad (see below). The settlement was at the northern terminus of the Castle Mountains and spread into the Piute Valley as it crosses the Nevada-California state line. The settlement is shown on a 1924 map of Nevada (Rand McNally and Company 1924:447). The resource of interest was perlite. The property is described as containing open perlite mines, old roads, former residential area, and a landing strip. It has not been evaluated for the NRHP.

Another historic settlement within the study area is Crescent, the central hub of the Crescent Mining District. This property is at the southern end of the McCullough Range, near where it abuts the New

York Mountains and spreads out into the McCullough-Lucy Gray Traverse. It was established around 1905, after the discovery of gold in the area and was located along the Searchlight to Nipton Road (see below). It is shown on a 1911 map of Nevada (Rand McNally 1911:321). The property includes the remains of buildings, wells, roads, and mines. A final settlement within the study area consists of a fairly dense refuse scatter in the Piute Valley, at the north end of the Castle Mountains and along the Barnwell to Searchlight Railroad (see below). Based on its location and artifact assemblage, it is interpreted as a possible labor camp associated with construction and/or operation of the railroad. The Crescent townsite was recommended as eligible for inclusion in the NRHP, while the Nevada SHPO deemed the unnamed labor camp ineligible.

Transportation Facilities

As with the energy and utility conduits, the low-relief valley settings within the study area are ideal contexts for vehicular transportation corridors and related infrastructure. Nineteen historic transportation-related properties have been documented within the study area. Most of these (n = 10) are unnamed two-tracks of uncertain age. Named roads include Crescent Peak Road, 7 Mile Road, Road to Eldorado, Searchlight to Nipton Road, and U.S. 95. Planning for U.S. 95 through Nevada was finalized in 1940, and construction began shortly thereafter. Piute Bridge, built in 1941 and altered in 1981, is an element of U.S. 95 but is considered a separate historic property within the NVCRIS.

The Searchlight to Nipton Road cuts through the pass between the New York Mountains and McCullough Range and, thus, through the Crescent Mining District. It was a major east-west artery at the turn of the twentieth century and was used by the Searchlight Stage and Freight Line beginning in 1904 as a conduit between Nipton and Searchlight as well as the surrounding mining camps. The Nevada Transportation Company of South Dakota filed an application in 1908 to operate a toll road over this route. This road was improved over the years, with slight readjustments to its course, and it was eventually designated as SR 68.

The Road to Eldorado lies in the Piute Valley immediately east of the pass between the New York Mountains and McCullough Range. It was in use by at least the 1880s, as determined by associated artifacts and its depiction on the 1884 General Land Office (GLO) map. It may be a segment of the same wagon road recognized as the Searchlight to Nipton Road. Crescent Peak Road and 7 Mile Road lie in the New York Mountains and were in use by the early twentieth century. They facilitated access to the mining operations in and around the Crescent Mining District. Regarding significance, only the Searchlight to Nipton Road and the Road to Eldorado have been deemed eligible for inclusion in the NRHP by the Nevada SHPO. The other roads are recommended ineligible, or in the case of three of them, deemed so by the Nevada SHPO.

In addition to roads, the documented historic transportation facilities within study area include the Barnwell-Searchlight Railroad. This short-line railroad was built in 1906 and 1907 by the Barnwell & Searchlight Railway Company, a subsidiary of the Atchison, Topeka and Santa Fe Railway. It served to bring the then-booming mining town of Searchlight into its rail network at Goffs, California, where it connected to the then-main Santa Fe line running between Needles and Mojave. It was consolidated into the California, Arizona and Santa Fe Railway Company in 1911. A section of the track was washed out in 1923, and the line was subsequently abandoned in 1924 (Robertson 1998:76).

While the bed of the railroad remains, most of the associated infrastructure, including ties and rails, has been removed, and the remaining graded bed has since been used as a road. Artifacts associated with the rail are still present, and the cultural resources inventory includes a record for a single railroad spike that would otherwise be considered an isolated find. Nonetheless, the railroad has been so modified that it lacks integrity, and the Nevada SHPO has determined it ineligible for inclusion in the NRHP.

As for the Indigenous trails described above, there is historical documentation for important roads that crossed the study area but that have not yet been inventoried by cultural resources surveys within the state of Nevada. One of these is the historic Mojave Road that ascends "Beale's Pass" between the Dead and Newberry Mountains as it climbs west from the vicinity of the former Beaver Lake along the Colorado River (Chapter 4, this volume). The general location of this road is well known (see Figure 4.2), and it is often depicted on maps as "Old Government Road." Many sections of the road have been inventoried and evaluated in California, and portions of it within the Mojave National Preserve are recognized as part of the Old Spanish National Historic Trail (BLM and NPS 2017) and were added as a district to the NRHP in September 2021 (Livingston et al. 2020). However, the section in Nevada, between the Piute Valley and Colorado River that arcs around the north end of the Dead Mountains, has never been professionally inventoried, mapped, or evaluated for eligibility to the NRHP. Based on a preliminary assessment, however, Deur and the Aha Makav Cultural Society (2018) suggested the Mojave Road, including the yet to be formally documented section in Nevada and within the proposed national monument, could merit treatment as a TCP given the road's prior existence as an important Indigenous trail tied to Creation narratives.

The Eldorado Canyon Cut-Off is another important historic road crossing the study area that has not yet been inventoried within the state of Nevada. This pack trail and later wagon road, whose use began in the early 1860s, stretched northeast from the vicinity of Rock Spring in the Lanfair Valley to reach Eldorado Canyon, northeast of the study area (see Figure 4.2). Lewis Holes was a noted way-point along the route as it wound its way through the Castle Mountains. The stretch of this road in California has been identified and mapped north to the state boundary, just south of Lewis Holes. Wilke and McCarthy (1987:66) suggest the old road could be eligible for inclusion in the NRHP if more reliably identified and its integrity more fully assessed than what is presently known.

CHAPTER 7

THE INTANGIBLE CULTURAL HERITAGE SIGNIFICANCE OF AVI KWA AME AND THE SURROUNDING LANDSCAPE

The status of archaeological and historical research within the proposed Avi Kwa Ame National Monument have been reviewed in the previous chapters of this volume. Particular attention was devoted to *cultural resources*, which were defined in Chapter 5 (this volume) as material indicia of human activity on the landscape, including but not limited to objects, architecture, landscape alterations, and graphic expressions fixed in place. Cultural resources are generally synonymous with archaeological and historic sites and artifacts, although they can include places of traditional cultural importance regardless of whether or not they manifest material indicia of human activity. As explained in Chapter 6 (this volume), the federal government recognizes the topmost point of Avi Kwa Ame as a Traditional Cultural Place (TCP) for many Tribes, and they established the boundary, in part, by the *absence* of archaeological materials. However, to the Aha Macav, Avi Kwa Ame is the entire mass of the landform, not just the peak (Kroeber 1972:22). The Nuwuvi maintain a similar perception of mountains, in that it is the entire range that is significant and powerful, not just the isolated peaks (Chmara-Huff 2006:11–12).

Avi Kwa Ame, and even the larger landscape in which it lies, can be regarded as *tangible* cultural resources, which is the purpose of the Spirit Mountain TCP designation, as well as the Bureau of Land Management's (BLM) short-lived concept of a Spirit Mountain Traditional Lifeway Area (TLA) around the peak of the mountain (see Chapter 6). That is, these, like archaeological sites and artifacts, are properties in that they are physical entities. The basis of the TCP designation, though, is Avi Kwa Ame's exceptional and unique role in the traditional lives of associated Indigenous communities. The *intangible* cultural resources that help explain the cultural and spiritual significance of Avi Kwa Ame and the surrounding landscape to the Nuwuvi and some Yuman Tribes, namely the Ah Macav, Kwatsáan, Cocopah, Piipaash, and Hualapai, are surveyed in this chapter.

Avi Kwa Ame is suspected to also be significant to other contemporary Yuman Tribes, particularly the Yavapai, Havasupai, PaiPai, and Kiliwa (the latter two of whom are Indigenous communities in Baja California Norte, in Mexico and therefore are not recognized as formal Tribes), but the ethnographic record is currently silent on the matter, as it is for the Hopi Tribe who supported the original Spirit Mountain TCP proposal more than 20 years ago. Likewise, any significance Avi Kwa Ame and the surrounding landscape may have to other Tribal communities not involved in the TCP scoping and outreach but whose traditional territories are quite close—such as the Cahuilla, Kawaiisu, and Koso—remains to be addressed through further study, research, and consultation.

Cultural heritage can be understood in both material and immaterial terms (Carr 2013). Properties—places and artifacts—constitute elements of tangible cultural heritage. In contrast, the United Nations (2020:5) defines intangible cultural heritage as "the practices, representations, expressions, knowledge, skills…that communities, groups and, in some cases, individuals recognize as part of their cultural heritage." Elements of intangible cultural heritage, or what might be regarded as intangible cultural resources, include artistic affairs such as dance, theatre, songs, and crafts. They can also revolve around matters of religion, language, and ceremony.

For the current study, the communities of focus are those Indigenous communities historically, culturally, and spiritually aligned with the greater Avi Kwa Ame landscape, namely the Nuwuvi and Aha Macav described in Chapter 3 (this volume), but also the other Yuman Tribes who identify Avi Kwa Ame as their place of origin. Important for this study is the immutable nexus between elements of intangible and material cultural heritage. It is the intangible cultural heritage associated with places that establish and justify those places as being forms of tangible or material heritage in the first place. The relevance of Avi Kwa Ame and the surrounding landscape to Yuman and Nuwuvi heritage is undoubtedly much richer than what can be verbalized and summarized on pages. What follows is a summation of Nuwuvi and Yuman intangible cultural resources that pertain to Avi Kwa Ame and other places within the proposed Avi Kwa Ame National Monument that can be gleaned from published accounts and the public record.

SPIRITUAL POWER IN NUMIC AND YUMAN ONTOLOGY

Understanding the Nuwuvi and Yuman connections to Avi Kwa Ame and other places within the proposed monument, specifically the heritage value they derive from it, first requires a basic understanding of personal spiritual power and how it manifests within the world. In both Yuman and Numic ontology, the universe is a living entity, much like an organism (Stoffle and Zedeño 2001b). An energy, or Power, flows through the universe and everything within it, much like blood through the body (Bean 1976; Miller 1983). This energizing essence, or *puha* as it is sometimes called by the Nuwuvi, is *the* source for personal well-being and ability (Liljeblad 1986:643–644). Rather than a static force, however, this Power is better conceptualized as kinetic, always present but perpetually flowing throughout everything to maintain an equilibrium within the universe (Miller 1983:73). It is spiritual Power that connects people, places, and natural resources as one living entity, and in this regard, inert and otherwise inanimate things are alive and affect everything else within the universal system (Trafzer 2012:122–128).

Spiritual Power flows along a network resembling a spider's web, but its flux-like nature means that sometimes and in some places it is thin while in others it is concentrated. Thus, it varies in intensity across the landscape and among people, animals, plants, and other elements of the universe. Similarly, the network through which this energy flows is not finite, but rather, it connects, disconnects, and reconnects to different elements.

This Power originated with Creation, but over time, it has diminished in quantity, quality, and accessibility as people have neglected it or treated it poorly. This occurred profoundly as a result of Euro-American colonial processes in which Indigenous knowledge about the control and regulation of spiritual Power was lost (Stoffle and Zedeño 2001b:64). Nevertheless, this energy is still present and available to those who seek it, and there are places within the landscape where it can be acquired. There is, however, cultural protocol on how that is done, who can do it, and when it should be done (Stoffle, Chmara-Huff et al. 2004:24–45; Traftzer 2012:122–129).

Because it flows through the universe, spiritual Power has an essential relationship with the landscape. It tends to be most concentrated at the tops of high mountains, from where it flows downslope, only to collect and concentrate again in select places but at intensities less than at the mountain tops. This Power has a strong connection to water, because the latter is also essential to life, and living beings are most concentrated around where water is found in the landscape. Bodies of water, such as springs, wells, lakes, rivers, clouds, reservoirs, and snow masses, are generally regarded as areas of intense spiritual energy. The flow of the energy is much like that of water.

Concentrated masses of snow atop the highest mountains are the source of water that flows down and out, across the landscape along a braided network of channels, much like how Power moves through the landscape (Miller 1983:77–79). Just as water surfaces or pools in places, Power can gather and produce exceptionally potent places within the material world. Further, the power of places can effectively grow, as powerful places attract other powerful elements of the universe (Stoffle and Zedeño 2001b:70).

While spiritual Power flows throughout, it is notably concentrated in particular types of landscape features. Stoffle and Zedeño (200b1) identified five types of powerful places in the Numic and Yuman landscapes: water sources, elevated land masses, caves, petroglyph and pictograph localities, and trails. Caves, especially those along mountain slopes, are powerful because "they shelter life and collect water by seepage while remaining moist and dark" (Miller 1983:78). Trails are powerful because they direct the flow of life and, thus, the spiritual Power concentrated within. Trails also connect places of concentrated Power and therefore mirror, in a way, the web-like nature of this spiritual energy's flow through the universe. In reference to the cultural resources inventory summarized in Chapter 6, note the correlation between petroglyphs and pictographs with springs and rockshelters—powerful places can draw additional power toward them, thereby concentrating vital spiritual energy within the landscape. Places with petroglyphs and pictographs, known as *tumpituxwinap* ("storied rocks") among the Nuwuvi, are sites of great Power because the marks were made by supernatural forces (Stoffle, Chmara-Huff et al. 2004:71), and they continue to be used for rituals (Stoffle et al. 2000).

Spiritual Power is the substance and basis of Yuman and Nuwuvi cultural landscapes. Due to its flux-like essence, Power flows between places thereby binding them together so that no place of Power is isolated from another. It is the concentration of spiritual energy in places of Power and the ebb and flow of energy between places that establishes the cohesion of the Nuwuvi and Yuman cultural landscapes (Cachora 2000). Ruptures in the Power "web" result from the destruction or desecration of Power places, as well as the severing of pathways or conduits through which this spiritual engery flows. Some of these conduits are tangible, such as watercourses and the Indigenous trails stretching between Power places that are themselves places of Power (as noted above). For example, damming rivers and the destruction of trails break the web in those places, impeding the conductivity along that course. Less obvious, but just as important, is the fact that some conduits are also intangible.

A critical aspect of the concept of Power is that an obstruction in the inter-visibility of places of Power can disrupt the flow of energy between them and thus sever the spiritual connection between them. Among the Yuman Tribes, for instance, the ability to see the mountains and other landforms that feature so prominently in their Creation narratives (see below) from different vantages, especially from one mountain to another, is vital to their spirituality (Cachora 2000; Wright et al. 2022). That line of sight is also a conduit of Power situates the people as nodes within the web and elemental to the balance of the universe. Therefore, viewshed disruptions can negatively affect "people's spiritual, social, psychic, and physical well-being" (Deur and the Aha Makav Cultural Society 2018:12).

AVI KWA AME IN YUMAN COSMOLOGY

As the name portends, Avi Kwa Ame, "Spirit Mountain," is of the utmost religious and spiritual significance to the Yuman Tribes, or the Indigenous communities of the lower Colorado River Valley, its tributaries, and surrounding deserts whose languages are of the Yuman family (Kroeber 1920). In addition to the Aha Macav described above, the Yuman Tribes include the Kwatsáan, Cocopah, Piipaash, Kumeyaay, Hualapai, Havasupai, Yavapai, PaiPai, and Kiliwa, with the latter two located today exclu-

sively within the Mexican state of Baja California Norte. While Avi Kwa Ame is relevant to all the Yuman Tribes, the nature of the cultural and spiritual relationship to the mountain is variable, and the extent to which that relationship is known outside those communities is uneven.

This imbalance reflects the different amount and intensity of ethnographic research conducted among these communities, as well as variations in willingness and ability to share sacred and privileged knowledge outside prescribed contexts or with people from other communities. For example, the documentary record is silent on the relationships the Kiliwa, PaiPai, Yavapai, and Havasuapi maintain with Avi Kwa Ame. The Kiliwa and PaiPai creation narratives, at least the versions published by Meigs (1939) and Gifford and Lowie (1928), respectively, share elements with those of the of the other Yuman Tribes, but they do not specifically call out Avi Kwa Ame as the place of origin as most others do. When the Havasupai and Yavapai were consulted as part of the Spirit Mountain TCP nomination process (see Chapter 6), they explained that their knowledge of Avi Kwa Ame was too sensitive to share (Ellis-Pinto and Rolf 1999).

As has been explained to the author by traditional cultural representatives of the Aha Macav, Kwatsáan, and Cocopah, their spiritual relationships with Avi Kwa Ame are difficult to frame in text, even more so in the words and grammar of non-Yuman languages. To them, it is self-evident because it is something they live and feel every moment of every day. Nevertheless, an outside appreciation of those relationships, although incomplete, can be fostered through a consideration of how the mountain figures into Yuman cosmology. Apparently, the earliest written description of a Yuman religious connection to Avi Kwa Ame comes from Olive Oatman's account of her time with the Aha Macav in the 1850s.

> They [the Aha Macav] said, pointing to a high mountain at the northern end of the valley, (the highest in the vicinity,) [Avi Kwa Ame] there was once a flood in ancient time that covered all the world but that mountain, and all the present races were merged then in one family, and this family was saved from the general deluge by getting upon that mountain. They said that this antediluvian family was very large, and had great riches, clothing, cattle, horses, and much to eat. They said that after the water subsided, one of the family took all the cattle and our kind of clothing and went north, was turned from red to white and so there settled. That another part of this family took deer skins and bark, and from these the Indians came. They held that this ancient family were all of red complexion until the progenitor of the whites stole; then he was turned white. They said the Hiccos (dishonest whites) would lose their cattle yet; that this thieving would turn upon themselves. They said remains of the old 'big house' was up there yet, in which this ancient family lived, also pieces of bottles, broken dishes, and remnants of all the various kinds of articles used by them.
>
> We were told by them that this venerated spot had ever since the flood been the abode of spirits; and that these spirits were perfectly acquainted with all the doings, and even the secret motives and character of each individual of the tribe. And also, that it was a place consecrated to these spirits, and if the feet of mortals should presume to tread this enchanted spirit land, a fire would burst from the mountain and instantly consume them, except it be those who were selected and appointed by these spirits to communicate some special message to the tribe. This favored class were generally the physicians of the tribe (Stratton 1857:146–148).

Oatman's narrative, while certainly biased and sensationalized by Stratton (1857) to sell books (McGinty 2005), manifests key elements of a core Yuman conception of Avi Kwa Ame. These include: (1) the mountain's place in creation as the first home for all the people; (2) its quintessential spiritual essence and the reverence afforded it by associated Tribes; and (3) its paramount role in spiritual well-being as facilitated by a select few with the requisite knowledge and wisdom to engage with the inher-

ent power of the mountain. This becomes apparent when her telling is compared with variations of the creation narrative among the different Yuman Tribes.

AHA MACAV

Aspects of the Aha Macav creation narrative have been published in pieces throughout the years (e.g., Bourke 1889; Kroeber 1906:314–316, 1925:770–778, 1948:50–68, 1972:5–16). What follows is a brief sketch of that narrative as it relates to Avi Kwa Ame and abstracted solely on the published accounts.

> All beings were born from sky (male) and earth (female) at a place far in the west and in a sunless time of darkness. These include the deity-like, first-born Matavilya, his younger brother Mastamho, and Frog, as well as people, animals, and plants. Led by Matavilya, they traveled eastward and toward the center of the earth. Once there, they surfaced at a place called Aha Avalpa, "house place in the water," and near the mouth of Eldorado Canyon. There Matavilya built a house. Because the world was in darkness, Matavilya accidentally defiled Frog while attempting to leave the house to relieve himself. Offended, Frog followed and secretly consumed Matavilya's excrement, which caused him sickness. Matavilya's sickness brought about his death. Before succumbing, he instructed Mastamho on what to do in order to take care of the people and everything else in his stead.
>
> Matavilya was to be cremated, but there was no fire. Coyote set out to find it, but while he was gone Fly rubbed her hands over bark, created fire, and set about lighting the pyre. Upon seeing the pyre burning in the distance, Coyote hurried back, snatched Matavilya's heart before it was consumed by the fire, and fled. With Matavilya's death and cremation the people learned to mourn. They were not pleased that the ashes remained, so Mastamho tried several times to obliterate them. He summoned wind in hopes it would cover them with sand, but it only blew around the ashes and left bones. He then tried hail with no success, followed by heavy rain, but the bones remained.
>
> Failing to remove Matavilya's remains through weather, Mastamho led the people a short distance north where he thrust a stick into the ground. Upon removing the stick, water began to flow out of the earth, thus creating a river. From the hole also came a raft, and after placing the people in it Mastamho led them south. As they floated along the river, the rocking back and forth of the raft created the different valleys. Upon reaching the river's delta, the people wished to go back upriver. So they climbed upon Mastamho who was so tall he could walk upstream through the river. But the water kept flowing and flooded the world so as only the tips of mountains rose from the surface. Mastamho reached one, Akokehumi (Crossman Peak in the Mohave Mountains, east of Chemehuevi Valley), where he set the people down. But the small tip of the mountain was not big enough for all the people, so Mastamho expanded the land and drained the quickly forming sea. He then took the people north to the spot of Avi Kwa Ame and they settled there and set about building a house, Ava Ka Humara. With the house complete, Mastamho lighted the world by creating the sun and moon, which completed creation.
>
> One day a person at Avi Kwa Ame began to feign sickness. Mastamho sent a messenger to request succor from Kamaiavete, a giant snake-like being ("Sky Rattlesnake") with immense spiritual power who lived in the sea. Kamaiavete came to Avi Kwa Ame, but it was too large to enter the house. It eventually was able to squeeze its head inside, at which point someone chopped it off and thereby killed Kamaiavete. Mastamho then instructed the people to burn the house and to cry, but the mourning was for Matavilya, not Kamaiavete. With the house burned, Mastamho decided to send the people away. He sent them thus: Chemehuevi northwest; Hualapai northeast; Kumeyaay southwest; Piipaash southeast; Cocopah south; Kwatsáan south; Yavapai southeast; Vanyume Serrano west; Southern Paiute northwest.

> The Aha Macav stayed with Mastamho at Avi Kwa Ame because they were still little children. So he taught them how to speak, count, make and use pottery, and farm the valleys below Avi Kwa Ame. Alone and no longer needed, Mastamho decided to leave, first by trying to sink into the ground. That did not feel right, so he came out and saw that his arms had grown feathers. Mastamho thus determined it was best that he fly away, and after several attempts he ascended the sky as a common and powerless fish-eating eagle.

KWATSÁAN

Contemporary Kwatsáan are politically organized as the Quechan Tribe of the Fort Yuma Reservation, located near Yuma, Arizona. Their traditional lands are centered on the confluence of the Colorado and Gila Rivers and stretch the length of the Colorado River between Parker and San Luis Río Colorado. The Kwatsáan language is of the River Branch of the Yuman language family (Campbell 1997:127) and is, thus, quite similar to the Aha Macav language. Historically, the Kwatsáan were close allies of the Aha Macav, an allegiance that was often in conflict with other Yuman Tribes such as the Cocopah, Piipaash, and several others that have since been amalgamated by other Tribes.

Avi Kwa Ame is essential to Kwatsáan cultural and Tribal identity. In fact, the Tribal name, Kwatsáan or the longer Xam Kwatsáan—"the group who descended by way of water"—is a direct reference to their migration from atop Avi Kwa Ame and down the Colorado River to the homeland given during creation (Bee 1983:97; Bryant and Miller 2013:4; Forde 1931:8; Halpern 1947:105). The Kwatsáan creation narrative is akin to that of the Aha Macav, with primordial origins at Avi Kwa Ame, although it is sufficiently different that an abstract of it is warranted.

Multiple versions of the narrative have been passed down and published throughout the years (e.g., Bryant and Miller 2013; Curtis 1909; Harrington 1908; Trippel 1889). This is because different families maintain their own accounts that pertain to particular lineages and traditions (Bryant and Miller 2013:4). While no two accounts are the same, the similarities among them are so strong that they bear upon a common origin (Trippel 1889:2). The following draws strongly from the narrative of Kwatsáan elder George Bryant (Bryant and Miller 2013:19–58), and secondarily from that of Joe Homer, as transcribed and published by Harrington (1908).

> In the beginning there was no land nor people, but merely water everywhere. At the bottom of the water, in a cave, lived Kukumat ("Body of Cloud") and Akákumat ("Body of Fog"). Kukumat became restless and decided to rise to the surface and look around. Akákumat chose to follow but opened his eyes on the ascent and was blinded by the salt in the water. Kukumat thus named him Kweraák Kutár ("Old Man Sharing"), because his blindness prevented him from sharing in creation of the world.
>
> After surfacing, Kukumat began to create land and the heavenly bodies. While he was doing this, Kweraák Kutár, better known as "Blind Old Man" on account of his condition, began molding images of his likeness out of clay. These were to be the people to live upon the newly created land. The clay dolls, however, had webbed appendages instead of hands and feet. Kukumat was displeased with Blind Old Man's creations, so he kicked them into the water where they became duck, wild goose, turtle, and beaver. In their stead, Kukumat made the Kwatsáan, Cocopah, Kumeyaay, and Piipaash out of clay and taught them how to speak.
>
> One of the women made by Kukumat wished to bear children but did not know how. She went to Kukumat for advice and he copulated with her. The woman then gave birth to a son, Kumastamho (compare to Aha Macav's Mastamho), and then a daughter, Xanyé ("Frog"). As Kukumat's son, Kumastamho was vested with helping him finish creating the world. He added the sun and more stars,

then plants. He taught the people how to farm, invented the bow and taught them how to hunt. In the meantime, Kukumat continued to make people, including the Hualapai, Havasupai, Apache, Chemehuevi, and finally the Aha Macav.

One day Kukumat defiled Frog on his way to relieve himself. To exact revenge, Frog secretly followed him and consumed his excrement, which caused Kukumat to fall deathly ill. Kukumat's fate was the first death. Wishing to take Kukumat's power, Coyote conspired to steal and eat his heart. The people decided to cremate Kukumat to prevent this from happening, but Coyote was able to sneak through and steal the heart from the funeral pyre and eat it elsewhere. With the first cremation, the people mourned and learned to cry.

Following Kukumat's death, Kumastamho decided to make the Colorado River, and did so by piercing the earth with his spear and dragging it all the way to the ocean. He then led the people on a journey up the river to their new home atop Avi Kwa Ame, but before reaching it he instructed the Yavapai to settle down east of the river. On Avi Kwa Ame, Kumastamho continued to teach the people and he gave them their clan names. When done, he thought it best to disperse the people across the land. He sent the Hualapai and Havasupai to the northeast, the Chemehuevi to the northwest, and the Cahuilla to the west. To the south he sent the Kumeyaay, Cocopah, Piipaash, and Kwatsáan, while the Aha Macav were to stay nearby because they were too young for such an arduous exodus. After the people had settled in their new lands, Kumastamho chose to leave the world. He first descended into the earth at Avi Kwa Ame but soon changed his mind. After resurfacing he chose to ascend the sky and thus transformed into four eagles—Black Eagle in the west, Fish Eagle in the south, White Eagle in the north, and High Eagle in the east. While gone in body, Kumastamho's spirit remained at Avi Kwa Ame.

COCOPAH

The Cocopah Tribe's reservation lies around the town of Somerton, Arizona and near the delta of the Colorado River. Additional Cocopah settlements are located in and around the border cities of San Luis Río Colorado in Sonora and Mexicali in Baja California North in Mexico. Their traditional territory stretches along the extreme lower end of the Colorado River and the Hardy River in Baja California and covers the intervening mountains. The Cocopah language is part of the Delta Branch of the Yuman language family (Campbell 1997:127).

Gifford's (1933) early ethnographic work among the Cocopah solicited only brief and fragmented dimensions to their creation narrative. He learned that the creator's name is Makwayak, which he equated with the Kwatsáan's Kukumat, and that Avi Kwa Ame was one of five great mountains surrounding their traditional lands that are inhabited by powerful spiritual beings (Gifford 1933:308). Through subsequent work, community members shared with Kelly (1977:115-121) a fuller account of creation. An abstracted version of what he learned follows.

The earth was once covered in water, and the creators Sipa and Komat (compare to Kwatsáan's Akákumat) lived in the ground at the bottom of the water. Sipa was the first to rise to the surface. Komat asked how it was done, and Sipa replied that he opened his eyes. Sipa, however, opened his eyes before reaching the surface and was blinded by the salt water. To create land, the creators employed ants to dig holes through which the water could drain. With land, Sipa and Komat commenced with making people, but they made people in different forms and each was displeased with the other's. They then made the sun and moon so as to provide light and seasons.

Eventually, Sipa changed the form of Komat's people into that of his own. Offended, Komat descended into the earth, and sickness came forth through the hole he created in the ground. With

Komat gone, Sipa began to make more people and organize them into Tribes. He taught them how to talk and live and gave them their clan affiliations. When he was done instructing the people and providing them with the things necessary, Sipa took the people to the sacred mountain Wi Kami (Avi Kwa Ame of the Aha Macav and Kwatsáan). There, Sipa built a big house for everyone, and inside they sang, played games, and otherwise enjoyed themselves.

Coyote died when bitten by Snake. No one knew what to do or how to mourn. Eventually Locust began to cry. Displeased with the crying, Sipa shut Locust's mouth which caused him to bust open. Out-spilled the crying, which caused the people to cry too. Three birds then proceeded to cremate Coyote atop a funeral pyre, and all the people watched and learned how to do it. Two Frogs decided to exact revenge on Sipa for giving Snake the fangs that killed Coyote. They went underground and waited for Sipa to defecate in his usual place and time. Each Frog consumed some of the excrement, and Sipa soon fell gravely ill.

With Sipa's death, another Coyote sought to take his heart and eat it in order to gain Sipa's power. Three birds tricked Coyote into seeking fire elsewhere, and while he was gone they proceeded to cremate Sipa. Coyote realized the blunder, returned, and was able to steal Sipa's heart from the pyre. He fled east, eating pieces of the heart in various places along the way. In Sipa's absence, the people began to forget how to take care of themselves. The birds sent word to Sipa, who had not yet reached his eternal resting place, and asked him to return. Sipa agreed to come back temporarily to teach the people once more. When the instruction was complete, Sipa recommenced his journey to the afterworld.

Several years passed since Sipa's death, and seeing that the people were still not happy Coyote took it upon himself to organize a big mourning ceremony. Coyote assisted the people in building a big house atop Wi Kami, and when complete they all went inside and cried. Coyote sent a messenger to gather more people for the rite, including Mahiawi, a giant snake-like being that lived in the ocean (compare to Aha Macav's Kamaiavete). The big house was too small for Mahiawi, so Coyote had the people rebuild it several times. It was never big enough, so Coyote killed Mahiawi by cutting off its head. He then set the house and Mahiawi's body afire, thus performing the first *kuruk*. To cover the stain marking where Mahiawi's burned body once laid, Coyote took Sipa's staff and gouged a hole in a big mountain. Water spewed forth, creating the Colorado River. This river ran past Wi Kami, the current taking half of the mountain away.

PIIPAASH

The Piipaash are not an independent Tribe recognized by the federal government. Instead, they are part of the Salt River Pima-Maricopa and Gila River Indian Communities, two sovereign Tribal governments with associated reservations shared with the Akimel O'Odham. The Piipaash language is of the Yuman River Branch, and is closest to that of the Aha Macav and Kwatsáan, their former neighbors. Centuries ago, the Piipaash lived along the lower Colorado and lower Gila Rivers; they moved to their present location in the Phoenix Basin due to constant conflict with the Aha Macav, Kwatsáan, and Yavapai. The Piipaash are an amalgam of at least five different but closely related and allied Yuman ethnic groups—Halykiwamai, Kohuana, Xalychidom, Opa, and Cocomaricopa (Dobyns et al. 1963; Kroeber 1920; Spier 1933, 1936). The former three once resided along the lower Colorado River; the latter two were in residence along the lower Gila and sometimes shared settlements with the O'Odham. Though descendants today consider themselves all Piipaash, "the people," those at the Salt River reservation maintain a strong Xalychidom identity (Kelly 1972).

Though Culin (1907:201–204) and Curtis (1908:86–88) published brief outlines of the Piipaash creation narrative, that provided by Spier (1933:345–367) is the most substantive and is the one referred to

here. The account is quite reminiscent of that of the Cocopah, with lesser elements of the Aha Macav and Kwatsáan accounts, so it does not need to be repeated in full. Significant deviations follow.

> The first act of the elder Cipas (compare to Cocopah's Sipa) and younger Kukumat following recession of the water was to make the sun, moon, and stars so there would be light to continue their work. Snake bit Rabbit (rather than Coyote), and Frog then exacted revenge by drinking the water from the slough in which Cipas swam. Cipas then fell ill and died. Following Cipas' death the people were afraid that Coyote would eat them, so they sent him to find fire. In the meantime, they built a funeral pyre and set about cremating Cipas. Realizing he had been tricked, Coyote returned and clutched Cipas' unburned heart from the fire and fled east. With Cipas' death, the people dispersed, the different Tribes heading in different directions.
>
> In Cipas' absence, the people forgot how to grow food and sustain themselves, so they asked him to come back. Waiting for his return, the people gathered into one big house near the mouth of Eldorado Canyon at the foot of Avi Kwa Ame. When Cipas returned and spoke, the people were stunned unconscious. So Cipas taught Coyote everything the people should know, which Coyote then taught to the people. The people eventually became thirsty, so they thrust a staff into the ground in the center of their house, near the mouth of Eldorado Canyon at the foot of Avi Kwa Ame. Out-flowed water, thus creating the Colorado River. The remains of this old house are called Ahavulpo, "water post" (a clear cognate with the Aha Macav's Aha Avalpa, "house place in the water"). The river's water carried people south to the desert. Cipas then returned but was now known and Kwistamho (compare to Aha Macav's Mastamho and Kwatsáan's Kumastamho). He took the people to the top of Vikwame (Avi Kwa Ame), where he gave them wisdom and knowledge about the world.

KUMEYAAY

Kumeyaay traditional lands extend across southern California and northern Baja California. As an ethnic entity, the Kumeyaay include groups otherwise known as the Diegueño, Kamia, Ipai, Tipai, and Metiipay, the distinctions being regional, dialectical, and overall gradational (Hedges 1975; Langdon 1975). Today, they are associated with 13 sovereign Nations in California and four villages in the Mexican state of Baja California Norte. The Kumeyaay language is of the Delta Branch of the Yuman language family, of which the Cocopah language is also a part (Campbell 1997:127). Thus, they are linguistically close to the other Yuman Tribes of the lower Colorado River, undoubtedly because they, or at least a sizeable contingent of them, once lived alongside the river near its delta (Forbes 1965).

Given the linguistic and historical affinities between the Kumeyaay and other Yuman-speaking Tribes along the Colorado River, their primordial association with Avi Kwa Ame should not be surprising (DuBois 1907a). To them, however, this most sacred mountain is known as Wikami, a cognate of Avi Kwa Ame (Gifford 1931:12; Waterman 1909:52, 1910:342). Still, the Kumeyaay creation narrative is distinct enough to warrant it unique to them (Waterman 1909, 1910). Below is a basic synthesis of the narrative, as pieced together from various published renditions (DuBois 1901, 1907a, 1908a; Gifford 1931; Spier 1923; Waterman 1910).

> The world started as water. Tuchaipai and his younger brother, Yokomatis (compare to Kwatsáan's Akákumat), lived in water but kept their eyes closed to protect against blindness from the salt in the water. Tuchaipai and Yokomatis were so aligned in purpose and capacity that some Kumeyaay equate them as one, Chapipakomat. One day the elder brother rose to the surface, opened his eyes, looked around, and saw only water. The younger followed, but opened his eyes before reaching the surface and was blinded. Unable to see the world at the surface of the water, Yokomatis descended back into it.

> Realizing the bleakness of the world, Tuchaipai decided to begin making land and beings. He started with hills and valleys, then lakes and marshes, followed by forests. He then made birds, but these beings lived in darkness until Tuchaipai crafted the sun and moon from clay and flung them into the sky, where they stuck. Using clay again, Tuchaipai made a man, and taking clay from the man he made a woman. He made these two first people atop Wikami, and there they and their children lived. The first people were all the same, spoke one language, and hunted for all their food.
>
> Eventually a man in the east became sick. He was brought back to Wikami, where he died. The people wanted to have a rite to mourn the first death. They built a ceremonial house, *wukururk*, but they did not know what else to do. West of Wikami, in the ocean, lived a massive mystical snake named Maihaiowit (compare to Aha Macav's Kamaiavete). Maihaiowit had all knowledge, art, and wisdom within its body. The people sent a messenger to summon Maihaiowit in hopes that it could instruct them in singing and dancing. Maihaiowit agreed, and went to Wikami and entered the wukururk. Maihaiowit coiled itself inside the building, but there was no end to its length. It eventually filled the wukuruk but needed more and more room. To remedy the matter, the people burned the wukuruk with Maihaiowit inside. Miahaiowit burst apart from the fire, thus releasing the knowledge contained within it. Each piece that came off was a different bit of wisdom—song, dance, game, medicine, etc.—and each person was privy to a certain piece. This is why some are better than others at games, some know songs and dance that other do not, some are better singers, and some have medicine.
>
> Following the debacle, the people were stressed and unsatisfied, so they decided to splinter and leave Wikami. They scattered about, each taking the knowledge gained from Maihaiowit. Different people went different ways, which explains the origin of the different Tribes. After the Kumeyaay had settled in their new homes, they were joined by three people who had left Wikami at a later time. These were a two-spirit person (i.e., berdache) and their two children, all of whom were exceptionally wise due to their time at Wikami. They brought bows, arrows, and war clubs as well as seeds of beans and corn and settled among the Kumeyaay.

The above synthetic narrative glosses over differences among the various published renditions to highlight their similarities, or the core narrative around which the individual tellings add nuance specific to local communities or families. Clearly shared among all of the narratives is the spiritual significance of Avi Kwa Ame, or Wikami in Kumeyaay etymology. The narratives maintain that it is the origin place of all people, as well as all ceremonial knowledge, including songs and dances that prove so vital to Kumeyaay religious life (DuBois 1905a:627; Waterman 1910:339). For this reason, all Kumeyaay ceremonies begin with reference to Wikami (DuBois 1907a:131, 1908b:123).

The Kumeyaay's wukuruk mourning ceremony—which is sometimes referred to as the Image Fiesta or Dance for the Dead (DuBois 1905b:626, 1907b:135) or the Ceremony of Death Images (Davis 1919) and is quite similar to the kuruk of the Kwatsáan and Cocopah and demonstrative of a shared origin—is a reenactment of the first mourning ceremony atop Wikami. This is discussed below with regard to Yuman ceremonies.

The Kumeyaay agree that the Aha Macav were the youngest people, or the last of the Tribes to be made, and therefore, they stayed in the primordial home area near Wikami (DuBois 1908b:103n52). While the Kumeyaay settled at a considerable distance from Wikami following the exodus, the mountain remains sacred and important to them. They insist that rocks there have impressions of the first people, whether those be of their bodies as they sat and stood there as the world was created (DuBois 1907a:131) or their footprints as people started on their migrations following Maihaiowit's cremation (Spier 1923:331).

A Kumeyaay man from Mesa Grande, known to others as Rafael Charles but of the local Quilpsh family, shared with DuBois (1907a:129) that despite being far away, Wikami remained a place of pilgrimage: "If a person wants to be rich and to have money and everything he needs he can get it by going to Wik-a-mee; and if he wants to be a witch-doctor and know everything, he can gain that too by going there." Waterman (1910:339) was told that if he were to go there, he would hear spirits dancing and singing in all languages; all spirits return there upon death and rejoice.

HUALAPAI

The traditional lands of the Hualapai Tribe cover the mountainous zone of northern Arizona north of the Bill Williams and Santa Maria Rivers and south of the Colorado River. Thus, it is east of the proposed monument and borders the traditional lands of the Aha Macav along its western front (see Figure 3.1). The Hualapai language is of the Pai, or Northern Branch, of the Yuman language family (Campbell 1997:127). The Hualapai are culturally and linguistically most similar to the neighboring, though at times antagonistic, Yavapai and Havasupai (Dobyns and Euler 1970; Ewing 1960). As is the case with most other Yuman Tribes, the Hualapai connection to Avi Kwa Ame is spiritual and primordial, as they conceptualize the mountain as the original home for all people, when all the Tribes were one.

Four detailed versions of the Hualapai creation narrative have been published (Ewing 1961; Kroeber 1935; MacGregor 1935; Talieje 1984). The narrative is similar enough to that of the Aha Macav described above that a full appraisal is not warranted for explaining the Tribal connection to Avi Kwa Ame, which is known to them as Wikame. Important divergences are as follows.

> Among the Hualapai, the two brother who made the world are the elder Matvilya and the younger Tuchupa. Wikame formed as the waters drained through a hole in the ground made by Matvilya's walking stick. Rather than using clay, Tuchupa made the first people from reeds from the vicinity of Wikame, and once alive the people lived there, around Wikame.
>
> Following the cremation of Matvilya, whose demise came about from sickness associated with Frog's excrement, the people acquired corn, beans, melons, and squash that grew from his grave. After infighting, Tuchupa decided to separate the people into different tribes. After teaching the Aha Macav how to sustain themselves, he instructed them to stay at Wikame. He then sent the Nuwuvi north and led the others to Meriwhitica Canyon, where he taught them how to sustain themselves on upland resources. Tuchupa then sent the Hopi away, who first went into the Grand Canyon for a spell before moving on and settling at their present homeland around the Hopi Mesas in northeastern Arizona. The remaining people consisted entirely of the Pai. There were so many that a few followed the Hopi as they left. These Pai chose to stay in the Grand Canyon and became known as Havasupai. Quarrels beset the Pai who stayed in Meriwhitica Canyon, so Tuchupa split them into Hualapai and Yavapai, giving the latter a territory to the south and east of the former.

As the primordial place of origin, Wikame is a spiritually powerful place to the Hualapai, which is attested to by its continued role in Hualapai spiritual medicine. As is customary of the Yuman Tribes, Hualapai spiritual doctors come into their profession through dreaming in which the spirit of a deceased relative would visit and solicit the dreamer to take up the practice (McKennan 1935). Such spiritual doctors are often aligned with landforms, particularly mountains. The spirits of these mountains aid the doctors in their curing, but sometimes, the Power is not sufficient. In those extreme cases, the spiritual doctor seeks the Power of Wikame, but to do so they must work through the spirit of their own mountain as an intermediary because Wikame is too powerful to be approached otherwise.

Spiritual doctors do not acquire the Power of Wikame, but merely act as conduits for the spirit of the sacred mountain. As Hualapai traditional cultural practitioners once explained, "The spirit of Wikame has gone into the doctor's heart…Then the spirit of Wikame begins to talk through the doctor…The powerful spirit of Wikame comes into the doctor and goes down into his heart but before it goes down it stop in his mouth and speaks" (McKennan 1935:186).

YUMAN "DREAMING"

Hualapai dream encounters with Avi Kwa Ame preface a fundamental aspect of Yuman cosmology. The mountain is not just the place of creation; it is the determinant of one's lot in life and the ultimate source of personal power and responsibility, which derive through "dreaming." The dream experience is the quintessential traditional religious practice of the Yuman Tribes. While hallucinogenic plants factor into traditional Yuman medicine, the dream experience is an unaided natural phenomenon that takes place as an actual dream, while asleep. During the dream experience, one's spirit traverses the landscape to gather Power and knowledge from important places.

For the Aha Macav, Kwatsáan, and Piipaash, Avi Kwa Ame is the principle destination and ultimate source of power and knowledge while dreaming. Among the Kwatsáan, after reaching Avi Kwa Ame, a dreamer's spirit interacts with either Kumastamho or one of the animal spirits from the time of creation from whom the dreamer learns spiritually powerful songs (Forde 1931:201–204; Gifford 1926; Harrington 1908). The Piipaash experience is quite similar. For them, the dreamer's spirit is led from place to place by other spirit beings, and songs and medicinal knowledge are learned from the places, one of which is Avi Kwa Ame (Spier 1933:247). For Cocopah dreamers, their spirits are led to different sacred mountains by animal spirits to learn cures and songs associated with the landforms (Gifford 1933:303–304, 309). While the ethnographies are not specific, Avi Kwa Ame is undoubtedly one of the mountains Cocopah dreamers visit, as it is one of the scared mountains that define the Cocopah landscape. In Yuman cosmology, the dreamer's spirit moves about and engages within the physical world, although the travels and engagements take place during the dream. The experience thus takes place in both the spiritual and physical worlds, and in so doing, transcends them. Among the Piipaash, spirits and dreams are both called *cama'g*, suggesting the concepts are largely synonymous (Spier 1933:236–237).

For the Piipaash, dreaming is at "the heart" of their culture (Spier 1933:236). Dreams are the source for all songs and associated performances, and the entire content of those songs are about dream experiences. Kroeber (1925:754–755) described the dream experience among the Aha Macav as "the basis of everything in life," and further, that they "can not tell a story or a dream without naming the exact spot at which each character journeyed or slept or stood or looked about." Among the Aha Macav, almost everyone dreams, and each dream is important. However, there is a difference in significance between ordinary dreams and "Power dreams" (Deveraux 1956, 1957). Ordinary dreams have power in that they foretell one's personal future (Fathauer 1951a:276). While less common, Power dreams are more important because they establish one's role and responsibilities within the community. For the Aha Macav, Power dreams begin during childhood, but they can also occur while in utero or before, while the soul is still on Avi Kwa Ame (Stewart 1956). All positions of social power and authority—political leaders, healers, singers, war leaders, and speakers—require the necessary dreams for that person to hold those positions and fulfill its duties. Proper dreaming brings about fulfillment and satisfaction in life (Stewart 1956).

YUMAN SONGS

Avi Kwa Ame and other places in the surrounding landscape factor prominently in traditional Aha Macav songs. At the turn of the twentieth century, Kroeber (1925:755) learned of some 30 traditional Aha Macav song cycles, with each consisting of anywhere from 100 to 200 songs. Many, if not all of them, continue to be sung today. Aha Macav songs, and those of the other Yuman Tribes as well, are tied to traditional stories, many of which are related to the creation narrative in some manner. The songs and narratives constitute a unique mode of oral literature that teach tradition, morality, and history (Hinton and Watahomigie 1984:6). The associated story, however, is not fully decipherable from the song. In some cases, singers moved between song and recitation of the story so as to connect the lyrics with the historical events, but Kroeber (1925:755) suggested that was not the normal practice. Instead, singers and audiences were more familiar with the songs than the recitations, and rarely did anyone know the full tale tied to any one song cycle.

As dreaming is the substance of traditional Yuman life, Aha Macav singers maintain that they "dream" their songs, either full or in parts, as well as the stories to which they pertain. Traditional Aha Macav songs are sung for entertainment and pleasure, but they also feature prominently in mourning. They are sung during a loved one's final hours, even by the one passing if they are capable, as well as during the funeral ceremony, *nyimichivauk* (Stewart 1947c). That the same songs accompany leisure and mourning underscores how they, and the figures and places featured in the stories to which they are aligned, permeate Aha Macav traditional life. According to Kroeber (1925:756), the stories behind the songs are part of the "fabric" of one's life.

Traditional Aha Macav songs relay how places, things, and persons came into being, and they explain the inter-relatedness of all aspects of the Aha Macav world. According to Hinton and Watahomigie (1984:6), "Through these songs and tales, everything in their daily lives would be imbued with powerful significance." Embedded in the stories are the locations of important resources and the many paths people took to reach distant lands. The song cycles are, in essence, maps of both the material and spiritual landscapes in which the Aha Macav have come to be who they are today (Klasky 2013:114).

As an essential part of traditional life, the Aha Macav safeguard their songs, and Kroeber's (1925, 1948, 1972) synopses remain the definitive published sources on them. Published information on the Song Cycles of the other Yuman Tribes who also "dream" of Avi Kwa Ame is too limited other than to say that the Kwatsáan, Kumeyaay, Piipaash, and Hualapai also sing about it (Kroeber 1925:788). Although details and explanations are sparse, several of the Aha Macav songs Kroeber (1925) featured help contextualize the sacredness of the land within the proposed Avi Kwa Ame National Monument to the Aha Macav. For example, the *Ath'i* (Salt), *Kapeta* (Turtle), *Ohwera*, *Chuhuecha*, *Vinimulya Hapacha*, and *Tumanpa Vanyume* Song Cycles are aligned with narratives about the deserts west of the Colorado River in places otherwise recognized as Chemehuevi, Vanyume Serrano, and Kawaiisu country. *Vinimulya Hapacha*, *Kapeta*, *Ohwera*, and *Chuhuecha* specifically detail stops at or events that occurred in and around Avi Watha, known to others as the New York Mountains.

Akwaka, or the Deer Song Cycle, consists of approximately 90 songs and is tied to a story about two deer, with the song being through the deer's perspective (Kroeber 1948:41–45). As it goes, upon Matavilya's death, the two feline brothers Numeta and Hatakulya sank into the earth at Aha Avalpa, and after rising briefly in several places, they resurfaced for good far in the west, past San Bernardino. There

they made two deer from clay. The song then describes the deer's journey east, through the Mojave Desert, past the New York Mountains, through the Dead Mountains and then Avi Kwa Ame, over the Colorado River, and finally into Hualapai territory. There, the two brothers hunted the deer, successfully killing the male one. This is how the Hualapai and Yavapai of that region learned to hunt. The song cycle itself initiates in the New York Mountains.

While the significance of Avi Kwa Ame to the Yuman Tribes is explicit in their creation narratives, the importance of surrounding landforms and the greater landscape comes through in their traditional songs. The Aha Macav songs just mentioned make this clear, specifically for the New York and Dead Mountains, the northern ends of which lie within the proposed Avi Kwa Ame National Monument. The BLM in California established the Dead Mountains Area of Environmental Concern in 1989 in recognition of the range's traditional values to the Aha Macav and Nuwuvi (Bureau of Land Management [BLM] 1999b:Table 15). That management designation does not encompass the northern portion of the range within the state of Nevada, even though that portion is of particularly significance to the Aha Macav. In fact, Avi Matpha (Wind Mountain), the northernmost promontory in the Dead Mountains, just north of the California state line (and thus within the proposed monument), is a place where the Aha Macav have long gathered eagle and hawk feathers that are vital for traditional ceremonies (Bean et al. 1979:7–29).

YUMAN CEREMONIES

As the place of cremation, Avi Kwa Ame manifests a prominent role in Yuman ceremonial life. Notably, several Yuman Tribes have historically performed a mourning ceremony that is essentially a reenactment of the first cremation rite held on Avi Kwa Ame for the Creator. This is the kuruk of the Kwatsáan and Cocopah, wukuruk of the Kumeyaay, and the kerukam of the Xalychidom Piipaash. Elements of the ceremony are shared with the mourning rites of the PaiPai, Aha Macav, Nuwuvi, and Walapai (Drucker 1941:148–150), but the kuruk is unique in that it is a re-enactment of the Creator's cremation atop Avi Kwa Ame. Therefore, while taking place within each Tribe's homeland, the ceremony symbolically and spiritual situates the performance atop the sacred mountain of primordial origin.

Re-enactment is a misnomer, in that the distinction between the event in the Creation narrative and the historic and contemporary ritual is not recognized by the performers and the participants. Forde (1931:214) described it as a mimetic rite, in that the substance of the ceremony has the same spiritual gravitas and socio-religious purpose as the original. This mourning ceremony is on par with the dream experience (described above) and warfare as being quintessential to traditional Yuman cultural identity. Bee (1983:93) characterized it as "microcosm of the [Kwatsáan] way of life," and Kelly (1977:89) remarked similarly that it is "symbolic of the greatness and rightness of the Cocopa way of life."

The kuruk, or wukuruk or kerukam, is not the normative mortuary ceremony that is conducted for each person's passing. It is a separate affair intended to be more collective and community centric. The ceremony is reserved for when a prominent person in the community passes, or when the families of multiple decedents come together to commemorate their loved ones' passings in unison. In a sense, it is a second funeral in which the decedents are again cremated but in effigy form. Among the Cocopah and Xalychidom Piipaash, the kuruk is traditionally held a year or longer after the first funeral (Alvarez de Williams 1983:111; Spier 1933:305).

The Kwatsáan version of the mourning ceremony is perhaps the best known due to Forde's (1931:214–251) lengthy description and Halpern's (1997) book-length treatment of the subject; it is, however, also thoroughly described for the Xalychidom Piipaash (Spier 1933:305–308), the Cocopah (Kelly 1977:90–96, 121–128), and the Kumeyaay (Davis 1919; DuBois 1905a). Traditionally, the ceremony is an elaborate, orchestrated event held over several days—four for the Kwatsáan and six for the Cocopah and Kumeyaay. The affair invariably involved a sham battle, the gathering of specific material for the ceremony, including items for building a special house, and the house's subsequent cremation along with the effigies, or images of the decedents, and material gifts such as food and clothing for the decedents. Interspersed throughout the ceremony are rites of purification, prescribed meals, songs, speeches, dancing, and wailing (or "crying"). In addition, to serve to collectively commemorate the lost family members and loved ones, the ceremony—specifically the cremation of essential items—is intended to provide the decedents with the materials needed in the afterlife that may not have been readily available at the time of their initial funeral. It is to ensure a proper and successful journey in the afterlife.

Pilgrimage is another contemporary rite that continues to connect the Yuman Tribes with Avi Kwa Ame, the place of primordial origin. This was shared explicitly a century ago by Rafael Charles, DuBois' (1907a:129) Kumeyaay informant who described going to the mountain to gain spiritual knowledge and to alter one's lot in life. Some Kwatsáan also undertake pilgrimages to Avi Kwa Ame, as they were instructed to do by the Creator (Johnson 2003:162, 2006:48). At times, the pilgrimages take place in body, while for others, the journey takes place in spirit while dreaming. To reach Avi Kwa Ame, Kwatsáan pilgrims and dreamers follow the Xam Kwatsáan Trail, a network of trails that extends north from Avi Kwa Lal (i.e., Pilot Knob) in the Kwatsáan homeland around the confluence of the Colorado and Gila Rivers.

Known also at the Trail of Dreams and the Kuruk Trail, for understandable reasons, the Xam Kwatsáan Trail is the route the Kwatsáan took to the reach their homeland when the Creator sent the people away from Avi Kwa Ame (Cleland 2005, 2008; Johnson 2003, 2006; Whitley 2014). The trail network thus acts as a metaphorical umbilical cord that keeps the Kwatsáan, and probably other Yuman Tribes, connected to and spiritually nurtured by Avi Kwa Ame.

THE NUWUVI HOLY LAND

Through extensive dialogue and cultural work with Nuwuvi consultants for more than 40 years, and borrowing a concept from Spicer (1957), Stoffle and colleagues (Stoffle, Carroll et al. 2004; Stoffle, Chmara-Huff et al. 2004; Stoffle et al. 1994, 1997, 1998, 2005) characterize the Nuwuvi relationship with their aboriginal territory as essentially that of a people and their "holy land." This holy land, called Puaxant Tuvip among the Nuwuvi, encompasses all the lands given to them at the time of creation, which is regarded as the territories in which the Nuwuvi have lived and used since the beginning of time as depicted in Figure 3.2. Puha flows through Puaxant Tuvip and is concentrated in places such as springs, caves, rockshelters, and petroglyph sites, as explained above.

Formal ethnographic work among the Nuwuvi regarding the tangible and intangible cultural resources within the proposed Avi Kwa Ame National Monument has not been conducted, so information specific places of puha within the study area have not yet been published. Nevertheless, based on a general understanding of the logic of puha afforded through prior ethnographic research in other locations, it is

reasonable to suspect that some of the cultural properties identified in Chapter 6, primarily the petroglyph and pictograph sites, rockshelters, and possibly quarries, as well as natural landscape features *not yet* recognized as cultural properties, will prove, upon further research, to be quite powerful places in the Puaxant Tuvip.

The most holy place in Puaxant Tuvip is Mount Charleston in the Spring Mountains, northwest of Avi Kwa Ame and west of Las Vegas (Stoffle, Chmara-Huff et al. 2004). Known as Nuvagantu (Where Snow Sits), this mountain is the place of creation in Nuwuvi cosmology (Kroeber 1908; Martineau 1992). Kroeber (1925:600) drew explicit attention to the similarity in how the Nuwuvi connect with their sacred mountain Nuvagantu as the Aha Macav do Avi Kwa Ame.

As with other cultural factors, the Chemehuevi and Las Vegas groups shared the practice of dreaming with the Aha Macav (Kelly and Fowler 1986:380–381). Their songs and narratives of Nuvagantu and the events of creation that took place there are dreamed. Skills and aptitudes, especially those of spiritual doctors, are acquired through dreams of Nuvagantu. Spiritual doctors are known as Puh Aganti, "having Power" (Laird 1976). That does not negate any significance Avi Kwa Ame may have to the Nuwuvi, however. Rather, the sacred mountain to the Yuman Tribes, known as Tumpibat (Kroeber 1908b:242) and Aagah (Bean et al. 1979:Map D) to the Nuwuvi, is still an important landform because it lies within the Puaxant Tuvip, the Nuwuvi holy land. As Stoffle, Chmara, and colleagues (2004:43) explain, "places of Power are usually culturally important to more than one American Indian ethnic group." In fact, the entirety of the proposed Avi Kwa Ame National Monument lies within the Puaxant Tuvip, a relationship that continues to be lived through intangible cultural resources of the Nuwuvi, the most explicit of which is perhaps song.

NUWUVI SONGS

As it is with the Aha Macav, the Nuwuvi have a rich tradition of oral literature embedded in song that ties them to the land and reifies their primordial relationship to Puaxant Tuvip. According to Kroeber (1908b:241, 1925:599), Nuwuvi songs belong to four separate cycles—Salt, Deer, Mountain Sheep, and those of spiritual doctors. Kelly and Fowler (1986) could not find additional information about songs associated with spiritual doctors, but through contributions from Laird (1976:11), they added those of the Funeral, Bird, Quail, Coyote, Skunk, and Day Owl Song Cycles.

These were in addition to songs of a different Tribal origin and associated with dances, such as the Ghost Dance, Bear Dance, and Prophecy Dance. Nuwuvi song traditions are best known from the Chemehuevi, Las Vegas, and Moapa groups, those closest to the Aha Macav. That the themes of Nuwuvi song cycles center on a journey more so than a definable plot that is repeated in each telling, as is characteristic of Aha Macav song cycles, speak to a general history of shared song practice (Kroeber 1925:599).

Ownership of Nuwuvi songs is somewhat hereditary. While nearly all traditional Nuwuvi songs can be learned from a relative, dreaming factors into Nuwuvi song culture. Deer, Mountain, and Funeral songs have to be dreamed, at least in part. This can occur in an unsolicited manner, or people can seek the necessary dreams by spending time in certain caves (Laird 1976:38). The dreams serve to validate a person's capacity to sing the particular songs.

Traditionally, not all Nuwuvi groups sang the same songs. The details in the songs varied among singers, and some song cycles were associated with certain regional groups. For examples, Quail was sung exclusively among the Chemehuevi, while Coyote was sung among the Las Vegas group. This is probably due to the sharing of songs among neighbors, as the Bird, Quail, and Coyote Song Cycles are possibly of Cahuilla and/or Vanyume Serrano origin (Kelly and Fowler 1986:385; Laird 1976:19), western neighbors of the Chemehuevi and Las Vegas groups.

Another reason for regional variation in Nuwuvi songs is that they are associated with particular families and serve to tie them to their territories. As the Deer, Mountain Sheep, Quail, Skunk, and Day Owl songs relate to hunting, their content effectively references the hunting territories of different families and bands (Bean et al. 1979:5–24; Laird 1976:9–19). As Laird (1976) related, different variations of the Mountain Sheep Song Cycle feature the New York, Providence, and Granite Mountains, depending on who is singing. Other landforms featured prominently in the Mountain Sheep Song Cycle include the Dead, Newberry, Castle, and Ivanpah Mountains (Laird 1976:11ff). Of course, part of the New York Mountain—known as Kaivaya Amanti to the Chemehuevi (Bean et al. 1979:Map D)— as well as parts of the Dead, Newberry, and Castles Mountains lie within the proposed Avi Kwa Ame National Monument, while the other ranges are farther south.

Perhaps the Nuwuvi song cycle best known to non-Tribal members are the Salt Songs (Figure 7.1). This is due to a recent revival of sorts brought about by the Salt Song Trail Project, a collaboration among Matthew Leivas (Chemehuevi), Vivienne Caron Jake (Kaibab Paiute), and the Cultural Conservancy (Leivas et al. 2009). Beginning in 2001, the project set out to record—for the first time in many instances—Salt Songs sung by 13 Nuwuvi elders from different bands and Tribes (Cultural Conservancy 2022). The Salt Song Trail Project gained additional traction through the more recent Mojave Project, a "transmedia documentary and curatorial project" that explores the natural and cultural geography of the Mojave Desert (Stringfellow 2021). In contemporary contexts, the Salt Song revitalization is part of an intergenerational process of Nuwuvi cultural healing (Nelson 2006).

As with other Nuwuvi songs, those of the Salt cycle were both hereditary, partly taught by family members, and dreamed (Kelly and Fowler 1986:383). Salt Songs are sacred orations that describe the material and spiritual landscape encompassed by Nuwuvi aboriginal territory. Comprising a 142-song cycle, these sacred orations are reserved for memorial ceremonies and are intended to aid the spirit of the decedent along their journey to *Naugurivipi*, a land of spirits in the Milky Way.

The song cycle accompanies the Yagap, a mourning ceremony described as a "Cry" (Sapir 1912, 1930), Traditionally, Cries were multi-day events sponsored by relatives of the deceased in which offerings of valuables in memory of the dead, such as baskets, horses, nets, and clothing, were burned. Dances and speeches were also part into the ceremony (Franklin and Bunte 1996:189–193). Cries are so similar to traditional Aha Macav mourning ceremonies that Sapir (1912:169) suggested the Nuwuvi Cry originated among the Yuman Tribes. Franklin and Bunte (1996:190) postulated a source among the Aha Macav or Hualapai. According to Kelly and Fowler (1986:383), a Nuwuvi consultant shared that Cries were introduced to the Moapa group by an Aha Macav visitor.

Elements of the Salt Song Cycle have been described as unintelligible to the standard Nuwuvi audience, with words possibly of Aha Macav origin (Kroeber 1925:599; Sapir 1910:472). According to Laird (1976:16), who was fluent in both Nuwuvi and Aha Macav languages, the words in the Salt Song Cycle

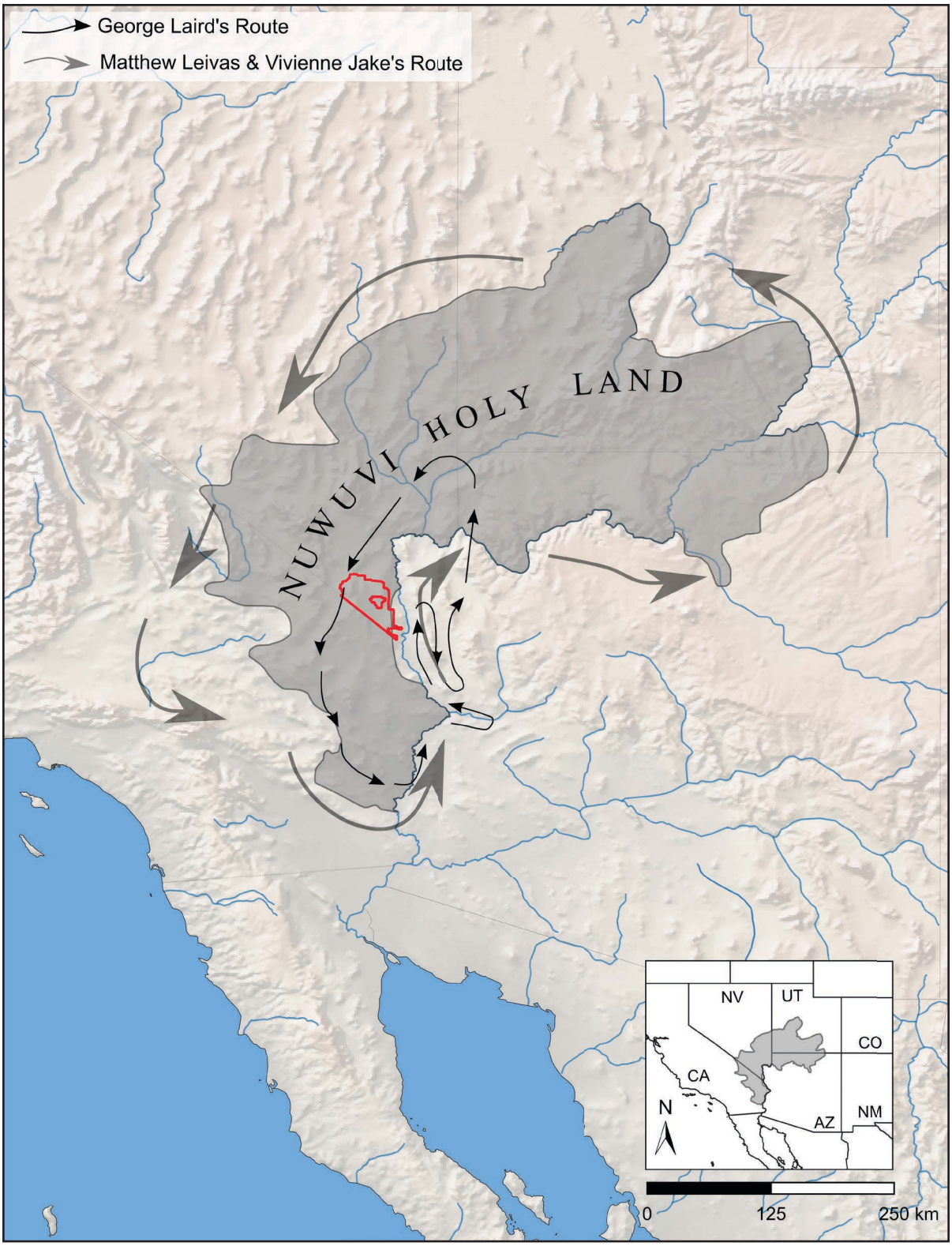


Figure 7.1. Routes of the Salt Songs around the Nuwuvi Holy Land and the proposed Avi Kwa Ame National Monument (in red). George Laird's route adapted from Laird (1976:Map); Matthew Leivas and Vivienne Jake's route adapted from Levias et al. (2009).

are Yuman, but their pronunciation and syntax have been altered in ways so as to be unintelligible to anyone unfamiliar with it, including the Aha Macav.

In describing important places as well as routes to those places, individual Salt Songs encode vital economic information pertinent to the singer's lineage and territory. Geographical features include ancestral villages, resource patches (including salt deposits), shrines, and trails. When the songs of different families are collated, they reveal a map of Nuwuvi traditional territory and a description of a route through it. When sung during Cries, the cycle takes the singer, audience, and spirits of the decedents on a circuitous, counterclockwise path that, when stretched out, would measure some 1,000 miles in length (Stoffle and Arnold 2008, cited in Musser-Lopez and Miller 2010:1).

Each portion of the cycle moves the singer and the spirit of the departed to a different place, further exemplifying the connection between certain songs and specific places. The cycle begins at a sacred cave, Avi Nava, in Arizona near the confluence of the Bill Williams and Colorado Rivers. From there, it ascends the Colorado River to the Colorado Plateau region of southern Utah, where it then arcs north and west to Mount Charleston in the Spring Mountains of southern Nevada. It then continues south and west to the Pacific Ocean before arcing back to the Colorado River and returning to Avi Nava.

The itinerary of the Salt Songs circumambulates the proposed Avi Kwa Ame National Monument, with northward movement from the Bill Williams River following the Colorado River and southward movement from Mount Charleston heading just west of the New York Mountains (Leivas et al. 2009). This Song Cycle thus reaffirms the region as central to the Nuwuvi holy land. Multiple archaeologists have suggested that some of the actual Indigenous trails and trail-related features still extant within and around the proposed Avi Kwa Ame National Monument may be to the material dimension of the Salt Song Cycle (Fowler 2009; Musser-Lopez and Miller 2010).

CHAPTER 8

SCIENTIFIC AND HISTORIC RESEARCH POTENTIAL

The inventory of documented archaeological and historic properties within the study area, summarized in Chapter 6 (this volume), demonstrates the potential of the region for addressing a range of questions of historical, anthropological, and scientific relevance at multiple scales. Known Indigenous properties include petroglyph and pictograph sites, rockshelters, quarries, trails, artifact scatters of variable density and diversity, and places of traditional cultural value and importance. It is important to recognize that the inventory, while rich and diverse, is only a sample of what the landscape contains. Less than 5 percent of the study area has been professionally surveyed (Chapter 5, this volume). Raish (2013) regards the low proportion of land inventoried to date for archaeological and historic properties as the primary reason for knowledge gaps in the Indigenous history of southern Nevada. She further points out that knowledge gaps are born out of the un-random nature of where federal projects have been conducted, which has dictated where and when cultural resources inventories were carried out (Raish 2013:170).

While each topographic zone within the proposed Avi Kwa Ame National Monument has been subject to some amount of investigation, over time, the un-random nature of federal projects has created spatial biases in cultural resources survey coverage in southern Nevada. Regarding the current study area, the portion closest to Laughlin—the Mohave Valley and Dead Mountains topographic regions—has experienced a disproportionately higher amount of aerial coverage than the rest of the proposed monument (see Table 5.1). Further, the proportion of survey coverage in valley settings is more than twice that of the upland settings, as the valleys have served as natural corridors for transportation- and energy-related undertakings (see Chapter 5).

The relative sparseness and unevenness of survey coverage within the study area underscores that many archaeological and historic properties remain to be found and inventoried. This prospect is especially salient for upland settings, as they have received the least investigatory attention yet they contain a disproportionately higher number of Indigenous and Euro-American historic properties (see Chapter 6). Despite the small sample of documented cultural resources, the known inventory remains an unrealized source of historical and scientific information, as the study area lies within the least archaeological investigated and understood region of southern Nevada (Roberts 2012b). None of the archaeological sites within the study area have been professionally excavated, and only a very few have been damaged by looters and vandals or disturbed by development. Their integrity and data potential remains high as a result. Further, these properties span a 10,000-year-long epoch from the Palaeoarchaic to the Ethnohistoric, representing nearly the entire length of known human history in the region and attesting to the deep Indigenous legacy on and within this landscape.

The Avi Kwa Ame landscape manifests a rich and well-preserved body of cultural, archaeological, and historical properties, but its potential has been underutilized by the professional scientific community. Ways in which the relatively untapped and untrammeled character of the study area's cultural resources can help fill recognized knowledge gaps in the Indigenous history of southern Nevada are suggested here. To do so, aspects of the inventory summarized in Chapter 6 are aligned to the seven "prehistoric research themes" Roberts and colleagues (2012) argue should drive future archaeological research in southern Nevada.

INDIGENOUS HISTORY RESEARCH THEMES

Chronology

The dating of archaeological properties and materials is necessary to the discipline. In southern Nevada and the encompassing desert region more broadly, chronology is typically afforded by the presence of temporally diagnostic artifact types, such as ceramics and projectile points, and less so by absolute (i.e., scientific) dating techniques of materials and deposits. This is due to the relative lack of excavation that has been conducted in this region, in which absolute dating techniques can be utilized, as well as the prohibitive cost of such techniques. However, as Roberts and colleagues (2012:277–278) note, the independent dating of archaeological traits, such as ceramics and projectile points, is not as accurate as it could be if there was a concerted effort to refine it through increased employment of absolute dating techniques. They outline several steps that could improve the regional chronology of archaeological sites and traits, two of which are quite relevant to the study area: the excavation of stratified archaeological sites and the investment in generating absolute dates from well provenienced archaeological material.

Although none of the archaeological sites within the study area have been professional excavated, limited amounts of testing have identified subsurface deposits in both open-air sites and some rockshelters. From what has been reported, the depth of deposits in open-air sites is relatively minimal, while deposits in rockshelters hold considerable promise. Much of what is known about the archaeology of the Great Basin and Mojave Desert has been learned from excavations in rockshelters. As natural refuges, rockshelters tend to attract repeated use across time and cultures. Their sheltered nature tends to preserve organic matter conducive to radiocarbon dating, and the depositional environment is relatively stable and can lead to the develop of deep and well-stratified material. Thus, the several dozen utilized rockshelters reported from the study area (see Table 6.1) are prime settings for refining regional chronologies via stratigraphic excavation and radiocarbon dating.

Obsidian hydration dating is an absolute dating technique that could be productively utilized in the study area to better refine regional chronologies. Lyon and colleagues (2008) have demonstrated the utility of obsidian hydration dating of surface artifacts in southern Nevada as a viable tool for chronological studies. The study area contains the Juan obsidian source near the merger of the Castle and New York Mountains, and many of the surrounding archaeological sites are reported to include obsidian artifacts, particularly diagnostic projectile points. Obsidian hydration dating could aid in dating the archaeological sites, and because obsidian artifacts have been reported from the surfaces of the sites, such a program of research could be conducted without excavation. Obsidian hydration dating of obsidian projectile points found within the study area could also aid in refining date ranges of defined projectile point styles.

Settlement Patterns and Settlement Systems

Roberts and colleagues (2012) distinguish between settlement patterns and settlement systems. A settlement pattern is the spatial distribution of different site types that pertains to the same cultural group, and these are narrowly defined in time. A settlement system, in contrast, in an interpretation of the settlement pattern that expounds on how the sites are interrelated and what they and the pattern reveal about the social groups responsible for the pattern. Recognition of a settlement pattern requires that the archaeological sites that reveal that pattern be present and recognizable. This is typically not possible in landscapes that have witnessed considerable change over time, whether that be natural geomorphi-

cal change or anthropogenic change as a result of a range of activities such as ranching and farming or urban development. Because inferences of a settlement system are dependent upon recognizing the settlement pattern, any such inferences are increasingly abstracted and are likely flawed as more of the sites comprising the settlement pattern are lost or unrecognizable.

One of the most archaeologically important aspects of the study area is the lack of development that has been conducted within it. While lack of development is the principal reason so little is known about the Indigenous history of the current study area, it is simultaneously a reason why the properties that are known are so valuable to research. A great amount of the study area is untrammeled desert, and only a few of the known archaeological sites have been significantly disturbed. Thus, not only are the archaeological properties well preserved, the *relationships between them* are as well. With concerted attention, it may be possible to tie the different properties into temporally and culturally discrete settlement patterns. Discrete properties can be connected directly via trails or indirectly through related artifact classes such as ceramics.

The study area contains a range of archaeological sites that seem to constitute separate facets of settlement patterns. Many of the documented rockshelters show evidence of residential use on a short-term or seasonal basis. The artifact scatters likely represent a range of site types, from activity areas to camps to seasonal villages. These sites are interspersed by quarries, petroglyph and pictograph localities, and an unknown number of trails. Temporally diagnostic artifacts, culturally diagnostic ceramics, and stylistically differentiated petroglyph and pictograph motifs and styles provide a way to organize the properties into separate settlement patterns differentiated along temporal and possibly cultural parameters.

The potential for archaeological properties within the study area, and the relationships among them, to inform on Indigenous settlement patterns and settlement systems was tested by Brosman's (2012) study of hunter-gatherer mobility and foraging around the Piute Valley. By comparing the distribution of natural resources across the Piute Valley to the distribution of known archaeological sites, Brosman (2012) proposed that settlement on the valley floors was avoided to take advantage of the resources available at higher elevations. What he found lead him to conclude that area residents migrated among four primary resource zones on an annual round.

These zones included the Colorado River Valley and/or Lake Mojave to capitalize on aquatic resources. From there, people moved in a circuitous route among the Highland Range (for acorns, bighorn sheep, lithic sources, and springs), the McCullough Range (for springs, pinyon nuts, and big game), and the Castle Mountains (for obsidian, grasses, and small game). Brosman (2012:69) suggests these "areas in total represent a circular region of seasonal foraging activity which surrounds the Piute Valley." Brosman's (2012) study offers a basic model that can be tested, expanded upon, and refined with continued study and inventory. The inventory of archaeological sites documented within the study area shows a disproportionately higher number of archaeological sites in upland settings (see Table 6.2), and therefore, supports Brosman's (2012) model of a settlement pattern focused on upland resource zones.

Subsistence and Diet

The subject of subsistence concerns the types of foods sought and consumed, how they were sought and consumed, and scheduling acquisition and consumption practices. Subsistence also involves the social rules and norms surrounding food acquisition and consumption. The numerous rockshelters documented from the study area provide a critical context for studying early diets and subsistence practices.

Organic material, such as faunal bone, seeds and fibers of plants, kernels of corn, and coprolites, tends to be better preserved in such settings than in open-air sites. These materials are also conducive to radiocarbon dating and, in conjunction with stratigraphic excavations, can elucidate temporal changes in diets and subsistence practices.

As Roberts and colleagues (2012) indicate, the nature of Palaeoarchaic and Archaic subsistence and diet is one of the largest knowledge gaps in the Indigenous history of southern Nevada. This is because most sites from those periods lack direct evidence of subsistence. One of the major questions is the role of plants in the subsistence practices of these periods, because it is assumed that subsistence pursuits at that time were focused on lacustrine environments and/or big-game hunting. A dearth of grinding stones and features from Paleoindian and Early Archaic sites has long contributed to that assumption, but grinding tools do occur at some of these early sites (Chapter 4, this volume).

Sites within the study area can help address this question. In particular, a site in the Piute Valley at the northern end of the Castle Mountains was reported to include Paleoarchaic Silver Lake projectile points along with metates. These materials were found on the surface of the site, so their association remains a matter of question. Intensive study of this site could examine the relationship between the projectile and ground stone technologies and determine if they were contemporaneous or sequential. Such research could also shed light on why Silver Lake projectile points, which are typically found around ancient lake shores in the Mojave Desert, are occasionally found in upland and non-lacustrine settings.

The origin and nature of Indigenous farming is another significant question in the Indigenous history of southern Nevada. In particular, archaeological and ethnographic evidence indicates the Chemehuevi and Las Vegas Nuwuvi groups practiced a nascent level of agriculture in opportune settings within the Mojave Desert, such as around springs. The 47+ springs within the study area provide ideal contexts to explore if spring-irrigated horticulture was conducted in the study area and, if so, how early and to what degree. One site reported from the southern end of the McCullough Range contained brown ware ceramics and a Rose Spring projectile point along with a well-developed area of refuse that was up to 0.5 m deep. Diagnostic artifacts suggest the site is probably early Numic in origin, and the presence of ceramics and a midden make this site one of the more likely ones to contain evidence of horticulture or farming in the study area.

Technology

Technological aspects evidenced among the archaeological material found within the study area include projectile point forms, other forms of flaked stone objects, ceramic wares and vessel forms, turquoise and lithic resource quarrying and mining, and potentially spring-based irrigation (see Subsistence and Diet section). Projectile points from the Paleoarchaic (e.g., Silver Lake specimens) through the Ethnohistoric (Cottonwood Triangular) have been reported from the study area. A detailed examination of the contexts and contents of the sites where these objects are found could provide information about how this technology changed through time,and why.

Beyond projectile points, Roberts and colleagues (2012:285) pose three questions about Indigenous lithic technology in southern Nevada that merit further study.

1. Are specific tool types time sensitive and therefore diagnostic of particular periods, as once suggested by Lyneis (1982)?

2. Did raw lithic material selection change through time or across social groups; if so, how does that relate to shifts in mobility?
3. Did bifacial and unifacial tool technology change through time?

Determining if lithic tool types are time sensitive requires stratigraphic excavation. Rockshelters are again the ideal setting for such research. Raw material selection, however, can be studied without the need for excavation. The study area contains a variety of desirable lithic materials, including obsidian, rhyolite, basalt, cryptocrystalline silicates, and turquoise. Quarries documented in the Castle Mountains, Highland Range, New York Mountains, Eldorado Valley, and Piute Valley (see Table 6.2) show the study area contains ample sources of lithic raw material that was sought for stone tool and ornament manufacture.

Also noteworthy is that, from the documentary record at least, there appears to be preferential modes of lithic reduction across the study area, with some quarries exhibiting a predominance of bifacial reduction compared to unifacial reduction at others. This would imply certain quarries or stone varieties were preferred for specific technologies, although explaining such variability in terms of time and cultural practice has not yet been done.

Identifying cultural or temporal differences in lithic material selection has long been hampered by a general inability to date quarry sites because they often lack associated diagnostic artifacts and/or features suitable for absolute dating techniques (see Chronology section). Nevertheless, Roberts and Flenniken (2008) have presented a case study from southern Utah in which they associated quarries with different cultural traditions and time periods based on the proximity of the quarries to other sites of known age and cultural association. In this way, they identified important differences in lithic technology across time and cultural practice.

Elsewhere in the Mojave Desert, Byrd and colleagues (2010) demonstrated how a detailed examination of pavement quarries can inform on changes in residential mobility throughout the Holocene. Application of these models, and others yet to be formulated, to the study area could identify similar shifts in lithic technology through time and among the diverse archaeological and ethnohistoric social groups who lived in and moved through the region.

Turquoise is another raw lithic material that was quarried within the study area. Documentation pertaining to the relevant sites is sparse, but details indicate the possible presence of nearby lapidary workshops to manufacture turquoise ornaments (Morrissey 1968:7). Records also indicate the presence of mining tools, such as mauls, hammers, and wedges. Almost nothing is known about the Indigenous mining of turquoise or the technologies involved in ornament manufacture. Turquoise economies are usually addressed from the perspective of finished objects found in places where they were deposited, not as raw materials at their source. The study area provides an opportunity to examine the technologies behind Indigenous turquoise mining and ornament manufacture in a more than cursory way.

Religion and Ritualism

Petroglyph and pictograph localities (n = 43), including rockshelters where such graphics are also present, are currently the most numerous class of Indigenous property documented within the study area (see Chapter 6). Current organizational schemes that attempt to differentiate petroglyphs and pictographs in southern Nevada and surrounding regions into discrete cultural and temporal groupings

continue to be debated (Quinlan 2012). Regardless, there is widespread agreement they were made over several millennia and were authored by the multiple social and cultural groups who lived in and moved through the area.

There is also widespread agreement that the creation and perhaps subsequent interaction with Indigenous petroglyphs and pictographs, specifically those in the Mojave Desert, were practices tied to Indigenous spirituality or religion (Christensen and Dickey 1998; Garfinkel 2006, 2007; Garfinkel and Austin 2011; Whitley 1992, 1994a, 1998, 2000). Redundancy and repetition in imagery, location, context, and association, as with the petroglyphs and pictographs in the study area, point toward ritualism behind their production and consumption (Wright 2014).

The petroglyphs and pictographs within the study area are some of the few material objects that can inform on Indigenous religion and ritualism. Their scientific study therefore stands to provide critical information about these topics, especially in light of recent technological advances that can date and chemically characterize pigments used in pictographs. It is now possible to date pictographs via radiocarbon analysis of minute amounts of the pigment (Petchey 2018). Techniques such as portable X-ray fluorescence (pXRF) can identify the mineral composition of pigments, which can aid in recognizing different paint "recipes" and potentially source where the pigment originated (Chalmin and Huntley 2018). The field of petroglyph and pictograph research is advancing rapidly, and many new analytical developments have yet to be applied to the those in the study area and the broader Mojave Desert.

In addition to petroglyphs and pictographs, rockshelters and caves within the study area have the potential to provide useful information about Indigenous religion and ritualism. There is a growing number of examples where researchers have uncovered sacral offerings in rockshelters very near the study area (see Chapter 4). In such places, special items were carefully placed en masse or left intermittently over time to the point where caches of rare objects such as painted sticks, figurines, crystals, and the like accumulated. As noted, none of the rockshelters in the study area have been professional excavated, and only a few have been disturbed. The rich presence of pictographs and petroglyphs in and around some of these rockshelters add credence to the notion that they were places of religious importance and ritual practice. This conception of rockshelters and caves as sacred places of Power and the residences of spiritual agents is shared with some contemporary Nuwuvi and Aha Macav people (e.g., Stoffle and Zedeño 2001b).

Contact and Trade

The various footpaths associated with the Mojave Trail facilitated the movement of nonlocal material into and across the study area (Farmer 1935). The role of the Aha Macav in the trade and exchange of materials among communities near the Pacific Coast and those inland and east of the Colorado River is well documented (for a review, see Koerper and Hedges 1996:213–214). Textiles originating on the Colorado Plateau seemingly moved west into coastal economies while seashells and ornaments made thereof moved east. While trails are an underreported dimension to the cultural landscape in which the study area lies, the early archaeological observations of Malcolm Rogers and historical accounts of surveyors and explorers (see Chapter 6) indicate several major east-west trails pass through the region. These trails certainly factored into an extensive system of exchange that was in place across the greater Southwest region of North America.

While shell and textiles were not acquired within the study area, only moved through it, obsidian and turquoise were quarried and mined locally and exchanged broadly. Recent advances in geochemistry en-

able researchers to identify the parent source of turquoise and obsidian artifacts. The elemental characterization of obsidian via pXRF can identify the parent source of obsidian artifacts (Shackley 1998). The application of pXRF and other geochemical analytical techniques have also shown promise for sourcing rhyolite, specifically in the Mojave Desert (Coffman and Rasic 2015; Scharlotta 2010). The numerous rhyolite outcrops in the study area (Chapter 2, this volume) and identified quarries of such (see Chapter 6) indicate future research holds promise for studying the exchange of this tool stone across and beyond the study area.

Although the Juan obsidian source is within the study area, none of the obsidian artifacts found in the study area have been subject to pXRF to determine their source. Artifacts of Juan obsidian have been found outside the study area, however, which indicates the material was sought and traded or transported. Brosman (2012) suggests the Juan obsidian source was one of the major attractants to the northern end of the Castle Mountains within a hypothesized migration route around Piute Valley. A carefully designed research program centered on sourcing obsidian artifacts from the study area would add considerably to the understanding of how local obsidian was used and distributed across the Mojave Desert. The ability to chemically source rhyolite is not as well tested and refined as that of obsidian. However, given that many of the quarries within the study area are centered on high quality rhyolitic formations, the potential to study the trade and exchange of rhyolite acquired from within the study area awaits study.

As with obsidian and rhyolite, it is now possible to chemically source turquoise (Thibodeau et al. 2015). This is a relatively new techniques and has not been widely applied. Nevertheless, a profile of Crescent turquoise was successfully developed, and it is now possible to source artifacts from across North America's western deserts to identify how and to what extent Crescent turquoise factored into Indigenous economies at local to regional scales. That the turquoise mines within the study area are so close to the Mojave Trail, it is not unreasonable to suspect that Crescent turquoise was elemental to the trade and exchange network that connected coastal communities with the Aha Macav and the Aha Macav to Puebloan, Athabaskan, and Pai communities farther east.

Archaeological Cultures, Ethnicity, and Ethnogenesis

The history of the study area is multicultural and has been for more than a millennium if not longer (Chapter 3, this volume; see also Chapter 6). The earliest written records attest to how this landscape sits within the traditional territories of the Aha Macav and Nuwuvi. The archaeological record affirms their embedded presence centuries before those records were written. Indigenous oral histories confirm their place within their homelands since time immemorial. The meeting and blending of cultural traditions within the study area in the recent and distant past provides researchers ample opportunity to study the formation and endurance of cultural traditions and ethnic identities.

The study area has particular potential for resolving debate around the linguistic and archaeological model of a supposed Numic expansion (see Chapter 4). Many of the rockshelters within the area have material evidence attributable to Nuwuvi ancestors. Most research on this problem has been conducted in other regions, some at great distances from the study area. Thus, the applicability of the linguistic and archaeological models to the archaeology in and immediately around the proposed national monument remains to be shown. What transpired in southern Nevada should not be assumed a priori to mirror what has been learned in other regions, especially given how close the region is to Nuvagantu (Mount Charleston), the place of creation in Nuwuvi cosmology. In light of this, if any such expansion of Nu-

wuvi did occur, Nuvagantu might be considered the point of origin, as it was the place of creation. Data from sites within the study area—situated only 100 km southeast of Nuvagantu—can be leveraged to understand this anthropological and historical problem within the southern Nevada.

A similar potential holds for elucidating the origin of Patayan as an archaeological manifestation. Resolving the earliest manifestations of the Patayan tradition in and around southern Nevada remains a major theme in local research (Ahlstrom and Roberts 2012:147–148). In Rogers' (1941, 1945) conception, Patayan material culture originated in the Mojave Desert and subsequently spread east to the Colorado River and then south to the river's delta. Rogers (1941, 1945) placed the time of this "emergence" somewhere around AD 800, and he envisioned the archaeological pattern as representing a migration of people, but the same debate holds as it does for the supposed Numic expansion.

The Aha Macav assert that they have been in their homeland since time immemorial. The foundation of the Aha Macav claim lies within their Creation narrative, not a material record. The archaeological model tracks the spread of artifact forms and styles, not necessarily people. That the other Yuman Tribes ascribe to a similar Creation narrative in which their ancestors migrated from Avi Kwa Ame while the Aha Macav stayed supports the Aha Macav claim (Chapter 7, this volume). That Rogers' (1941, 1945) model places Yuman origins in and around the Mojave Desert, followed by a migration down the Colorado River, aligns remarkably well with the essential nature of the Yuman Creation narrative.

LANDSCAPE AS SCALE, CONTEXT, AND STRATEGY

Cultural resources, and archaeological and historic properties in particular tend to be conceptualized as independent, discrete spatial phenomena that can be defined by the presence and density of elements of material culture vis-à-vis the absence thereof. Their significance, as determined by their relevance to issues of historical importance or their potential to address questions of archaeological research as set forth by the National Park Service (NPS 1990) (see Chapter 5), is also commonly evaluated as that of a bounded entity, divorced from the broader contexts in which they reside and their connection to other cultural and natural resources. Traditional Cultural Places (TCPs) and historic districts are the exceptions, although they also mandate definable boundaries with regard to issues of management.

It is worth noting that the National Historic Preservation Act (NHPA) was written in an era when archaeological research focused on the identification and excavation of discrete archaeological sites. Reports and publications were similarly restricted to the analysis of single sites. However, as the archaeological discipline has evolved, so too have the analytical units and the theory and methodology behind the research (Binford 1982; Kowalewski 2008; Parsons 1972). Archaeological "sites" are now conceptualized as elements of larger patterns of sociocultural interaction. Concepts such as settlement systems and archaeological landscapes now pervade the discipline and are an inherent dimension of the research if not an explicit topic of study.

The interrelatedness and interdependence of archaeological sites is perhaps nowhere more relevant than in the interiors of the western deserts of North America. In places with little water, people moved around out of necessity; in so doing, they created patterns of utilized places that were connected through seasonality, movement, memory, and spirituality. Archaeologists now recognize this interconnectivity, and they rely on the distribution of different archaeological sites—different in terms of size, complexity, composition, location, season of use, etc.—to test and refine models of human mobility and subsistence. In this regard, the significance and research value of individual sites is not within the boundary of the

site alone, but in the larger archaeological system, or structure, in which it is integral and to which in can inform.

Recent archaeological research in the Mojave Desert is showing how the investigation of the compositions of interrelated archaeological sites yields insights not possible by looking at single sites alone (e.g., Arend and Roth 2015; Basgall 2000; Byrd et al. 2009; Knell et al. 2014; Thomas 2011). Archaeological sites in this broader landscape represent places used by the same groups of people but at different times of the year to take advantage of seasonally available resources. As Arend and Roth (2015) demonstrate, the sites are elements of larger regional patterns of how people once used the landscape, and they cannot be fully understood without consideration of the other elements of the pattern.

Importantly, Brosman's (2012) study of the distribution of archaeological sites within the Piute Valley, much of which is within the proposed Avi Kwa Ame National Monument, followed this landscape approach. In so doing, he was able to make interpretive connections across many of the properties reported here (see Chapter 6). Brosman's (2012) study also showed that the archaeological properties within the proposed national monument are inherently related to archaeological properties outside of it; that is, the relevant archaeological landscape extends beyond the study area and reaches into the adjacent Castle Mountains National Monument, Mojave National Preserve, Dead Mountains Wilderness Area, all in California, as well as the lower Colorado River Valley.

The interconnections of the archaeological sites within the proposed national monument and their relationship with other properties, both natural and archaeological, in the greater Mojave Desert landscape conforms well with how the Nuwuvi and Aha Macav conceptualize their cultural landscapes. The ontologies of North America's Indigenous communities generally conceptualize cultural objects (i.e., artifacts) and properties (i.e., places) as entangled in complex relationships with other such objects and properties (see Chapter 7), as well as with material and places non-Indigenous communities might regard as "natural" or "non-cultural." In this way, boundaries are meaningless, because archaeological and historic sites and objects cannot be fully understood outside their broader contexts, and their significance is largely dependent on their relationship with other things, places, and beings.

However, the various pieces of legislation driving cultural resources inventories and assessments of significance and integrity (and therefore value and worth) do not originate from such an ontology or worldview. The advent of TCPs was an effort to acknowledge and incorporate Indigenous values and concerns into matters of cultural heritage management, but they still impose discrete boundaries around otherwise "fuzzy" subjects, and their significance and integrity are determined by criteria established and evaluated external to the Indigenous communities whose heritage those objects and places pertain. The complicated history of the Spirit Mountain TCP (see Chapter 6) demonstrates this shortcoming quite well.

Effectively reconciling existing legal frameworks for managing cultural resources and other matters of heritage with the concerns and interests of the affected parties, namely the Indigenous communities whose heritage is at stake, remains a monumental challenge for land managers. Cleland (2005, 2008) and Stoffle and colleagues (Stoffle et al. 1997, 2001) have explicitly drawn attention to the fundamental incompatibility between the federal legislation regarding the management of cultural resources and the values systems of the Yuman Tribes and Nuwuvi, respectively.

To remedy this disjunction, some federal agencies have developed protocols and management frameworks better molded to Indigenous ontologies, such as the NPS's recognition of "Indigenous cultural

landscapes" (Beacham 2012) and the Bureau of Ocean Energy Management's similar conception of "Tribal cultural landscapes" (Ball et al. 2015). The Bureau of Land Management's (BLM) experiment with establishing a Spirit Mountain Tribal Lifeway Area (see Chapter 6) was an early effort as well, but one that did not have staying power.

The BLM does not currently utilize a specific framework for recognizing, defining, and managing cultural landscapes as conceptualized by the nation's Indigenous communities. It lacks a framework that expressly acknowledges the interconnectedness, interrelatedness, and interdependence of cultural and natural properties, objects, and places divorced from the NHPA or other legislation pertaining to cultural resources. The National Landscape Conservation System (NLCS), of which an Avi Kwa Ame National Monument would become a part, is one way to holistically recognize and manage the archaeological and cultural properties within the Avi Kwa Ame landscape, the "non-cultural" places and spaces between them, the viewscapes and viewsheds afforded by them, and the topography that contextualizes it all. Writing from the Hualapai perspective, Suagee and Bungard (2013:4) note that the NLCS offers the country's Indigenous communities a "glimmer of hope" that the BLM can steward places and landscapes in ways congruent with their values and interests and that help ensure their cultural and spiritual vitality.

APPENDIX A

INVENTORY OF PRIOR CULTURAL RESOURCES AND HISTORIC PROPERTIES INVENTORIES

Table A.1. Inventory of prior cultural resources and historic property inventories.

SHPO Report No.[a]	NVCRIS Report No.[b]	BLM Project No.[c]	Survey Type[d]	Area (km²)[e]	No. of Properties[f]	Agency[g]	Industry[h]	Reference(s)[i]
2019	2019	5-2596	Pedestrian	0.12	0	Contractor	Other	McDaniel (2008)
2166	2166	5-2594	Pedestrian	0.04	0	Contractor	Other	Whitesides et al. (2008)
2375	2375	5-2587	Pedestrian	0.22	38	Contractor	Range management	White et al. (2008)
3977	3977	5-2613	Pedestrian	4.44	0	Contractor	Energy	Sander et al. (2009)
4178	–	-	Pedestrian	10.03	0	NPS	Other	Dickinson (2009)
6537	6537	5-2646	Pedestrian	0.01	0	Contractor	Mining	Hutmacher (2010)
6921	6921	–	–	–	22	–	–	McLane (2001)
6957	6957	–	Pedestrian	0.07	0	Contractor	Telecom	Anderson (1998)
9089	–	5-2653	Pedestrian	43.90	2	Contractor	Energy	Stegner and Bevill (2012)
10165	CT-166	–	Pedestrian	0.01	0	Contractor	Telecom	Leavitt (2003b)
10184	CT-185	–	Pedestrian	0.01	0	Contractor	Telecom	Leavitt (2003a)
10820	BR51	–	Pedestrian	0.02	0	Contractor	Telecom	Rogge et al. (1997)
11031	NPS2	–	Pedestrian	0.03	0	NPS	Other	Fox (1993)
11145	11145	–	Pedestrian	5.49	0	NPS	Other	Daron (1994)
11169	007-98-LAME	–	Pedestrian	0.00	0	NPS	Transportation	Daron (1996)
11362	MISC46	–	Pedestrian	0.22	0	ACOE	Transportation	Perry (1992)
11529	11529	–	Pedestrian	146.91	0	Contractor	Energy	Bungart and Raney (2007)
11642	NDOT-024-79	5-552	Pedestrian	0.17	0	NDOT	Transportation	Steinberg (1979)
11720	5-835	5-835	Pedestrian	0.01	0	NDOT	Transportation	Leavitt and Turner (1980)
11828	11828	5-1044	Pedestrian	0.05	0	NDOT	Transportation	Leavitt (1983d)
11830	5-1042	5-1042	Pedestrian	0.03	0	NDOT	Transportation	Dennis (1983)
11845	5-1158	5-1158	Pedestrian	0.51	0	NDOT	Transportation	Leavitt (1983b)
11851	5-1173	5-1173	Pedestrian	0.14	0	NDOT	Transportation	Leavitt (1983a)
11854	5-1331	5-1331	Pedestrian	0.47	1	NDOT	Transportation	Leavitt (1983c)
11876	11876	5-1413	Pedestrian	0.68	0	NDOT	Transportation	Leavitt (1984)
11903	5-1402	5-1402	Pedestrian	0.19	0	NDOT	Transportation	Knight (1984)
11915	5-1456	5-1456	Pedestrian	0.55	0	NDOT	Transportation	Leavitt (1985b)
11916	11916	5-1457	Pedestrian	1.63	0	NDOT	Transportation	Leavitt (1985c)
11937	5-1550	5-1550	Pedestrian	0.63	0	NDOT	Transportation	Leavitt (1985a)

Table A.1. Continued.

SHPO Report No.	NVCRIS Report No.	BLM Project No.	Survey Type	Area (km^2)	No. of Properties	Agency	Industry	Reference(s)
11940	NDOT-008-86	5-1520	Pedestrian	0.48	1	NDOT	Transportation	Knight (1986)
11945	5-1511	5-1511	Pedestrian	4.20	0	NDOT	Transportation	Leavitt (1986)
11965	11965	5-1713	Pedestrian	1.99	0	NDOT	Transportation	Leavitt (1987)
11990	5-1794	5-1794	Pedestrian	0.14	1	NDOT	Transportation	Seldomridge (1988)
11999	5-1919	5-1919	Pedestrian	0.96	0	NDOT	Transportation	Knight (1989)
12076	NDOT-CL97-012	5-2355	Pedestrian	0.43	1	NDOT	Transportation	Moore (1997)
12092	NDOT CL004-005R	–	Pedestrian	0.05	1	NDOT	Transportation	Stearns (2004)
12104	12104	5-1955	Pedestrian	1.91	2	Contractor	Telecom	Davis et al. (1989)
12234	1-1-16	5-232	Pedestrian	0.04	0	Contractor	Other	Brooks et al. (1976)
12236	1-1-17	–	Pedestrian	3.29	2	Contractor	Range management	Brooks (1972)
12241	1-1-23	5-231, 5-232	Pedestrian	0.04	0	Contractor	Other	Brooks, King et al. (1977)
12297	12297	–	Pedestrian	0.55	0	NDOT	Transportation	Walloff (1974)
12299	12299	5-1123	Pedestrian	1.89	6	Contractor	Energy	Bondley and Brooks (1973)
12375	5-319	5-319	Pedestrian	0.04	1	BLM	Range management	Botti (1977)
12564	12564	5-238	Pedestrian	1.98	0	Contractor	Energy	Brooks, Larson et al. (1977)
12595	12595	5-2508	Pedestrian	1.51	5	Contractor	Other	Byrd et al. (2004)
12728	12728	5-400	Pedestrian	4.73	1	Contractor	Energy	Fowler et al. (1978)
12732	5-327	5-327	Pedestrian	0.43	0	NDOT	Transportation	Turner (1977)
12734	12734	5-904 A	Pedestrian	2.41	9	Contractor	Energy	Barker et al. (1979)
12830	5-1980	5-1980	Pedestrian	0.17	0	Contractor	Telecom	Blair (1990)
12879	5-71-1	5-1310	Pedestrian	0.02	0	Contractor	Telecom	Rafferty (1983)
12896	5-1407	5-1407	Windshield	0.24	0	BLM	Recreation permitting	Zale (1984)
13122, 13123, 13124	5-2346	5-2346	Pedestrian	0.10	2	Contractor	Mining	Blair (1996a, 1996b); Murphy (1994)
13142	13142	5-2559	Pedestrian	0.09	0	Contractor	Other	Halbmaier (2007)
13205	13205	5-2538	Pedestrian	0.12	1	Contractor	Mining	Slaughter (2006)
13389	5-2163	5-2163	Windshield	0.10	0	Contractor	Mining	Rafferty (1992)
13394	5-6	5-6	Windshield	1.16	0	BLM	Recreation permitting	Williams (1975c)
13401	5-14	5-14	Windshield	1.67	0	BLM	Recreation permitting	Williams (1975d)

Table A.1. Continued.

SHPO Report No.	NVCRIS Report No.	BLM Project No.	Survey Type	Area (km²)	No. of Properties	Agency	Industry	Reference(s)
13445	5-61	5-61	Pedestrian	0.13	0	BLM	Mining	Williams (1975b)
13471	5-94	5-94	Windshield	0.25	0	BLM	Mining	Hatoff (1975a)
13479	5-103	5-103	Windshield	1.06	0	BLM	Recreation permitting	Hatoff (1975b)
13484	5-108	5-108	Horseback	0.03	0	BLM	Recreation permitting	Hatoff (1975c)
13485	5-109	5-109	Pedestrian	0.01	0	BLM	Range management	Williams (1975a)
13630	13630	5-1317	Pedestrian	0.10	0	BLM	Telecom	Arellano (1984a)
13670	5-291	5-291	Pedestrian	1.57	0	BLM	Mining	Kuniyoshi (1977)
13679	5-303	5-303	Windshield	1.23	0	BLM	Recreation permitting	Williams (1977)
13715	5-347	5-347	Windshield	1.63	0	BLM	Recreation permitting	Monroe (1977)
13718	5-2113	5-2113	Pedestrian	0.66	0	BLM	Recreation permitting	Myhrer (1990a)
13742	13742	5-377	Windshield	0.11	0	BLM	Recreation permitting	Thomsen (1978b)
13746	5-381	5-381	Windshield	1.24	0	BLM	Recreation permitting	Myhrer (1990c)
13772	5-416	5-416	Windshield	1.10	0	BLM	Recreation permitting	Wolf (1978a)
13782	5-429	5-429	Windshield	0.17	0	BLM	Recreation permitting	Thomsen (1978a)
13817	5-486	5-486	Pedestrian	0.05	0	BLM	Range management	Martin (1979a)
13818	5-487	5-487	Pedestrian	0.07	0	BLM	Range management	Martin (1979b)
14017	5-785	5-785	Pedestrian	0.08	0	BLM	Recreation permitting	Selman (1981)
14155	5-1027	5-1027	Pedestrian	0.10	3	BLM	Mining	Rafferty (1982b)
14157, 14158	5-1033	5-1033	Pedestrian	0.12	4	Contractor	Energy	Hall et al. (1981)
14184	5-1118	5-1118	Pedestrian	0.39	0	BLM	Mining	Rafferty (1982a)
14226	5-1196	5-1196	Pedestrian	0.06	0	BLM	Energy	Pizatella (1983)
14349	5-1375	5-1375	Pedestrian	0.15	0	BLM	Telecom	Hall (1984)
14393	5-1451	5-1451	Pedestrian	0.03	0	BLM	Telecom	Zale (1985c)
14394	5-1452	5-1452	Pedestrian	0.03	0	BLM	Telecom	Zale (1985b)
14395	5-1453	5-1453	Pedestrian	0.03	0	BLM	Telecom	Zale (1985d)
14406	5-1469	5-1469	Pedestrian	0.05	0	BLM	Mining	Zale (1985a)
14408	5-1471	5-1471	Pedestrian	0.01	0	BLM	Telecom	Hall and Zale (1985)
14437	5-1515	5-1515	Pedestrian	0.01	0	BLM	Telecom	Hall (1986a)
14448	5-1531	5-1531	Pedestrian	0.01	0	BLM	Telecom	Arellano (1984b)

Table A.1. Continued.

SHPO Report No.	NVCRIS Report No.	BLM Project No.	Survey Type	Area (km^2)	No. of Properties	Agency	Industry	Reference(s)
14450	5-1534	5-1534	Pedestrian	0.01	0	BLM	Telecom	Hall (1986b)
14459	5-1544	5-1544	Pedestrian	0.03	0	BLM	Mining	Zale and Kershaw (1986)
14479	5-1583	5-1583	Pedestrian	0.02	0	BLM	Mining	Myhrer (1986)
14585	5-1712	5-1712	Pedestrian	0.14	1	BLM	Range management	Myhrer (1987)
14604, 14605, 14606	5-1741	5-1741	Pedestrian	0.15	1	Contractor	Mining	Wilke and McCarthy (1987); Wilke and Schroth (1988)
14624	5-1770	5-1770	Pedestrian	0.46	4	Contractor	Mining	Burke (1988)
14724	5-1922	5-1922	Pedestrian	0.18	0	BLM	Transportation	Samuelson (1988)
14735	5-1949	5-1949	Pedestrian	0.43	0	Contractor	Mining	Young (1989)
14744	14744	5-1968	Pedestrian	1.44	8	Contractor	Energy	Young (1990)
14749	5-1977	5-1977	Pedestrian	2.37	0	BLM	Range management	Myhrer (1990b)
14764	5-2112	5-2112	Pedestrian	0.19	0	Contractor	Energy	Rafferty and Leavitt (1990)
14767	5-2117	5-2117	Pedestrian	0.71	1	Contractor	Other	McCabe (1991)
14783	5-2142	5-2142	Windshield	1.20	0	BLM	Recreation permitting	Myhrer (1991a)
14784	5-2144	5-2144	Pedestrian	0.36	0	BLM	Telecom	Myhrer (1991b)
14803	5-2180	5-2180	Pedestrian	0.10	0	Contractor	Mining	Wilke (1992)
14820	5-2200	5-2200	Pedestrian	0.32	1	BLM	Mining	Myhrer (1992)
14828	5-2213	5-2213	Pedestrian	0.38	1	BLM	Mining	Myhrer (1993)
14863	5-2259	5-2259	Pedestrian	0.13	0	Contractor	Other	Johnston (1994)
14899	5-2311	5-2311	Pedestrian	0.01	0	BLM	Telecom	Leavitt (1995)
15016	DBI_NV_2006_70	5-2541	Pedestrian	0.94	9	Contractor	Other	Stokes et al. (2006)
15021	15021	5-2555	Pedestrian	0.93	3	Contractor	Range management	Seymour et al. (2006)
15039	2012	5-2592	Pedestrian	0.08	4	Contractor	Other	Gruis and Switalski (2008)
18528	18528	–	Pedestrian	0.00	0	NDOT	Transportation	Rigtrup (2013)
21593	21593	5-2750	Pedestrian	0.00	0	NDOT	Telecom	Rigtrup (2016)
22222	22222	5-2756	Pedestrian	0.62	5	Contractor	Energy	Crawford et al. (2016)
23538	23538	5-2773-2	Pedestrian	0.09	8	Contractor	Energy	Davis and George (2018); Winslow (2017)

Table A.1. Continued.

SHPO Report No.	NVCRIS Report No.	BLM Project No.	Survey Type	Area (km^2)	No. of Properties	Agency	Industry	Reference(s)
25332	25332	5-2773-1	Pedestrian	2.78	21	Contractor	Energy	Davis and George (2019); Winslow and Kramer (2019)
25690	–	–	Pedestrian	24.17	0	NPS	Other	Peterson (2019)
26664	26664	5-2802	Pedestrian	0.62	1	NDOT	Transportation	Sprengeler and Goshen (2020)
5-381	13746	5-381	Windshield	306.76	0	BLM	Recreation permitting	Wolf (1978b)
5-489	13820	5-489	Windshield	491.77	0	BLM	Recreation permitting	Sozzi and Robinson (1979)
5-556	13862	5-556	Pedestrian	11.28	0	BLM	Energy	Martin (1980)
5-1082	13839	5-519	Pedestrian	41.07	0	BLM	Other	Martin (1979c)
5-1755	14618	5-1755	Pedestrian	2.38	1	BLM	Transportation	Myhrer and Samuelson (1987)
5-1997	13008	5-1997	Pedestrian	585.54	2	Contractor	Mining	Edwards (1990)
Pending	–	5-2791	Pedestrian	9.30	101	Contractor	Energy	Vicari and Villagran (2018); Vicari et al. (2018)
Pending	–	5-2803	Pedestrian	3.80	19	Contractor	Energy	Arcadis U.S. (2020)
Pending	–	5-2820	Pedestrian	0.62	16	Contractor	Energy	Vicari et al. (2020)
–	–	–	Pedestrian	5.69	2	Contractor	Energy	Dobbins (1979, 1980)
–	–	–	Pedestrian	–	6	–	–	Rogers (n.d., 1930)
–	–	4-500	Pedestrian	0.32	0	?	?	?

[a]The unique identifier for the report of the survey used by the Nevada State Historic Preservation Office (SHPO).

[b]The unique identifier for the report of the survey used by the Nevada Cultural Resource Inventory System (NVCRIS).

[c]The unique identifier for the project and corresponding report used by the Bureau of Land Management (BLM) Nevada.

[d]Method of ground coverage: pedestrian (on foot); windshield (by vehicle); horseback.

[e]The area of coverage from the corresponding project that falls within the study area.

[f]Number of cultural resources records generated for properties within the study area.

[g]The agency that conducted the cultural resources and/or historic property inventory: ACOE = Army Corps of Engineers; BLM = Bureau of Land Management; NDOT = Nevada Department of Transportation; NPS = National Park Service.

[h]The type of federal undertaking that triggered the corresponding cultural resources or historic property inventory.

[i]Citation(s) for the corresponding reports listed in References Cited.

APPENDIX B

INVENTORY OF DOCUMENTED CULTURAL RESOURCES AND HISTORIC PROPERTIES

Table B.1. Inventory of documented cultural resources and historic properties.

Trinomial[a]	Site Name[b]	Topographic Region(s)[c]	Association[d]	Property Class[e]	NRHP Status[f]	Reference(s)[g]
CK3	Hiko Springs	Newberry Mountains	M	–	U	Beekman (n.d.); Botti (1977); Green (1987); Heizer and Baumhoff (1962); McLane (2001); Rogers (n.d.); Steward (1929)
CK121	Lewis Holes	Castle Mountains	I	Rockshelter and petroglyphs	U	Haenszel (1953); Heizer and Baumhoff (1962); McLane (2001); Moen (1968); Yoder and Brosman (2007)
CK170	Crescent	McCullough Range	I	Traditional Cultural Place	U	Haenszel (1953)
CK1152	–	Piute Valley	I	Artifact scatter	U	Brooks (1972)
CK1153	–	Piute Valley	I	Artifact scatter	U	Brooks (1972)
CK1190	–	Eldorado Valley	I	Quarry	U	Bondley and Brooks (1973)
CK1191	–	Eldorado Valley	I	Quarry	U	Bondley and Brooks (1973)
CK1192	–	Eldorado Valley	I	Quarry	U	Bondley and Brooks (1973)
CK1193	–	Eldorado Valley	I	Quarry	U	Bondley and Brooks (1973)
CK1194	–	Eldorado Valley	I	Miscellaneous rock features	U	Bondley and Brooks (1973)
CK1198	–	Newberry Mountains	I	Miscellaneous rock features	U	Bondley and Brooks (1973)
CK1308	–	Eldorado Valley	U	Indeterminate	Unknown	Missing record
CK1343	Nat Canyon Petroglyphs	Newberry Mountains	I	Rockshelter and petroglyphs	U	Burkholder (1988); McLane (2001); Yoder and Brosman (2007)
CK1587, CK2113	–	Eldorado Valley, Highland Range	I	Quarry	I	Barker et al. (1979); Dobbins (1979, 1980)
CK1588	–	Highland Range	I	Quarry	i	Dobbins (1979, 1980)
CK1595	–	Newberry Mountains	I	Rockshelter	U	Green (1979)
CK1596	–	Newberry Mountains	EA	Homesteading and ranching	U	Green (1979)
CK1597	–	Newberry Mountains	I	Rockshelter	U	Green (1979)
CK1601	Granite Tanks	Dead Mountains	I	Petroglyphs	U	Burkholder (1989); Christensen (2000); Christensen and Dickey (2001); McLane (2001)
CK1602	Granite Tanks	Dead Mountains	I	Rockshelter	U	Burkholder (1989); Christensen (2000); Christensen and Dickey (2001); McLane (2001)
CK1603	–	Newberry Mountains	I	Petroglyphs	i	Haenszel (1970); Knight (1986); McLane (2001)
CK2110	–	McCullough Range	I	Artifact scatter	U	Barker et al. (1979)
CK2112	–	Highland Range	I	Artifact scatter	U	Barker et al. (1979)

Table B.1. Continued.

Trinomial[a]	Site Name[b]	Topographic Region(s)[c]	Association[d]	Property Class[e]	NRHP Status[f]	Reference(s)[g]
CK2114	–	McCullough Range	I	Trail	U	Barker et al. (1979)
CK2115	–	Highland Range	I	Quarry	U	Barker et al. (1979)
CK2116	–	Highland Range	U	Miscellaneous rock features	U	Barker et al. (1979)
CK2117	–	Highland Range	I	Rockshelter	U	Barker et al. (1979)
CK2118	–	Highland Range	I	Rockshelter	U	Barker et al. (1979)
CK2119	–	Highland Range	I	Rockshelter	U	Barker et al. (1979)
CK2120	–	Highland Range	I	Rockshelter	U	Barker et al. (1979)
CK2121	–	Highland Range	I	Rockshelter	U	Barker et al. (1979)
CK2626	–	Highland Range	I	Artifact scatter	U	Botti (1977)
CK2631	–	Eldorado Valley	I	Artifact scatter	U	Fowler et al. (1978)
CK2949	–	McCullough-Lucy Gray Traverse	EA	Homesteading and ranching	U	Hall et al. (1981)
CK2950	–	McCullough-Lucy Gray Traverse	EA	Homesteading and ranching	U	Hall et al. (1981)
CK2951	Crescent Townsite	McCullough Range, McCullough-Lucy Gray Traverse	M	–	e	Hall et al. (1981); Vicari et al. (2018); Young (1990)
CK2953	Searchlight Memorial Cemetery	Cottonwood Valley	EA	Homesteading and ranching	U	Hall et al. (1981)
CK3078	Morgan's Mill	McCullough Range	EA	Mining	U	Rafferty (1982b)
CK3079	–	McCullough Range	EA	Homesteading and ranching	U	Rafferty (1982b)
CK3081, CK7466	Searchlight to Nipton Road	McCullough Range, Piute Valley	EA	Transportation	E	Davis and George (2018); Rafferty (1982b); Vicari et al. (2018, 2020)
CK3214	–	Eldorado Valley	I	Artifact scatter	i	Leavitt (1983c)
CK3215	–	Eldorado Valley	I	Artifact scatter	i	Leavitt (1983c)
CK3509	–	New York Mountains	I	Rockshelter	U	Storbo (1981)
CK3637	Highland Springs	Highland Range	I	Petroglyphs	e	Burkholder (1996); Halbmaier (2007); McLane (2001); Rogers (n.d.)
CK3638	Cow Spring	Highland Range	I	Petroglyphs	U	McLane (2001); Rogers (n.d.)
CK3644	Crescent Turquoise Mines	New York Mountains	M	–	U	Rogers (n.d.); Yoder and Brosman (2007)
CK3645	Crescent Wash (South Fork)	McCullough Range	I	Rockshelter	U	Rogers (n.d.)

Table B.1. Continued.

Trinomial[a]	Site Name[b]	Topographic Region(s)[c]	Association[d]	Property Class[e]	NRHP Status[f]	Reference(s)[g]
CK3646	Crescent Wash (North Fork)	McCullough Range	I	Rockshelter	U	Rogers (n.d.)
CK3803	BLM Well No. 1	Piute Valley	EA	Homesteading and ranching	I	Myhrer (1987); Stokes et al. (2006)
CK3805	–	Piute Valley	I	Artifact scatter	U	Leavitt (1987)
CK3849	Juan Obsidian Source	Piute Valley	I	Quarry	U	Wilke (1988); Wilke and McCarthy (1987)
CK3850	Juan	Castle Mountains, Piute Valley	M	–	U	Wilke (1987)
CK3862	–	Eldorado Valley	EA	Mining	i	Myhrer and Samuelson (1987)
CK3873	Barnwell-Searchlight Railroad	Piute Valley	EA	Transportation	I	Arcadis U.S. (2020); Burke (1988); Vicari et al. (2018)
CK3875	–	Piute Valley	EA	Transportation	U	Burke (1988)
CK3876	–	Piute Valley	EA	Refuse scatter	U	Burke (1988)
CK3878	–	Piute Valley	EA	Residential	I	Burke (1988)
CK3880	–	Piute Valley	EA	Refuse scatter	U	Burke (1988)
CK3881	–	Piute Valley	EA	Refuse scatter	U	Burke (1988)
CK3883	–	Piute Valley	EA	Refuse scatter	U	Burke (1988)
CK3889	Corral	Highland Range	I	Petroglyphs	U	Burkholder (1988); McLane (2001)
CK3890	Snowcamp	Highland Range	I	Petroglyphs	U	Burkholder (1987); McLane (2001)
CK3892	Explorer I	Highland Range	I	Rockshelter and petroglyphs	U	Burkholder (1987)
CK3894	Explorer II	Highland Range	I	Petroglyphs	U	Burkholder (1987)
CK3899	Six Circles	Highland Range	U	Miscellaneous rock features	U	Burkholder (1988)
CK4095	Goldmine	Ireteba Peaks	I	Petroglyphs	U	Burkholder (1988)
CK4099	Explorer III	Highland Range	I	Petroglyphs	U	Burkholder (1988)
CK4111	Recreation Area Boundary	Newberry Mountains	I	Petroglyphs	U	Burkholder (1988)
CK4116	–	Newberry Mountains	I	Petroglyphs	e	Seldomridge (1988)
CK4168	Supercave	Castle Mountains	I	Rockshelter and petroglyphs	e	Christensen (1996); Christensen and Dickey (1996); McLane (2001); Murphy and Burkholder (1989)
CK4175	–	Piute Valley	EA	Refuse scatter	U	Davis et al. (1989)

Table B.1. Continued.

Trinomial[a]	Site Name[b]	Topographic Region(s)[c]	Association[d]	Property Class[e]	NRHP Status[f]	Reference(s)[g]
CK4176	–	Piute Valley	I	Quarry	i	Arcadis U.S. (2020); Davis et al. (1989)
CK4233	Stan's Site	Castle Mountains	I	Rockshelter and petroglyphs	i	Burkholder (1989); Vicari et al. (2018)
CK4320	–	Mohave Valley	EA	Refuse scatter	U	Davis et al. (1989)
CK4326	Lucky Day	Piute Valley	I	Petroglyphs	U	Burkholder (1989)
CK4342	Look 4 'em	Piute Range	I	Petroglyphs	U	Burkholder (1989)
CK4343	Obsidian Quest	Castle Mountains	I	Rockshelter	U	Burkholder (1990)
CK4344	Lucky II	Piute Valley	I	Petroglyphs	U	Burkholder (1990)
CK4345 (A)	Mystic Marker (A)	Piute Valley	I	Petroglyphs	U	Burkholder (1990)
CK4345 (B)	Mystic Marker (B)	Piute Range	I	Petroglyphs	U	Burkholder (1990)
CK4346	Mystic Mountain	Piute Range	I	Petroglyphs	U	Burkholder (1990)
CK4347	Down the Wash	Piute Valley	I	Petroglyphs	U	Burkholder (1990)
CK4371	–	Eldorado Valley	EA	Refuse scatter	U	Edwards (1990)
CK4372	–	Eldorado Valley	I	Artifact scatter	U	Edwards (1990)
CK4611	–	New York Mountains	M	–	e	Vicari et al. (2018); Young (1990)
CK4612	–	Piute Valley	I	Artifact scatter	e	Young (1990)
CK4613	Guzzler Road	Highland Range	I	Petroglyphs	U	Burkholder (1990)
CK4614	Deadhorse Canyon	Highland Range	I	Petroglyphs	U	Burkholder (1990)
CK4622	–	Piute Valley	EA	Refuse scatter	U	McCabe (1991)
CK4626	Walking Box Ranch	Piute Valley	EA	Homesteading and ranching	L	McCabe (1991)
CK4782	White Quartz	Newberry Mountains	I	Artifact scatter	i	Blair (1996a)
CK4783	Yellowstone Mine	Newberry Mountains	EA	Mining	i	Blair (1996a)
CK4807	Mohave Gateway	Castle Mountains	I	Rockshelter and petroglyphs	U	Burkholder (1991); Yoder and Brosman (2007)
CK4819	Windmill Road	Highland Range	I	Petroglyphs	U	Burkholder (1992)
CK4846	–	Piute Range	I	Miscellaneous rock features	i	Wilke (1992)
CK4847	–	Piute Range	I	Miscellaneous rock features	i	Wilke (1992)
CK4851	Phillips-Lory	Ireteba Peaks	I	Petroglyphs	U	Burkholder (1992)
CK4899	Roman Mine	Newberry Mountains	EA	Mining	i	Myhrer (1992)
CK4910	–	New York Mountains	EA	Mining	i	Myhrer (1993)
CK4911	–	New York Mountains	EA	Mining	i	Myhrer (1993)

Table B.1. Continued.

Trinomial[a]	Site Name[b]	Topographic Region(s)[c]	Association[d]	Property Class[e]	NRHP Status[f]	Reference(s)[g]
CK5113	Rosie McDonald's Homesite	Newberry Mountains	EA	Homesteading and ranching	i	Myhrer (1994)
CK5249	Ireteba Peaks I	Ireteba Peaks	I	Petroglyphs	U	Burkholder (1995)
CK5250	Ireteba Peaks II	Ireteba Peaks	I	Petroglyphs	U	Burkholder (1995); White (2006)
CK5251	Ireteba Peaks III	Cottonwood Valley	I	Petroglyphs	U	Burkholder (1995)
CK5277	Ireteba Peaks IV	Ireteba Peaks	I	Petroglyphs	U	Burkholder (1995)
CK5388	Spirit Mountain TCP	Newberry Mountains	I	Traditional Cultural Place	L	Blair (1996a); Ellis-Pinto and Rolf (1999); Myrher (1994)
CK5448	–	Piute Valley	M	–	i	Moore (1997)
CK5615	–	McCullough-Lucy Gray Traverse	EA	Refuse scatter	U	Young (1990)
CK5616	–	McCullough Range	I	Artifact scatter	U	Young (1990)
CK5617	–	McCullough Range	M	–	i	Vicari et al. (2018); Young (1990)
CK5618	–	McCullough Range	EA	Refuse scatter	U	Young (1990)
CK5619	–	New York Mountains	EA	Mining	U	Young (1990)
CK5620	–	New York Mountains	EA	Miscellaneous rock features	U	Young (1990)
CK5621	–	New York Mountains	EA	Refuse scatter	U	Young (1990)
CK5622	–	Piute Valley	I	Quarry	U	Young (1990)
CK5968	Highland View	Newberry Mountains	I	Quarry	U	White (2000)
CK5969	Tired Dog Shelter	Newberry Mountains	I	Rockshelter	i	White (2000)
CK5970	Headwater Shelter	Newberry Mountains	I	Rockshelter	i	White (2000)
CK5971	Lost Spring	Newberry Mountains	M	–	i	White (2000)
CK6179	Copper Mountain Mine	Ireteba Peaks	EA	Mining	E	Shirley (2000); White (2000)
CK6450	Davis Hoover Transmission Line	Cottonwood Valley, Eldorado Valley, Ireteba Peaks	EA	Energy and utility conduit	i	Schweigert (2001)
CK7024	–	Piute Valley	EA	Refuse scatter	i	Stearns (2004)
CK7138	–	Newberry Mountains	EA	Miscellaneous rock features	I	Byrd et al. (2004)
CK7139	–	Newberry Mountains	EA	Miscellaneous rock features	I	Byrd et al. (2004)
CK7140	–	Newberry Mountains	EA	Miscellaneous rock features	I	Byrd et al. (2004)
CK7141	–	Newberry Mountains	EA	Miscellaneous rock features	i	Byrd et al. (2004)

Table B.1. Continued.

Trinomial[a]	Site Name[b]	Topographic Region(s)[c]	Association[d]	Property Class[e]	NRHP Status[f]	Reference(s)[g]
CK7142	–	Newberry Mountains	EA	Mining	I	Byrd et al. (2004)
CK7143	–	Newberry Mountains	EA	Miscellaneous rock features	I	Byrd et al. (2004)
CK7144	–	Newberry Mountains	I	Trail	I	Byrd et al. (2004)
CK7145	–	Newberry Mountains	I	Artifact scatter	I	Byrd et al. (2004)
CK7146	–	Newberry Mountains	I	Artifact scatter	I	Byrd et al. (2004)
CK7147	–	Newberry Mountains	I	Miscellaneous rock features	I	Byrd et al. (2004)
CK7148	–	Newberry Mountains	I	Trail	I	Byrd et al. (2004)
CK7149	–	Newberry Mountains	I	Rockshelter	I	Byrd et al. (2004)
CK7256	Luck Lode Mine	New York Mountains	EA	Mining	E	Slaughter (2006)
CK7258	–	Chiquita Hills	EA	Military	e	Sprengeler and Goshen (2020)
CK7460	–	Piute Valley	EA	Mining	E	Stokes et al. (2006)
CK7461	–	Piute Valley	EA	Mining	I	Stokes et al. (2006)
CK7462	–	Piute Valley	EA	Refuse scatter	I	Stokes et al. (2006)
CK7463	–	Piute Valley	EA	Energy and utility conduit	I	Stokes et al. (2006)
CK7464	–	Piute Valley	EA	Refuse scatter	I	Stokes et al. (2006)
CK7465	–	Piute Valley	M	–	I	Stokes et al. (2006)
CK7468	–	Piute Valley	EA	Transportation	I	Stokes et al. (2006)
CK7469	–	Piute Valley	EA	Energy and utility conduit	I	Stokes et al. (2006)
CK7555	Walking Box Trough Site	McCullough Range	EA	Homesteading and ranching	I	Seymour et al. (2006)
CK7556	–	McCullough Range	EA	Homesteading and ranching	I	Seymour et al. (2006)
CK7557	Road to Eldorado	Piute Valley	EA	Transportation	E	Seymour et al. (2006)
CK7647	–	Piute Valley	EA	Mining	e	White et al. (2008)
CK7648	–	Piute Valley	EA	Mining	i	White et al. (2008)
CK7649	Juniper Mine	Newberry Mountains	EA	Mining	i	White et al. (2008)
CK7651	–	Newberry Mountains	EA	Mining	e	White et al. (2008)
CK7652	–	Newberry Mountains	EA	Mining	i	White et al. (2008)
CK7670	–	Newberry Mountains	EA	Mining	i	White et al. (2008)
CK7671	Moonbeam No. 1 Mine	Eldorado Valley	EA	Mining	i	White et al. (2008)

Table B.1. Continued.

Trinomial[a]	Site Name[b]	Topographic Region(s)[c]	Association[d]	Property Class[e]	NRHP Status[f]	Reference(s)[g]
CK7672	–	Eldorado Valley	EA	Mining	i	White et al. (2008)
CK7673	–	Eldorado Valley	EA	Mining	i	White et al. (2008)
CK7679	–	Ireteba Peaks	EA	Mining	i	White et al. (2008)
CK7680	–	Ireteba Peaks	EA	Mining	e	White et al. (2008)
CK7681	–	Ireteba Peaks	EA	Mining	i	White et al. (2008)
CK7683	–	New York Mountains	EA	Mining	i	White et al. (2008)
CK7684	–	New York Mountains	EA	Mining	i	White et al. (2008)
CK7685	–	New York Mountains	EA	Mining	i	White et al. (2008)
CK7686	–	New York Mountains	EA	Mining	i	White et al. (2008)
CK7687	–	New York Mountains	EA	Mining	i	Vicari et al. (2018); White et al. (2008)
CK7688	–	New York Mountains	EA	Mining	i	White et al. (2008)
CK7689	–	New York Mountains	EA	Mining	i	White et al. (2008)
CK7690	–	New York Mountains	EA	Mining	i	White et al. (2008)
CK7691	–	New York Mountains	EA	Mining	i	Vicari et al. (2018); White et al. (2008)
CK7692	Marlboro Mine	New York Mountains	EA	Mining	e	White et al. (2008)
CK7693	–	McCullough Range	EA	Mining	i	Vicari et al. (2018); White et al. (2008)
CK7694	Silver Bell Mine	McCullough Range, New York Mountains	EA	Mining	i	White et al. (2008)
CK7695	–	New York Mountains	EA	Mining	i	White et al. (2008)
CK7696	–	New York Mountains	EA	Mining	i	White et al. (2008)
CK7697	–	New York Mountains	EA	Mining	i	White et al. (2008)
CK7712	–	Highland Range	EA	Mining	i	White et al. (2008)
CK7752	–	Piute Valley	EA	Homesteading and ranching	e	White et al. (2008)
CK7753	–	Newberry Mountains	EA	Mining	i	White et al. (2008)
CK7754	–	Newberry Mountains	EA	Mining	i	White et al. (2008)
CK7755	–	Newberry Mountains	EA	Mining	i	White et al. (2008)
CK7757	–	New York Mountains	EA	Mining	i	Vicari et al. (2018); White et al. (2008)
CK7759	–	New York Mountains	EA	Mining	i	White et al. (2008)

Table B.1. Continued.

Trinomial[a]	Site Name[b]	Topographic Region(s)[c]	Association[d]	Property Class[e]	NRHP Status[f]	Reference(s)[g]
CK8253	–	New York Mountains	EA	Refuse scatter	I	Gruis and Switalski (2008); Vicari et al. (2018)
CK8254	–	New York Mountains	EA	Transportation	I	Gruis and Switalski (2008); Vicari et al. (2018)
CK8255	–	New York Mountains	EA	Military	I	Gruis and Switalski (2008)
CK8256	–	New York Mountains	EA	Mining	i	Gruis and Switalski (2008)
CK9269	–	Piute Valley	M	–	i	Stegner and Bevill (2012)
CK9278	–	Cottonwood Valley	EA	Refuse scatter	i	Stegner and Bevill (2012)
CK10297	–	Eldorado Valley	I	Artifact scatter	i	Crawford et al. (2016)
CK10298	–	Eldorado Valley	I	Artifact scatter	i	Crawford et al. (2016)
CK10299	–	Eldorado Valley	I	Artifact scatter	i	Crawford et al. (2016)
CK10300	–	Eldorado Valley	I	Artifact scatter	i	Crawford et al. (2016)
CK10301	–	Eldorado Valley	I	Artifact scatter	i	Crawford et al. (2016)
CK10369	–	McCullough-Lucy Gray Traverse	EA	Refuse scatter	I	Vicari et al. (2020); Winslow (2017)
CK10370	–	McCullough-Lucy Gray Traverse	EA	Refuse scatter	I	Winslow (2017)
CK10371	–	McCullough-Lucy Gray Traverse	EA	Refuse scatter	I	Winslow (2017)
CK10372	–	McCullough-Lucy Gray Traverse	EA	Refuse scatter	I	Winslow (2017)
CK10373	–	McCullough-Lucy Gray Traverse	EA	Refuse scatter	I	Winslow (2017)
CK10374	–	McCullough-Lucy Gray Traverse	EA	Refuse scatter	I	Winslow (2017)
CK10519	–	McCullough-Highland Traverse	EA	Refuse scatter	I	Winslow and Kramer (2019)
CK10520	–	McCullough-Highland Traverse	EA	Refuse scatter	I	Winslow and Kramer (2019)
CK10521	–	McCullough-Highland Traverse	EA	Refuse scatter	I	Winslow and Kramer (2019)
CK10522	–	Eldorado Valley	EA	Homesteading and ranching	I	Winslow and Kramer (2019)
CK10523	–	Piute Valley	EA	Refuse scatter	I	Winslow and Kramer (2019)
CK10527	–	Highland Range	I	Quarry	E	Winslow and Kramer (2019)
CK10533	–	Mohave Valley	EA	Refuse scatter	I	Winslow and Kramer (2019)
CK10535	–	Mohave Valley	EA	Mining	I	Winslow and Kramer (2019)
CK10540	–	Highland Range	EA	Refuse scatter	I	Winslow and Kramer (2019)
CK10541	–	Highland Range	EA	Mining	I	Winslow and Kramer (2019)
CK10542	–	Highland Range	EA	Refuse scatter	I	Winslow and Kramer (2019)
CK10543	–	Eldorado Valley	EA	Mining	I	Winslow and Kramer (2019)

Table B.1. Continued.

Trinomial[a]	Site Name[b]	Topographic Region(s)[c]	Association[d]	Property Class[e]	NRHP Status[f]	Reference(s)[g]
CK10544	–	Eldorado Valley	I	Artifact scatter	I	Winslow and Kramer (2019)
CK10550	–	Piute Valley	EA	Refuse scatter	I	Winslow and Kramer (2019)
CK10551	–	Piute Valley	EA	Refuse scatter	I	Winslow and Kramer (2019)
CK10552	–	Piute Valley	EA	Refuse scatter	I	Winslow and Kramer (2019)
CK10553	–	Newberry Mountains	EA	Refuse scatter	I	Winslow and Kramer (2019)
CK10555	–	Eldorado Valley	EA	Transportation	I	Winslow and Kramer (2019)
CK10619	Crescent Peak Road	Ivanpah Valley, McCullough-Lucy Gray Traverse, McCullough Range, New York Mountains, Piute Valley	EA	Transportation	i	Vicari et al. (2018)
CK10620	–	McCullough Range	EA	Transportation	i	Vicari et al. (2018)
CK10621	–	Piute Valley	EA	Homesteading and ranching	i	Vicari et al. (2018)
CK10622	–	Piute Valley	EA	Homesteading and ranching	i	Vicari et al. (2018)
CK10623	–	Piute Valley	EA	Refuse scatter	i	Vicari et al. (2018)
CK10624	–	McCullough-Highland Traverse	EA	Transportation	i	Vicari et al. (2018)
CK10625	–	McCullough-Highland Traverse, McCullough Range	EA	Transportation	i	Vicari et al. (2018)
CK10626	–	Piute Valley	EA	Refuse scatter	i	Vicari et al. (2018)
CK10627	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10628	Clark's Well	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10629	–	New York Mountains	M	–	i	Vicari et al. (2018)
CK10630	–	Piute Valley	EA	Homesteading and ranching	i	Vicari et al. (2018)
CK10631	–	Piute Valley	EA	Homesteading and ranching	i	Vicari et al. (2018)
CK10633	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10634	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10635	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10636	–	McCullough Range	EA	Mining	i	Vicari et al. (2018)
CK10637	–	McCullough Range	EA	Refuse scatter	i	Vicari et al. (2018)

Table B.1. Continued.

Trinomial[a]	Site Name[b]	Topographic Region(s)[c]	Association[d]	Property Class[e]	NRHP Status[f]	Reference(s)[g]
CK10638	7 Mile Road	New York Mountains, Piute Valley	EA	Transportation	i	Vicari et al. (2018)
CK10639	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10640	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10641	–	New York Mountains	EA	Military	i	Vicari et al. (2018)
CK10642	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10643	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10644	–	New York Mountains	EA	Military	i	Vicari et al. (2018)
CK10645	–	New York Mountains, Piute Valley	EA	Transportation	i	Vicari et al. (2018)
CK10646	–	Piute Valley	EA	Military	i	Vicari et al. (2018)
CK10647	–	New York Mountains	I	Artifact scatter	i	Vicari et al. (2018)
CK10648	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10649	–	New York Mountains	U	Miscellaneous rock features	i	Vicari et al. (2018)
CK10650	–	New York Mountains	U	Miscellaneous rock features	i	Vicari et al. (2018)
CK10651	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10652	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10653	–	Piute Valley	EA	Refuse scatter	i	Vicari et al. (2018)
CK10654	–	New York Mountains	EA	Miscellaneous rock features	i	Vicari et al. (2018)
CK10655	–	McCullough Range	EA	Refuse scatter	i	Vicari et al. (2018)
CK10656	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10657	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10658	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10659	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10660	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10661	–	Piute Valley	EA	Transportation	i	Vicari et al. (2018)
CK10662	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10663	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10664	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)

Table B.1. Continued.

Trinomial[a]	Site Name[b]	Topographic Region(s)[c]	Association[d]	Property Class[e]	NRHP Status[f]	Reference(s)[g]
CK10665	–	New York Mountains	EA	Homesteading and ranching	i	Vicari et al. (2018)
CK10666	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10667	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10668	–	McCullough Range	EA	Miscellaneous rock features	i	Vicari et al. (2018)
CK10669	–	Piute Valley	EA	Refuse scatter	i	Vicari et al. (2018)
CK10670	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10671	–	New York Mountains	EA	Miscellaneous rock features	i	Vicari et al. (2018)
CK10672	–	New York Mountains	EA	Military	i	Vicari et al. (2018)
CK10673	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10674	–	New York Mountains	EA	Military	i	Vicari et al. (2018)
CK10675	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10676	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10677	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10678	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10679	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10680	–	New York Mountains	I	Artifact scatter	i	Vicari et al. (2018)
CK10681	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10682	–	Piute Valley	I	Artifact scatter	i	Vicari et al. (2018)
CK10683	–	New York Mountains	I	Artifact scatter	i	Vicari et al. (2018)
CK10684	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10685	–	Castle Mountains	I	Artifact scatter	i	Vicari et al. (2018)
CK10686	–	Castle Mountains	I	Artifact scatter	i	Vicari et al. (2018)
CK10687	–	Castle Mountains	I	Rockshelter	e	Vicari et al. (2018)
CK10688	–	Castle Mountains	M		i	Vicari et al. (2018)
CK10689	–	Piute Valley	EA	Refuse scatter	i	Vicari et al. (2018)
CK10690	–	McCullough Range	EA	Refuse scatter	i	Vicari et al. (2018)
CK10691	–	McCullough Range	EA	Refuse scatter	i	Vicari et al. (2018)
CK10692	–	Piute Valley	EA	Military	i	Vicari et al. (2018)
CK10693	–	McCullough Range	EA	Refuse scatter	i	Vicari et al. (2018)

Table B.1. Continued.

Trinomial[a]	Site Name[b]	Topographic Region(s)[c]	Association[d]	Property Class[e]	NRHP Status[f]	Reference(s)[g]
CK10694	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10695	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10696	–	New York Mountains	EA	Mining	i	Vicari et al. (2018)
CK10697	–	New York Mountains, Piute Valley	EA	Transportation	i	Vicari et al. (2018)
CK10698	–	New York Mountains	EA	Homesteading and ranching	i	Vicari et al. (2018)
CK10699	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10700	–	Piute Valley	I	Artifact scatter	i	Vicari et al. (2018)
CK10701	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10702	–	New York Mountains	EA	Military	i	Vicari et al. (2018)
CK10703	–	New York Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10704	–	Castle Mountains	EA	Refuse scatter	i	Vicari et al. (2018)
CK10705	–	Piute Valley	EA	Refuse scatter	i	Vicari et al. (2018)
CK10706	–	Piute Valley	I	Artifact scatter	i	Vicari et al. (2018)
CK10707	–	Castle Mountains, Piute Valley	EA	Transportation	i	Vicari et al. (2018)
CK10708	–	New York Mountains	EA	Military	i	Vicari et al. (2018)
CK10763	–	Eldorado Valley	EA	Refuse scatter	i	Arcadis U.S. (2020)
CK10764	–	Eldorado Valley	EA	Refuse scatter	i	Arcadis U.S. (2020)
CK10765	–	Eldorado Valley	EA	Refuse scatter	i	Arcadis U.S. (2020)
CK10767	–	Eldorado Valley	EA	Refuse scatter	i	Arcadis U.S. (2020)
CK10768	–	Eldorado Valley	EA	Refuse scatter	i	Arcadis U.S. (2020)
CK10769	–	Eldorado Valley	EA	Refuse scatter	i	Arcadis U.S. (2020)
CK10770	–	Eldorado Valley	EA	Refuse scatter	i	Arcadis U.S. (2020)
CK10772	–	Eldorado Valley	I	Artifact scatter	i	Arcadis U.S. (2020)
CK10776	–	Piute Valley	EA	Refuse scatter	i	Arcadis U.S. (2020)
CK10777	–	Piute Valley	EA	Refuse scatter	i	Arcadis U.S. (2020)
CK10778	–	Piute Valley	EA	Refuse scatter	i	Arcadis U.S. (2020)
CK10779	–	Eldorado Valley	EA	Refuse scatter	i	Arcadis U.S. (2020)

Table B.1. Continued.

Trinomial[a]	Site Name[b]	Topographic Region(s)[c]	Association[d]	Property Class[e]	NRHP Status[f]	Reference(s)[g]
CK10780	–	Piute Valley	EA	Refuse scatter	i	Arcadis U.S. (2020)
CK10781	–	Piute Valley	EA	Refuse scatter	i	Arcadis U.S. (2020)
CK10782	–	Piute Valley	EA	Refuse scatter	i	Arcadis U.S. (2020)
CK10783	–	Chiquita Hills	EA	Refuse scatter	I	Arcadis U.S. (2020)
CK10784	Southwest Gas Southern Transmission System, L and R Lines	Eldorado Valley, Mohave Valley, Newberry Mountains, Piute Valley	EA	Energy and utility conduit	i	Arcadis U.S. (2020)
CK10806	Eldorado-Lugo 500kV Transmission Line	McCullough-Lucy Gray Traverse, McCullough Range, Piute Valley	EA	Energy and utility conduit	e	Chiang and Becker (2016); Davis and George (2018, 2019); Vicari et al. (2018, 2020)
CK10927	–	McCullough-Lucy Gray Traverse	EA	Refuse scatter	i	Vicari et al. (2020)
CK10928	–	McCullough Range	EA	Refuse scatter	i	Vicari et al. (2020)
CK10929	–	McCullough Range	EA	Refuse scatter	i	Vicari et al. (2020)
CK10930	–	McCullough Range	EA	Refuse scatter	i	Vicari et al. (2020)
CK10931	–	McCullough Range	EA	Refuse scatter	i	Vicari et al. (2020)
CK10932	–	McCullough Range	EA	Refuse scatter	i	Vicari et al. (2020)
CK10933	–	McCullough Range	EA	Refuse scatter	i	Vicari et al. (2020)
CK10934	–	McCullough Range	EA	Refuse scatter	i	Vicari et al. (2020)
CK10935	–	McCullough Range	EA	Refuse scatter	i	Vicari et al. (2020)
CK10936	–	McCullough Range	EA	Refuse scatter	i	Vicari et al. (2020)
CK10937	–	McCullough-Lucy Gray Traverse	EA	Refuse scatter	i	Vicari et al. (2020)
CK10938	–	McCullough-Lucy Gray Traverse	EA	Refuse scatter	i	Vicari et al. (2020)
CK10939	–	McCullough-Lucy Gray Traverse	EA	Transportation	i	Vicari et al. (2020)
Unknown	–	Highland Range	U	Indeterminate	Unknown	Misassigned as CK4913
N/A	On Cliff Site	Newberry Mountains	I	Petroglyphs	U	McLane (2001)
N/A	Ora Hanna Site	Highland Range	I	Petroglyphs	U	McLane (2001)
N/A	The Lone Star Site	Castle Mountains	I	Petroglyphs	U	McLane (2001)
N/A	CK4/10/01-6	Highland Range	I	Petroglyphs	U	Burkholder (1996); McLane (2001)
N/A	CK4/10/01-5	Highland Range	I	Petroglyphs	U	McLane (2001)

Table B.1. Continued.

Trinomial[a]	Site Name[b]	Topographic Region(s)[c]	Association[d]	Property Class[e]	NRHP Status[f]	Reference(s)[g]
N/A	CK4/10/01-3	Highland Range	I	Petroglyphs	U	McLane (2001)
N/A	CK4/10/01-7	Highland Range	I	Petroglyphs	U	McLane (2001)
N/A	CK4/9/01-10	Newberry Mountains	I	Petroglyphs	U	McLane (2001)
N/A	CK2/17/01-1	Newberry Mountains	I	Petroglyphs	U	McLane (2001)
N/A	CK2/17/01-2	Newberry Mountains	I	Rockshelter, petroglyphs	U	McLane (2001)
N/A	Eldorado-Mohave 500kV Transmission Line	Mohave Valley	EA	Energy and utility conduit	e	Davis and George (2019)
N/A	U.S. 95	Piute Valley	EA	Transportation	i	
N/A	Paiute Wash Bridge	Piute Valley	EA	Transportation	i	Snyder (2003)

[a]The unique identifier for the cultural resources or historic property assigned by the Nevada State Historic Preservation Office (SHPO).

[b]The name attributed to the property, as provided in the corresponding record.

[c]The setting(s) in which the property is located (see Figure 5.1).

[d]EA = Euro-American; I = Indigenous; U = indeterminate.

[e]General property type.

[f]Status with regarding to the National Register of Historic Places (NRHP): E = determined eligible by the Nevada SHPO; e = recommended eligible by the recorder and/or land manager; I = determined ineligible by the Nevada SHPO; i = recommended ineligible by the recorder and/or land manager; L = listed on the NRHP; U = eligibility unevaluated.

[g]Citation(s) for the corresponding reports listed in References Cited.

REFERENCES CITED

Adams, David K., and Andrew C. Comrie
1997 The North American Monsoon. *Bulletin of the American Meteorological Society* 78:2197–2214.

Ahlstrom, Richard V. N.
2008 Re-Imagining the History of Maize Farming in the Las Vegas Valley. In *Proceedings of the 2007 Three Corners Conference*, edited by Mark C. Slaughter, Steven Daron, Eva Jensen, and Kathleen A. Sprowl, pp. 1–20. Nevada Archaeological Association, Las Vegas.

2012 Obsidian Sourcing Data. In *A Prehistoric Context for Southern Nevada*, edited by Heidi Roberts and Richard V. N. Ahlstrom, pp. B1–B27. Archaeological Report No. 011-05. HRI Inc., Las Vegas.

2019 Prehistoric Hunter-Gatherer-Farmer Identifies in the Las Vegas Valley, Southern Nevada. In *Interaction and Connectivity in the Greater Southwest*, edited by Karen G. Harry and Barbara J. Roth, pp. 329–352. University Press of Colorado, Boulder.

Ahlstrom, Richard V. N., and Heidi Roberts
2012 Puebloan Period (A.D. 200 – 1300). In *A Prehistoric Context for Southern Nevada*, edited by Heidi Roberts and Richard V. N. Ahlstrom, pp. 115–164. Archaeological Report No. 011-05. HRI Inc., Las Vegas.

Aikens, C. Melvin
1994 Adaptive Strategies and Environmental Change in the Great Basin and Its Peripheries as Determinants in the Migrations of Numic-Speaking Peoples. In *Across the West: Human Population Movement and the Expansion of the Numa*, edited by David B. Madsen and David Rhode, pp. 35–43. University of Utah Press, Salt Lake City.

Aikens, C. Melvin, and Younger T. Witherspoon
1986 Great Basin Numic Prehistory: Linguistics, Archaeology, and Environment. In *Anthropology of the Desert West: Essays in Honor of Jesse D. Jennings*, edited by Carol Condie and Don D. Fowler, pp. 7–20. Anthropological Papers No. 110. University of Utah Press, Salt Lake City.

Allison, James R.
2008 Shinarump Red Ware and Other Red Ware Pottery North and West of the Colorado River. *Pottery Southwest* 27(1):21–34.

Alley, John
1977 *The Las Vegas Paiutes: A Short History*. Las Vegas Tribe of Paiute Indians, Las Vegas.

Alvarez de Williams, Anita
1983 Cocopah. In *Southwest*, edited by Alfonso Ortiz, pp. 99–112. Handbook of North American Indians, vol. 10, William C. Sturtevant, general editor. Smithsonian Institution, Washington D.C.

Ambler, J. Richard, and Mark Q. Sutton
1989 The Anasazi Abandonment of the San Juan Drainage and the Numic Expansion. *North American Archaeologist* 10:39–53.

Amsden, Charles A.
1937 The Lake Mojave Artifacts. In *The Archaeology of Pleistocene Lake Mojave: A Symposium*, by Elizabeth W. Campbell, William H. Campbell, Ernst Antevs, Charles A. Amsden, Joseph A. Barbieri, and Francis D. Bode, pp. 51–95. Southwest Museum Papers No. 11. Southwest Museum, Los Angeles.

Anderson, Bruce A.
1998 *Archaeological Monitoring for the McCullough-Liberty Fiber Optics Project: The Nevada Segment*. Intermountain Cultural Resource Services Research Paper No. 41B. Dames & Moore, Las Vegas.

Anderson, R. Scott, and Thomas R. Van Devender
1995 Vegetation History and Paleoclimates of the Coastal Lowlands of Sonora, Mexico: Pollen Records from Packrat Middens. *Journal of Arid Environments* 30:295–306.

Antevs, Ernst V.
1929 Studies on the Past Climate in Relation to Man in the Southwest. *Carnegie Institution of Washington Year Book* 38:317–319.

1955 Geologic-Climatic Dating in the West. *American Antiquity* 20:317–335.

Arcadis U.S.
2020 *Class III Cultural Resource Inventory, Southern Transmission System Replacement Project, Clark County, Nevada*. Arcadis U.S., Inc., Reno, Nevada.

Arellano, Elena
1984a BLM Cultural Resources Report Format/Field Worksheet: Proposed Communication Site for Mohave County Communications. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1984b BLM Cultural Resources Report Format/Field Worksheet: Proposed Communication Site for Mohave County Communications. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Arend, Tiffany, and Barbara J. Roth
2015 Landscapes and Land Use along Soda Playa in the Mojave Desert. *California Archaeology* 7:175–204.

Baksh, Michael
1995 *Native American Research Plan for the Spirit Mountain Study Area of the Lake Mead National Recreation Area*. Tierra Environmental Service, San Diego.

Baldwin, Gordon C.
1943 Archaeological Survey of the Davis Dam Reservoir Area. On file, U.S. Department of the Interior, National Park Service, Boulder Dam National Recreation Area, Boulder City, Nevada.

1948 Archaeological Surveys and Excavations in the Davis Dam Reservoir Area. On file, National Park Service, Region 3, Lake Mead Recreation Area, Boulder City, Nevada.

1950a Archaeological Survey of the Lake Mead Area. In *For the Dean: Essays in Anthropology in Honor of Byron Cummings on His Eighty-Ninth Birthday, September 20, 1950*, edited by Erik K. Reed, pp. 41–49. Hohokam Museums Association, Tucson, and the Southwestern Monuments Association, Santa Fe.

1950b The Pottery of the Southern Paiute. *American Antiquity* 16:50–56.

Ball, David, Rosie Clayburn, Roberta Cordero, Briece Edwards, Valerie Grussing, Janine Ledford, Robert McConnell, Rebekah Monette, Robet Steelquist, Eirik Thorsgard, and Jon Townsend
2015 *A Guidance Document for Characterizing Tribal Cultural Landscapes*. OCS Study BOEM 2015-047. U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, California.

Bancroft, Hubert Howe
1867 *Bancroft's Map of the Pacific States*. Compiled by Wm. Henry Knight. Bancroft & Co. Booksellers and Stationers, San Francisco.

1884 *History of California: Vol. I. 154-1800*. The Works of Hubert Howe Bancroft Vol. 18. A. L. Bancroft and Company, San Francisco.

Barker, James P., Carol H. Rector, and Philip J. Wilke
1979 *An Archaeological Sampling of the Proposed Allen-Warner Valley Energy System, Western Transmission Line Corridors, Mojave Desert, Los Angeles and San Bernardino Counties, California, and Clark County, Nevada*. UCRARU No. 467. Archaeological Research Unit, University of California, Riverside.

Basgall, Mark E.
2000 The Structure of Archaeological Landscapes in the North-Central Mojave Desert. In *Archaeological Passages, a Volume in Honor of Claude Nelson Warren,* edited by Joan S. Schneider, Robert M. Yohe II, and Jill K. Gardner, pp. 123–138. Publication in Archaeology No. 1. Western Center for Archaeology & Paleontology, Hemet, California.

Beacham, Deanna
2012 The Indigenous Cultural Landscape of the Eastern Woodlands: A Model for Conservation, Interpretation, and Tourism. In *Rethinking Protected Areas in a Changing World: Proceedings of the 2011 George Wright Society Biennial Conference on Parks, Protected Areas, and Cultural Sites*, edited by Samantha Weber, pp. 40–42. The George Wright Society, Hancock, Michigan.

Beale, Edward F.
1858 *The Report of the Superintendent of the Wagon Road from Fort Defiance to the Colorado River*. 35th Congress, 1st Session, House of Representative Executive Document No. 124. U.S. Government Printing Office, Washington D.C.

1912 [1857] Report to the Secretary of War from the Colorado River, California, October 18, 1857. In *Edward Fitzgerald Beale, A Pioneer in the Path of Empire, 1822-1903*, by Stephen Bonsal, pp. 211–217. The Knickerbocker Press, New York

Bean, Lowell J.
1976 Power and Its Applications in Native California. In *Native Californians: A Theoretical Retrospective*, edited by Lowell J. Bean and Thomas C. Blackburn, pp. 407–420. Ballena Press, Ramona, California.

Bean, Lowell John, Michael J. Evans, Ngapare K. Hopa, Lee Gooding Massey, Diane Rothenberg, Richard W. Stoffle, Sylvia Brakke Vane, Lois Weinman-Roberts, and Jackson Young
1979 *Allen-Warner Valley Energy System: Western Transmission System Ethnographic and Historical Resources*. Cultural Systems Research, Menlo Park, California.

Beatley, Janice C.
1975 Climates and Vegetation Pattern across the Mohave/Great Basin Desert Transition of Southern Nevada. *American Midland Naturalist* 93:53–70.

Beck, Charlotte, and George T. Jones
1997 The Terminal Pleistocene/Early Holocene Archaeology of the Great Basin. *Journal of World Prehistory* 11:161–236.

2009 *The Archaeology of the Eastern Nevada Paleoarchaic: Part 1. The Sunshine Locality*. University of Utah Anthropological Papers No. 126. University of Utah Press, Salt Lake City.

2010 Clovis and Western Stemmed: Population Migration and the Meeting of Two Technologies in the Intermountain West. *American Antiquity* 75:81–116.

Beckerman, Gary M., Jamie P. Robinson, and J. Lawford Anderson
1982 The Teutonia Batholith: A Large Intrusive Complex of Jurassic and Cretaceous Age in the Eastern Mojave Desert, California. In *Mesozoic-Cenozoic Tectonic Evolution of the Colorado River Region, California, Arizona, and Nevada*, edited by Eric G. Frost and Donna L. Martin, pp. 206–220. Cordilleran Publishers, San Diego.

Bedinger, Melissa S., William H. Langer, and J. E. Reed
1989 Ground-Water Hydrology. In *Studies of Geology and Hydrology in the Basin and Range Province, Southwestern United States, for Isolation of High-Level Radioactive Waste: Characterization of the Death Valley Region, Nevada and California*, edited by Melissa S. Bedinger, Kenneth A. Sargent, and William H. Langer, pp. 28–35. Professional Paper No. 1370-F. U.S. Geological Survey, Boulder.

Bedwell, Stephen F.
1973 *Fort Rock Basin: Prehistory and Environment*. University of Oregon Books, Eugene.

Bee, Robert L.
1983 Quechan. In *Southwest*, edited by Alfred Ortiz, pp. 86–98. Handbook of North American Indians, vol. 10, William C. Sturtevant, general editor. Smithsonian Institution, Washington D.C.

Beekman, C.
n.d. San Bernardino County Museum Site Card for SB 563 (Hiko Springs). On file, San Bernardino County Museum, Redlands, California.

Belcher, Wayne R., Michael J. Moran, and Megan E. Rogers
2013 Water and Water-Use in Southern Nevada. In *The Southern Nevada Agency Partnership Science and Research Synthesis: Science to Support Land Management in Southern Nevada*, edited by Jeanne C. Chambers, Matthew L. Brooks, Burton K. Pendleton, and Carol B. Raish, pp. 37–58. General Technical Report No. RMRS-GTR-303. U.S. Forest Service, Fort Collins, Colorado.

Bennett, Matthew R., David Bustos, Jeffrey S. Pigati, Kathleen B. Springer, Thomas M. Urban, Vance T. Holliday, Sally C. Reynolds, Marcin Budka, Jeffrey S. Honke, Adam M. Hudson, Brendan Fenerty, Clare Connelly, Patrick J. Martinez, Vincent L. Santucci, and Daniel Odess
2021 Evidence of Humans in North America during the Last Glacial Maximum. *Science* 373:1528–1531.

Benson, Larry V., Donald R. Currey, Ronald I. Dorn, Kenneth R. Lajoie, Charles G. Oviatt, Steven W. Robinson, George I. Smith, and Scott Stine
1990 Chronology of Expansion and Contraction of Four Great Basin Lake Systems during the Past 35,000 Years. *Palaeogeography, Palaeoclimatology, Palaeoecology* 78:241–286.

Benson, Larry V., Michaele Kashgarian, Robert O. Rye., Steve P. Lund, Fred Paillet, Joseph P. Smoot, Cynthia Kester, Scott A. Mensing, Dave Meko, and Susan Lindström
2002 Holocene Multidecadal and Multicentennial Droughts affecting Northern California and Nevada. *Quaternary Science Reviews* 21:659–682.

Benson, Lyman David, and Robert Arthur Darrow
1981 *The Trees and Shrubs of the Southwestern Deserts*. University of Arizona Press, Tucson.

Berg, John, Jerome King, Amy Gilreath, William Hildebrandt, and Kelly McGuire
2013 *Prehistory of Gold Butte: A Virgin River Hinterland, Clark County, Nevada*. University of Utah Anthropological Papers No. 127. University of Utah Press, Salt Lake City.

Bergland, Eric
1876 Preliminary Report upon the Operations of Party No. 3, California Section, Season of 1875-'76, with a View to Determine the Feasibility of Diverting the Colorado River for Purposes of Irrigation. In *Annual Report Upon the Geographical Surveys West of the One Hundredth Meridian, in California, Nevada, Utah, Colorado, Wyoming, New Mexico, Arizona, and Montana for 1876*, compiled by George M. Wheeler, pp. 109–124. U.S. Government Printing Office, Washington D.C.

Betenson, Britt J.
2005 Pottery and Mobility: A Functional Analysis of Intermountain Brownware. Unpublished Master's thesis, Department of Anthropology, University of Nevada, Las Vegas.

Bettinger, Robert L.
1986 Intersite Comparison of Great Basin Brown Ware Assemblages. In *Pottery of the Great Basin and Adjacent Areas*, edited by Suzanne Griset, 97–106. University of Utah Anthropological Papers No. 111. University of Utah Press, Salt Lake City.

1994 How, When, and Why Numic Spread. In *Across the West: Human Population Movement and the Expansion of the Numa*, edited by David B. Madsen and David Rhode, pp. 44–55. University of Utah Press, Salt Lake City.

Bettinger, Robert L., and Martin A. Baumhoff
1982 The Numic Spread: Great Basin Cultures in Competition. *American Antiquity* 47:485–503.

Binford, Lewis R.
1982 *The Archaeology of Place. Journal* of Anthropological Archaeology 1:5–31.

Bischoff, Matt C.
2000 *The Desert Training Center/California-Arizona Maneuver Area, 1942-1944*. Technical Series No. 75. Statistical Research, Inc., Tucson.

Blair, Lynda M.
1990 *A Cultural Resource Investigation for Central Telephone Company in Searchlight, Clark County, Nevada*. DAS Report No. 5-45-6. Division of Anthropological Studies, Environmental Research Center, Marjorie Barrick Museum of Natural History, University of Nevada, Las Vegas.

1995 *A Cultural Resource Investigation for Nevada Environmental Consultants, Inc., Exploratory Drill Pads and Access Roads in the Castle Mountain Region, East Mojave National Scenic Area, San Bernardino County, California*. HRC Report No. 5-164-1. Harry Reid Center for Environmental Studies, University of Nevada, Las Vegas.

1996a *A Cultural Resource Investigation near Spirit Mountain, Clark County, Nevada*. HRC Report No. 5-161-2. Harry Reid Center for Environmental Studies, University of Nevada, Las Vegas.

1996b *Addendum to: A Cultural Resource Investigation near Spirit Mountain, Clark County, Nevada*. HRC Report No. 5-161-2. Harry Reid Center for Environmental Studies, University of Nevada, Las Vegas.

Blair, Lynda M., and Diane L. Winslow
2006 *Firebrand Cave: An Archaic Ceremonial Site in Southern Nevada*. Anthropological Series No. 1(1). Harry Reid Center for Environmental Studies, Division of Cultural Resources, University of Nevada, Las Vegas.

Bolton, Herbert Eugene
1950 *Pageant in the Wilderness: The Story of the Escalante Expedition to the Interior Basin, 1776*. Utah State Historical Society, Salt Lake City.

Bolton, Herbert Eugene (translator and editor)
1917 The Early Explorations of Father Garcés on the Pacific Slope. In *The Pacific Ocean in History: Papers and Addresses Presented at the Panama-Pacific Historical Congress, Held at San Francisco, Berkeley and Palo Alto, California July 19-23, 1915*, edited by Henry M. Stephens and Herbert E. Bolton, pp. 317–330. The Macmillan Company, New York.

1919 Father Escobar's Relation of the Oñate Expedition to California. *Catholic Historical Review* 5(1):19–41.

1930 *Anza's California Expeditions: Vol. 2. Opening a Land Route to California: Diaries of Anza, Díaz, Garcés, and Palóu*. University of California Press, Berkeley.

Bondley, George A., and Richard H. Brooks
1973 *An Archaeological Survey of the Mead-Davis-Parker 230kV Transmission Line No. 2*. Report No. 1-3-3. Nevada Archaeological Survey, Southern Branch, University of Nevada, Las Vegas.

Botti, Nancy
1977 Cultural Resource Clearance for Nevada Department of Fish and Game Proposed Bighorn Sheep Water Developments. U.S. Department of the Interior, Bureau of Land Management, Nevada State Office, Reno.

Bourke, John G.
1889 Notes on the Cosmogeny and Theogony of the Mojave Indians of the Rio Colorado, Arizona. *The Journal of American Folk-Lore* 2(6):169–189.

Bradford, David F., Anne C. Neale, Maliha S. Nash, Donald W. Sada, and Jef R. Jaeger
2003 Habitat Patch Occupancy by Toads (*Bufo punctatus*) in a Naturally Fragmented Landscape. *Ecology* 84:1012–1023.

Brooks, Richard H.
1972 Letter Report of an Archaeological Survey in the Las Vegas District for a Proposed Pasture Fence No. 1. Report No. 1-1-17. Nevada Archaeological Survey, Southern Branch, University of Nevada, Las Vegas.

Brooks, Richard H., Joseph King, Matt McMackin, David Ferraro, and Kathryne Olson
1977 *The Fort Mojave Cultural Resource Inventory, an Archaeological/Historical Field Investigation in Southern Clark County, Nevada: Second Phase*. Report No. 1-1-23. Nevada Archaeological Survey, Southern Branch, University of Nevada, Las Vegas.

Brooks, Richard H., Daniel O. Larson, Michael Compton, and Kathryne Olson
1977 *Final Report on the Preliminary Archaeological Reconnaissance of the Proposed Eldorado/Kaiparowits Transmission Line Right-of-Way Corridor and Alternate Route*. Report No. 5-2-2. Nevada Archaeological Survey, Southern Branch, University of Nevada, Las Vegas.

Brooks, Richard H., Daniel O. Larson, Kathryne Olson, Joseph King, and Robert Leavitt
1976 *The Fort Mojave Cultural Resource Inventory, an Archaeological/Historic Field Investigation in Southern Clark County, Nevada*. Report No. 1-1-16. Nevada Archaeological Survey, Southern Branch, University of Nevada, Las Vegas.

Brosman, Christopher Alan
2012 Prehistoric Foraging Strategies in the Piute Valley of Southern Nevada. Unpublished Master's thesis, Department of Anthropology, University of Nevada, Las Vegas.

Broughton, Jack M., and Frank E. Bayham
2003 Showing Off, Foraging Models, and the Ascendance of Hunting in the California Middle Archaic. *American Antiquity* 68:783–789.

Broughton, Jack M., David B. Madsen, and Jay Quade
2000 Fish Remains from Homestead Cave and Lake Levels of the Past 13,000 Years in the Bonneville Basin. *Quaternary Research* 53:392–401.

Bryant, George, and Amy Miller
2013 Xiipúktan *(First of All): Three Views of the Origins of the Quechan People*. World Oral Literature Series Vol. 5. Open Book Publishers, Cambridge, Massachusetts.

Buck, Paul E., and Anne DuBarton
1994 Archaeological Investigations at Pintwater Cave, Nevada, during the 1963-64 Field Season. *Journal of California and Great Basin Anthropology* 16:221–242.

Bungart, Peter W., and Anne Raney
2007 *An Archaeological Survey of the Davis to Mead 230 kV Transmission Line, Mohave County, Arizona and Clark County, Nevada*. Report No. 05-27. Circa Cultural Consulting, Flagstaff, Arizona.

Bureau of Land Management [BLM]
1994 *Supplement to the Draft Stateline Resource Management Plan and Environmental Impact Statement*. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Stateline Resource Area Office, Las Vegas.

1999a Nevada Springs Dataset (nv_springs). Electronic document, https://archive.epa.gov/esd/archive-nerl-esd1/web/html/nvgeo_gis10_springs_md.html, accessed October 2, 2021.

1999b *The California Desert Conservation Area Plan 1980, as Amended*. U.S. Department of the Interior, Bureau of Land Management, Desert District, Riverside, California.

2014 State Protocol Agreement between the Bureau of Land Management, Nevada and the Nevada State Historic Preservation Officer for Implementing the National Historic Preservation Act (Revised). On file, Nevada State Historic Preservation Office, Carson City.

2016 *Improving and Sustaining BLM-Tribal Relations*. Handbook No. 1780-1. U.S. Department of the Interior, Bureau of Land Management, Washington D.C.

2019 *Guidelines and Standards for Archaeological Inventory*. Sixth ed. U.S. Department of the Interior, Bureau of Land Management, Nevada State Office, Reno.

Bureau of Land Management and National Park Service [BLM and NPS]
2017 *Old Spanish National Historic Trail Comprehensive Administrative Strategy*. U.S. Department of the Interior, Washington D.C.

Burke, Raymond M., and Peter W. Birkeland
1983 Holocene Glaciation in the Mountain Ranges of the Western United States. In *The Holocene*, edited by Herbert E. Wright Jr., pp. 2–11. Late-Quaternary Environments of the United States No. 2. University of Minnesota Press, Minneapolis.

Burke, Thomas D.
1988 *A Cultural Resources Inventory of a Proposed Access Road for the Castle Mountain Project of Viceroy Resource Corporation, Clark County, Nevada*. ARS Report No. 478. Archaeological Research Services, Inc., Virginia City, Nevada.

Burkholder, Grace
1987 Intermountain Antiquities Computer System Forms for 26CK3890, 26CK3892, 26CK3894. On file, Nevada State Historic Preservation Office, Carson City.

1988 Intermountain Antiquities Computer System Form for 26CK1343, 26CK3889, 26CK3899, 26CK4095, 26CK4099, 26CK4111. On file, Nevada State Historic Preservation Office, Carson City.

1989 Intermountain Antiquities Computer System Forms for 26CK1601, 26CK4233, 26CK4326. On file, Nevada State Historic Preservation Office, Carson City.

1990 Intermountain Antiquities Computer System Forms for 26CK4342 through 26CK4347, 26CK4613, 26CK4614. On file, Nevada State Historic Preservation Office, Carson City.

1991 Intermountain Antiquities Computer System Form for 26CK4807. On file, Nevada State Historic Preservation Office, Carson City.

1992 Intermountain Antiquities Computer System Forms for 26CK4819, 26CK4851. On file, Nevada State Historic Preservation Office, Carson City.

1995 Intermountain Antiquities Computer System Forms for 26CK5249, 26CK5250, 26CK5251, 26CK5277. On file, Nevada State Historic Preservation Office, Carson City.

1996 Intermountain Antiquities Computer System Form for 26CK3637. On file, Nevada State Historic Preservation Office, Carson City.

Byers, David A., and Jack M. Broughton
2004 Holocene Environmental Change, Artiodactyl Abundances, and Human Hunting Strategies in the Great Basin. *American Antiquity* 69:235–257.

Byrd, Brian F., John Berg, and Laura Leach-Palm
2004 *A Class III Cultural Resources Inventory of 2165 Acres of BLM Lands for the Laughlin Land Sale, Clark County, Nevada*. Far Western Anthropological Group, Inc., Davis, California.

Byrd, Brian F., D. Craig Young, and Kelly R. McGuire
2009 Pavement Quarries, Gypsum Period Residential Stability, and Trans-Holocene Settlement Systems of the Mojave Desert: A Case Study at Fort Irwin. *Journal of California and Great Basin Anthropology* 29:121–143.

Cachora, Lorey
2000 Antelope Hill and the Region: A Native American View. In *Of Stone and Spirits: Pursuing the Past of Antelope Hill*, edited by Joan S. Schneider and Jeffrey H. Altschul, pp. 79–81. Technical Series No. 76. Statistical Research, Inc., Tucson.

Camp, Charles L.
1922 Kit Carson in California: With Extracts from His Own Story. *California Historical Society Quarterly* 1(2):111–151.

1923 The Chronicles of George C. Yount, California Pioneer of 1826. *California Historical Society Quarterly* 2(1):3–66.

Campbell, Elizabeth W. Crozer, and William H. Campbell
1935 *The Pinto Basin Site*. Papers No. 9. Southwest Museum, Los Angeles.

Campbell, Elizabeth W. Crozer, William H. Campbell, Ernst V. Antevs, Charles A. Amsden, Joseph A. Barbieri, and Fancis D. Bode
1937 *The Archaeology of Pleistocene Lake Mohave: A Symposium*. Papers No. 11. Southwest Museum, Los Angeles.

Campbell, Lyle
1997 *American Indian Languages: The Historical Linguistics of North America*. Oxford Studies in Anthropological Linguistics No. 2. Oxford University Press, Oxford, England.

Capp, Richard C., and John A. Moore
1997 *Geologic Map of the Castle Mountains, San Bernardino County, California and Clark County, Nevada*. Map No. 108. Nevada Bureau of Mines and Geology, University of Nevada, Reno.

Carlson, Anders E.
2013 The Younger Dryas Climate Event. In *Encyclopedia of Quaternary Sciences*. 2nd ed., edited by Scott A. Elias and Cary J. Mock, pp. 126–134. Elseveir, Amsterdam, Netherlands.

Carr, Gerald
2013 Protecting Intangible Cultural Resources: Alternatives to Intellectual Property Law. *Michigan Journal of Race and Law* 18:363–390.

Casebier, Dennis G.
1975 *The Mojave Road*. Tales of the Mojave Road No. 5. Tales of the Mojave Road Publishing Company, Norco, California.

Castetter, Edward F., and Willis H. Bell
1951 *Yuma Indian Agriculture: Primitive Subsistence on the Lower Colorado and Gila Rivers.* University of New Mexico Press, Albuquerque.

Chalmin, Emilie, and Jillian Huntley
2018 Characterizing Rock Art Pigments. In *The Oxford Handbook of the Archaeology and Anthropology of Rock Art*, edited by Bruno David and Ian J. McNiven, pp. 885–909. Oxford University Press, Oxford, England.

Chiang, Christina, and Wendy L. Tinsley Becker
2016 *Historical Resource Analysis Report/ Historic Property Survey Report for Southern California Edison Company: Edison 500 kV Transmission Line System*. Urbana Preservation and Planning, LLC, La Mesa, California.

Childers, W. Morlin, and Herbert L. Minshall
1978 Evidence of Early Man Exposed at Yuha Pinto Wash. *American Antiquity* 45:297–308.

Chmara-Huff, Fletcher P.
2006 A Critical Cultural Landscape of the Pahrump Band of Southern Paiute. Unpublished Master's thesis, Department of Geography and Regional Development, University of Arizona, Tucson.

Christensen, Don D.
1996 Intermountain Antiquities Computer System Form for 26CK4168(Update). On file, Nevada State Historic Preservation Office, Carson City.

2000 Intermountain Antiquities Computer System Form for 26CK1601(Update). On file, Nevada State Historic Preservation Office, Carson City.

Christensen, Don D., and Jerry Dickey
1996 The Pictographs of the Eastern Mojave Desert of California and Nevada: An Initial Investigation. *Pacific Coast Archaeological Society Quarterly* 32(2–3):1–81.

1998 Rock Art with Prehistoric Trail Associations: A Study in the Needles Region, Mojave Desert, California. In *Rock Art Papers*, vol. 13, edited by Ken Hedges, pp. 31–44. Papers No. 35. San Diego Museum of Man, San Diego.

2001 The Grapevine Style of the Eastern Mojave Desert of California and Nevada. In *American Indian Rock Art*, vol. 27, edited by Steven M. Freers and Alanah Woody, pp. 185–200. American Rock Art Research Association, Tucson.

Cleland, James H.
2005 The Sacred and the Mundane—Cultural Landscape Concepts and Archaeological Interpretation in the Colorado Desert. *Proceedings of the Society for California Archaeology* 18:131–136.

2008 Ethnographic Trail Systems as Large-Scale Cultural Landscapes: Preservation and Management Issues. In *Exploring the Boundaries of Historic Landscape Preservation: Proceedings of the Twenty-ninth Annual Meeting of the Alliance for Historic Landscape Preservation 2007*, edited by Cari Goetcheus and Eric MacDonald, pp. 41–55. Clemson University Digital Press, Clemson, South Carolina.

Cleland, Robert Glass
1922 *A History of California: The American Period*. The Macmillan Company, New York.

Clements, Thomas, and Lydia Clements
1953 Evidence of Pleistocene Man in Death Valley, California. *Bulletin of the Geological Society of America* 84:1189–1204.

Coffman, Sam, and Jeffrey T. Rasic
2015 Rhyolite Characterization and Distribution in Central Alaska. *Journal of Archaeological Science* 57:142–157.

Cole, Kenneth L.
1990 Reconstruction of Past Desert Vegetation along the Colorado River Using Packrat Middens. *Paleogeography, Paleoclimatology, Paleoecology* 76: 349–366.

Cole, Kenneth L., and Robert H. Webb
1985 Late Holocene Vegetation Changes in Greenwater Valley, Mojave Desert, California. *Quaternary Research* 23:227–235.

Colton, Harold S.
1939 *Prehistoric Culture Units and Their Relationships in Northern Arizona*. Museum of Northern Arizona Bulletin No. 17. Northern Arizona Society of Science and Art, Flagstaff.

1952 *Pottery Types of the Arizona Strip and Adjacent Areas in Utah and Nevada*. Museum of Northern Arizona Ceramic Series No. 1. Northern Arizona Society of Science and Art, Flagstaff.

Conrad, James E., Gary A. Nowlan, J. Douglas Causey, and Michael S. Miller
1991 *Mineral Resources of the El Dorado and Ireteba Peaks Wilderness Study Areas, Clark County, Nevada*. Open-File Report No. 91-323. U.S. Geological Survey, Menlo Park, California, and U.S. Bureau of Mines, Spokane, Washington.

Coues, Elliott (translator and editor)
1900 *On the Trail of a Spanish Pioneer: The Diary and Itinerary of Fracisco Garcés (Missionary Priest) in His Travels through Sonora, Arizona, and California, 1775-1776: Vol. 1*. Francis P. Harper, New York.

Coulam, Nancy J., and Alan R. Schroedl
2004 Late Archaic Totemism in the Greater American Southwest. *American Antiquity* 69:41–62.

Crabtree, Robert H., Elizabeth Warren, and Tara Shepperson
1979 Cultural Historical Review. In *The Archaeology of the Northeastern Mojave Desert*, by Gary B. Coombs, pp. 18–28. U.S. Department of the Interior, Bureau of Land Management, Desert Planning Area, Riverside, California.

Crawford, Karen, Timothy Yates, Andrew Belcourt, and Karolina Chmiel
2016 *Class III Resources Inventory Report for the Eldorado-Moenkopi 500kV and Eldorado-Mohave 500kV Line Swap Project, Clark County, Nevada*. ICF International, San Diego.

Culin, Stewart
1907 *Games of the North American Indians*. Twenty-Fourth Annual Report of the Bureau of American Ethnolgoy to the Smithsonian Institution, 1902-1903. U.S. Government Printing Office, Washington D.C.

Cultural Conservancy
2022 *The Salt Song Trail Project*. Electronic document, https://www.nativeland.org/salt-song-trail, accessed March 2022.

Curtis, Edward S.
1908 *The North American Indian: Vol. 2. The Pima. The Papago. The Qahatika. The Mohave. The Yuma. The Maricopa. The Walapai. The Havasupai. The Apache-Mohave, or Yavapai*. Frank W. Hodge, general editor. University Press, Cambridge, Massachusetts.

Curtis, Natalie
1909 The Creation Myth of the Cochans (Yuma Indians). *The Craftsman* 16:559–567.

Daron, Steve E.
1996 *Archaeological Clearance Survey Form for WACC Project No. LAME 1998G, Christmas Tree Pass Spur Road Rehabilitation West, Lake Mead National Recreation Area, Clark County, Nevada*. Report No. 007-98-LAME. National Park Service, Western Archeological and Conservation Center, Tucson.

1994 Construction of Proposed Entrance Stations, Lake Mead National Recreation Area (NRA), Clark County, Nevada and Mohave County, Arizona. Clearance No. 022-95-LAME. National Park Service, Western Archeological and Conservation Center, Tucson.

Davidson, Nancy J.
2009 Making the Connections: An Archaeological Survey of Prehistoric Trails and Trail Markers along the Lower Colorado River. Unpublished Master's thesis, Department of Anthropology, University of California, Fullerton.

Davis, Alan C., and Gerald A. Smith
1981 *Newberry Cave*. San Bernardino County Museum Association, Redlands, California.

Davis, Edward
1919 *The Diegueno Ceremony of the Death Images*. Contributions from the Museum of the American Indian No. 5(2). Heye Foundation, New York.

Davis, Emma Lou (editor)
1978 *The Ancient Californians: Rancholabrean Hunters of the Mojave Lakes Country*. County Science Series No. 29. Natural History Museum of Los Angeles County, Los Angeles.

Davis, Gene P., J. Simon Bruder, Everett J. Bassett, and A. E. Rogge
1989 *Cultural Resources Technical Report for the AT&T Communications Fiber Optic Project between Flagstaff, Arizona and Las Vegas, Nevada: The Nevada Segment*. Dames & Moore, Phoenix.

Davis, Owen K., and William D. Sellers
1994 Orbital History and Seasonality of Regional Precipitation. *Human Ecology* 22:97–113.

Davis, Shannon, and Laura Voisin George
2018 *Historic Resources Assessment Report for the Lugo-Victorville 500kV Transmission Line Special Protection Scheme Project, Clark County, Nevada*. ASM Project No. 25700.1. ASM Affiliates, Pasadena, California.

2019 *Historic Resources Assessment Report for the Eldorado-Lugo-Mohave Capacitor Project, Clark County, Nevada*. ASM Project No. 25700.1. ASM Affiliates, Pasadena, California.

Davis, Thompson P
1988 Holocene Glacier Fluctuations in the American Cordillera. *Quaternary Science Reviews* 7:129–157.

Dennis, Robert N.
1983 NDOT Cultural Resources Report: From 16.3 Miles North of Searchlight, EA 71100. NDOT Report No. 078-82R. Nevada Department of Transportation, Las Vegas District, Las Vegas.

Desert Conservation Program
2008 Adaptive Management Report for the Clark County, Nevada Multiple Species Habitat Conservation Plan. Clark County Department of Air Quality and Environmental Management, Las Vegas.

Deur, Douglas
2014 Mohave Valley Ethnographic Study: Phase I and II Report. On file, Bureau of Land Management, Kingman Field Office, Kingman, Arizona.

Deur, Douglas, and Deborah Confer
2012 *People of Snowy Mountain, People of the River: A Multi-Agency Ethnographic Overview and Compendium Relating to Tribes Associated with Clark County, Nevada*. Social Science Series Publication No. 2012-01. National Park Service, Pacific West Region, Seattle.

Deur, Douglas, and the Aha Makav Cultural Society
2018 Southland Solar Traditional Cultural Property Preliminary Assessment, Clark County, Nevada. On file, Pipa Aha Macav Cultural Center, Mohave Valley, Arizona.

Devereaux, George
1937 Mohave Soul Concepts. *American Anthropologist* 39:417–422.

1948 Mohave Coyote Tales. *The Journal of American Folklore* 61:233–255.

1949 Mohave Voice and Speech Mannerisms. *WORD* 5(3):268–272.

1950 Education and Discipline in Mohave Society. *Primitive Man* 23(4):85–102.

1951 Mohave Chieftainship in Action: A Narrative of the First Contacts of the Mohave Indians with the United States. *Plateau* 23(3):33–43.

1956 Mohave Dreams of Omen and Power. *Tomorrow* 4(3):17–24.

1957 Dream Learning and Individual Ritual Differences in Mohave Shamanism. *American Anthropologist* 59:1036–1045.

Dickinson, William K.
2009 Proposal to Close Several Hazardous Mine Openings, Clark County. National Park Service, Western Archeological and Conservation Center, Tucson.

Dobbins, Ed
1979 A Cultural Resource Survey of the McCullough-Davis 30kV Transmission Line, Clark County, Nevada, a Feature of the Granite Reef Transmission System, Central Arizona Project. Office of Cultural Resource Management, Department of Anthropology, Arizona State University, Tempe.

1980 Archaeological Investigations along the McCullough-Davis Transmission Line, a Feature of the Granite Reef Aqueduct, Central Arizona Project (Task 34). In *Interim Reports, Granit Reef Aqueduct Project: Tasks 31, 32A, 33, 34, 35, 35A, 36*, by Ed Dobbins, pp. 100–101. Report No. 50. Office of Cultural Resource Management, Department of Anthropology, Arizona State University, Tempe.

Dobyns, Henry F., and Robert C. Euler
1970 *Wauba Yuma's People: A Comparative Socio-Political Structure of the Pai Indians of Arizona*. Prescott College Press, Prescott, Arizona.

Dobyns, Henry F., Paul H. Ezell, and Greta S. Ezell
1963 Death of a Society. *Ethnohistory* 10:105–161.

Drucker, Philip
1941 *Culture Element Distributions: XVII Yuman-Piman*. University of California Anthropological Records No. 6(3). University of California Press, Berkeley.

DuBois, Constance Goddard
1901 The Mythology of the Diegueños. *Journal of American Folk-Lore* 14(54):181–185.

1905a Religious Ceremonies and Myths of the Mission Indians. *American Anthropologist* 7:620–629.

1905b The Mythology of the Diegueños, Mission Indians of San Diego County, California, as Proving Their Status to Be Higher than Is Generally Believed. In *Proceedings of the International Congress of Americanists, Thirteenth Session, New York, 1902*, pp. 101–106. Eschenbach Printing Company, New York.

1907a Diegueno Myths and Their Connections with the Mohave. In *Proceedings of the International Congress of Americanists, Fifteenth Session, Québec, 1906*, vol. 2, pp. 129–133. Dussault & Prouln, Québec.

1907b Two Types or Styles of Diegueno Religious Dancing: The Old and the New in Southern California. In *Proceedings of the International Congress of Americanists, Fifteenth Session, Québec, 1906*, vol. 2, pp. 135–138. Dussault & Prouln, Québec.

1908a The Religion of the Luiseño Indians of Southern California. *University of California Publications in American Archaeology and Ethnology* 8(3):69–186.

1908b Ceremonies and Traditions of the Diegueño Indians. *Journal of American Folk-Lore* 21(81):228–236.

Earle, David D.
2005 The Mojave River and the Central Mojave Desert; Native Settlement, Travel, and Exchange in the Eighteenth and Nineteenth Centuries. *Journal of California and Great Basin Anthropology* 25:1–38.

Edwards, Susan R.
1990 *A Cultural Resource Inventory for Brookline Mining of a Proposed Expansion of Mining Operations in the Eldorado Valley, Clark County, Nevada*. Report No. 5-132-1. Division of Anthropological Studies, Envionmental Research Center, University of Nevada, Las Vegas.

Eerkens, Jelmer W., Hector Neff, and Michael D. Glascock
2002 Typologies and Classification of Great Basin Pottery: A New Look at Death Valley Brownwares. In *Ceramic Production and Circulation in the Greater Southwest: Source Determination by INAA and Complementary Mineralogical Investigtations*, edited by Donna M. Glowacki and Hector Neff pp. 140–151. Monograph No. 44. Cotsen Institute of Archaeology, Los Angeles.

Eisen, Edward Winslow
1926 Long Long Mines of Precious Gems are Found Again, Located in the Remotest Wilds of San Bernardino County and Marked by Strange Hieroglyphs. *The San Francisco Call*, March 18.

Ellis-Pinto, Cynthia, and Stanton Rolf
1999 National Register of Historic Places Inventory-Nomination Form for Spirit Mountain Traditional Cultural Property. Division of History, National Park Service. On file, Pipa Aha Macav Cultural Center, Fort Mojave Indian Tribe, Mohave Valley, Arizona.

Enzel, Yehouda, William J. Brown, Roger Y. Anderson, Leslie D. McFadden, and Stephen G. Wells
1992 Short-Duration Holocene Lakes in the Mojave River Drainage Basin, Southern California. *Quaternary Research* 38:60–73.

Enzel, Yehouda, Daniel R. Cayan, Roger Y. Anderson, and Stephen G. Wells
1989 Atmospheric Circulation during Holocene Lake Stands in the Mojave Desert; Evidence of Regional Climate Change. *Nature* 341:44–47.

Enzel, Yehouda, Stephen G. Wells, and Nicholas Lancaster (editors)
2003 *Paleoenvironments and Paleohydrology of the Mojave and Southern Great Basin Deserts*. Special Paper No. 368. Geological Society of America, Boulder.

Erlandson, Jon M., Torben C. Rick, Todd J. Braje, Molly Casperson, Brendan Culleton, Brian Fulfrost, Tracy Garcia, Daniel A. Guthrie, Nicholas Jew, Douglas J. Kennett, Madonna L. Moss, Leslie, Reeder, Craig Skinner, Jack Watts, and Lauren Willis
2011 Paleoindian Seafaring, Maritime Technologies, and Coastal Foraging on California's Channel Islands. *Science* 331:1181–1185.

Euler, Robert C.
1966 *Southern Paiute Ethnohistory*. University of Utah Anthropological Papers No. 78. University of Utah Press, Salt Lake City.

Ewing, Henry P.
1960 The Pai Tribes, edited by Robert C. Euler and Henry F. Dobyns. *Ethnohistory* 7:61–80.

1961 The Origin of the Pai Tribes, edited by Henry F. Dobbins and Robert C. Euler. *Kiva* 26(3):8–23.

Ezell, Paul H.
1963 *The Maricopas: An Identification from Documentary Sources*. University of Arizona Anthropological Papers No. 6. University of Arizona Press, Tucson.

Farmer, Malcolm F.
1935 The Mojave Trade Route. *The Masterkey* 9(5):154–157.

Fathauer, George, H.
1951a Religion in Mohave Social Structure. *The Ohio Journal of Science* 51:273–276.

1951b The Mohave "Ghost Doctor." *American Anthropologist* 53:605–607.

1954 The Structure and Causation of Mohave Warfare. *Southwestern Journal of Anthropology* 10:97–118.

Faulds, James E., Daniel L. Feuerbach, Calvin F. Miller, and Eugene I. Smith
2001 Cenozoic Evolution of the Northern Colorado River Extensional Corridor, Southern Nevada and Northwest Arizona. *Utah Geological Association Publication* 30:239–271.

Faulds, James E., Eric L. Olson, Stephen S. Harlan, and William C. McIntosh
2002 Miocene Extension and Fault-Related Folding in the Highland Range, Southern Nevada: A Three-Dimensional Perspective. *Journal of Structural Geology* 24:861–886.

Feng, Xiahong, and Samuel Epstein
1994 Climatic Implications of an 8000-Year Hydrogen Isotope Time Series from Bristlecone Pine Trees. *Science* 265:1079–1081.

Fenneman, Nevin M.
1931 *Physiography of Western United States*. McGraw-Hill Book Company, New York.

Forbes, Jack D.
1965 *Warriors of the Colorado: The Yumas of the Quechan Nation and Their Neighbors*. University of Oklahoma Press, Norman.

Forde, C. Daryll
1931 Ethnography of the Yuma Indians. *University of California Publications in American Archaeology and Ethnology* 28:83–278.

Fowler, Catherine S.
2009 Reconstructing Southern Paiute-Chemehuevi Trails in the Mojave Desert of Southern Nevada and California: Ethnographic Perspectives from the 1930s. In *Landscapes of Movement: Trails, Paths, and Roads in Anthropological Perspective*, edited by James E. Snead, Clark L. Erickson, and J. Andrew Darling, pp. 84–105. University of Pennsylvania Museum of Archaeology and Anthropology, Philadelphia.

Fowler, Catherine C., and Don D. Fowler
1971 Notes on the History of the Southern Paiutes and Western Shoshonis. *Utah Historical Quarterly* 39:95–113.

Fowler, Don D., and David B. Madsen
1986 Prehistory of the Southeastern Area. In *Great Basin*, edited by Warren L. D'Azevedo, pp, 172–182. Handbook of North American Indians, Vol. 11, William C. Sturtevant, general editor. Smithsonian Institution, Washington D.C.

Fowler, Don D., and Catherine S. Fowler (editors)
1971 *Anthropology of the Numa: John Wesley Powell's Manuscripts on the Numic Peoples of Western North America, 1868-1880*. Contributions to Archaeology No. 14. Smithsonian Institution, Washington D.C.

Fowler, Don D., Elizabeth Budy, Dennis DeSart, Joyce Bath, and Alma Smith
1978 *Final Report: Class II Cultural Resources Field Sampling Inventory along Proposed IPP Transmission Line Corridors, Utah-Nevada-California*. Desert Research Institute Publication No. 72004. Social Sciences Center Technical Report No. 4. University of Nevada, Las Vegas.

Fox, Gregory L.
1993 *Newberry Mountains Archeological Inventory: A Section 110 Planning Survey and Site Assessment, Lake Mead National Recreation Area, Clark County, Nevada*. National Park Service, Western Archeological and Conservation Center, Tucson.

1994 *Newberry Mountains Archeological Inventory 1993-1994: A Section 110 Planning Survey and Site Assessment, Lake Mead National Recreation Area, Clark County, Nevada*. National Park Service, Western Archeological and Conservation Center, Tucson.

Franklin, Robert, and Pamela Bunte
1996 Animals and Humans, Sex and Death: Toward a Symbolic Analysis of Four Southern Numic Rituals. *Journal of California and Great Basin Anthropology* 18:178–203.

Fremont, John C.
1845 *Report of the Exploring Expedition to the Rocky Mountains in the Year 1842, and to Oregon and North California in the Years 1843-'44*. Senate Executive Document, 28th Congress, 2nd Session, No. 174. Gales and Seaton, Washington D.C.

Gantz, Kenneth F., Jack H. Mooney, Harmon H. Harper, Edmund O. Barker, Johan A. Westcott Jr., Enrique Gaston, William J. DePaola, and Robert G. Sparkman
1964 Exercise Desert Strike: Concept and Operations. *Air University Review* 16(1):2–18.

Garfinkel, Alan P.
2006 Paradigm Shifts, Rock Art Theory, and the Coso Sheep Cult of Eastern California. *North American Archaeologist* 27:203–244.

2007 *Archaeology and Rock Art of the Eastern Sierra and Great Basin Frontier*. Publication No. 22. Maturango Museum, Ridgecrest, California.

Garfinkel, Alan P., and Donald R. Austin
2011 Reproductive Symbolism in Great Basin Rock Art: Bighorn Sheep Hunting, Fertility, and Forager Ideology. *Cambridge Archaeological Journal* 21:453–471.

Gifford, Edward Winslow
1918 Clans and Moieties in Southern California. *University of California Publications in American Archaeology and Ethnology* 14:155–200.

1926 Yuman Dreams and Omens. *Journal of American Folk-Lore* 39(151):58–69.

1931 *The Kamia of Imperial Valley*. Bulletin of American No. Ethnology 97. U.S. Government Printing Office, Washington D.C.

1933 The Cocopa. *University of California Publications in American Archaeology and Ethnology* 31(5):257–334.

Gifford, Edward Winslow, and Robert H. Lowie
1928 Notes on the Akwa'ala Indians of Lower California. *University of California Publications in American Archaeology and Ethnology* 23(7):339–352.

Gilreath, Amy J. (editor)
2009 *Gypsum Cave Revisited*. Nevada Cultural Resources Report No. CR5-2462-4(P). Far Western Anthropological Research Group, Davis, California.

Goebel, Ted, and Joshua L. Keene
2014 Are Great Basin Stemmed Points as Old as Clovis in the Intermontaine West? A Review of the Geochronological Evidence. In *Archaeology in the Great Basin and Southwest: Papers in Honor of Don D. Fowler*, edited by Nancy J. Parezo and Joel C. Janetski, pp. 35–60. University of Utah Press, Salt Lake City.

Gorman, Frederick J. E.
1981 The Persistent Identity of the Mohave Indians, 1859-1965. In *Persistent Peoples: Cultural Enclaves in Perspective*, edited by Gilbert Kushner and George Pierre Castile, pp. 45–70. University of Arizona Press, Tucson.

Graf, Kelly E., and Dave N. Schmitt (editors)
2007 *Paleoindian or Paleoarchaic? Great Basin Human Ecology at the Pleistocene/Holocene Transition.* University of Utah Press, Salt Lake City.

Grayson, Donald K.
2000 Mammalian Responses to Middle Holocene Climatic Change in the Great Basin of the Western United States. *Journal of Biogeography* 27:181–192.

2011 *The Great Basin: A Natural Prehistory*. University of California Press, Berkeley.

Green, Eileen Margaret
1979 Site Forms for 26CK1595, 26CK1596, 26CK1597. On file, Nevada State Historic Preservation Office, Carson City.

1987 A Cultural Ecological Approach to the Rock Art of Southern Nevada. Unpublished Master's thesis, Department of Anthropology, University of Nevada, Las Vegas.

Gruis, Rachael, and Hubert Switalski
2008 *A Class III Cultural Resource Survey for the Proposed Installation of Meteorological Towers for the Castle Mountain Wind Project in San Bernardino County, California and Clark County, Nevada*. AMEC Job No. 7171001900. AMEC Earth & Environmental, Sandy, Utah.

Gudde, Erwin G.
1948 Mohave and Mojave. *Western Folklore* 7(2):169–171.

Gunnerson, James H.
1962 Plateau Shoshonean Prehistory: A Suggested Reconstruction. *American Antiquity* 28:41–45.

Haenszel, Arda
1953 University of California Archaeological Site Survey Records for 26-Cl-121(26CK121), 26-Cl-122(26CK170). On file, Nevada State Historic Preservation Office, Carson City.

1965 *Nevada Sites Related to California Sites along the Colorado River*. Archaeological Research Facility Manuscript No. 391. Phoebe A. Hearst Museum of Anthropology, University of California, Berkeley.

1970 San Bernardino County Museum Archaeological Site Survey Record for SBCM-780. On file, San Bernardino County Museum, Redlands, California.

Halbmaier, Rebecca
2007 *A Cultural Resource Survey for a Proposed Wind Monitoring Station near Searchlight, Clark County, Nevada*. EPG Cultural Resource Services Technical Paper No. 2007-001R. Environmental Planning Group, Reno, Nevada.

Hall, Matthew C.
1981 Inventory of Spring/Seep Locations in the East Mojave Desert Region. In *Background to Historic and Prehistoric Resources of the East Mojave Desert Region*, by Chester King and Dennis G. Casebier, pp. 70–193. U.S. Department of the Interior, Bureau of Land Management, Riverside, California.

Hall, Matthew C., Philip J. Wilke, Doran L. Cart, James D. Swenson, Stephen Bouscaren, and Kendall Kroesen
1981 *An Archaeological Survey of the Proposed Southern California Edison Ivanpah Generating Station Plant Site, and Related Rail, Coal Slurry, Water, and Transmission Line Corridors, San Bernardino County, California, and Clark County, Nevada (2 vol.)*. UCRARU No. 620. Archaeological Research Unit, University of California, Riverside.

Hall, Patricia L.
1984 BLM Cultural Resources Report Format/Field Worksheet: CP National, Inc. Powerline Right-of-way N-39509 to Serve MCI's Communication Site (N-38448). U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1986a BLM Class III Cultural Resource Inventory Report: N-43022; a Proposed Right-of-way for a Communication Site to Include a 12' x 20' Prefabricated Building, 60' Microwave Antenna Tower and a 300-gallon Propane Tank. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1986b BLM Class III Cultural Resource Inventory Report: N-43318; a Proposed Right-of-way for a Communication Site to Include a 16' x 24' Prefabricated Building, 100' Microwave Antenna Tower and an Emergency Generator. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Hall, Patricia L., and Thomas F. Zale
1985 BLM Class III Cultural Resource Inventory Report: N-41364; a Proposed Right-of-way for the Construction of Communication Facilities to Include an 8 x 8-foot Area for the Placement of Antennas Mounted on Ground-dunk Metal Poles. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Halmo, David
1995 *Tumpituxwinap (Storied Rocks): Southern Paiute Rock Art in the Colorado River Corridor*. Bureau of Applied Research in Anthropology, University of Arizona, Tucson.

Halpern, Abraham M.
1947 Yuma V: Conjugation of the Verb Theme. *International Journal of American Linguistics* 13:92–107.

1997 *Kar'úk: Native Accounts of the Quechan Mourning Ceremony*, edited by Amy Miller and Margaret Langdon. Publications in Linguistics No. 128. University of California Press, Berkeley.

Hanna, David C. Jr.
1982 Malcolm J. Rogers: The Biography of a Paradigm. Unpublished Master's thesis, Department of Anthropology, San Diego State University, San Diego.

Harner, Michael J.
1953 Gravel Pictographs of the Lower Colorado River Region. *Reports of the University of California Archaeological Survey* 20:1–29.

Harner, Michael J.
1958 Lowland Patayan Phases in the Lower Colorado River Valley and Colorado Desert. *Reports of the University of California Archaeological Survey* 42:93–97.

Harrington, John Peabody
n.d. Chemehuevi Field Notes. Unpublished notes in the collection "The Papers of John Peabody Harrington in the Smithsonian Institution, 1907-1957." Smithsonian Institution, Washington D.C.

1908 A Yuma Account of Origins. *The Journal of American Folk-Lore* 21(82):324–348.

Harrington, Mark R.
1926 Western Extension of Early Pueblo Culture. *Indian Notes* 3(2):69–72.

1957 *A Pinto Site at Little Lake, California*. Southwest Museum Papers No. 17. Southwest Museum, Los Angeles.

Harry, Karen G., and James T. Watson
2018 Shaping Identity in Prehispanic Southern Nevada. In *Life Beyond Boundaries: Constructing Identity in Edge Regions of the North American Southwest*, edited by Karen G. Harry and Sarah A. Herr, pp. 122–156. University Press of Colorado, Boulder.

Hatoff, Brian W.
1975a BLM Cultural Resource Report: N-11697 Right-of-way Application for Overhead Telephone Line. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1975b BLM Cultural Resource Report: Laughlin 300 ORV Race. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1975c BLM Cultural Resource Report: Red Rock 50-Mile Endurance Horseback Ride (SLUP N5-75-39). U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Hatzenbuehler, Lynn
1994 Defining Mojave Traditional Territory. Paper presented at the annual meeting of the Southwest Anthropological Association, April 7, Las Vegas.

Hayden, Julian D.
1976 Pre-Altithermal Archaeology in the Sierra Pinacate, Sonora, Mexico. *American Antiquity* 41:274–289.

Haynes, C. Vance
1991 Geoarchaeological and Paleohydrological Evidence for a Clovis-Age Drought in North America and its Bearing on Extinction. *Quaternary Research* 35:438–450.

2008 Younger Dryas "Black Mats" and the Rancholabrean Termination in North America. *Proceedings of the National Academy of Sciences* 105:6520–6525.

Hedges, Ken
1975 Notes on the Kumeyaay: A Problem of Identification. *Journal of California Anthropology* 2:71–83.

Heizer, Robert F., and Martin A. Baumhoff
1962 *Prehistoric Rock Art of Nevada and Eastern California*. University of California Press, Berkeley.

1970 Big Game Hunters in the Great Basin: A Critical Review of the Evidence. *Contributions of the University of California Archaeological Research Facility* 7:1–12.

Heizer, Robert F., and A. E. Treganza
1944 Mines and Quarries of the Indians of California. *California Journal of Mines and Geology* 40:291–359.

Hester, Thomas R.
1973 Chronological Ordering of Great Basin Prehistory. *Contributions of the University of California Archaeological Research Facility* 17:55–128.

Hewett, Donnel F.
1956 *Geology and Mineral Resources of the Ivanpah Quadrangle, California and Nevada*. U.S. Geological Survey Professional Paper No. 275. U.S. Government Printing Office, Washington D.C.

Hildebrandt, William R., and Kelly R. McGuire
2002 The Ascendance of Hunting during the California Middle Archaic: An Evolutionary Perspective. *American Antiquity* 67:231–256.

Hill, Joseph J.
1923a New Light on Pattie and the Southwestern Fur Trade. *The Southwestern Historical Quarterly* 2:243–254.

1923b Ewing Young in the Fur Trade of the Far Southwest, 1822-1834. *The Quarterly of the Oregon Historical Society* 24(1):1–35.

Hinton, Leanne, and Lucille J. Watahomigie
1984 Introduction. *Spirit Mountain: An Anthology of Yuman Story and Song*, edited by Leanne Hinton and Lucille J. Watahomigie, pp. 1–8. Sun Tracks Vol. 10. University of Arizona Press, Tucson.

Hinz, Nicholas H., James E. Faulds, Alan R. Ramelli, and Heather Green
2012 *Preliminary Geologic Map of the Ireteba Peaks Quadrangle, Clark County, Nevada*. Open-File Report No. 2012-09. Nevada Bureau of Mines and Geology, University of Nevada, Reno.

Hockett, Brian Scott
2000 Paleobiogeographic Changes at the Pleistocene-Holocene Boundary near Pintwater Cave, Southern Nevada. *Quaternary Research* 53:263–269.

Hodge, Frederick Webb
1907 *Handbook of American Indians North of Mexico,* part 1. Bulletin No. 30. Bureau of American Ethnology. U.S. Government Printing Office, Washington D.C.

Holdredge, Sterling M.
1866 Arizona. In *State, Territorial, and Ocean Guide Book of the Pacific*. Sterling M. Holdredge, San Francisco.

Honke, Jeffrey S., Jeffrey S. Pigatti, Jim Wilson, Jordan E. Bright, Harland L. Goldstein, Gary L. Skipp, Marith C. Reheis, and Jeremy C. Havens
2019 Late Quaternary Paleohydrology of Desert Wetlands and Pluvial Lakes in the Soda Lake Basin, Central Mojave Desert, California (USA). *Quaternary Science Reviews* 216:89–106.

Howard, Keith A., P. Kyle House, Barbara E. John, Ryan S. Crow, and Philip A. Pearthree
2019 A River Is Born: Highlights of the Geologic Evolution of the Colorado River Extensional Corridor and Its River: A Field Guide Honoring the Life and Legacy of Warren Hamilton. In *Geologic Excursions in Southwestern North America*, edited by Philip A. Pearthree, pp. 61–113. Field Guide No. 55. Geological Society of America, Boulder.

Huckleberry, Gary, Charlotte Beck, George T. Jones, Amy Holmes, Michael Cannon, Stephanie Livingston, and Jack M. Broughton
2001 Terminal Pleistocene/Early Holocene Environmental Change at the Sunshine Locality, North-Central Nevada, U.S.A. *Quaternary Research* 55:303–312.

Hughes, Malcolm K., and Henry F. Diaz
1994 Was There a "Medieval Warm Period," and If So, Where and When? *Climatic Change* 26:109–142.

Hunter, Kimberly L.
1991 Impacts of the Little Ice Age on the Vegetation of Southern Nevada. Unpublished Master's thesis, Department of Biological Sciences, University of Nevada, Las Vegas.

Hunter, Kimberly L., and Joseph R. McAuliffe
1994 Elevational Shifts of *Coleogyne ramossissima* in the Mojave Desert during the Little Ice Age. *Quaternary Research* 42:216–221.

Hutmacher, Sonia
2010 Letter Report Regarding N-82729, Castle Mountains Right-of-Way Results of Class III Cultural Resources Inventory. AMEC Project No. 717100900. AMEC Earth & Environmental, Sandy, Utah.

ICC [United States Indian Claims Commission]
1978 *Final Report, United States Indian Claims Commission, August 12, 1946-September 30, 1978*. U.S. Indian Claims Commission, Washington, D.C.

Inter-Tribal Council of Nevada
1976 *Nuwuvi: A Southern Paiute History*. Inter-Tribal Council of Nevada, Reno.

Ives, Joseph C.
1861 *Report upon the Colorado River of the West, Explored in 1857 and 1858*. 36th Congress, 1st Session, Senate Executive Document. U.S. Government Printing Office, Washington D.C.

Jennings, Charles W.
1961 *Geologic Map of California, Kingman Sheet*. 1:250,000. Department of Natural Resources, Division of Mines, Sacramento, California.

Jennings, Jesse D.
1986 Prehistory: Introduction. In *Great Basin*, edited by Warren L. D'Azevedo, pp. 113–119. Handbook of North American Indians, Vol. 11, William C. Sturtevant, general editor. Smithsonian Institution, Washington DC.

Johnson, Boma
1986 *Earth Figures of the Lower Colorado and Gila River Deserts: A Functional Analysis*. The Arizona Archaeologist No. 20. Arizona Archaeological Society, Phoenix.

2003 Geoglyphs Associated with the Xam Kwatcan Trail in the Palo Verde Point Area, South of Blythe, California. In *View across the Cultural Landscape of the Lower Colorado Desert: Cultural Resource Investigations for the North Baja Pipeline Project*, edited by James H. Cleland and Rebecca McCorkle Apple, pp. 159–177. EDAW, Inc., San Diego.

2006 "Hi Jay." In *Festschrift Honoring the Contributions of California Archaeologist Jay von Werlhof*, edited by Russell L. Kaldenberg, pp. 41–62. Publication No. 20. Maturango Museum, Ridgecrest, California.

Johnston, Jeff
1994 *A Class II Inventory of the Proposed Eldorado Valley Land Acts, Clark County, Arizona*. MAI Project No. 840-07. Mariah Associates, Inc., Reno, Nevada.

Jones, Robert C., and Susan R. Edwards
1994 A Clovis Point on the Nevada Test Site. *Nevada Archaeologist* 16:18–23.

Judge, W. James, and Lynne Sebastian (editors)
1998 *Quantifying the Present and Predicting the Past: Theory, Method, and Application of Archaeological Predictive Modeling*. U.S. Department of the Interior, Bureau of Land Management, Denver.

Kelly, Isabel T.
1934 Southern Paiute Bands. *American Anthropologist* 36:548–560.

1936 Chemehuevi Shamanism. In *Essays in Anthropology Presented to A. L. Kroeber in Celebration of his Sixtieth Birthday*, edited by Robert H. Lowie, pp. 129–142. University of California Press, Berkeley.

1964 *Southern Paiute Ethnography*. University of Utah Anthropological Papers No. 69. University of Utah Press, Salt Lake City.

Kelly, Isabel T.
2016 *Isabel T. Kelly's Southern Paiute Ethnographic Field Notes, 1932-1934*, edited by Catherine S. Fowler and Darla Garey-Sage. University of Utah Anthropological Papers No. 130. University of Utah Press, Salt Lake City.

Kelly, Isabel T., and Catherine S. Fowler
1986 Southern Paiute. In *Great Basin*, edited by Warren L. D'Azevedo, pp. 368–397. Handbook of North American Indians, Vol. 11, William C. Sturtevant, general editor. Smithsonian Institution, Washington D.C.

Kelly, Marsha C.
1972 The Society that Did not Die. *Ethnohistory* 19:261–265.

Kelly, William H.
1977 *Cocopa Ethnography*. Anthropological Papers of the University of Arizona No. 29. University of Arizona Press, Tucson.

Klasky, Philip M.
2013 The Song of the Land. In *Dreamers of the Colorado: The Mojave Indians, Part 2: Their Culture and Arts*, edited by Frances L. O'Neil and Paul W. Wittmer, pp. 113–116. Tunxis Community College, Farmington, Connecticut.

Knack, Martha C.
2002 *Boundaries Between: The Southern Paiutes, 1775-1995*. University of Nebraska Press, Lincoln.

Knell, Edward J., Leah C. Walden-Hurtgen, and Matthew E. Kirby
2014 Terminal Pleistocene-Early Holocene Spatio-Temporal and Settlement Patterns around Pluvial Lake Mojave, California. *Journal of California and Great Basin Anthropology* 34:43–60.

Knight, Kenneth C.
1984 NDOT Cultural Resources Report: Improvement on US 95, EA 70745. NDOT Report No. 080-84P. Nevada Department of Transportation, Carson City.

1986 NDOT Cultural Resource Report: Maintenance and Improvements, SR 163 CL 0.0 to 19.53, EA 71303. Nevada Department of Transportation, Carson City.

1989 NDOT Cultural Resources Report: Clearance of a New Material Source to be Used for SR-163 Netterment Work. NDOT Report No. CL082-88P. Nevada Department of Transportation, Carson City.

Koehler, Peter A., R. Scott Anderson, and W. Geoffrey Spaulding
2005 Development of Vegetation in the Central Mojave Desert of California during the Late Quaternary. *Paleogeography, Paleogeology, Paleoecology* 215:297–311.

Koerper, Henry C., and Ken Hedges
1996 Patayan Anthropomorphic Figurines from an Orange County Site. *Journal of California and Great Basin Anthropology* 18:204–220.

Kowalewski, Stephen A.
2008 Regional Settlement Pattern Studies. *Journal of Archaeological Research* 16:225–285.

Kroeber, Alfred L.
1902 Preliminary Sketch of the Mohave Indians. *American Anthropologist* 4:276–285.

1906 Two Myths of the Mission Indians of California. *Journal of American Folk-Lore* 19(75):309–321.

1908a Ethnography of the Cahuilla Indians. *University of California Publications in American Archaeology and Ethnology* 8(2):29–68.

1908b Origin Tradition of the Chemehuevi Indians. *Journal of American Folk-Lore* 21(81):240–242.

1920 Yuman Tribes of the Lower Colorado. *University of California Publications in American Archaeology and Ethnology* 16(8):475–485.

1925 *Handbook of the Indians of California*. Bureau of American Ethnology Bulletin No. 78. U.S. Government Printing Office, Washington D.C.

1935 Myths and Tales. In *Walapai Ethnography*, edited by Alfred L. Kroeber, pp. 245–291. Memoirs of the American Anthropological Association No. 42. Menasha, Wisconsin.

1939 *Cultural and Natural Areas of Native North America*. University of California Publications in American Archaeology and Ethnology No. 38. University of California Press, Berkeley.

1948 Seven Mohave Myths. *University of California Anthropological Records* 11(1):1–70.

1951a A Mohave Historical Epic. *University of California Anthropological Records* 11(2):71–176.

1951b Olive Oatman's Return. *Kroeber Anthropological Society Papers* 4:1–18.

1957 Ethnographic Interpretations 1–16. *University of California Publications in American Archaeology and Ethnology* 47(2):191–234.

1959a Desert Mohave: Fact or Fancy. *University of California Publications in American Archaeology and Ethnology* 47(3):294–307.

1959b Recent Ethnic Spreads. *University of California Publications in American Archaeology and Ethnology* 47(3):259–281.

1972 *More Mohave Myths*. Anthropological Records No. 27. University of California Press, Berkeley.

1974 *Mohave Indians: Report on Aboriginal Territory and Occupancy of the Mohave Tribe*. Garland Publishing Company, New York.

Kroeber, Alfred L., and Michael J. Harner
1955 *Mohave Pottery*. University of California Anthropological Records No. 16(1). University of California Press, Berkeley.

Kroeber, Alfred L., and Clifton Kroeber
1973 *A Mohave War Reminiscence, 1854-1880*. Publications in Anthropology No. 10. University of California Press, Berkeley.

Kroeber, Clifton B.
1964 The Route of James O. Pattie on the Colorado in 1826: A Reappraisal by A. L. Kroeber. *Arizona and the West* 6(2):119–136.

1965 The Mohave as Nationalist, 1859-1874. *Proceedings of the American Philosophical Society* 109:173–180.

Kuniyoshi, Shingi
1977 BLM Cultural Resources Report Field Worksheet: Mineral Material Sale. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Lachniet, Matthew S., Yemane Asmerom, Victor Polyak, and Rhawn Denniston
2020 Great Basin Paleoclimate and Aridity Linked to Artic Warming and Tropical Pacific Sea Surface Temperature. *Paleoceanography and Paleoclimatology* 35(7):1–22.

Lahoff, Rachel E.
2013 The Search for Interpretation Sovereignty: Accommodating Nuwuvi (Southern Paiute) Voice in Protected Area Interpretation. Unpublished Master's thesis, Department of Anthropology, Portland State University, Portland, Oregon.

Laird, Carobeth
1974 Chemehuevi Religious Beliefs and Practices. *Journal of California Anthropology* 1(1):19–25.

1976 *The Chemehuevis*. Malki Museum Press, Banning, California.

1977 Behavioral Patterns in Chemehuevi Myths. In *Flowers of the Wind: Papers on Ritual, Myth and Symbolism in California and the Southwest*, edited by Thomas C. Blackburn, pp. 97–119. Ballena Press, Socorro, New Mexico.

1980 Chemehuevi Shamanism, Sorcery, and Charms. *Journal of California and Great Basin Anthropology* 2(1):80–87.

1984 *Mirror and Pattern: George Laird's World of Chemehuevi Mythology*. Malki Museum Press, Banning, California.

LaMarche, Valmore C. Jr.
1973 Holocene Climatic Variations Inferred from Treeline Fluctuations in the White Mountains, California. *Quaternary Research* 3:632–660.

Lamb, Hubert H.
1965 The Early Medieval Epoch and Its Sequel. *Paleogeography, Paleoclimatology, Paleoecology*, 1:13–37.

Lamb, Sydney
1958 Linguistic Prehistory of the Great Basin. *International Journal of American Linguistics* 24:95–100.

Langdon, Margaret
1975 Kamia and Kumeyaay: A Linguistic Perspective. *Journal of California Anthropology* 2:64–70.

Lapides, Jeff (editor)
2018 *The Mojave Road in 1863: The Pioneering Photographs of Rudolph D'Heureuse*. Tales of the Mojave Road Publishing Company, Essex, California.

Larson, Daniel O.
1996 Population Growth, Agricultural Intensification, and Culture Change among the Virgin Branch Anasazi, Nevada. *Journal of Field Archaeology* 23:55–76.

Larson, Daniel O., and Joel Michaelsen
1990 Impacts of Climatic Variability and Population Growth on Virgin Branch Anasazi Cultural Developments. *American Antiquity* 55:227–249.

Layton, Stanford J.
1988 *To No Privileged Class: The Rationalization of Homesteading and Rural Life in the Early Twentieth-Century American West*. Charles Redd Center for Western Studies, Brigham Young University, Provo, Utah.

Leavitt, Robert M.
1983a NDOT Cultural Resources Report: Maintenance Material Pit, District I, W. O. 20726. NDOT Report No. 034-83P. Nevada Department of Transportation, Carson City.

1983b NDOT Cultural Resources Report: Material Locations for Use on US95, EA 71083. NDOT Report No. 02-83P. Nevada Department of Transportation, Carson City.

1983c NDOT Cultural Resources Report: Safety Improvements to US 95 near Searchlight, Nevada, EA 71100. NDOT Report No. 040-83P. Nevada Department of Transportation, Carson City.

1983d NDOT Cultural Resources Report: SR 164, MP 14.0-18.0. NDOT Report No. 070-82R. Nevada Department of Transportation, Carson City.

1984 NDOT Cultural Resources Report: Improvements on SR164, W.O. 20726. NDOT Report No. 023-84B. Nevada Department of Transportation, Carson City.

1985a NDOT Cultural Resources Report: Improvements on US95 from the California State Line to Milepost CL 13.0, EA 71255. NDOT Report No. 108-85R. Nevada Department of Transportation, Carson City.

Leavitt, Robert M.
1985b NDOT Cultural Resources Report: Material Locations on SR164 between Searchlight and Nipton, California for Use on Improvements, US95, EA 70745. NDOT Report No. 029-85P. Nevada Department of Transportation, Carson City.

1985c NDOT Cultural Resources Report: Material Locations, US95 Milepost CL 9.5. NDOT Report No. 0231-85P. Nevada Department of Transportation, Carson City.

1986 NDOT Cultural Resources Report: Material Locations. Nevada Department of Transportation, Carson City.

1987 NDOT Cultural Resources Report: Improvements and Maintenance on US95, Milepost CL 0.00 to 13.00 (EA 713120). NDOT Report No. 024-87P. Nevada Department of Transportation, Carson City.

1995 BLM Class III Cultural Resources Inventory Negative Report: Survey of a Cellular Phone Facility South of State Route 164 on Eastern Edge of Paiute Valley. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

2003a Letter Report to GeoTek Regarding Records Search and Field Investigation for AAT Communications Corporation Facility No. 32423. Knight & Leavitt Associates, Inc., Las Vegas.

2003b *Records Search and Cultural Assessment, Cingular Site No. LV-175-01*. Knight & Leavitt Associates, Inc., Las Vegas.

Leavitt, Robert M., and T. Hal Turner
1980 NDOT Cultural Resources Report on Right-of-Way: Piute Wash Bridge B-420, BRF-095-1(11)/70988. Nevada Department of Transportation, Carson City.

Leavitt, Stephen W.
1994 Major Wet Interval in White Mountains Medieval Warm Period Evidenced in δ13C of Bristlecone Pine Tree Rings. *Climatic Change* 26:299–307.

Lefler, Brian John
2014 Nuwuvi (Southern Paiute) Ecological Knowledge of Piñon-Juniper Woodlands: Implications for Conservation and Sustainable Resource Use in Two Southern Nevada Protected Areas. Unpublished Master's thesis, Department of Anthropology, Portland State University, Portland, Oregon.

Leivas, Matthew, Vivienne Jake, and Philip Klasky
2009 *Salt Song Trail Map of Nuwuvi (Southern Paiute) Sacred Landscapes, Culture Areas and Bands*. The Cultural Conservancy, San Francisco.

Levick, Lainie R., Julia Fonseca, David C. Goodrich, Mariano Hernandez, Darius J. Semmens, Juliet Stromberg, Robert A. Leidy, Melissa Scianni, D. Phillip Guertin, Melanie Tluczek, and William G. Kepner
2008 *The Ecological and Hydrological Significance of Ephemeral and Intermittent Streams in the Arid and Semi-Arid American Southwes*t. EPA/600/R-08/134, ARS/233046. U.S. Environmental Protection Agency, Office of Research and Development, Washington D.C.

Liljeblad, Sven
1986 Oral Tradition: Content and Style of Verbal Arts. In *Great Basin*, edited by Warren L. D'Azevedo, pp. 641–659. Handbook of North American Indians, Vol. 11, William C. Sturtevant, general editor. Smithsonian Institution, Washington D.C.

Lincoln, Francis Church
1923 *Mining Districts and Mineral Resources of Nevada*. Nevada Newsletter Publishing Company, Reno.

Lindström Susan
1990 Submerged Tree Stumps as Indicators of Mid-Holocene Aridity in the Lake Tahoe Basin. *Journal of California and Great Basin Anthropology* 12:146–157.

Livingston, Dewey, Andy Kirk, Megan Weatherly, and Jonathan Foster
2020 National Register of Historic Places Nomination Form for the Mojave Road. National Park Service, U.S. Department of the Interior, Washington D.C.

Longwell, Chester R., Earl H. Pampeyan, Ben Bowyer, and Ralph J. Roberts
1965 *Geology and Mineral Deposits of Clark County, Nevada*. Nevada Bureau of Mines and Geology Bulletin No. 62. Mackay School of Mines, University of Nevada, Reno.

Loren-Webb, Barbara Ann
2003 The Pueblo in the Mojave Sink: An Archaeological Myth. Unpublished Master's thesis, Interdisciplinary Studies, California State University, San Bernardino.

Lowie, Robert H.
1924 Notes on Shoshonean Ethnography. *Anthropological Papers of the American Museum of Natural History* 20(3):185–324.

Ludington, Steve, Stephen B. Castor, Brett T. McLaurin, Kathryn S. Flynn, and James E. Faulds
2006 Mineral Resource Potential of the Piute-Eldorado Tortoise, Crescent Townsite, and Keyhole Canyon Areas of Critical Environmental Concern, Clark County, Nevada. In *Mineral Resource Assessment of Selected Areas in Clark and Nye Counties, Nevada*, edited by Steve Ludington, pp. B1–B67. Scientific Investigations Report No. 2006-5197. U.S. Geological Survey, Reston, Virginia.

Lyneis, Margaret M.
1982 *An Archaeological Element for the Nevada Historic Preservation Plan.* Nevada Division of Historic Preservation and Archaeology, Carson City.

Lyneis, Margaret M.
1994 East and onto the Plateaus?: An Archaeological Examination of the Numic Expansion in Southern Nevada, Northern Arizona and Southern Utah. In *Across the West: Human Population Movement and the Expansion of the Numa*, edited by David Madsen and David Rhode, pp. 141–149. University of Utah Press, Salt Lake City.

1995 The Virgin Anasazi, Far Western Puebloans. *Journal of World Prehistory* 9:199–241.

2008 New and Revised Prehistoric Pueblo Pottery Wares and Types from North and West of the Colorado River: Part 1, Gray Wares from the Western Area. *Pottery Southwest* 27(1):3–20.

Lyon, Jerry D. Heidi Roberts, Rick Ahlstrom, Christopher Harper, Suzanne Eskenazi, Robert Davide, Catherine Fowler, and Elizabeth von Till Warren
2008 *Shared Place: An Archaeological Survey of the Ash Meadows National Wildlife Refuge, Nye County, Nevada.* Archaeological Report No. 07-24. HRA Inc., Las Vegas.

MacGregor, Gordon
1935 Origin Myth. In *Walapai Ethnography*, edited by Alfred L. Kroeber, pp. 12–26. Memoirs of the American Anthropological Association No. 42. Menasha, Wisconsin.

MacMahon, James A., and Frederic H. Wagner
1985 The Mojave, Sonoran and Chihuahuan Deserts of North America. In *Hot Deserts and Arid Shrublands*, edited by Michael Evenari, Imanuel Noy-Meir, and David W. Goodall, pp. 105–202. Ecosystems of the World No. 12A. Elsevier Scientific Publishers, Amsterdam, Netherlands.

Madsen, David B.
1975 Dating Paiute-Shoshoni Expansion in the Great Basin. *American Antiquity* 40:82–86.

2007 The Paleoarchaic to Archaic transition in the Great Basin. In *Paleoindian or Paleoarchaic? Great Basin Human Ecology at the Pleistocene-Holocene Transition*, edited by Kelly E. Graf and David N. Schmitt, pp. 3–20. University of Utah Press, Salt Lake City.

Madsen, David B., and David Rhode (editors)
1994 *Across the West: Human Population Movement and the Expansion of the Numa*. University of Utah Press, Salt Lake City.

Mallery, Garrick
1893 *Picture-Writing of the American Indians*. Annual Report of the Bureau of American Ethnology, Vol. 10. Smithsonian Institution, U.S. Government Printing Office, Washington D.C.

Mann, Michael E.
2003 Little Ice Age. In *The Earth System: Physical and Chemical Dimensions of Global Environmental Change*, edited by Michael C. MacCracken and John S. Perry, pp. 504–509. Encyclopedia of Global Environmental Change Vol. 1. John Wiley & Sons, Chichester, England.

Mann, Michael E., Zhihua Zhang, Scott Rutherford, Raymond S. Bradley, Malcolm K. Hughes, Drew Shindell, Caspar Ammann, Greg Faluvegi, and Fenbiao Ni
2009 Global Signatures and Dynamical Origins of the Little Ice Age and Medieval Climate Anomaly. *Science* 326:1256–1259.

Martin, Beverly L.
1979a BLM Cultural Resources Report Field Worksheet: Well Site, Russell Knight, Cooperative Agreement. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1979b BLM Cultural Resources Report Field Worksheet: Well Site, Russell Knight, Cooperative Agreement. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1979c BLM Cultural Resources Report Field Worksheet: N-20391, R&PP Lease/Purchase, the Roman Catholic Bishop of Reno-Las Vegas. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1980 BLM Cultural Resources Report Field Worksheet: N-21065, R/W for Power Line and Access Road. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Martineau, LaVan
1992 *The Southern Paiutes: Legends, Lore, Language, and Lineage*. KC Publications, Las Vegas.

Matthews, John A., and Keith R. Briffa
2005 The "Little Ice Age": Re-evaluation of an Evolving Concept. *Geografiska Annaler: Series A, Physical Geography* 87(1):17–36.

McCabe, Allen
1991 *A Cultural Resources Inventory of a Powerline and an Access Road in Clark County, Nevada*. ARS Report No. 646. Archaeological Research Services, Inc., Virginia City, Nevada.

McDaniel, Sandy
2008 *A Cultural Resource Survey in Support of Three Additional Anemometer Poles near Searchlight, Clark County, Nevada*. Cultural Resource Services Technical Paper No. 2008-014. Environmental Planning Group, Phoenix.

McGinty, Brian
2005 *The Oatman Massacre: A Tale of Desert Captivity and Survival*. University of Oklahoma Press, Norman.

McGuire, Kelly R., and William R. Hildebrandt
2005 Re-Thinking Great Basin Foragers: Prestige Hunting and Costly Signaling during the Middle Archaic Period. *American Antiquity* 70:695–712.

McKennan, Robert
1935 Shamanism. In *Walapai Ethnography*, edited by Alfred L. Kroeber, pp. 185–193. Memoirs of the American Anthropological Association No. 42. Menasha, Wisconsin.

McLane, Alvin
2001 Clark County Petroglyphs. On file, Harry Reid Center, University of Nevada, Las Vegas.

McManamon, Francis P.
2018 Developments in American Archaeology: Fifty Years of the National Historic Preservation Act. *Annual Review of Anthropology* 47:553–574.

Mehringer, Peter J. Jr.
1985 Late-Quaternary Pollen Records from the Interior Pacific Northwest and Northern Great Basin of the United States. In *Pollen Records of Late-Quaternary Sediments*, edited by Vaughn M. Bryant and Richard G. Holloway, pp. 167–189. American Association of Stratigraphic Palynologists Foundation, Dallas.

Meigs, Peveril
1939 *The Kiliwa Indians of Lower California*. Ibero-Americana No. 15. University of California Press, Berkeley.

Meller, Sidney L.
1946 *History of Army Ground Forces*. The Desert Training Center and C-AMA Study No. 15. Historical Section, Army Ground Forces, Washington D.C.

Merriam, John C.
1939 Paleontology, Early Man, and Historical Geology. *Carnegie Institution of Washington Year Book* 38:301–310.

Millar, Constance I., and Wallace B. Wolfenden
1999 The Role of Climate Change in Interpreting Historical Variability. *Ecological Applications* 9:1207–1216.

Miller, David M., and Joseph L. Wooden
1993 *Geological Map of the New York Mountains Area, California and Nevada*. Open-file Report No. 93-198. U.S. Geological Survey, Reston, Virginia.

Miller, David M., Kevin M. Schmidt, Shannon A. Mahan, John P. McGeehin, Lewis A. Owen, John A. Barron, Frank Lehmkuhl, and Rene Lohrer
2010 Holocene Landscape Response to Seasonality of Storms in the Mojave Desert. *Quaternary International* 215:45–61.

Miller, Jay
1983 Basin Religion and Theology: A Comparative Study of Power (*Puha*). *Journal of California and Great Basin Anthropology* 5(1–2):66–86.

Miller, Ronald Dean, and Peggy Jean Miller
1967 *The Chemehuevi Indians of Southern California*. Malki Museum Press, Banning, California.

Moen, Michael
1968 Site Form for Lewis Holes (26CK121). On file, Nevada State Historic Preservation Office, Carson City.

Möllhausen, Baldwin
1858 *Diary of a Journey from the Mississippi to the Coasts of the Pacific with a United States Government Expedition*, vol. 2. Longman, Brown, Green, Longmans, & Roberts, London, England.

Monroe, Larry
1977 BLM Cultural Resources Report Field Worksheet: Groundshakers Motorcycle Off-road Race. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Moore, Joseph M.
1997 *The NDOT Class III Archaeological Investigations of a Proposed 600 Acre Regional Aggregate Material Source (Expansion of Existing Application NEV059097, SR 164 CL 15.36) near Searchlight in Clark County, Nevada*. NDOT Report No. CL97-012P. Cultural Resources Section, Environmental Services Division, Nevada Department of Transportation, Carson City.

Morrison, Roger B.
1991 Quaternary Stratigraphic, Hydrologic, and Climatic History of the Great Basin with Emphasis on Lakes Lahontan, Bonneville, and Tecopa. In *Quaternary Nonglacial Geology: Conterminous U.S.*, edited by Roger B. Morrison, pp. 283–320. The Geology of North America, vol. K-2. Geological Society of America, Boulder.

Morrissey, Frank R.
1968 *Turquoise Deposits of Nevada*. Nevada Bureau of Mines Report No. 17. Mackay School of Mines, University of Nevada, Reno.

Munro, Pamela, and Judith Crawford (editors)
1984 Mojave Literature. In *Spirit Mountain: An Anthology of Yuman Story and Song*, edited by Leanne Hinton and Lucille J. Watahomigie, pp. 279–290. Sun Tracks Vol. 10. University of Arizona Press, Tucson.

Murphy, Susan
1994 Letter Report Regarding the Recordation of the Quartette Mine and Mill Complex, 26CK5081. HRC Report No. 5-161-1. Harry Reid Center for Environmental Studies, University of Nevada, Las Vegas.

Murphy, Susan, and Grace Burkholder
1989 Intermountain Antiquities Computer System Form for 26CK4168. On file, Nevada State Historic Preservation Office, Carson City.

Musser-Lopez, Arlene Ruth, and Steve Miller
2010 Archaeological Trails and Ethnographic Trails: Can They Meet? *Proceedings of the Society of California Archaeology* 24:1–25.

Myers, Merilyn J., and Vincent H. Resh
1999 Spring-Formed Wetlands of the Arid West: Islands of Aquatic Invertebrate Biodiversity. In *Invertebrates in Freshwater Wetlands of North America*, edited by Darold P. Batzer, Russell B. Rader, and Scott A. Wissinger, pp. 811–828. John Wiley & Sons, Hoboken, New Jersey.

Myhrer, Keith
1986 BLM Class III Cultural Resource Inventory Report: Proposed Surface Disturbance for Mining Activity for Highland No. 2, Rodeway Systems, Inc. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1987 BLM Class III Cultural Resource Inventory Report: Construction of a Fence to Provide an Access Land for Cattle in Pasture 3 to Obtain Water at Six-Mile Well. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1990a BLM Class III Cultural Resource Inventory Report: NV54-90-34, Survey of Motorcycle Race Course in the Newberry Mountains, Southern Nevada. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1990b BLM Class III Cultural Resource Inventory Report: Survey of Tortoise Exclosure Fence in Piute Valley, Southern Nevada. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1990c BLM Class III Cultural Resource Inventory Report: NV54-90-34: Survey of Motorcycle Race Course in the Newberry Mountains, Southern Nevada. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1991a BLM Class III Cultural Resource Inventory Report: NV5-90-37, Survey of an Off-road Course in the Highland Range, Southern Nevada. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1991b BLM Class III Cultural Resource Inventory Report: Review of Eight Previous Surveys and Inventory of Another for the Christmas Tree Pass Communication Site Plan, Spirit Mountain, Southern Nevada. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1992 BLM Class III Cultural Resource Inventory Report: N54-89-024P, Inventory for the Jetco Enterprises Mining Plan of Operations at Roman Mine in the Newberry Mountains, Clark County, Nevada. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1993 BLM Class III Cultural Resource Inventory Report: N54-92-034P, Inventory of 80 Acres for a Mining Plan of Operations near Crescent Peak, Clark County, Nevada. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1994 Intermountain Antiquities Computer System Form for 26CK5113. On file, Nevada State Historic Preservation Office, Carson City.

Myhrer, Keith, and Dennis Samuelson
1987 BLM Class III Cultural Resource Inventory Report: Proposed R/W for Access Road between Two Patented Mining Claims near Searchlight. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Myhrer, Keith, William G. White, and Stanton D. Rolf
1990 *Archaeology of the Old Spanish Trail/Mormon Road from Las Vegas, Nevada to the California Border*. Contributions to the Study of Cultural Resources Technical Report No. 17. U.S. Department of the Interior, Bureau of Land Management, Nevada State Office, Reno.

National Park Service [NPS]
1990 *How to Apply the National Register Criteria for Evaluation*. National Register Bulletin No. 15. National Park Service, Washington D.C.

1998 *Guidelines for Evaluating and Documenting Traditional Cultural Properties*. National Register Bulletin No. 38. National Park Service, Washington D.C.

Nelson, Leonard N. III, and Christopher E. Drover
1980 Prehistoric Turquoise Mining in the Halloran Springs District, San Bernardino County, California. *Journal of California and Great Basin Anthropology* 2:245–256.

Nelson, Michelle
2006 Oral Tradition, Identity, and Inter-generational Healing through the Southern Paiute Salt Songs. In *Cultural Representation and Contestation in Native America*, edited by Andrew Jolivette, pp. 96–110. Contemporary Native American Communities No. 18. AltaMira Press, Berkeley, California.

Nevada Division of Forestry
2020 *Nevada Forest, Range & Watershed Action Plan*. Nevada Department of Conservation & Natural Resources, Carson City.

Nevada State Historic Preservation Office
2020 *Nevada Historic Preservation Plan, 2020-2028*. Nevada Department of Conservation and Natural Resources, State Historic Preservation Office, Carson City.

Nielson, Jane E.
1998 *Geological Map of the East of Grotto Hills Quadrangle, California*. Open-file Report No. 98-469. U.S. Geological Survey, Reston, Virginia.

Nielson Jane E., James G. Frisken, Robert C. Jachens, and John R. McDonnell Jr.
1987 *Mineral Resources of the Fort Piute Wilderness Study Area, San Bernardino County, California*. Bulletin No. 1713-C. U.S. Geological Survey, Denver.

Northwest Research
2019 *Northwest Research Obsidian Source Reference Database*. Electronic document, http://obsidianlab.com/universe.html, accessed October 2, 2021.

Oestreich Lurie, Nancy
1978 The Indian Claims Commission. *Annals of the American Academy of Political and Social Science* 436:97–110.

Ogden, Peter Skene
1853 *Traits of American-Indian Life and Character by a Fur Trader*. Smith, Elder and Company, London, England.

Oviatt, Charles G.
1988 Late Pleistocene and Holocene Lake Fluctuations in the Sevier Lake Basin, Utah, USA. *Journal of Paleolimnology* 1(1):9–21.

Owens, Erica, and Shaun Provencer
2007 Cultural Landscapes Inventory, Rock Springs Land and Cattle Company, Mojave National Preserve. U.S. Department of the Interior, National Park Service, Washington D.C.

Paher, Stanley
1970 *Nevada Ghost Towns and Mining Camps*. Howell-North Books, Berkeley, California.

Palmer, William R.
1928 Utah Indians Past and Present. *Utah Historical Quarterly* 1:35–52.

Parsons, Jeffrey R.
1972 Archaeological Settlement Patterns. *Annual Review of Anthropology* 1:127–150.

Pattie, James Ohio
1831 *The Personal Narrative of James O. Pattie, of Kentucky*, edited by Timothy Fling. John H. Wood, Cincinnati, Ohio.

Pearthree, Philip A., and P. Kyle House
2014 Paleogeomorphology and Evolution of the Colorado River Inferred from Relationships in Mohave and Cottonwood Valleys, Arizona, California, and Nevada. *Geosphere* 10:1139–1160.

Perry, Richard
1992 ACOE Memorandum for Record Regarding a Cultural Resources Survey of a 4.2-mile Access Road to U.S.C.G. Loran Station near Searchlight, Nevada. U.S. Army Corps of Engineers, Sacramento District, Sacramento, California.

Petchey, Fiona
2018 Radiocarbon Dating in Rock Art Research. In *The Oxford Handbook of the Archaeology and Anthropology of Rock Art*, edited by Bruno David and Ian J. McNiven, pp. 927–943. Oxford University Press, Oxford, England.

Peterson, Frederick F.
1981 *Landforms of the Basin & Range Provide Defined for Soil Survey*. Technical Bulletin No. 28. Nevada Agricultural Experiment Station, University of Nevada, Reno.

Peterson, Steffan
2019 Cottonwood Cove Flood Mitigation Structure. LAME Clearance No. 19-009. National Park Service, Western Archeological and Conservation Center, Tucson.

Pezzati, Alessandro
2013 Edward Sapir and Tony Tillohash. *Expedition* 55(3):42–43.

Pigati, Jeffrey S., Jordon E. Bright, Timothy M. Shanahan, and Shannon A. Mahan
2009 Late Pleistocene Paleohydrology near the Boundary of the Sonoran and Chihuahuan Deserts, Southeastern Arizona, USA. *Quaternary Science Reviews* 28:286–300.

Pippin, Lonnie C.
1986 Intermountain Brown Wares: An Assessment. In *Pottery of the Great Basin and Adjacent Areas*, edited by Suzanne Griset, pp. 9–21. University of Utah Anthropological Papers No. 111. University of Utah Press, Salt Lake City.

Pizatella, Louis
1983 BLM Cultural Resources Report Format/Field Worksheet: Calada Well Pipeline. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Porter, Stephen C., and George H. Denton
1967 Chronology of Neoglaciation in North American Cordillera. *American Journal of Science* 265:177–210.

Presnall, Clifford C.
1936 Paiute Names for Zion Canyon. *Zion and Bryce Nature Notes* 8(1):4–5.

Prose, Doug V.
1986 *Map Showing Areas of Visible Land Disturbances Caused by Two Military Training Operations in the Mojave Desert, California*. Miscellaneous Field Studies Map No. MF-18555. U.S. Geological Survey, Reston, Virginia.

Quade, Jay, Richard M. Forester, William L. Pratt, and Claire Carter
1998 Black Mats, Spring-Fed Streams, and Late-Glacial-Age Recharge in the Southern Great Basin. *Quaternary Research* 49:129–148.

Quinlan, Angus R.
2012 Rock Art. In *A Prehistoric Context for Southern Nevada*, edited by Heidi Roberts and Richard V. N. Ahlstrom, pp. 209–236. Archaeological Report No. 011-05. HRI Inc., Las Vegas.

Rafferty, Kevin
1982a BLM Cultural Resource Report Field Worksheet: Plan of Operations, NV-056-83-01P, The Continental Company, Involving Disturbances to 17 Acres of Area. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1982b BLM Cultural Resources Report Format/Field Worksheet: Mineral Patent Examination N-19969, Crescent Area, Impacts to 25 Acres of Land: 20 acres at Mill Lode, 5 Acres at Mill Site. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Rafferty, Kevin
1983 A Cultural Resources Investigation of the MCI Communications Piute Mountain Repeater Station in Clark County, Nevada. DAS Report No. 5-71-1. Environmental Research Center, Division of Anthropological Studies, University of Nevada, Las Vegas.

1990 *Geoglyph/Earth Figure Patterns on the Fort Mojave Indian Reservation, Clark County, Nevada*. ARSN Report No. 4-1-4. Archaeological Research of Southern Nevada, Las Vegas.

1991 *Geoglyph/Earth Figure Patterns on the Fort Mojave Indian Reservation, Clark County, Nevada*. Report No. 4-1-4. Archaeological Research of Southern Nevada, Las Vegas.

1992 *A Cultural Resource Inventory of an Access Road and Two Drill Pad Locations near Crescent Peak, Clark County, Nevada*. ARSN Report No. 4-19-1. Archaeological Research of Southern Nevada, North Las Vegas.

2008 The Las Vegas Wash Intaglio and Patayan/Yuman Occupation of the Las Vegas Valley. *Nevada Archaeologist* 23:1-16.

2012 Intaglios, Rock Alignments, and Trails. In *A Prehistoric Context for Southern Nevada*, edited by Heidi Roberts and Richard V. N. Ahlstrom, pp. 237–276. Archaeological Report No. 011-05. HRI Inc., Las Vegas.

Rafferty, Kevin, and Robert M. Leavitt
1990 *A Cultural Resource Inventory of a 19-Mile Long Gas Pipeline Right-of-Way in the Eldorado Valley, Clark County, Nevada*. Knight & Leavitt Associates, Las Vegas.

Raish, Carol
2013 Human Interactions with the Environment through Time in Southern Nevada. In *The Southern Nevada Agency Partnership Science and Research Synthesis: Science to Support Land Management in Southern Nevada*, edited by Jeanne C. Chambers, Matthew L. Brooks, Burton K. Pendleton, and Carol B. Raish, pp. 155–174. General Technical Report No. RMRS-GTR-303. U.S. Forest Service, Fort Collins, Colorado.

Rand McNally and Company
1889 *Enlarged Business Atlas and Shipper's Guide*. Rand McNally and Company, Chicago.

1911 *New Business Atlas of Nevada*. Rand McNally and Company, Chicago.

1924 *Commercial Atlas of America*. Rand McNally and Company, Chicago.

Ransome, Frederick Leslie
1907 *Preliminary Account of Goldfield, Bullfrog, and Other Mining Districts in Southern Nevada*. U.S. Geological Survey Bulletin No. 303. U.S. Government Printing Office, Washington D.C.

RECON
2000 Final Clark County Nevada Multiple Species Habitat Conservation Plan and Environmental Impact Statement for Issuance of a Permit to Allow Incidental Take of 79 Species in Clark County, Nevada September 2000. On file, RECON, San Diego.

Rector, Carol H.
1981 Rock Art of the East Mojave Desert. In *Background to Historic and Prehistoric Resources of the East Mojave Desert Region*, by Chester King and Dennis G. Casebier, pp. 236–259. U.S. Department of the Interior, Bureau of Land Management, Riverside, California.

Reinemann, Scott A., David F. Porinchu, Amy M. Bloom, Bryan G. Mark, and Jason E. Box
2009 A Multi-Proxy Paleolimnological Reconstruction of Holocene Climate Conditions in the Great Basin, United States. *Quaternary Research* 72:347–358.

Riddell, Harry S.
1951 The Archaeology of a Paiute Village Site in Owens Valley. *Reports of the University of California Archaeological Survey* 12:14–28.

Rigtrup, David E.
2013 NDOT Cultural Resource Narrative Report: A Cultural Resource Survey of a Culvert along SR 164 near Searchlight, Clark County, NV. NDOT Report No. CL13-005. Cultural Resources Section, Environmental Services Division, Nevada Department of Transportation, Carson City.

2016 A Negative Class III Inventory for the ITS Fast Package K1 Upgrade, US95 Milepost 0.0-55.1, Clark County, Nevada. NDOT Report No. CL15-53. Cultural Resources Section Environmental Services Division, Nevada Department of Transportation, Carson City.

Roberts, Heidi
2012a Post-Puebloan Period (A.D. 1300–1776). In *A Prehistoric Context for Southern Nevada*, edited by Heidi Roberts and Richard V. N. Ahlstrom, pp. 165–208. Archaeological Report No. 011-05. HRI Inc., Las Vegas.

2012b Literature Review. In *A Prehistoric Context for Southern Nevada*, edited by Heidi Roberts and Richard V. N. Ahlstrom, pp. 61–78. Archaeological Report No. 011-05. HRI Inc., Las Vegas.

Roberts, Heidi, and Richard V. N. Ahlstrom
2012 Introduction. In *A Prehistoric Context for Southern Nevada*, edited by Heidi Roberts and Richard V. N. Ahlstrom, pp. 1–10. Archaeological Report No. 011-05. HRI Inc., Las Vegas.

2016 Farmers on the Go: A Forager-Farmer Model for the Las Vegas Valley, Southern Nevada. In *Late Holocene Research on Foragers and Farmers in the Desert West*, edited by Barbara J. Roth and Maxine E. McBrinn, pp. 214–233. University of Utah Press, Salt Lake City.

Roberts, Heidi, and J. Jeffrey Flenniken
2008 New Methods of Analyzing Flaked Stone Quarries. *Nevada Archaeologist* 23:45–56.

Roberts, Heidi, Richard V. N. Ahlstrom, and Barbara J. Roth
2012 Prehistoric Research Themes for Southern Nevada. In *A Prehistoric Context for Southern Nevada*, edited by Heidi Roberts and Richard V. N. Ahlstrom, pp. 277–292. Archaeological Report No. 011-05. HRI Inc., Las Vegas,.

Robertson, Donald B.
1998 *Encyclopedia of Western Railroad History: Vol. 4. California*. Caxton Printers, Caldwell, Idaho.

Rogers, Malcolm J.
n.d. Field Notes on Mohave Desert (M) and Nevada (N). Malcolm J. Rogers Archival Collection, Boxes 3 and 4, Museum of Us, San Diego.

1929 *Report on an Archaeological Reconnaissance in the Mojave Sink Region*. Archaeological Papers No. 1(1). San Diego Museum of Man, San Diego.

1930 Report of Archaeological Investigations on the Mohave Desert Region during 1930. On file, Museum of Us, San Diego.

1936 *Yuman Pottery Making*. San Diego Museum Papers No. 2. San Diego.

1939 *Early Lithic Industries of the Lower Basin of the Colorado River and Adjacent Desert Areas*. Archaeological Papers No. 3 San Diego Museum of Man, San Diego.

1941 Aboriginal Culture Relations between Southern California and the Southwest. *The San Diego Museum Bulletin* 5(3):1–6.

1945 An Outline of Yuman Prehistory. *Southwestern Journal of Anthropology* 1(2):167–198.

1966 *Ancient Hunters of the Far West*, edited by Richard F. Pourade. The Union-Tribune Publishing Company, San Diego.

Rogge, A. E., Michael Corbett, and Lori Hunsaker
1997 *Cultural Resource Survey for the McCullough–Liberty Fiber Optics Project*. Intermountain Cultural Resource Services Research Paper No. 41. Dames & Moore, Las Vegas.

Rose, Suzan, Michael S. Kelley, Tracy Palluck, and Christopher Harper
2002 *Bighorn Cave and Yellow Pine Mining Company Railroad Siding, An Archaeological Data Recovery of Prehistoric Site 26CK4446 and Historic Site 26CK6105, Southern Clark County, Nevada*. BLM Report No. CR5-2448. URS Corp., Las Vegas.

Roth, Barbara J.
2012 Paleoindian and Archaic Periods. In *A Prehistoric Context for Southern Nevada*, edited by Heidi Roberts and Richard V. N. Ahlstrom, pp. 87–114. Archaeological Report No. 011-05. HRI Inc., Las Vegas.

Roth, George Edwin
1976 Incorporation and Changes in Ethnic Structure: The Chemehuevi Indians. Unpublished Ph.D. dissertation, Department of Anthropology, Northwestern University, Evanston, Illinois.

Rudy, Jack R.
1953 *An Archaeological Survey of Western Utah*. University of Utah Anthropological Papers No. 12. University of Utah Press, Salt Lake City.

Rush, F. Eugene, and Charels J. Huxel Jr.
1966 *Ground-Water Appraisal of the Eldorado-Piute Valley Area, Nevada and California*. Water Resources-Reconnaissance Series Report No. 36. State of Nevada Department of Conservation and Natural Resources, Carson City.

Sada, Donald W., Erica Fleishman, and Dennis D. Murphy
2005 Associations among Spring-Dependent Aquatic Assemblages and Environmental and Land Use Gradients in a Mojave Desert Mountain Range. *Diversity and Distributions* 11(1):91–99.

Samuelson, Dennis
1988 BLM Class III Cultural Resource Inventory Report: Inspection of Proposed Right-of-way in Piute Valley. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Sanchez-Barnett, Susan
2006 Chemehuevi. in *Encyclopedia of Immigration and Migration in the American West*, vol. 1, edited by Gordon Morris Bakken and Alexandra Kindell, pp. 129–133. Sage Publications, Thousand Oaks, California.

Sander, Jay K., Jessica J. Auck, David M. Smith, and Christopher E. Drover
2009 *A Class III Cultural Resources Inventory, Southern California Edition, Eldorado-Ivanpah Transmission Project, San Bernardino County, California and Clark County, Nevada*. Chambers Group, Inc., Redlands, California.

Sapir, Edward
1910 Song Recitative in Paiute Mythology. *Journal of American Folk-Lore* 23(90):455–472.

1912 The Mourning Ceremony of the Southern Paiutes. *American Anthropologist* 14(1):168–169.

1930 Texts of the Kaibab Paiutes and Uintah Utes. *Proceedings of the American Academy of Arts and Sciences* 65(2):297–535.

2010 Kaibab Paiute and Northern Ute Ethnographic Field Notes, edited by Catherine S. Fowler and Robert C. Euler. *In Southern Paiute and Ute Linguistics and Ethnography*, edited by William Bright, pp. 779–888. Edward Sapir, the Collected Works Vol. 10. De Gruyter Mouton, Berlin, Germany.

Sayles, E. B., and Ernst V. Antevs
1941 *The Cochise Culture*. Medallion Papers No. 29. Gila Pueblo, Globe, Arizona.

Schaafsma, Polly
1986 Rock Art. In *Great Basin*, edited by Warren L. D'Azevedo, pp. 215–226. Handbook of North American Indians, Vol. 11, William C. Sturtevant, general editor. Smithsonian Institution, Washington D.C.

Scharlotta, Ian
2010 Groundmass Microsampling Using Laser Ablation Time-of-Flight Inductively Coupled Plasma Mass Spectrometry (LA-TOF-ICP-MS): Potential for Rhyolite Provenance Research. *Journal of Archaeological Science* 37:1929–1941.

Schroeder, Albert H.
1952 A Brief Survey of the Lower Colorado River from Davis Dam to the International Border. On file, Bureau of Reclamation, Reproduction Unit, Region Three, Boulder City, Nevada.

1958 Lower Colorado Buff Ware: A Descriptive Revision. In *Pottery Types of the Southwest*, edited by Harold S. Colton, Ware 16. Ceramic Series No. 3D. Museum of Northern Arizona, Flagstaff.

1961 *The Archaeological Excavations at Willow Beach, Arizona, 1950*. University of Utah Anthropological Papers No. 50. University of Utah Press, Salt Lake City.

Schweigert, Kurt
2001 *Boulder City/U.S. 93 Corridor Study Historic Structures Survey*. Associated Cultural Resource Experts, Littleton, Colorado.

Seldomridge, Jeffry S.
1988 NDOT Cultural Resources Report: Three Proposed Material Pits along SR 163 West of Laughlin, Nevada, EA 71474-1. NDOT Report No. CL030-88P. Nevada Department of Transportation, Carson City.

Selman, W. Michael
1981 BLM Cultural Resources Report Field Worksheet: N5-81-1; Gambler's M/C Hare Scrambles Race. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Seymour, Gregory R., D. Craig Young, and Daron Duke
2006 *A Class III Cultural Resources Inventory of Wilderness Area Improvements in the McCullough and Wee Thump Joshua Tree Wilderness Areas, Clark County, Nevada*. Far Western Anthropological Research Group, Inc., Davis, California.

Shackley, M. Steven (editor)
1998 *Archaeological Obsidian Studies: Method and Theory*. Advances in Archaeological and Museum Science Vol. 3. Plenum Press, New York.

Shaul, David
1986 Linguistic Adaptation and the Great Basin. *American Antiquity* 51:415–416.

Sheppard, Paul R., Andrew C. Comrie, Gregory D. Packin, Kurt Angersbach, and Malcolm K. Hughes
2002 The Climate of the US Southwest. *Climate Research* 21:219–232.

Sherer, Lorraine Miller
1965 The Clan System of the Fort Mojave Indians. *Southern California Quarterly* 47(1):1–72.

1966 Great Chieftains of the Mohave Indians. *Southern California Quarterly* 48(1):1–35.

1967 The Name Mojave, Mohave: A History of Its Origin and Meaning. *Southern California Quarterly* 49(1):1–36.

Sherer, Lorraine M., and Frances Stillman
1994 *Bitterness Road: The Mojave, 1604-1860*. Ballena Press, Menlo Park, California.

Shirley, S.
2000 Intermountain Antiquities Computer System Forms for 26CK6179. On file, Nevada State Historic Preservation Office, Carson City.

Shreve, Forrest
1942 The Desert Vegetation of North America. *Botanical Review* 8(4):195–246.

Shutler, Richard, Jr.
1961 *Lost City: Pueblo Grande de Nevada*. Anthropological Papers No. 5. Nevada State Museum, Carson City.

Simpson, Ruth D.
1958 The Manix Lake Archaeological Survey. *The Masterkey* 32(1):4–10.

1961 *Coyote Gulch: Archaeological Investigations of an Early Lithic Locality in the Mojave Desert of San Bernardino County*. Archaeological Survey Association of Southern California Paper No. 5. Los Angeles.

Simpson, Ruth D., Leland W. Patterson, and Clay A. Singer
1986 Lithic Technology of the Calico Mountain Site, Southern California. In *New Evidence of the Pleistocene Peopling of the Americas*, edited by Alan L. Bryan, pp. 89–106. University of Maine, Orono.

Sitgreaves, Lorenzo
1853 *Report of an Expedition Down the Zuni and Colorado Rivers*. 32nd Congress, 2nd Session, Senate Executive Document No. 59. Robert Armstrong, Washington D.C.

Slaughter, Suzan F.
2006 *A Class III Cultural Resources Investigation of 18 Acres of Land for Eldorado Mining Company in Southern Clark County, Nevada*. HRC Report No. 5-189-1. Harry Reid Center for Environmental Studies, University of Nevada, Las Vegas.

Smith, Eugene, Denise Honn, and Racheal Johnsen
2010 Volcanoes of the McCullough Range, Southern Nevada. In *Miocene Tectonics of the Lake Mead Region, Central Basin and Range*, edited by Paul John Umhoefer, Sue Beard, and Melissa A. Lamb, pp. 203-219. Special Paper No. 463. Geological Society of America, Boulder.

Smith, Gerald Arthur
1966 *The Mohave Indians*. San Bernardino County Museum Association, Redlands, California.

Smith, Jedediah Strong
1918 [1827] Letter to General William Clark, Superintendent of Indian Affairs, July 17, 1827. In *The Ashley-Smith Explorations and the Discovery of a Central Route to the Pacific, 1822-1829*, edited by Harrison Clifford Dale, pp. 186–194. The Arthur H. Clark Company, Cleveland, Ohio.

Smith, Jedediah Strong
1977 *The Southwest Expeditions of Jedediah S. Smith: His Personal Account of the Journey to California, 1826-1827*, edited by George R. Brooks. The Arthur H. Clark Company, Glendale, California.

Smith, Stanley D., Russell K. Monson, and Jay E. Anderson
1997 *Physiological Ecology of North American Deserts*. Springer-Verlag, Berlin, Germany.

Snyder, John
2003 Nevada State Historic Preservation Office Historic Resource Inventory Form for Piute Wash Bridge (Bridge No. B-420). On file, Nevada State Historic Preservation Office, Carson City.

Sozzi, Peter, and Ralph Robinson
1979 BLM Cultural Resources Report Field Worksheet: NS-79-4, Gamblers' Hare Scrambles. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Spaulding, W. Geoffrey
1990 Vegetation Dynamics during the Last Deglaciation, Southeastern Great Basin, U.S.A. *Quaternary Research* 33:88–203.

1991 A Middle Holocene Vegetation Record from the Mojave Desert of North America and Its Paleoclimatic Significance. *Quaternary Research* 35:427–437.

Spaulding, W. Geoffrey, and Lisa J. Graumlich
1986 The Last Pluvial Climatic Episodes in the Deserts of Southwestern North America. *Nature* 320:441–444.

Spicer, Edward H.
1957 Worlds Apart: Cultural Differences in the Modern Southwest. *Arizona Quarterly* 13(3):197–203.

Spier, Leslie
1923 Southern Diegueño Customs. *University of California Publications in American Archaeology and Ethnology* 20:297–358.

1933 *Yuman Tribes of the Gila River*. University of Chicago Press, Chicago.

1936 *Cultural Relations of the Gila River and Lower Colorado Tribes*. Publications in Anthropology No. 3. Yale University Press, New Haven, Connecticut.

1953 Some Observations on Mohave Clans. *Southwestern Journal of Anthropology* 9:324–342.

1955 *Mohave Culture Items*. Bulletin No. 28. Museum of Northern Arizona, Flagstaff.

Spoon, Jeremy and Richard Arnold
2012 Collaborative Research and Co-Learning: Integrating Nuwuvi (Southern Paiute) Ecological Knowledge and Spirituality to Revitalize a Fragmented Land. *Journal for the Study of Religion, Nature and Culture* 6:477–500.

Spoon, Jeremy, Richard Arnold, Brian Lefler, and Christopher Milton
2015 Nuwuvi (Southern Paiute), Shifting Fire Regimes, and the Carpenter One Fire in the Spring Mountains National Recreation Area, Nevada. *Journal of Ethnobiology* 35(1):85–110.

Spoon, Jeremy, Richard Arnold, and the Nuwuvi Working Group
2011 *Nuwu Kanee, Nuwu Tooveenup (Our Home, Our Story): Nuwuvi (Southern Paiute) and the Spring Mountains*. The Mountain Institute and Portland State University, Portland, Oregon.

2012a *Our Gathering Place: Newe (Western Shoshone), Nuwuvi (Southern Paiute) and the Ash Meadows Landscape*. The Mountain Institute and Portland State University, Portland, Oregon.

2012b *Nuwu-Vots (Our Footprints): Nuwuvi (Southern Paiute) and the Pahranagat Valley*. The Mountain Institute and Portland State University, Portland, Oregon.

2014 *The Voices of the Rocks Sing Through Us: Nuwuvi (Southern Paiute) and Black Canyon*. The Mountain Institute and Portland State University, Portland, Oregon.

Sprengeler, Kari, and Shannon Goshen
2020 A Class III Cultural Resources Inventory of Material Source CL09-04, Clark County, Nevada. NDOT Report No. CL19-006P. Nevada Department of Transportation, Carson City.

Sprinkle, John H. Jr.
2007 "Of Exceptional Importance": The Origins of the "Fifty-Year Rule" in Historic Preservation. *The Public Historian* 29(2):81–103.

Stearns, Steven
2004 A Class III Cultural Resource Survey of US 93 South of Searchlight, Clark County, Nevada (Milepost US95-CL-13.00 to 14.00). NDOT Report No. CL004-005R. Nevada Department of Transportation, Carson City.

Stegner, Michelle L., and Russell Bevill
2012 *Class III Cultural Resources Inventory of the Searchlight Wind Energy Project, Clark County, Nevada*. URS Corporation, Portland, Oregon.

Steinberg, Clare
2014 Establishment of *Larrea tridentata* at the Northern Edge of the Modern Mojave Desert: Insights from *Neotoma* Paleomiddens. Unpublished Master's thesis, Department of Biology, University of New Mexico, Albuquerque.

Steinberg, Seth
1979 NDOT Cultural Resources Report: Material and Testing Searchlight Material Pits, EA 70971. NDOT Report No. 024-79P. Nevada State Highway Department, Carson City.

Steward, Julian D.
1929 *Petroglyphs of California and Adjoining States*. University of California Publications in American Archaeology and Ethnology 24(2). Berkeley.

Steward, Julian D.
1938 *Basin-Plateau Aboriginal Sociopolitical Groups*. Bureau of American Ethnology Bulletin No. 120. U.S. Government Printing Office, Washington D.C.

Stewart, Kenneth M.
1947a Mohave Hunting. *The Masterkey* 21(3):80–84.

1947b Mohave Warfare. *Southwestern Journal of Anthropology* 3:257–278.

1947c An Account of the Mohave Mourning Ceremony. *American Anthropologist* 49:146–148.

1956 Dreamers of the Mojave. *Desert Magazine* 19(11):11–12.

1957 Mohave Fishing. *The Masterkey* 31(6):198–203.

1965 Mohave Indian Gathering of Wild Plants. *The Kiva* 31(1):46–53.

1966a The Mohave Indians and the Fur Trappers. *Plateau* 39(2):73–79.

1966b The Mohave Indians in Hispanic Times. *The Kiva* 32(1):25–36.

1966c Mohave Indian Agriculture. *The Masterkey* 40(1):4–15.

1967 Chemehuevi Culture Changes. *Plateau* 15(1):14–21.

1968a Culinary Practices of the Mohave Indians. *El Palacio* 75(1):1–12.

1968b A Brief History of the Chemehuevi Indians. *The Kiva* 34(1):9–27.

1969a A Brief History of the Mohave Indians since 1850. *The Kiva* 34(4):219–236.

1969b The Aboriginal Territory of the Mohave Indians. *Ethnohistory* 16(3):257–276.

1969c Scalps and Scalpers in Mohave Indian Culture. *El Palacio* 76(2):25–30.

1973 Witchcraft among the Mohave Indians. *Ethnology* 12(3):315–324.

1974a Mortuary Practices of the Mohave Indians. *El Palacio* 75(10):2–12.

1974b Mojave Shamanistic Specialists. *The Masterkey* 48(1):4–13.

1977 Mojave Indian Ghosts and the Land of the Dead. *The Masterkey* 51(1):14–21.

1983 Mohave. In *Southwest*, edited by Alfonso Ortiz, pp. 55–72. Handbook of North American Indians, vol. 10, William C. Sturtevant, general editor. Smithsonian Institution, Washington D.C.

Stewart, Omer C.
1942 *Culture Element Distributions: XVIII, Ute-Southern Paiute*. Anthropological Records No. 6:4. University of California Press, Berkeley.

Stine, Scott
1994 Extreme and Persistent Drought in California and Patagonia during Medieval Time. *Nature* 369:546–549.

Stoffle, Richard W., and Henry F. Dobyns
1983 Nuvagantu*: Nevada Indians Comment on the Intermountain Power Project*. Cultural Resource Series No. 7. Bureau of Land Management, Nevada State Office, Reno.

Stoffle, Richard W., and Maria Nieves Zedeño
2001a Historical Memory and Ethnographic Perspectives on the Southern Paiute Homeland. *Journal of California and Great Basin Anthropology* 23:229–248.

2001b American Indian Worldviews I: The Concept of "Power" and Its Connection to People, Places, and Resources. In *American Indians and the Nevada Test Site: A Model of Research and Consultation*, edited by Richard W. Stoffle, María Nieves Zedeño, and David B. Halmo, pp. 58–76. U.S. Department of Commerce, National Technical Information Service, Springfield, Virginia.

Stoffle, Richard W., Alex K. Carroll, Amy Eisenberg, and John Amato
2004 *Ethnographic Assessment of Kaibab Paiute Cultural Resources in Grand Staircase- Escalante National Monument, Utah*. Bureau of Applied Research in Anthropology, University of Arizona, Tucson.

Stoffle, Richard W., Fletcher P. Chmara-Huff, Kathleen A. Van Vlakc, and Rebecca S. Toupal
2004 *Puha Flows from It: The Cultural Landscape of the Spring Mountains*. Bureau of Applied Research in Anthropology, University of Arizona, Tucson.

Stoffle, Richard W., David B. Halmo, and Diane E. Austin
1997 Cultural Landscapes and Traditional Cultural Properties: A Southern Paiute View of the Grand Canyon and Colorado River. *American Indian Quarterly* 21:229–249.

Stoffle, Richard W., David B. Halmo, Michael J. Evans, and Diane E. Austin
1994 Piapaxa 'Uipi *(Big River Canyon). Southern Paiute Ethnographic Resource Inventory and Assessment for Colorado River Corridor, Glen Canyon National Recreation Area, Utah and Arizona, and Grand Canyon National Park, Arizona*. Bureau of Applied Research in Anthropology, University of Arizona, Tucson.

Stoffle, Richard W., D. Halmo, M. Evans, and J. Olmsted
1990 Calculating the Cultural Significance of American Indian Plants: Paiute and Shoshone Ethnobotany at Yucca Mountain, Nevada. *American Anthropologist* 92:416–432.

Stoffle, Richard W., Lawrence Loendorf, Diane E. Austin, David B. Halmo, and Angelita Bulletts
2000 Ghost Dancing the Grand Canyon: Southern Paiute Rock Art, Ceremony, and Cultural Landscapes. *Current Anthropology* 41:11–38.

Stoffle, Richard W., Fabio Pittaluga, Tray G. Earnest, Amy Eisenberg, John Amato, and Genevieve Dewey-Hefley
1998 Pah hu wichi *(From Big Spring Running Down): Big Spring Ethnographic Assessment, US 95 Corridor Study*. Bureau of Applied Research in Anthropology, University of Arizona, Tucson.

Stoffle, Richard, Kathleen Van Vlack, Richard Arnold, and Gloria Bulletts Benson
2017 Cant of Reconquest and the Struggle for Restoring Sustainability of the Southern Paiutes. In *Going Beyond*, edited by Marie-Theres Albert, Francesco Bandarin, and Ana Pereira Roder, pp. 231–246. Perceptions of Sustainability in Heritage Studies No. 2. Springer, New York.

Stoffle, Richard W., Kathleen Van Vlack, Alex K. Carroll, Fletcher Chmaraa-Huff, and Aja Martinez
2005 Yanawant: *Paiute Places and Landscapes in the Arizona Strip. The Arizona Strip Landscapes and Place Name Study*, vol. 1. Bureau of Applied Research in Anthropology, University of Arizona, Tucson.

Stoffle, Richard W., María Nieves Zedeno, and David B. Halmo (editors)
2001 *American Indians and the Nevada Test Site: A Model of Research and Consultation*. U.S. Department of Energy, Nevada Operations Office. U.S. Government Printing Office, Washington D.C.

Stokes, Wendy L, Matthew T. Seddon, Heather K. Stettler, Kendanne M. Altizer, Jacob Foss, and Nicole Burnitt
2006 *A Cultural Resources Inventory of the Las Vegas Valley District Searchlight Groundwater Exploratory Wells Project and Additional Areas, Clark County, Nevada*. Cultural Resources Report No. 2006-190. SWCA Environmental Consultants, Salt Lake City.

Stone, Connie L.
2006 Far from the River: Relating Mohave Oral History to Prehistoric Use of the Western Arizona Desert. In *Beginnings: Proceedings of the 2005 Three Corners Conference*, edited by Mark C. Slaughter, Gregory R. Seymour, and Laureen M. Perry, pp. 263–273. Three Corners Conference, Boulder City, Nevada.

Storbo, Russel
1981 BLM Cultural Resource Inventory Record for 26CK3509. On file, Nevada State Historic Preservation Office, Carson City.

Stratton, Royal B.
1857 *Captivity of the Oatman Girls: Being an Interesting Narrative of Life among the Apache and Mohave Indians*. Whitton, Towne & Company's Excelsior Steam Power Presses, San Francisco.

Stringfellow, Kim
2021 The Mojave Project. Electronic document, https://mojaveproject.org, accessed March 2022.

Stuart, Bradley R.
1945 Southern Paiute Staff of Life. *The Masterkey* 19(4):133–144.

Suagee, Dean B., and Peter Bungard
2013 Taking Care of Native American Cultural Landscapes. *Natural Resources & Environment* 27(4):1–5.

Sullivan, Maurice
1992 *The Travels of Jedediah Smith: A Documentary Outline, including His Journal*. University of Nebraska Press, Lincoln. Originally published 1934, Fine Arts Press, Santa Clara, California.

Sutton, Mark Q.
1996 The Current Status of Archaeological Research in the Mojave Desert. *Journal of California and Great Basin Anthropology* 18:221–257.

2016 Evolving Patterns of Villages in the Southwestern Mojave Desert, California. In *Late Holocene Research on Foragers and Farmers in the Desert West*, edited by Barbara J. Roth and Maxine E. McBrinn, pp. 265–284. University of Utah Press, Salt Lake City.

2017 Chasing Ghosts? Rethinking the Prehistory of the Late Holocene Mojave Desert. *Pacific Coast Archaeological Society Quarterly* 53(1):1–78.

Sutton, Mark Q., and David D. Earle
2017 The Desert Serrano of the Mojave River. *Pacific Coast Archaeological Society Quarterly* 53(2–3):1–61.

Talieje, Paul
1984 Wikahme'. In *Spirit Mountain: An Anthology of Yuman Story and Song*, edited by Leanne Hinton and Lucille J. Watahomigie, pp. 15–41. Sun Tracks Vol. 10. University of Arizona Press, Tucson.

Taylor, Edith, and William Wallace
1947 *Mohave Tattooing and Face-Painting*. Leaflet No. 20. Southwest Museum, Los Angeles.

Theissen Kevin M., Thomas A. Hickson, Ashley L. Brundrett, Sarah E. Horns, and Matthew S. Lachniet
2019 A Record of Mid- and Late Holocene Paleohydroclimate from Lower Pahranagat Lake, Southern Great Basin. *Quaternary Research* 92:352–364.

Thibodeau, Alyson M., David J. Killick, Saul L. Hedquist, John T. Chesley, and Joaquin Ruiz
2015 Isotopic Evidence for the Provenance of Turquoise in the Southwestern United States. *Geological Society of America Bulletin* 127(11–12):1617–1631.

Thomas, Tiffany Ann
2011 A Landscape Approach to Late Prehistoric Settlement and Subsistence Patterns in the Mojave Sink. Unpublished Master's thesis, Department of Anthropology, University of Nevada, Las Vegas.

Thompson, David G.
1921 *Routes to Desert Watering Places in the Mohave Desert Region, California*. U.S. Geological Society Water-Supply Paper No. 490-B. U.S. Government Printing Office, Washington D.C.

Thompson, Robert S.
1992 Late Quaternary Environments in Ruby Valley, Nevada. *Quaternary Research* 37:1–15.

Thompson, Robert S., and Katherine H. Anderson
2000 Biomes of Western North America at 18,000, 6000, and 0 ^{14}C yr BP Reconstructed from Pollen and Packrat Midden Data. *Journal of Biogeography* 27: 555–584.

Thomsen, Greg
1978a BLM Cultural Resources Report Field Worksheet: N5-78-27; Southern Nevada Jackrabbits Hare Scrambles. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1978b BLM Cultural Resources Report Field Worksheet: Project N5-78-9, WRA Shamrock 350 Buggy Race. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District Las Vegas.

Tingley, Joseph V.
1998 *Mining Districts of Nevada*. 2nd edition. Nevada Bureau of Mines and Geology Report No. 47. Mackay School of Mines, University of Nevada, Reno.

Torgler, Kim J.
1995 Continuous Artifact Tradition from the Middle Archaic to the Historical Present: Analyses of Lithics and Pottery from Selected Sites in Southeast Idaho. *Tebiwa* 25:80–107.

Trafzer, Clifford E.
2012 Historic Property Inventory of Traditional Cultural Properties: Quechan Indian Tribe of the Fort Yuma Indian Reservation Cultural Ethnography of Lands on the Yuma Proving Ground. On file, Cultural Committee Office, Fort Yuma Quechan Tribe, Winterhaven, California.

2015 *A Chemehuevi Song: The Resilience of a Southern Paiute Tribe*. University of Washington Press, Seattle.

Trafzer, Clifford, Luke Madrigal, and Anthony Madrigal
1997 *Chemehuevi People of the Coachella Valley*. Chemehuevi Press of the Twenty-Nine Palms Tribe, Coachella, California.

Trippel, Eugene J.
1889 The Yuma Indians-II. *The Overland Monthly* (Second Series) 14(79):1–11.

Turner, T. Hal
1977 NDOT Cultural Resources Report: US 95 Searchlight, EA 70745, RF-006-1(31). NDOT Report No. 144-80P. Nevada Department of Highways, Las Vegas District, Las Vegas.

United Nations
2020 *Basic Texts of the 2003 Convention for the Safeguarding of the Intangible Cultural Heritage, 2020 Edition*. Living Heritage Entity, Culture Sector, UNESCO, Paris, France.

U.S. Geological Survey [USGS]
1912 *Ivanpah Quadrangle, California-Nevada*. 1:250,000. U.S. Geological Survey, Reston, Virginia.

2018-2019 *National Hydrography Dataset (ver. USGS National Hydrography Dataset Plus High Resolution [NHDPlus HR] for r-digit Hydrological Units 1501, 1503, 1606, 1809, 1810)*. Electronic document, https://www.usgs.gov/core-science-systems/ngp/national-hydrography/access-national-hydrography-products, accessed October 2, 2021.

Van Dyke, Dix
1927 A Modern Interpretation of the Garces Route. *Historical Society of Southern California Quarterly* 13:353–359.

Van Valkenburgh, Richard F.
1976 Chemehuevi Notes. In *Paiute Indians II*, edited by David A. Horr, pp. 225–253. Garland Publishing, New York.

Van Vlack, Kathleen A.
2012a Puaxant Tuvip: Powerlands Southern Paiute Cultural Landscapes and Pilgrimage Trails. Unpublished Ph.D. dissertation, Department of Anthropology, University of Arizona, Tucson.

2012b Southern Paiute Pilgrimage and Relationship Formation. *Ethnology* 51(2):129–140.

Vanderburg, William O.
1937 *Reconnaissance of Mining Districts in Clark County, Nevada*. Information Circular No. 6964. U.S. Department of the Interior, Bureau of Mines, Washington D.C.

Vicari, Mary Ann, and Victor Villagran
2018 *Cultural Resources Indirect Effects Assessment for the Crescent Peak Wind Project, Clark County, Nevada*. Cultural Resources Report No. 18-739. SWCA Environmental Consultants, Las Vegas.

Vicari, Mary Ann, Diane L. Winslow, Victor Villagran, and Jennifer Durk
2020 *Class III Cultural Resources Inventory for Southern California Edison's Eldorado-Pisgah-Lugo 220-kV Transmission Line Project, Clark County, Nevada*. Cultural Resources Report No. 20-493. SWCA Environmental Consultants, Las Vegas.

Vicari, Mary Ann, Ashlee Younie, Sean McMurry, Victor Villagran, Katie Martin, and Sara Rickett
2018 *Class III Cultural Resources Inventory for the Crescent Peak Wind Project, Clark County, Nevada*. Cultural Resources Report No. 18-578. SWCA Environmental Consultants, Las Vegas.

Von Till Warren, Elizabeth, and Ralph J. Roske
1981 *Cultural Resources of the California Desert, 1776-1980: Historic Trails and Wagon Roads*. U.S. Department of the Interior, Bureau of Land Management, California Desert Office, Riverside.

Von Werlhof, Jay
1987 *Spirits of the Earth: A Study of Earthen Art in the North American Deserts: Vol. I. The North Desert*. Imperial Valley College Museum Society, El Centro, California.

Vredenburgh, Larry M.
1995 The East Mojave Desert: A Brief Summary of the History of Mining, 1863-1947. *San Bernardino County Museum Association Quarterly* 42(3):83–84.

Walker, Barry Alan Jr.
2006 Geology and Geochronology of the Spirit Mountain Batholith, Southern Nevada: Implications for Timescales and Physical Processes of Batholith Construction. Unpublished Master's thesis, Department of Earth and Environmental Sciences, Vanderbilt University, Nashville, Tennessee.

Wallace, William J.
1947a The Girls' Puberty Rite of the Mohave. *Proceedings of the Indiana Academy of Science* 57:37–40.

1947b The Dream in Mohave Life. *Journal of American Folk-lore* 60(237):252–258.

1948 Infancy and Childhood among the Mohave Indians. *Primitive Man* 21:19–38.

1953 Tobacco and Its Use among the Mohave Indians. *The Masterkey* 27(6):193–202.

1955 Mohave Fishing Equipment and Methods. *Anthropological Quarterly* 28(2):87–94.

1962 Prehistoric Cultural Development in the Southern California Deserts. *American Antiquity* 28:172–180.

Walloff, Kurt
1974 *Nevada State Highway Project: Archaeological Survey from Caliente to Elgin, Lincoln County, Nevada*. Report No. 1-3-1. Nevada Archaeological Survey, Southern Branch, University of Nevada, Las Vegas.

Warren, Claude N.
1984 The Desert Region. In *California Archaeology*, by Michael J. Moratto, pp. 339–430. Academic Press, Orlando, Florida.

Warren, Claude N., and Robert H. Crabtree
1986 Prehistory of the Southwestern Area. In *Great Basin*, edited by Warren L. D'Azevedo, pp. 183–193. Handbook of North American Indians, Vol. 11, William C. Sturtevant, general editor. Smithsonian Institution, Washington D.C.

Warren, Claude N., Martha Knack, and Elizabeth von Till Warren
1980 *A Cultural Resource Overview for the Amargosa-Mojave Basin Planning Units*. U.S. Department of the Interior, Bureau of Land Management, Desert Planning Area, Riverside, California.

Waterman, Thomas
1909 Analysis of the Mission Indian Creation Story. *American Anthropologist* 11:41–55.

1910 The Religious Practices of the Diegueño Indians. *University of California Publications in American Archaeology and Ethnology* 8(6):271–358.

Waters, Michael R.
1982 The Lowland Patayan Ceramic Tradition. In *Hohokam and Patayan: Prehistory of Southwestern Arizona*, edited by Randall H. McGuire and Michael B. Schiffer, pp. 275–297. Academic Press, New York.

1998 The Sulphur Spring Stage of the Cochise Culture and Its Place in Southwestern Prehistory. *Kiva* 64:115–135.

Weaver, Richard A.
1982 The 1776 Route of Father Francisco Garcés into the San Bernardino Valley, California: A Reevaluation of the Evidence and Its Implications. *Journal of California and Great Basin Anthropology* 4:142–147.

Wedding, Jeffrey R., Alex L. Heindl, and David C. Smee
2012 An Archaeologist's Field Guide for Identifying World War II and Cold War Era Military Food Cans. *Nevada Archaeologist* 25:77–85.

Wendel, Kendra Lesley
2014 Lifeblood of the Earth: Nuwuvi (Southern Paiute) Hydrological Knowledge and Perceptions of Restoration in Two Southern Nevada Protected Areas. Unpublished Master's thesis, Department of Anthropology, Portland State University, Portland, Oregon.

Wescott, Konnie L., and R. Joe Brandon (editors)
2000 *Practical Applications of GIS for Archaeologists: A Predictive Modeling Toolkit*. Taylor and Francis, Philadelphia.

West, Neil E., Robin J. Tausch, K. H. Rea, and Paul T. Tueller
1978 Taxonomic Determination, Distribution, and Ecological Indicator Values of Sagebrush within the Pinyon-Juniper Woodlands of the Great Basin. *Journal of Range Management* 31(2):87–92.

Whipple, Amiel Weeks (compiler)
1856 *Report of Explorations and Surveys, to Ascertain the Most Practicable and Economical Route for a Railroad from the Mississippi River to the Pacific Ocean*, vol. 3. House of Representatives Executive Document No. 91. A. O. P. Nicolson, Washington D.C.

White, William G.
2000 Intermountain Antiquities Computer System Form for 26CK5969 through 26CK5971. On file, Nevada State Historic Preservation Office, Carson City.

2006 Intermountain Antiquities Computer System Form for 26CK5250 (update). On file, Nevada State Historic Preservation Office, Carson City.

White, William G., Teresita Majewski, and Manuel R. Palacios-Fest
2008 *Adits, Shafts, and Glory Holes: An Inventory and Evaluation of 380 Hazardous Mine Features in the Alunite, Charleston, Crescent, Eldorado, Goodsprings, and Searchlight Mining Districts, Clark County, Nevada*. Technical Report No. 07-20. Statistical Research, Inc., Tucson.

Whitesides, Scott M., Kendanne M. Altizer, Kristopher L. Boatman, Valerie Mazzaglia, and Nicole Barger
2008 *A Cultural Resources Inventory of the Searchlight Water Systems Improvement Project and Additional Areas, Clark County, Nevada*. Cultural Resources Report No. 2008-160. SWCA Environmental Consultants, Salt Lake City.

Whitley, David S.
1992 Shamanism and Rock Art in Far Western North America. *Cambridge Archaeological Journal* 2:89–113.

1994a Shamanism, Natural Modeling and the Rock Art of Far Western North American Hunter Gatherers. In *Shamanism and Rock Art in North America*, edited by Solveig A. Turpin, pp. 1–43. Special Publication No. 1. The Rock Art Foundation, San Antonio, Texas.

1994b By the Hunter, for the Gatherer: Art, Social Relations and Subsistence Change in the Prehistoric Great Basin. *World Archaeology* 25:356–373.

1994c Ethnography and Rock Art in the Far West: Some Archeological Implications. In *New Light on Old Art: Recent Advances in Hunter-Gatherer Rock Art Research*, edited by David Whitley and Lawrence Loendorf, pp. 81–94. Institute of Archeology, University of California, Los Angeles.

1998 Meaning and Metaphor in the Coso Petroglyphs: Understanding Great Basin Rock Art. In *Coso Rock Art: A New Perspective*, edited by Elva Younkin, pp. 109–174. Maturango Press, Ridgecrest, California.

2000 *The Art of the Shaman: Rock Art of California*. University of Utah Press, Salt Lake City.

2014 Jay von Werlhof's Trail of Dreams. *Pacific Coast Archaeological Society Quarterly* 50(3–4):47–60.

Wigand, Peter E., and David Rhode
2002 Great Basin Vegetation History and Aquatic Systems: The Last 150,000 Years. In *Great Basin Aquatic Systems History*, edited by Robert Hershler, David B. Madsen, and Donald R. Currey, pp. 309–367. Contributions to the Earth Sciences No. 33. Smithsonian Institution Press, Washington D.C.

Wigand, Peter E., Martha L. Hemphill, Saxon E. Sharpe, and Sikha Patra
1995 Great Basin Woodland Dynamics during the Holocene. In *Proceedings of the Workshop-Climate Change in the Four Corners and Adjacent Regions: Implications for Environmental Restoration and Land-Use Planning, CONF-9409325*, edited by W. Joseph Waugh, pp. 51–69. U.S. Department of Energy, Grand Junction, Colorado.

Wilke, Philip
1987 Intermountain Antiquities Computer System Form for 26CK3850. On file, Nevada State Historic Preservation Office, Carson City.

1988 Intermountain Antiquities Computer System Form for 26CK3849. On file, Nevada State Historic Preservation Office, Carson City.

Wilke, Philip
1992 *Archaeological Survey of Proposed Minerals-Prospecting Areas Northeast of the Castle Mountains, Clark County, Nevada*. UCRARU No. 1189. Archaeological Research Unit, University of California, Riverside.

Wilke, Philip J., and Daniel F. McCarthy
1987 *Archaeological Assessment of the Castle Mountain Venture, San Bernardino County, California: Data Recovery/Resource Protection Plan for Historic and Aboriginal Archaeological Sites* (2 vols.). UCRARU No. 871. Archaeological Research Unit, University of California, Riverside.

Wilke, Philip J., and Adella B. Schroth
1988 *Archaeological Assessment of the Castle Mountain Project, San Bernardino County, California, and Clark County, Nevada: Data Recovery/Resource Protection Plan for Historic and Aboriginal Archaeological Sites* (2 vols.). UCRARU No. 931. Archaeological Research Unit, University of California, Riverside.

Williams, Joseph O. I.
1975a BLM Cultural Resource Report: Ten-Mile Well Re-development, BLM No. NV-0597. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1975b BLM Cultural Resources Report: Project N-5675, B. L. Tanner, Mining Claim Occupancy Act Application. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1975c BLM Cultural Resource Report: Cultural Resources Investigation for the Proposed Cheaters Hare Scrambles Motorcycle Race in Paiute Valley, Nevada, Scheduled for April 20, 1985 (SLUP N5-75-24). U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1975d BLM Cultural Resource Report: Cultural Resources Investigation for the Proposed S.N.O.R.E., Midnight Special Off-road Vehicle Act, June 21, 1975, near Searchlight, Nevada. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1977 BLM Cultural Resources Report Field Worksheet: MRAN European Scrambles Motorcycle Course N5-77-19. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Willig, Judith A., and C. Melvin Aikens
1988 The Clovis-Archaic Interface in Far Western North America. In *Early Human Occupation in Far Western North America: The Clovis-Archaic Interface*, edited by Judith A. Willig, C. Melvin Aikens, and John L. Fagan, pp. 1–40. Anthropological Papers No. 21. Nevada State Museum, Carson City.

Winslow, Diane L.
2017 *Class III Cultural Resources Inventory for the Lugo-Victorville 500kV Transmission Line Special Protection Scheme Project, Clark County, Nevada*. ASM Project No. 25700.1. ASM Affiliates, Las Vegas.

Winslow, Diane L., and Julie E. Kramer
2019 *Class III Cultural Resources Inventory for the Eldorado-Lugo-Mohave Series Capacitor Project, Clark County, Nevada*. ASM Affiliates, Las Vegas, Nevada.

Wissler, Clark
1914 Material Cultures of the North American Indians. *American Anthropologist* 16:447–505.

Wolf, David
1978a BLM Cultural Resources Report Field Worksheet: Groundshakers Motorcycle Race. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1978b BLM Cultural Resources Report Field Worksheet: NS-78-11, Southern Nevada Jackrabbits. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Wollan, Katie, Sara Lardinois, and Dewey Livingston
2008 National Register of Historic Places Nomination Form for Walking Box Ranch. National Park Service, U.S. Department of the Interior, Washington D.C.

Wood, Raymund F.
2000 Francisco Garcés in the Mojave Desert, 1776. *The Branding Iron* 221:1, 3–8.

Woodward, Arthur
1953 Irataba, Chief of the Mohaves. *Plateau* 25(3):3–68.

1955 *Feud on the Colorado*. Westernlore Press, Los Angeles.

Wright, Aaron M.
2014 *Religion on the Rocks: Hohokam Rock Art, Ritual Practice, and Social Transformation*. University of Utah Press, Salt Lake City.

2020 Stucco as a Timestamp on Lowland Patayan Pottery in the Far-Western Southwest. *Kiva* 86:448–481.

2021 Lowland Patayan Pottery: A History, Crisis, and Manifesto. *California Archaeology* 13(1):1–35.

Wright, Aaron M., Lorey Cachora, and Nathalie O. Brusgaard
2022 An Ecology of the Patayn/Yuman Dreamland. In *Sacred Southwestern Landscapes: Archaeologies of Religious Ecology*, edited by Aaron M. Wright. University of Utah Press, Salt Lake City. Under review.

Wright, Barton Allen
1954 Excavations of Catclaw Cave, Lower Colorado River. Unpublished Master's thesis, Department of Anthropology, University of Arizona, Tucson.

Wriston, Teresa
2009 The Middle Holocene Period and Great Basin Archaeology: Past Ideas, Current Trends, and Future Research. In *Past, Present and Future Issues in Great Basin Archaeology: Papers in Honor of Don D. Fowler*, edited by Bryan Hockett, pp. 218–239. Cultural Resource Series No. 20. Bureau of Land Management, Nevada State Office, Elko.

Yoder, David T.
2017 Interpreting the 50-Year Rule. *Advances in Archaeological Practice* 2:324–337.

Yoder, David, and Chris Brosman
2007 Addenda for Site Nos. 26CK121, 26CK1343, 26CK3635, 26CK3644, 26CK4807. On file, Nevada State Historic Preservation Office, Carson City.

Yohe, Robert M. II
1998 The Introduction of the Bow and Arrow and Lithic Resource Use at Rose Spring (CA-INY-372). *Journal of California and Great Basin Anthropology* 20(1):26–52.

Yohe, Robert M. II., and Alan P. Garfinkel
2012 Great Basin Bighorn Ceremonialism: Reflections on a Possible Sheep Shrine at the Rose Spring Site (CA-INY-372), Rose Valley, Alta California. *California Archaeology* 4:201–224.

Young, Bertrand T.
1989 *Cultural Resource Inventory of Viceroy Gold Corporation's Castle Mountain Project Access Road, Clark County, Nevada*. ARS Report No. 576. Archaeological Research Services, Inc., Virginia City, Nevada.

1990 *Archaeological Inventory of the Nevada Portion of the Wyoming-California Pipeline Company's Proposed Piute Lateral in Clark County, Nevada*. ARS Report No. 582. Archaeological Research Services, Inc., Virginia City, Nevada.

Young, D. Craig
2009 Different Beginnings: A Great Basin View of the Younger-Dryas and the Pleistocene-Holocene Transition. In *Past, Present and Future Issues in Great Basin Archaeology: Papers in Honor of Don D. Fowler*, edited by Bryan Hockett, pp. 205–217. Cultural Resource Series No. 20. Bureau of Land Management, Nevada State Office, Elko.

Young, David A., and Robert L. Bettinger
1992 The Numic Spread: A Computer Simulation. *American Antiquity* 57: 5-98.

Young, James A, and B. Abbot Sparks
2002 *Cattle in the Cold Desert*. Expanded edition. University of Nevada Press, Reno.

Young, Nicolás E., Avriel D. Schweinsberg, Jason P. Brinerand, and Joerg M. Schaefer
2015 Glacier Maxima in Baffin Bay during the Medieval Warm Period Coeval with Norse Settlement. *Science Advances* 1:e1500806.

Zale, Thomas F.
1984 BLM Cultural Resource Inventory Report 5-1407(N), Whiskey Pete's World Championship II, Loop I (California Portion). U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1985a BLM Class III Cultural Resource Inventory Report: NV-056-85-01P; a Mining Plan of Operations for Wrethel Spendlove Involving the Construction of a Millsite and the Creation of a Pit Mine. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1985b BLM Cultural Resources Report Format/Field Worksheet: N-41257; a Right-of-way for the Construction of Communication Facilities to Include a Small Building and a Radio Tower. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1985c BLM Cultural Resources Report Format/Field Worksheet: N-30015 Amendment; a Right-of-way for the Construction of Communication Facilities to Include a sSmall Building and a Radio Tower. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

1985d BLM Cultural Resources Report Format/Field Worksheet: N-41367; a Right-of-way for the Construction of Communication Facilities to Include a Small Building and a Radio Tower. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Zale, Thomas L., and B. Kershaw
1986 BLM Class III Cultural Resource Inventory Report: Mining Plan of Operations (NV-056-85-01P) to Conduct Exploration and Milling Operations. U.S. Department of the Interior, Bureau of Land Management, Las Vegas District, Las Vegas.

Zárate Salmerón, Gerónimo de
1916 [1626] Journey of Oñate to California by Land. In *Spanish Exploration in the Southwest, 1542-1706*, compiled, edited, and translated by Herbert Eugene Bolton, pp. 268–280. Charles Scribner's Sons, New York. Originally published 1856 as Relaciones de Todas las Cosas en el Nuevo Mexico se han Visto, y Sabrido assi por Mar como por Tierra desde el Año de1538 hasta el de 1626. Documentos para la historia de Mexico 3(3):44–57. Vincent García Torres, Mexico.

Zeanah, David W., Eric E. Ingbar, Robert G. Elstyon, and Charles D. Zeier
2004 *Archaeological Predictive Model, Management Plan, and Treatment Plans for Northern Railroad Valley, Nevada*. Cultural Resource Series No. 15. U.S. Department of the Interior, Bureau of Land Management, Nevada State Office, Reno.

EIR APPENDIX 7

Geotechnical Feasibility Report (Call and Nicholas 2020)

CASTLE MOUNTAIN

GEOTECHNICAL FEASIBILITY REPORT

Prepared for

EQUINOX GOLD CORP.

By

Call & Nicholas, Inc.

April 2020

CALL & NICHOLAS, INC.

REVISION HISTORY

Revision	Date	Description
00	April 2020	Initial release.
01	February 2022	Revised issue with PE stamp.

Professional Certification

Call & Nicholas, Inc. (CNI) is pleased to present this geotechnical study to Equinox Gold Corp (EQX). This study was conducted in accordance with a proposal submitted by CNI to EQX on 01 November 2019 and reviewed by Mr. Scott Cylwik, a California registered Professional Engineer. This study builds upon the 2017 *Pre-feasibility Slope Stability Report for the Castle Mountain Reserve Pits* report by CNI and presents slope angle recommendations based on the known and provided data at the time of this report. As more information becomes available and pit designs change, the recommended and achievable slope angles may need to be updated to reflect the conditions.

Thank you for the opportunity and we look forward to assisting you in the future.

Sincerely,
Call & Nicholas, Inc.

Scott Cylwik, California P.E. 85060
Senior Engineer

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY 1–1

1.1 RECOMMENDED INTERRAMP SLOPE ANGLES FOR THE CASTLE MOUNTAIN PITS 1–1

1.2 BASIS FOR RECOMMENDATIONS 1–3

1.3 RECOMMENDED FUTURE WORK 1–4

2.0 INTRODUCTION 2-1

3.0 ENGINEERING GEOLOGY 3-1

3.1 GEOLOGIC STRUCTURE 3-2

3.2 FAULTS IDENTIFIED AT THE CASTLE MOUNTAIN MINING PROPERTY 3-3

3.3 ROCK FABRIC – CELL MAPPING 3-4

3.4 ROCK FABRIC – TELEVIEWER DATA 3-4

3.4.1 Geomechanical Logging 3-5

4.0 LABORATORY TESTING AND ROCK-MASS STRENGTHS 4-1

4.1 SPATIAL ROCK QUALITY 4-2

4.2 FRACTURE SHEAR STRENGTH 4-3

4.3 WEAK CLAY-ALTERED MATERIAL STRENGTH 4-4

4.3.1 Remolded Direct Shear Tests on Clay Samples 4-4

4.3.2 Back-Analyzed Clay Strengths 4-5

4.4 INTACT ROCK STRENGTH TESTING 4-7

4.4.1 Intact Shear Strength Based on Uniaxial Compressive Strength and Tensile Strength 4-7

4.5 ROCK-MASS STRENGTHS 4-8

4.5.1 CNI Rock-Mass Strength Estimation Method 4-9

4.5.2 Comparison of CNI and Hoek-Brown Rock-Mass Strength Estimation Methods 4-10

5.0 BENCH DESIGN 5-1

5.1 EXAMPLE OF ESTIMATING BENCH FACE ANGLE IN SW WALL OF CASTLE MOUNTAIN PITS 5-2

5.2 CATCH-BENCH WIDTH 5-3

5.3 CATCH-BENCH DESIGN 5-4

6.0 OVERALL SLOPE ANALYSIS 6-1

6.1 MODEL INPUT PARAMETERS 6-1

6.1.1 Geology Model 6-1

6.1.2 Material Properties 6-2

6.1.3 Hydrogeology 6-2

6.2 RESULTS 6-2

6.2.1 Section 1 6-3

6.2.2 Section 2 6-3

6.2.3 Section 3 6-4

6.2.4 Section 4 6-4
6.2.5 Section 5 6-4
6.2.6 Section 6 6-5
6.2.7 Section 7 6-5
6.2.8 Section 8 6-5
6.2.9 Section 9 6-6
6.2.10 Section 10 6-6
6.2.11 Section 11 6-6
6.2.12 Section 12 6-6
6.2.13 Section 13 6-7
6.2.14 Section 14 6-7
6.2.15 Section 15 6-7

7.0 BLASTING OPERATIONS 7-1
7.1 PRODUCTION BLASTING 7-1
7.2 CONTROLLED BLASTING 7-1
7.2.1 Initial Pre-Split Blasting Recommendation 7-2
7.2.2 Initial Buffer Blasting Recommendation 7-3
7.2.3 Controlled Blast Audits 7-5

Appendices

Appendix A RQD Block Model Release Notes
Appendix B 1993 and 2017 CNI Cell Mapping
Appendix C 2019 Televiewer Data
Appendix D 2019 Geomechanical Data
Appendix E Rock Strength Data
Appendix F X-Ray Diffraction Results
Appendix G Modeled Bench Face Angle Curves

LIST OF TABLES

Table 1-1 Generic Recommended Interramp Slope Angles

Table 1-2 Domain-Specific Recommended Interramp Slope Angles

Table 1-3 Bench Design Parameters

Table 3-1 Average RQD and GSI Values by Rock Type

Table 4-1 Laboratory Testing Manifest

Table 4-2 30th Percentile RQD Values at Different Distances from Major Faults

Table 4-3 Fracture Shear Strengths

Table 4-4 Remolded Clay Direct Shear Strengths

Table 4-5 Intact Strength Summary

Table 4-6 Rock-Mass Strength Estimates

Table 5-1 Bench Scale Analysis Results

Table 6-1 Overall Stability Analyses Results

LIST OF FIGURES

Figure 1-1	Recommended Domain Boundaries on 2019 Preliminary Pit Design
Figure 3-1	Exposed Geology on 2019 Preliminary Pit Design
Figure 3-2	Fault Data from Capps 1991 and CNI 1993/2017
Figure 3-3	Exposed Faults on 2019 Preliminary Pit Design
Figure 3-4	Cell Mapping Data from 2017 and 1993
Figure 3-5	2017 and 1993 Cell Mapping Locations
Figure 3-6	20200203 Design Drill Holes Map
Figure 3-7	GT-001
Figure 3-8	GT-002
Figure 3-9	GT-003
Figure 3-10	GT-004
Figure 3-11	All Joints
Figure 3-12	All Faults
Figure 3-13	Andesite Structures
Figure 3-14	Autoclastic Structures
Figure 3-15	Epiclastic Structures
Figure 3-16	Rhyolite Structures
Figure 3-17	Volcaniclastic Structures
Figure 3-18	Downhole Plots of RQD and GSI
Figure 3-19	Down Hole Bar Charts of Core Quality
Figure 3-20	Cumulative Frequency RQD Plots for Each Formation
Figure 4-1	Epiclastic and Andesite Drillhole RQD Distribution
Figure 4-2	Volcaniclastic and Rhyolite Drillhole RQD Distribution
Figure 4-3	Relationship between Friction Angle and Cohesion of Clay Materials
Figure 4-4	Empirical Correlations to GSI
Figure 4-5	Rock-Mass Strength Comparison for Moderate Andesite
Figure 5-1	Number of Spaces of Control Joint Broken to Achieve the Measured Bench Face Angle as a Function of the Average Control Joint Spacing
Figure 5-2	Log-Log Plot of Number of Control Joint Spaces Broken to Achieve the Measured Bench Face Angle as a Function of the Average Control Joint Spacing

LIST OF FIGURES (Continued)

Figure 5-3 Log-Log Plot of Number of Control Joint Spaces Broken to Achieve the Measured Bench Face Angle as a Function of the Average Spacing x Length x the Angle to the Strike of the Bench Face

Figure 5-4 Definition of Back Break

Figure 5-5 Blast Damage Comparison between Pre-Split Perimeter and Trim Row Perimeter Blasting

Figure 5-6 Blast Damage Curve for the South and Southwest Walls Measured in the JSLA and OBHT Pits

Figure 5-7 Modeled Bench Face Angle Distributions for Southwest Slope with a Slope Direction of 45 Degrees

Figure 5-8 80-Percent Reliability Bench Face Angles as a Function of Slope Dip Direction

Figure 5-9 Example Bench Face Angle Distribution with 80-Percent Reliability

Figure 6-1 Slope Stability Cross Sections on 2019 Preliminary Pit Design

Figure 6-2 Geologic Section 1 (Looking North) Designed Pit

Figure 6-3 Geologic Section 1 (Looking NE) Optimized Pit

Figure 6-4 Geologic Section 2 (Looking NE) Designed Pit

Figure 6-5 Geologic Section 2 (Looking NE) Optimized Pit

Figure 6-6 Geologic Section 3 (Looking NE) Designed Pit

Figure 6-7 Geologic Section 3 (Looking NE) Optimized Pit

Figure 6-8 Geologic Section 4 (Looking NW) Designed Pit

Figure 6-9 Geologic Section 4 (Looking NW) Optimized Pit

Figure 6-10 Geologic Section 5 (Looking South) Designed Pit

Figure 6-11 Geologic Section 5 (Looking South) Optimized Pit

Figure 6-12 Geologic Section 6 (Looking SE) Designed Pit

Figure 6-13 Geologic Section 6 (Looking SE) Optimized Pit

Figure 6-14 Geologic Section 7 (Looking NW) Designed Pit

Figure 6-15 Geologic Section 7 (Looking NW) Optimized Pit

Figure 6-16 Geologic Section 8 (Looking NE) Designed Pit

Figure 6-17 Geologic Section 8 (Looking NE) Optimized Pit

Figure 6-18 Geologic Section 9 (Looking South) Designed Pit

Figure 6-19 Geologic Section 9 (Looking South) Optimized Pit

Figure 6-20 Geologic Section 10 (Looking SW) Designed Pit

LIST OF FIGURES (Continued)

Figure 6-21 Geologic Section 10 (Looking SW) Optimized Pit

Figure 6-22 Geologic Section 11 (Looking East) Designed Pit

Figure 6-23 Geologic Section 11 (Looking East) Optimized Pit

Figure 6-24 Geologic Section 12 (Looking North) Designed Pit

Figure 6-25 Geologic Section 13 (Looking South) Designed Pit

Figure 6-26 Geologic Section 13 (Looking South) Optimized Pit

Figure 6-27 Geologic Section 14 (Looking NE) Designed Pit

Figure 6-28 Geologic Section 14 (Looking NE) Optimized Pit

Figure 6-29 Geologic Section 15 (Looking NE) Designed Pit

Figure 6-30 Geologic Section 15 (Looking NE) Optimized Pit

Figure 7-1 Differential Tonnage Between 40- and 45- degree Interamp Slope Angles and Cost of Pre-splitting as a Function of Interramp Slope Height

Figure 7-2 Preliminary Pre-Split and Butter Blast Layout - 52° ISA

Figure 7-3 Benefit of Pre-Split Blasting at a Mine in Chile with a Good Quality Rock Mass

1.0 EXECUTIVE SUMMARY

As requested by Equinox Gold Corp. (EQX), Call & Nicholas, Inc. (CNI) performed a slope stability study for the Castle Mountain project based on preliminary pit designs provided by John Nilsson. The purpose of this study was primarily to update recommended design interramp slope angles and bench design parameters based on new laboratory testing, new geomechanical drilling information, and an updated geologic model.

Overall analytical stability analyses were conducted on key areas of the preliminary pits with updated rock-mass strengths. The rock-mass strengths were derived from the new laboratory testing and applied to zones of similar geology. An updated 3D geologic model was provided by EQX geologists. A rock quality block model using the rock quality designation parameter (RQD) was generated by CNI as part of this study. The model release notes are attached as *Appendix A - RQD Block Model Release Notes*.

1.1 Recommended Interramp Slope Angles for the Castle Mountain Pits

Figure 1-1 shows the locations of the recommended domain boundaries with interramp slope angles (ISA). Table 1-1 reports the recommended interramp slope angles resulting from the analyses listed above.

Table 1-1. Generic Recommended Interramp Slope Angles

Domain	ISA (deg)			
	Rhyolite	Volcaniclastic	Epiclastic	Andesite
ISA_GENERIC_SD	51	50	50	48
ISA_GENERIC_WEST	51	50	50	48
ISA_GENERIC_EAST	52	52	52	52

Zones around key fault geometries were identified as having potentially weak altered rock. Many of the instabilities that occurred in the Oro Belle and JSLA pits were attributed to this weak altered material and the unfavorable geometry in relation to the pit walls. Table 1-2 shows the recommended interramp slope angles for the zones around the major faults. The "ISA_ISLAND" domain is a special case where there is an intersection of multiple faults and associated highly altered zones. An overall slope stability model indicates that this area is unstable and will require remediation if left in the design. With the proposed design that was analyzed, removing the material above the 4040 elevation would be sufficient.

Table 1-2. Domain-Specific Recommended Interramp Slope Angles

Domain	ISA (deg)	Perpendicular Range
ISA_DILLON_FAULT	40	±100ft
ISA_MCLANE_FAULT	40	±200ft
ISA_MAVERICK_WEST_FAULT	46	±200ft
ISA_PREDATOR_FAULT	46	±200ft
ISA_ISLAND	Complete Removal	

The catch bench design criteria are presented in Table 1-3. The analytical results from the catch bench analyses have not been updated since the 2017 report but catch bench designs have been updated to reflect the updated ISA recommendations. The catch bench designs summarized in Table 1-3 assume high quality controlled blasting practices with single pass pre-split blasting over the entire triple bench height of 60 feet. If the as-mined catch benches do not consistently achieve the required 27-foot width (after blasting, excavation, and scaling), then either blasting and mining practices should to be improved or the ISA would need to be reduced. The as-mined bench geometries should be verified with either optical scans or drone scans to verify bench performance.

Table 1-3. Bench Design Parameters

Domain	ISA (deg)	Geology	Design BFA (deg)	Design Bench Height (ft)	Design Bench Width (ft)
ISA_GENERIC_EAST	52	All	79	60	35
ISA_GENERIC_WEST ISA_GENERIC_SD	51	Rhyolite	74	60	31
	50	Volcaniclastic Epiclastic	74	60	33
	48	Andesite	74	60	37
ISA_DILLON_FAULT ISA_MCLANE_FAULT	40	All	60	60	37
ISA_MAVERICK_WEST_FAULT ISA_PREDATOR_FAULT	46	All	65	60	30

In addition to the recommended interramp slope angles, a crest offset of 300 feet is recommended for infrastructure that will be constructed on the western side of the South Extension pit. Stability analyses indicate that the location and orientation of the Maverick fault could potentially lead to instability within 300 feet of the crest. This recommendation is based

on adding an anisotropy equal to the properties of the fault applied throughout the rock mass. If the fault is accurately modeled and does not deviate significantly from its modeled location, the slope is stable with current estimations. By allowing the fault to "move" throughout the rock mass, a safe distance behind the crest can be estimated where the modeled slip surface has a factor of safety (FOS) of at least 1.2.

1.2 Basis for Recommendations

Slope angles are recommended based on a combination of overall, interramp, and bench-scale stability concerns. Each component requires specific data that is refined and optimized as the project matures. As part of the prefeasibility study conducted in 2017, the interramp and bench-scale stability models were run with an adequate data set, but rock-mass strengths and the spatial application of the strengths was poorly defined for the overall stability analyses. This study focuses on further characterization of the rock mass and overall stability concerns.

Additionally, the overall stability analyses performed to complete this study assumed dry conditions and dewatering the slopes is critical to achieve the recommended angles.

1.3 Controlled Blasting on Final Wall

The recommended slope angles assume that controlled blasting will be performed, in particular on the final walls of the design. If controlled blasting is not performed, the recommendations will need to be updated to account for increased blast damage of the bench faces. Controlled blasting techniques include utilizing trim shots, buffer rows, pre-split blasting, always blasting to a free face, and not drop cutting next to the final wall. In addition to constructing clean, well-cut bench faces, the reliability of catch benches can be improved by ensuring the toes of each mining increment are cleaned before proceeding with the next increment. Leaving material that can be easily cleaned is not good practice because it reduces the capacity of the bench to catch falling rock and also interferes with the drill's ability to reach the toe of the current bench on the second double-bench increment. Drilling the final row of holes against the bench face to the full triple-bench height of 60 feet improves the reliability of the benches by increasing achieved bench-face angles

1.4 Uncertainty Regarding Clay Zones

Many of the previous slope instabilities that have occurred at Castle Mountain were

attributed to weak clay altered material combined with an unfavorable geometry in relation to the pit walls. Zones around key fault geometries were identified as having potentially weak altered rock in this study. However, current drilling coverage is relatively poor within the final walls of the proposed design. Therefore, some instability should be expected if unanticipated clay zones are intercepted. This risk can be remediated and reduced by drilling geotechnical core holes on 500-foot centers throughout the final walls of the proposed mine design.

1.5 Recommended Future Work

1. Slope design is an iterative process; optimum slope design requires continuous effort to collect, interpret, and analyze geologic and geotechnical data as they become available. When the mine plan with ramps is completed, a second series of overall analyses should be undertaken to optimize interramp slope angles. Updated mine designs should be reviewed and evaluated for geotechnical design compliance and, if necessary, slope stability before they are implemented.
2. Groundwater conditions are an important component for slope stability analyses. For the overall analysis performed herein, CNI assumed depressurized conditions. CNI recommends having a complete hydrological study completed that defines and models the regional in situ groundwater conditions. If pore pressures are anticipated within the final pit walls, the overall stability analyses will need to be updated with that information. Additionally, potential dewatering measures must be developed should it be necessary to lower water pressures to improve stability.
3. Optical drone scans of the constructed bench-face angles should be performed routinely to evaluate catch-bench width performance. These surveys utilize scans of as-mined bench faces to evaluate the success rate of achieving the designed bench and interramp geometries; it is important to collect scan data for all wall orientations. These data should be collected in all active mining areas and are used to calibrate bench-scale slope analysis and further refine the slope design template.
4. Reduction of triaxial tests yielded unrealistic intact rock strengths and a correlation between uniaxial and disk tension were used. Additional triaxial testing on all major rock units is recommended to further characterize the intact strength of materials.
5. CNI recommends starting a robust slope monitoring program to capture long-term trends of potential slope deformation. Installing optical prisms on benches as mining progresses is a best practice to maintain monitoring as benches may become inaccessible in the future.
6. CNI also recommends that intermediate and minor faults and intense clay altered zones should be modeled with up-to-date geologic bench maps. This mapping and modeling are continuous processes and key to mitigation of unstable areas and to provide input to design changes to maximize ore recovery in every design phase.
7. All core drilling should be geomechanically logged to update the geotechnical block models of rock quality, clay alteration, and rock hardness within each of the defined

geologic units. Drillholes located near and behind the final pit wall are critical for characterizing the rock mass.

8. Vibrating wire piezometers should be installed in stacked profiles in several holes in various locations of the mine to determine pore pressure gradients and how mining impacts the gradients over time. This will provide needed data for coupled geotechnical and hydrogeologic models to determine if groundwater will have an impact on the overall stability of the pits. This is especially true in the South Extension area where previous studies indicate a water table may exist at the 3900-foot elevation.

2.0 INTRODUCTION

At the request of Mr. Travis O'Farrell of Equinox Gold Corp. (EQX), Call & Nicholas, Inc. (CNI) conducted a slope stability analysis for the Castle Mountain Project, located in California, approximately 15 miles southwest of Searchlight, Nevada. The purpose of this study was to provide slope angles for a feasibility level study based on available data. Preliminary pit designs provided by John Nilsson on February 3, 2020 were used as for the basis of the study.

Data available for this study included the following:

1. CNI conducted field mapping to identify and measure geologic structural trends in the rock fabric and collected clay samples for laboratory testing as part of the 2017 prefeasibility study.
2. The rock fabric data collected in 2017 was combined with data originally collected by CNI in 1993 for the JSLA pit slope study. This data was used to analyze the bench-scale stability. Bench design recommendations for this study were based on these previous studies.
3. The major structure data used included Capps 1991 mapping in the JSLA pit. The major structure data was digitized and used to estimate the fault length, spacing, and orientation statistics for use in the interramp stability analysis in the 2017 prefeasibility study.
4. Clay strengths were estimated for use in the overall stability analysis based on laboratory samples collected from the field mapping and back-analyses from three previous failures that occurred at the property.
5. An RQD block model was created based on the available geomechanical drill data and was used to study the spatial relationship of rock quality.
6. Geomechanical measurements and laboratory samples were collected from four geotechnical drill holes. Data were logged and collected by CNI personnel.
7. Small scale direct shear, uniaxial compressive strength, triaxial compressive strength, and disk tension laboratory tests were conducted on samples obtained as part of the geotechnical drilling campaign.

2.1 Personnel

Mr. Ross Barkley, Vice President, is responsible for the technical direction and review of all project work. Mr. Scott Cylwik, Senior Engineer (California P.E. #85060), reviewed the work in February 2022 to confirm that the methods and practices meet California standards.

Various CNI engineers and geologists participated in data collection and analytical work. Mr. Sean DeBruin collected cell mapping data and materials to be tested in the laboratory. Mr. Daniel Childs collected cell mapping data, materials for laboratory testing, estimated rock mass

strengths, and ran 2D limit equilibrium models on the provided pit geometry. Mr. Ross Barkley ran the bench-scale stability analysis and oversaw all technical work.

3.0 ENGINEERING GEOLOGY

This geology summary is a brief compilation of work performed by previous owners of the property and their consulting geologists, including reports published by Capps and Moore (1991, 1994, and 1997); and Linder (1989). In particular, the rock types, alteration types, and structural patterns are important to the analysis of the stability of mined rock slopes.

Rocks that will be exposed in the slopes of the Castle Mountain project pits were deposited during a period of intense volcanism starting in the Miocene (18.5 Ma). This period of volcanism lasted roughly 5 million years and finished with the deposition of the Piute Range volcanics at 13.5 Ma. The sequence of rocks that will be exposed in the proposed pits is referred to as the Castle Mountains Volcanic (CMV) sequence. This sequence includes the Jacks Well volcanics (trachyandesite and basalt, 18.5 to 15.2 Ma), the Linder Peak volcanics (rhyolite flow domes and tuffs, 15 Ma), and the Hart Peak (rhyolite plugs, flows and trachydacite intrusions, 15 to 14 Ma). The updated geologic model provided by EQX is exposed on the preliminary pit designs and presented in Figure 3-1.

The alteration is described as typical of high-level epithermal systems. Ore mineralization is associated with silicification grading outward to argillic, propylitic, and unaltered rock. Of particular importance is the distribution of the argillic alteration zones. Samples of intensely clay altered rocks were collected from the west wall of the Oro Belle Pit and indicate that the major clay is a mixed layer illite and smectite. Multiple bench failures that occurred during mining in the 1990s and early 2000s in the Jumbo North and Oro Belle pits were related to significant volumes of this weak material. The upper east wall of the Oro Belle pit experienced a roughly 200-kiloton failure in clay altered agglomerate-lapilli-tuff. The wall was originally excavated at a 52-degree interramp slope angle that failed at an overall wall height of 260 feet. The wall was remediated to a stable configuration at a 33-degree interramp slope angle.

Another failure related to weak clay altered material occurred on the northwest wall of the Jumbo North pit. This failure was associated with a northeast striking, steeply SE dipping fault that acted as a backplane release to the failure. The weak clay-altered rock mass between the toe of the slope at the 4000-foot elevation and the fault backplane was not strong enough to overcome the driving forces of the 220-foot high slope that was excavated at a 53-degree angle.

Non-daylighted wedge failures also occurred in the east wall of the Jumbo North pit. Again, a weak clay altered material constituted the rock mass between the non-daylighted wedge release and the toe of the slope. The rock mass was not strong enough to withstand the driving forces of the 59-degree interramp angle for the 240-foot high slope.

Because all the failures experienced within the Castle Mountain pits have been associated with the weak clay altered materials, the location of these units is of paramount importance for slope stability. Working with EQX geologists, the current understanding is that the weak clay altered materials are in close vicinity of major mapped faults. Drillhole data indicate that there are other areas with the weak clay altered material not associated with the major mapped faults, but there is not a current model indicating where these units exist. Bench mapping will be key in identifying the extent of these clay bodies in the early phases of mining, and whether they are important in the overall stability of the designs.

3.1 Geologic Structure

Geologic structure, including faults, joints, bedding, and lithologic contacts, are weaknesses within the rock that must be identified and analyzed to design appropriate pit slope angles. These structures impact the rock-mass strength, provide major boundary releases to daylighted and non-daylighted failures, and impact the bench face angles that can be excavated.

In strong rock that is not adversely impacted by major fault releases, achievable interramp slope angles are limited by the bench face angles that can be achieved. The bench face angle, the bench height, and the designed bench width to provide adequate rock fall protection define the interramp slope angle. Controlled blasting in the zone near the designed bench face will serve to limit damage to the rock mass and provide the steep bench faces required to achieve the recommended interramp slope angles.

Structural domains that contain intermediate to long faults that strike and dip adversely to the designed pit walls impact the interramp slope angles that can be achieved. When long members of these faults are undercut by interramp slopes, plane shear or wedge failures occur. These structures are identified and analyzed statistically to estimate the volume of interramp slope failures in defined pit sectors for various interramp slope angles.

Non-daylighted faults provide releases and boundaries to failures where weak rock mass between the toe of the slope and the release structures is not strong enough to support the stresses in the toe of the slope.

3.2 Faults Identified at the Castle Mountain Mining Property

The main fault orientation mapped within the Castle Mountain Mining property is a NNE to NE striking dipping steeply to the SE. A few faults dip antithetically to the NW. Faults within this major system are sinuous and form "Y" shaped intersections with other faults of similar strike. Taylor (2015) reported that the fault pattern is typical of regional extension or collapsing of a caldera as the magma was evacuated from the magma chamber due to the intense volcanic activity. Evidence of the collapsing caldera included observations that faults in the lower strata of the caldera volcanics cannot be traced into upper units, indicating that faulting was contemporaneous with the period of volcanic activity associated with that phase of the volcanic cycle.

Figure 3-2 shows an equal area Schmidt plot of the fault structures greater than 60 feet long mapped by Capps in 1991 in the JSLA pit, and by CNI from cell mapping conducted in the JSLA pit in 1993 and in the Oro Belle pit in 2017. As shown, the main fault set dips greater than 60 degrees to the SE. The mean orientation of this fault set is expressed as a dip direction of 117 degrees and a dip of 75 degrees. This trend is also representative of the following geologic features: dominant joint orientation, alignment of rhyolite domes, trend of mineralization, and trend of major paleo-channels.

A few EW striking to WNW steeply dipping faults were mapped in the Miocene volcanic rocks. This structural trend has been reported as a major fabric in the Proterozoic basement rocks and is thought to have been reactivated during the regional extension associated with the Miocene volcanics.

EQX geologists have mapped the major faults throughout the project and Figure 3-3 shows the mapped faults draped on the preliminary pit design. Downhole drill data indicate that there are some intensely altered intervals that do not correspond to the major mapped faults. EQX geologists indicate that the lesser faulting has not been mapped.

3.3 Rock Fabric – Cell Mapping

Minor discontinuities such as rock joints are termed rock fabric. Because of the highly variable nature of the length, spacing, and orientations of these discontinuities, statistical methods are used to characterize these parameters for the dominant joint sets. Rock fabric, including joints, bedding, and foliation, impact the bench face angles that can be achieved. The statistics for these structures are defined using a mapping method developed by CNI known as cell mapping.

Figure 3-4 shows a lower hemisphere plot of the joint and bedding joint mapped during the 1993 and 2017 cell mapping campaigns at the Castle Mountain property. Figure 3-5 shows the location of the cells mapped by CNI during these two campaigns. As shown in Figures 3-2 and 3-4, the dominant north to northeast striking joint set orientation matches the dominant fault set orientation. The WNW steeply dipping joint matches the Proterozoic fault set mentioned in the previous section of this report. The cell mapping data collected as part of the 1993 and 2017 cell mapping campaign is reported in *Appendix B - 1993 and 2017 CNI Cell Mapping*.

The major bedding orientation of tuffaceous strata dips to the WNW. Taylor (2015) reported that this bedding dip indicates that the strata were rotated to the west as fault bounded grabens formed during the collapse of the caldera. Some minor bedding dips to the SSE and SSW were mapped and may be related to local rotations bounded by smaller fault bounded grabens.

3.4 Rock Fabric – Televiewer Data

Acoustic televiewer surveys can be used to obtain rock fabric information from boreholes where no surface exposure exists. CNI logged and analyzed four televiewer survey holes at Castle Mountain drilled specifically for the designed expansion phases: GT-001, GT-002, GT-003, and GT-004 (Figure 3-6). The locations, depths, and orientations of these drill holes were chosen to optimize coverage with respect to the final design, as well as to avoid any ‘blind zones’ that can occur when a drill hole does not intersect certain geologic features due to their orientations relative to the drill hole. Structures measured in the televiewer surveys are presented as stereonets by core hole in Figures 3-7 to 3-10, in all of the merged joints in Figure 3-11, in all of the merged faults in Figure 3-12, and by rock type in Figures 3-13 to 3-17. The

televiewer data collected during this core logging campaign is reported in *Appendix C - 2019 Televiewer Data*.

Analysis of the televiewer data for the four core holes reveals the following:

1. The dominant joint set centers around an average dip direction (DDR) of 104° and dip of 79°. Rhyolite and Epiclastic rocks exhibit the strongest representation of this set.
2. The dominant fault set is similar to the dominant joint set with an average DDR of 111° and dip of 84°, including opposite-dipping faults with an average DDR of 289° and dip of 88°. Another strong set with slightly lower dips has an average DDR of 136° and dip of 65°.
3. Low angle joints are most pronounced in Andesite with an average DDR of 132° and dip of 16°, Epiclastic rocks with a DDR of 76° and a dip of 25°, Rhyolite with a DDR of 274° and dip of 27°, and Volcaniclastics with dips ranging from 3° to 30°, and sets with average DDRs at 50°, 160°, and 260°.

3.4.1 Geomechanical Logging

Core logging of the four drillholes consisted of collecting detailed geomechanical data for each drill hole. Geomechanical data is measured directly on the core to determine mechanical properties of the rock, including degree of fracturing, hardness, recovery, and other parameters. The logged geomechanical data parameters included:

1. Drill interval (from and to depths)
2. Length of core recovered
3. Rock quality and fracture frequency
    a. Length of longest core piece
    b. Total length of core pieces greater than or equal to 0.4 foot (2 times the core diameter = rock quality designation [RQD])
    c. Total length of core pieces greater than or equal to 1.0 and 1.5 feet
    d. Number and length of whole pieces
    e. Total length of broken core
    f. Total length of rubble
    g. Average hardness
    h. Total length of core with a hardness less than or equal to R2
    i. Number of joint sets (Jn)
    j. Joint roughness (Jr), and alteration (Jn)

The RQD data are used in estimating the rock-mass shear strengths for analyzing interramp and overall slope stability. RQD, along with the joint properties data (Jr and Ja), may also be used to estimate the Geological Strength Index (GSI) for each drill interval, which is a method of estimating rock-mass strength and is commonly used when communicating rock-mass strengths in regards to slopes (Hoek, et al., 2013):

$$GSI = 52 * \frac{\frac{J_r}{J_a}}{1 + \frac{J_r}{J_a}} + \frac{RQD}{2}$$

The geomechanical data collected during this core logging campaign is reported in *Appendix D - 2019 Geomechanical Data*. Downhole plots of RQD and GSI for each core hole are presented in Figure 3-18, along with down hole bar charts of core quality in Figure 3-19. Cumulative frequency RQD plots for each formation are shown in Figure 3-20. The average RQD and GSI for each formation within the core holes are shown in Table 3-1.

Table 3-1. Average RQD and GSI Values by Rock Type

Rock Type	Average RQD	Average GSI
Andesite	64.5%	54.7
Autoclastic	26.4%	34.4
Epiclastic	46.9%	43.1
Rhyolite Apheric	43.3%	45.7
Rhyolite Porphyritic	29.6%	36.6
Volcaniclastic	35.3%	35.8

Geomechanical logging of the core from all four holes reveals the following:

1. Andesite consistently has the highest RQD and GSI values, with an overall average of 64.5% RQD and GSI of 54.7 (Andesite was not encountered in core hole GT-003).
2. Epiclastic rocks have an average RQD of 46.9% and GSI of 43.1, though the average is much lower in GT-002 (24.1% RQD and 27.6 GSI) than in GT-001 (57.5% RQD and GSI of 52.5) and GT-003 (54.5% RQD and GSI of 45.2) (Figure 3-18).
3. Volcaniclastics have an average RQD of 35.3% and GSI of 35.8, though significant variation exists between core holes. For example, GT-001 has an average Volcaniclastic RQD of 22.5% and GSI of 27.8, while GT-002 has an average Volcaniclastic RQD of 46.4% and GSI of 42.8 (Figure 3-18).
4. Rhyolite is partitioned into the apheric and porphyritic varieties, with the apheric rhyolite showing higher average RQD and GSI values at 43.4% and 45.7, and the porphyritic rhyolite showing average RQD and GSI values of 29.6% and 36.6.

5. Autoclastic rocks represent a relatively small portion of the analyzed core, though they may prove to be a significant geotechnical rock type because of their low average RQD of 26.5% and GSI of 34.4.

4.0 LABORATORY TESTING AND ROCK-MASS STRENGTHS

The purpose of geotechnical laboratory testing is to determine intact rock and fracture-shear strengths, which are used to estimate rock-mass strengths used for the overall slope analyses. Rock-mass quality and structural anisotropies are used along with the laboratory strength testing to estimate the strength of the rock mass. To estimate rock-mass strengths, the intact and fracture shear strength data for the various rock types are determined, and the rock-mass strengths are calculated based on rock quality zones distinguished first by rock and alteration type, and then by statistically similar RQD values for the stability sections analyzed. All data used in the rock strength estimates are presented in *Appendix E - Rock Strength Data*.

Building upon the prefeasibility report completed in 2017, a full suite of laboratory tests was completed on the major rock units found within the project. A manifest of the completed laboratory tests is provided in Table 4-1.

Table 4-1. Laboratory Testing Manifest

Geology	Uniaxial	Triaxial	Brazilian	SSDS
Volcaniclastic	3	3	3	0
Epiclastic	3	4	3	3
Rhyolite	9	10	9	8
Andesite	6	7	6	3

Small Scale Direct Shear (SSDS) samples of the volcaniclastic unit were difficult to collect due to the degraded nature of the material, and clean fractures were non-existent in the recovered core.

The CNI method to estimate rock-mass strengths uses the intact strength and the direct shear strength of the fractures to estimate the rock-mass shear strength. This method is explained in Section 4.5 “Rock-Mass Strengths.” The Hoek-Brown method for determining the rock-mass shear strength uses a rock-mass classification system and estimated intact triaxial shear strength parameters to estimate the rock-mass shear strength.

The multi-bench failures that occurred in mining the Jumbo North and the Oro Belle pits were related to weak clay altered rock and faults that acted as a back-plane weakness. Additional samples of the weak clay altered material were collected and tested to add to the database of clay strengths.

4.1 Spatial Rock Quality

Attempts were made to spatially characterize the rock quality designation (RQD) within each of the geologic units (Rhyolite, Volcaniclastic, Epiclastic, and Andesite), but no substantial correlations could be made. Within each geologic unit, data were filtered to within 100, 200, and 500 feet of the major faults to see if the RQD changed or if any trends could be found. Using the 30th percentile value of the available RQD data in each spatial bin, the Epiclastic and Andesite units were found to be within 5% RQD of their overall dataset, as reported in Table 4-2. Based on engineering judgement, the 30th percentile RQD value of 37% was used to calculate rock-mass strengths for the Epiclastic and Andesite units, irrespective of location. The RQD data for the Epiclastic and Andesite units appear to be normally distributed and are presented in Figure 4-1.

Using the 30th percentile RQD value for each spatial bin described above, the Rhyolite and Volcaniclastic units had slightly greater than a 10% difference in RQD compared to the overall dataset as reported in Table 4-2. The Rhyolite trends to higher RQD data the further the measurements get from the faults, but the Volcaniclastic trends to lower RQD values the further the measurements are from the faults. Tabulated data showing the 30th percentile RQD values at different distances from major faults are presented in Table 4-2.

Table 4-2. 30th Percentile RQD Values at Different Distances from Major Faults

Distance (ft)	Rhyolite	Volcaniclastic	Epiclastic	Andesite
100	11.0	32.9	35.8	41.1
200	17.1	26.4	38.2	37.0
500	19.0	24.2	37.8	35.0
All	24.8	22.0	37.0	37.0
Max Difference	*13.8*	*10.9*	*1.2*	*4.1*

Due to the discrepancy of data for the Rhyolite and Volcaniclastic units, a different approach was taken to estimate rock quality for these units. A histogram of the available RQD show that the data appear to be more uniform in the RQD range from 0 to 60%, and tapers off at RQD values greater than 60% data, which then tapers off at the higher RQD values. The histogram showing this relationship is presented in Figure 4-2. A 30% RQD value was used to estimate the rock-mass strengths for the Volcaniclastic and Rhyolite units. The 30% RQD value

is the average RQD found within the uniform portion of the distribution for both the Volcaniclastic and Rhyolite units.

4.2 Fracture Shear Strength

Slope displacements in open-pit mines typically occur along pre-existing geological discontinuities (natural fractures and faults), and at times through a combination of these structures and the rock mass. Consequently, determination of the shear strength of these joints and faults is an important input into the assessment of structural failures in the bench and interramp scale analyses. Additionally, the discontinuity strengths may be important to determine the strength of a defined anisotropy in the rock mass, or as a discrete back plane release that combines with a potential failure through the rock mass at the toe of the slope. The direct-shear test is used for measuring the shear strength along discontinuities. The test consists of applying a normal load to the discontinuity, which separates two blocks of rock. A shear load is then applied to displace the blocks relative to one another.

Table 4-3 reports the fracture shear strength used for the various rock strength categories defined at Castle Mountain. These strengths range from clay fillings to clean fractures and probably are slightly conservative for the stronger rocks. Because no fracture samples of the Volcaniclastic unit could be collected from the 2019 geotechnical drilling campaign, the Epiclastic friction angle and cohesion were used as a substitute for the analyses.

Table 4-3. Fracture Shear Strengths

Lithology	Friction Angle (deg)	Cohesion (psi)
Andesite	22.8	7.6
Rhyolite	31.6	11.2
Epiclastic	24.2	15.0

The following equation defines the linear shear-strength:

$$\tau = \sigma_n(\tan\phi) + C$$

where:

τ = Shear Stress
σ_n = Normal Stress
ϕ = Friction Angle
C = Cohesion

4.3 Weak Clay-Altered Material Strength

As identified in the 2017 geotechnical prefeasibility study, there is a weak clay-altered material that is associated with most of the instabilities that occurred during the previous mining. These weak clay-altered units are generally found in proximity with the major faults identified by EQX geologists, as well as other minor faults that have been intersected with geotechnical drilling. The minor faults are not extensively modeled and therefore cannot be considered in geotechnical analysis at this time.

Laboratory tests were conducted on clay-altered material collected during the 2019 geotechnical drilling campaign. The samples exhibited a wide variability in strengths compared to the remold testing conducted in 2017. Three back analyses have also been conducted on previous failures to calibrate the weak clay-altered strengths. Figure 4-3 shows 1) the laboratory tested residual shear strength by sample, and 2) the back-analyzed Mohr-Coulomb strengths determined in the three historical failures, where failure occurred through a weak altered rock mass. All of the tested samples were weaker than the back analyzed strengths, which indicates that the sampling of this material for testing was biased toward the weakest materials collected on the surface exposures in 2017 and in the core in 2019.

Therefore, for the stability analyses performed for the present study, the residual clay strengths tested in 2017 were used for the weak altered material surrounding the major named faults at the Castle Mountain Project. The 2017 clay strengths are more consistent in friction angle and cohesion and are slightly more conservative than the back-analyzed clay strengths. The 2017 residual direct shear tests for samples OCM-OB-02 and OCM-OB-04 were combined to provide the shear strength defined as a friction angle of 18.8 degrees and a cohesion of 14.9 psi.

4.3.1 Remolded Direct Shear Tests on Clay Samples

Two strongly clay-altered samples were collected in the Oro Belle pit for the 2017 study to determine the residual shear strength of this weak material. The samples (OCM-OB-02 and OCM-OB-04) were collected in the NW and SW walls of the Oro Belle pit, respectively. Sieve analyses, Atterberg limits tests, XRD analyses, and direct shear tests were performed to characterize these weak materials. The Atterberg limit tests are conducted on the material that is finer than 40 mesh (0.425 mm), which includes the fine sand to silt and clay sizes. These limits

determine the moisture contents at which the samples are in a plastic and liquid state. This test is used to determine how plastic the sample acts as defined by the plasticity index (the difference between the moisture content at the liquid limit and the moisture content at the plastic limit). A sand has no plasticity and a clay can hold a significant range of moisture in the plastic range. Mesri (2003) correlated the plasticity index to the shear strength of soils with significant volumes of clay. This correlation is instructive, but samples that have appreciable coarser grains (sand to gravel size) will increase the shear strength of clayey soils. Figures 4-1 and 4-2 report the sieve analyses and Atterberg limit results for samples OCM-OB-02 and OCM-OB-04.

The XRD analyses performed by DCM Science Laboratory in Wheat Ridge, Colorado are attached to this report as *Appendix F - X-Ray Diffraction Results*. Sample CM-OB-02 was 41% quartz and 59% rectorite, a one to one regular interstratification of muscovite/illite and smectite. CM-OB-04 was 23% quartz, 24% calcite, and 47% mixed layer illite/smectite (85% smectite).

In addition to the two surface samples, five clay samples were collected from the 2019 geotechnical drilling for testing. Table 4-4 summarizes the remolded direct shear tests with the best fit residual shear strength for each of the samples.

Table 4-4. Remolded Clay Direct Shear Strengths

Drill Hole	Sample	Friction Angle (deg)	Cohesion (psi)
GT001	19648-CMM-GT001-0685	2.5	8.0
GT002	19648-CMM-GT002-0403	24.6	8.4
GT002	19648-CMM-GT002-0429	13.9	13.7
GT003	19648-CMM-GT003-0575	9.9	12.7
GT004	19648-CMM-GT004-0965	9.1	7.3
Surface	17515-CM-OB-02	18.4	16.4
Surface	17515-CM-OB-04	19.3	13.3

4.3.2 Back-Analyzed Clay Strengths

Clay strengths were obtained by back-analyzing three historical failures in the Oro Belle and Jumbo North pits. The density of the materials analyzed was estimated to be 135 pcf. Using the Oro Belle Upper East Wall, Jumbo North Wall, and Oro Belle West Wall failure geometries, a relationship was developed between the friction angle and cohesion at a Factor of Safety just

below 1.00. This relationship, along with the laboratory tested residual shear strengths of remolded clay samples, is shown in Figure 4-3.

Oro Belle Upper East Wall

The first back analysis was performed on the upper eastern wall of the Oro Belle pit. The original plan indicated a slope height of 260 feet and slope angle of roughly 52 degrees, but was eventually laid back to 33 degrees to mitigate the failure. The pre-failure geometry was analyzed at friction angles of 18.8 degrees, 22 degrees, and 26 degrees. Cohesions for each friction angle were determined that yielded factors of safety slightly less than 1.00. The pairs of friction angle and cohesion that resulted in a FOS of slightly less than 1.00 are plotted on Figure 4-3.

Jumbo Northwest Wall

The second back analysis was performed on a slope failure that occurred just below the haul ramp on the northwest wall of the Oro Belle pit. The as-built topography shows an overall slope height of 120 feet with a slope angle of 49 degrees. The pre-failure geometry was analyzed at friction angles of 18.8 degrees, 22 degrees, and 26 degrees. Cohesions for each friction angle were determined that yielded factors of safety slightly less than 1.00. The pairs of friction angle and cohesion that resulted in a FOS of slightly less than 1.00 are plotted on Figure 4-3.

Oro Belle West Wall

The third back analysis was performed on a slop failure that occurred on the west wall of the Oro Belle pit. The area had previous instabilities in the upper portion of the wall at some point between the original mining and 2017, when the geotechnical prefeasibility study was conducted. Between 2017 and 2020, the lower portion of the slope failed within this fault zone. The pre-failure topography shows an overall slope height of 450 feet with a slope angle of 45 degrees. The pre-failure geometry was analyzed at friction angles of 18.8 degrees, 22 degrees, and 26 degrees. Cohesions for each friction angle were determined that yielded factors of safety slightly less than 1.00. The pairs of friction angle and cohesion that resulted in a FOS of slightly less than 1.00 are plotted on Figure 4-3.

4.4 Intact Rock Strength Testing

The intact shear strength of rock can be estimated from uniaxial compression, point load, Brazilian disk tension, and triaxial compression tests. Laboratory tests were conducted on samples from the 2019 drilling campaign to fill in the gaps of the intact rock strength estimates that were lacking in the original 2017 prefeasibility study.

4.4.1 Intact Shear Strength Based on Uniaxial Compressive Strength and Tensile Strength

The intact rock shear strength can be estimated if the uniaxial compressive strength (UCS) and the tensile strength (TS) of the rock are known. Table 4-5 shows the average compressive strength and the average tensile strength for each of the geologic units, and the resulting intact friction angle and cohesion resulting from these averages. The Volcaniclastic and Epiclastic laboratory tests were combined due to similar uniaxial, triaxial, and disk tension results.

Table 4-5. Intact Strength Summary

Lithology	UCS (psi)	TS (psi)	Friction Angle (deg)	Cohesion (psi)	Density (pcf)
Andesite	7466	643	48.7	1073.2	146.1
Rhyolite	18000	1419	49.8	2476.8	142.8
Volcaniclastic/Epiclastic	5612	730	42.8	991.7	139.2

These results are derived from the transformation of the stresses from principal stress space to normal and shear stress space, according to Obert and Duvall (1967):

$$\phi_{inctact} = \tan^{-1}\left(\frac{\beta - 1}{2\sqrt{\beta}}\right)$$

$$C_{inctact} = \left(\frac{\sigma_c}{2\sqrt{\beta}}\right)$$

where:

σ_c = Uniaxial Compression Strength (Y axis intercept in σ_1/σ_3 space)

σ_t = Tensile Strength

$\beta = \frac{\sigma_c}{\sigma_t}$

Additionally, values in Table 4-5 were corrected based on an empirical relationship developed by CNI between these intact linear strength estimates and linear fits to triaxial compression data. The corrections are as follows:

$$\phi_{i-estimated} = 0.85 * \phi_{empirical}$$

$$C_{i-estimated} = 0.98 * C_{empirical}$$

4.5 Rock-Mass Strengths

Overall slope failures can result from 1) daylighting large weak structures such as faults, bedding planes or lithologic contacts, 2) shearing stresses that exceed the strength of the rock mass, and 3) pore water pressure. An overall slope failure may occur as a combination of the factors listed above. For example, large slope failures typically have a structural anisotropy that may or may not daylight. The rock mass between the toe of the slope and a non-daylighted anisotropy and/or weak fault may fail if the stresses in the rock mass between the anisotropy and the toe of the slope exceed the rock-mass strength. To analyze the overall stability of a slope, the rock-mass strength must be estimated for zones identified as having statistically distinct strength characteristics.

The rock-mass shear strength is a function of the following:

1. Intact block size (related to RQD, fracture frequency, and number of joint sets)
2. Intact-rock shear strength
3. Fracture shear strength
4. Fracture orientations

Rock-mass strength estimates are based on characterizing the rock mass according to the parameters above. CNI developed a method to estimate the rock-mass strength that has been used successfully for more than 25 years for large open-pit design. The CNI approach was described on pages 130-132 in the published summary of the Large Open Pit (LOP) project entitled *Guidelines for Open Pit Slope Design*. An additional explanation of the method was published in Chapter 4 of a compilation of papers related to open pit slope stability titled *Slope Stability in Surface Mining*. The CNI method is described in section 4.5.1 of this report ("CNI Rock-Mass Strength Estimation Method").

The Hoek-Brown (1980, 1988) rock-mass strength estimation method is commonly used by geotechnical practitioners. This method has undergone numerous modifications based on its

use to back analyze failures and in forward analyses of slope stability and underground stability studies. In 1994 through 1997, Hoek, et.al., published papers relating the rock-mass strength parameters used in the method to a rock mass classification system called the Geological Strength Index (GSI). Originally, the GSI was estimated from Bieniawski's RMR classification system. In the 1989 version of the RMR system, the GSI was estimated as the RMR value with the ground water rating set to 15 and the joint orientation adjustment set to 0. Today, the method uses a classification matrix to estimate the GSI. The matrix currently used for the GSI classification is shown as Table 5.34 on page 126 in the published summary of the Large Open Pit (LOP) project titled *Guidelines for Open Pit Slope Design*. The Hoek-Brown method is also described in detail on pages 123-130 in the LOP publication. Figure 4-4 shows the GSI rock-mass classification matrix.

4.5.1 CNI Rock-Mass Strength Estimation Method

The rock-mass shear strength cannot exceed the intact-rock strength nor can it be less than the fracture shear strength. Intact-rock strengths must be reduced depending on the degree of fracturing. Experience with back-analyses of failures, as well as with fracture-modeling studies, indicates that the strength of the rock mass is a function of the ratio between the rock mass and rock substance (intact) elastic moduli.

More specifically, the relationship between the intact-rock and the rock-mass strength is proportional to the square of the modulus ratio. The rock-mass strength is determined as follows:

$$\tan \phi_{mass} = \tan \phi_{intact}\, r_{\phi}{}^2 + \tan \phi_{fracture}\,(1 - r_{\phi}{}^2)$$

$$C_{mass} = C_{intact} r_c{}^2 + C_{fracture}(1 - r_c{}^2)$$

where r is <1 and is equal to the modulus ratio:

$$r = \frac{E_{mass}}{E_{lab}}$$

and where E is equal to Young's Modulus.

Modified from Bieniawski (1978), the following illustrates the empirical relationship between RQD and the modulus ratio:

$$r_c = \frac{E_{mass}}{E_{lab}} = 0.225 e^{0.013 * RQD}$$

and

$$r_\phi = \frac{E_{mass}}{E_{lab}} = 0.3775e^{0.0075*RQD}$$

where RQD is expressed as a percentage.

The modulus ratio related to the rock-mass friction angle (r_ϕ) was modified to more accurately describe the friction angles derived in back-analyses of slope failures. Bieniawski's original ratio definition yielded friction angles that over-estimated the rock mass friction angle according to the back analyzed failures. The rock-mass strength estimates used in the slope stability analyses for this study are presented in Table 4-6.

Table 4-6. Rock-Mass Strength Estimates

Lithology	Friction Angle (deg)	Cohesion (psi)	Density (pcf)	RQD	CRF
Andesite	30.9	74.4	146.1	37	0.50
Rhyolite	36.6	99.2	142.8	30	0.35
Volcaniclastic	29.1	61.4	139.2	30	0.50
Epiclastic	29.6	72.2	139.2	37	0.50

4.5.2 Comparison of CNI and Hoek-Brown Rock-Mass Strength Estimation Methods

Based on experience, CNI has utilized correlations between measured joint strength from the laboratory and the RQD rock quality parameter to estimate GSI. The correlation matrix shown in Figure 4-4 explains the method used to estimate GSI from RQD and fracture shear strength.

The CNI method is a post-peak rock-mass strength estimation that uses measurable data. Figures 4-5 shows a comparison between the CNI rock-mass strength estimation and the Hoek-Brown rock-mass strength estimation for the Rhyolite material. The Hoek-Brown estimate of rock-mass strength assumed a disturbance factor of 0.7, which indicates reasonable care in blasting.

5.0 BENCH DESIGN

In pit slope sectors where the rock quality and major structure orientations are favorable, the bench design is the control on the interramp slope angles that can be achieved. The rock fabric, blast damage, and excavation practices impact the bench face angles that can be achieved. The bench face angle, along with the bench width required for rock fall protection, dictate the interramp slope angle that can be achieved. Several studies have been conducted to determine bench widths required to contain rockfall, most notably those published by Ritchie (1963) and the Oregon Department of Transportation (ODOT, 2001).

Recent research at CNI was conducted to estimate ranges of blast damage required to obtain measured bench face angles relative to the joint characteristics measured in discrete structural cells mapped in bench face exposures. Field observations of bench faces indicate that back break occurs along joint sets that form day-lighted plane shear and wedge geometries. When the joint orientation that controls the back break is determined, the number of mean joint spaces required to geometrically form the measured bench face angle are determined. The number of spaces that are required for the blasting to break to arrive at the measured bench face angle is a function of the mean joint spacing, the maximum length observed for the joint set, and the angle that the strike of the joint makes with the strike of the bench face. Although the mean joint spacing correlates reasonably well with the number of joint spaces that must be broken to calibrate to the measured bench face angle, the correlation becomes significantly better when the mean spacing is multiplied by the longest joint observed and the angle to the bench face strike, as explained below.

Figure 5-1 shows the broken spaces needed to obtain the measured bench face angle for the southwest walls mapped in the JSLA pit in 1993 and the Oro Belle pit in 2017 as a function of mean joint spacing. The data is fit best with a logarithmic function. Figure 5-2 shows the same dataset plotted on a log-log plot. A better fit to the data is had when the angle of the control structure to the bench face strike and the length of that structure are multiplied to the spacing, as shown in Figure 5-3.

It is postulated that a significant proportion of the remaining variance in the model shown in Figure 5-3 is related to blast damage. When more spaces are broken in the blasting process, the effective bench face angles are reduced. Figure 5-4 illustrates the definition of the effective

bench face angle (the angle between the toe of the bench and the crest of a viable rock containment bench). Figure 5-5 shows the blast damage plot at a mine that was experimenting with pre-split blasting to obtain steeper bench face angle. Cells were mapped in the same pit sector where pre-splits and no pre-splits were used in the blast patterns. The two sets of data indicate that the "no" pre-split benches suffered more breakage.

5.1 Example of Estimating Bench Face Angle in SW Wall of Castle Mountain Pits

The blast damage curve for the southwest wall, with a slope direction of 45 degrees, is shown in Figure 5-6. The equation for the mean damage curve to arrive at the measured bench face angles is also shown in the figure. If excellent blasting is practiced, the y intercept of the log-log plot is reduced from 2.60 for the mean curve to 2.35.

To smooth out the estimated bench face angle curves, the length, spacing, and orientation of the joint sets that control the back break are statistically sampled. The lengths and spacing are sampled according to a log normal distribution (Priest and Hudson, 1981). The joint orientations are sampled by randomizing the trend and plunge vector representing the pole of the joint according to the normal distribution. Sampling of the pole of the joint within one standard deviation of the mean gave reasonable results. The sampled poles reside within a cone of roughly 10 to 15 degrees from the mean pole.

For each sampled orientation (spacing and length), the back break is estimated by using the blast damage model shown in Figure 5-6 to estimate the number of spaces that break to fit the model. A geometric calculation can then be made to estimate the back break caused by the controlling joint set. Figure 5-7 shows the modeled bench face angles as a cumulative distribution curve. The curves shown include 1) a theoretical curve, which is the distribution if only one structure within the joint set fails out of the bench, 2) a predicted curve for average controlled blasting that was carried out during the previous mining, and 3) a predicted curve for a slight improvement in controlled blasting procedures.

For design purposes, the bench face angle estimates from the slightly improved controlled blasting predicted curve were used for the current recommendations for pit sectors, where bench design controls the interramp slope angle recommendation. The cumulative distribution curves of theoretical and predicted bench face angles for other expected major slope orientations are presented in *Appendix G - Modeled Bench Face Angle Curves*.

For design purposes, CNI uses the 80% reliable bench face angle (20% of the modeled bench faces are less than this value). As discussed in the next section, this BFA, along with a minimum catch bench width required to contain rock fall, dictates the interramp slope angle. The theoretical, regular blasting, and improved blasting bench face angles for 80% reliable benches are plotted as a function of slope dip direction in Figure 5-8.

5.2 Catch-Bench Width

CNI uses the Modified Ritchie Criterion as a guide for designing catch-bench widths. This method evolved following publication of a technical paper by A. M. Ritchie in 1963 on the design of highway shoulders for catching rockfall originating from excavated and natural slopes. Ritchie's investigation was limited to a relatively small number of slope angle and slope height geometries and therefore requires extrapolation for use in open-pit mining. Because slope (bench) height is one of the most important controls on the distance a rock will travel when detached from the bench, Richard Call suggested the empirical relationship between the slope height and average, or preferred, catch-bench width based on his experience:

Modified Ritchie Criterion (MRC) for Catch-Bench Width

*Catch-bench width (feet) = 0.2*bench height + 15 feet*

so, for single, double, and triple benching:

*(Single-bench width) 19 feet = 0.2 * 20 feet + 15 feet*

*(Double-bench width) 23 feet = 0.2 * 40 feet + 15 feet*

*(Triple-bench width) 27 feet = 0.2 * 60 feet + 15 feet*

This equation is published in the SME Surface Mining Handbook (2nd edition, 1990, p875). CNI sponsored research at the University of Arizona in 1987 in which it demonstrated the use of this criterion in benched mine slopes. In those field tests, the MRC was found to be conservative for containing rockfall in a limestone slope benched on 40- to 50-foot heights. At a height of 100 feet, the catch-bench width was more marginal in controlling rockfall. The MRC serves as a good general guide with wide applicability.

5.3 Catch-Bench Design

For bench-scale design, the maximum achievable ISA depends on the BFA that corresponds to the desired reliability for the design bench height. The design requirement of 80% reliability for benches means benches must achieve MRC width 80% of the time. Figure 5-9 shows the predicted bench face angle distribution for the SW slopes and the bench face angle associated with an 80% reliability that the bench faces will be greater than this value.

The 80% reliable BFA and the MRC catch bench width are used to calculate the recommended interramp slope angle. However, when the benches are constructed, the trim or pre-split shots are drilled near vertical (80 to 90 degrees from horizontal), so most catch bench widths are wider than the MRC catch bench width. The recommended interramp slope design is calculated using the 80% reliability bench face angle and the MRC bench width; however, the design bench face angle and bench width are calculated using the median bench face angle.

The achievable ISA given a BFA is calculated using the following equation:

Recommended ISA

$$ISA = \tan^{-1}\left(\frac{BH}{CBW + BH * \frac{1}{\tan(BFA)}}\right)$$

where:

BH = Bench Height
ISA = Interramp Slope Angle
CBW = Catch-Bench Width (Modified Ritchie Criterion)
BFA = Bench-Face Angle, (80% reliability)

Based on experience, an additional 4- to 6-foot offset is included in the CBW for ISA calculations between each mining increment when a multi-increment bench height is designed. This additional distance is used to reflect horizontal offset required by drilling space issues between mining increments. Pre-splitting over the entire 60-foot triple bench increment will eliminate this offset. The recommended angles in this report assume that pre-splitting will be used and that the pre-split holes will be drilled in a single pass of 60 feet. This 60-foot height assumes a triple bench for a 20-foot mining increment.

Recommended interramp slope angles based on the bench scale analyses are listed in Table 5-1. However, overall analyses dictate the interramp angle that can be achieved in many of these wall orientations, especially in proximity to the major named faults.

Table 5-1. Bench Scale Analysis Results

Slope Dip Direction (degrees)	60-Foot-High Bench (MRC Width = 27 feet)			
	Interramp Slope Angle (degrees)	Design BFA (degrees)	80% Reliable BFA (degrees)	Design Bench Width (feet)
130 - 140	50	80	69	39
225 - 240	56	80	77	30
315 – 320	55	80	76	31
45	50	80	69	39

6.0 OVERALL SLOPE ANALYSIS

Stress levels in pit slopes can locally exceed rock-mass strengths. The strength of the rock mass must be evaluated and compared to the predicted stresses based on geotechnical, geological, and geomechanical parameters.

Two-dimensional limit-equilibrium overall slope analyses were performed using Rocscience's Slide 2018 software. Spencer's method of slices was utilized to calculate FOS values. A linear Mohr-Coulomb shear strength relationship was assumed for all rock types. A phreatic water surface and pore water pressure conditions were not evaluated for these analyses, as EQX indicated that the pit would be dry. A factor of safety is calculated from the ratio of the resisting forces and driving forces for multiple potential failure surfaces. The lowest FOS obtained from the potential failure surfaces is then optimized and assigned to the cross section. A FOS of 1.20 was selected as the design criterion for the as-designed and optimized slope designs.

Fifteen representative cross sections were selected for analysis on the preliminary pit designs provided by John Nilsson. Figure 6-1 shows the plan view location of fifteen analysis sections as related to exposed geology. Factors affecting the selection of the overall slope analysis sections included:

- Slope height and slope angle
- Potential for low rock-mass strength at the toe of the slope
- Location and orientation of potential weak fault zones
- Critical infrastructure placement at the crest of the pits

6.1 Model Input Parameters

6.1.1 Geology Model

EQX provided CNI with a three-dimensional geology model that was substantially different from the original model received in 2017. The individual geologic units were grouped together based on expected geomechanical rock quality.

6.1.2 Material Properties

The rock-mass strength parameters used for each section are discussed in Chapter 4, "Laboratory Testing and Rock-Mass Strengths." Generic rock-mass strengths were created for each geologic unit and applied globally. Zones extending perpendicular from the major named faults were modeled using the weak altered strengths discussed in Chapter 4.

6.1.3 Hydrogeology

EQX personnel indicated that there was no water down to the final depths of the proposed pits. As a result, the recommended slope angles are based on dry conditions.

Water pressures play a crucial role when analyzing overall slope stability since water pressure reduces the effective normal stress on the shear plane. It should be noted that any pore water pressure will significantly impact slope stability. CNI recommends validating the groundwater conditions.

6.2 Results

The overall results for the fifteen cross sections are presented in Table 6-1. The cross sections for each stability analysis are presented in Figures 6-2 through 6-30 with critical slip surfaces and the resulting FOS. All optimized slopes meet or exceed a 1.20 FOS except for Section 8. The 1.16 FOS that was calculated was due to the re-introduction of a large fault zone that was cut in the provided design. The final pit geometry will need to be evaluated for stability.

Table 6-1. Overall Stability Analyses Results

Section	FOS		Optimized ISA (deg)					
	As-Designed	Optimized	Rhyolite	Andesite	Epiclastic	Volcaniclastics	±100 ft from fault	±200 ft from fault
1	1.34	1.25	51	-	-	50	-	-
2	1.56	1.21	-	48	50	50	-	-
3	1.32	1.22	51	-	-	50	-	-
4	1.51	1.34	51	-	-	50	-	-
5	1.35	1.35	51	-	-	-	40	-
6	1.59	1.25	-	48	50	50	-	-
7	1.05	1.21	51	-	-	-	-	46
8	1.51	1.16	-	48	50	50	-	40
9	1.72	1.46	52	-	-	-	-	-
10	1.61	1.58	52	-	-	-	-	-
11	1.75	1.48	51	-	-	-	-	-
12	0.91		-	-	-	-	-	-
13	1.51	1.28	52	-	-	-	-	-
14	1.52	1.34	51	-	50	50	-	-
15	1.62	1.33	-	-	51	51	-	-

6.2.1 Section 1

Section 1 is located on the western side of the South Extension pit. The cross section has a total height of approximately 1010 feet, a slope dip direction of approximately 90 degrees, and an overall slope angle of 46 degrees. Major rock units present in the model include the Volcaniclastic, Epiclastic, and Rhyolite units. The critical slip surface on the provided pit design occurs throughout the overall slope with a FOS of 1.34. Changing the ISA within the Rhyolite to 51 degrees and within the Volcaniclastic to 50 degrees, results in a FOS of 1.25.

6.2.2 Section 2

Section 2 is located on the northwestern side of the South Extension pit. The cross section has a total wall height of approximately 1020 feet, a slope dip direction of approximately 140 degrees, and an overall slope angle of 42 degrees. Major rock units present in the model include the Volcaniclastic, Epiclastic, Rhyolite, and Andesite units. The critical slip surface on the provided pit design occurs throughout the overall slope with a FOS of 1.56. Changing the ISA within the Epiclastic and Volcaniclastic slopes to 50 degrees, and within the Andesite to 48

degrees, results in a FOS of 1.21.

6.2.3 Section 3

Section 3 is located on the northwestern side of the South Extension pit. The cross section has a total wall height of approximately 1100 feet, a slope dip direction of approximately 120 degrees, and an overall slope angle of 47 degrees. Major rock units present in the model include the Volcaniclastic, Epiclastic, and Rhyolite units. The critical slip surface on the provided pit design occurs throughout the overall slope with a FOS of 1.32. Changing the ISA within the Rhyolite to 51 degrees and within the Volcaniclastic slopes to 50 degrees, results in a FOS of 1.22.

Section 3 is also the analysis where CNI calculated the 300-foot crest offset for critical infrastructure. An anisotropic strength was used where the fault strength would be applied to slices where the dip was between -90 to -65 degrees. This allows the fault to effectively move spatially and simulates the minimum offset distance required to maintain a 1.20 FOS. Using these assumptions, the maximum slip surface where the FOS is 1.20 was found at 282 feet behind the crest.

6.2.4 Section 4

Section 4 is located on the southwestern side of the JSLA pit. The cross section has a total wall height of approximately 800 feet, a slope dip direction of approximately 50 degrees, and an overall slope angle of 44 degrees. Major rock units present in the model include the Volcaniclastic, Epiclastic, and Rhyolite units. The critical slip surface on the provided pit design occurs throughout the overall slope with a FOS of 1.51. Changing the ISA within the Rhyolite to 51 degrees and within the Volcaniclastic slopes to 50 degrees, results in a FOS of 1.34.

6.2.5 Section 5

Section 5 is located on the eastern side of the South Extension pit. The cross section has a total wall height of approximately 1020 feet, a slope dip direction of approximately 270 degrees, and an overall slope angle of 39 degrees. Major rock units present in the model include the Volcaniclastic, Epiclastic, Rhyolite, Andesite, and fault zone units. The critical slip surface on the provided pit design occurs throughout the overall slope with a FOS of 1.35. For design purposes, the ISA of the Rhyolite was changed to 51 degrees, and a fault zone ISA of 40 degrees

was applied to a zone ±100 feet from the modeled Dillon fault. Changing the ISA to meet these parameters yields the same 1.35 FOS.

6.2.6 Section 6

Section 6 is located on the north side of the South Extension pit. The cross section has a total wall height of approximately 1015 feet, a slope dip direction of approximately 190 degrees, and an overall slope angle of 37 degrees. Major rock units present in the model include the Volcaniclastic, Epiclastic, and Andesite units. The critical slip surface on the provided pit design occurs throughout the overall slope with a FOS of 1.59. Changing the ISA within the Andesite to 48 degrees and within the Volcaniclastic and Epiclastic slopes to 50 degrees, results in a FOS of 1.25.

6.2.7 Section 7

Section 7 is located on the southwestern side of the JSLA pit. The cross section has a total wall height of approximately 780 feet, a slope dip direction of approximately 45 degrees, and an overall slope angle of 44 degrees. Major rock units present in the model include the Volcaniclastic, Epiclastic, Rhyolite, and fault zone units. The critical slip surface on the provided pit design occurs throughout the overall slope with a FOS of 1.05. Changing the ISA within the Rhyolite to 51 degrees and applying an ISA of 46 degrees to a zone ±200 feet from the modeled Maverick fault, results in a FOS of 1.21.

6.2.8 Section 8

Section 8 is located on the northwestern side of the JSLA pit. The cross section has a total wall height of approximately 960 feet, a slope dip direction of approximately 146 degrees, and an overall slope angle of 32 degrees. Major rock units present in the model include the Volcaniclastic, Epiclastic, Andesite, and fault zone units. The critical slip surface on the provided pit design occurs throughout the overall slope with a FOS of 1.51. Changing the ISA within the Andesite to 48 degrees and within the Volcaniclastic and Epiclastic slopes to 50 degrees, and applying an ISA of 40 degrees to a zone ±200 feet from the modeled McLane fault, results in a FOS of 1.16. The significant difference in FOS is due to the removal of a haul road in the original design and exposure of a large fault zone.

6.2.9 Section 9

Section 9 is located on the eastern side of the JSLA pit. The cross section has a total wall height of approximately 955 feet, a slope dip direction of approximately 270 degrees, and an overall slope angle of 42 degrees. Major rock units present in the model include the Volcaniclastic and Rhyolite units. The critical slip surface on the provided pit design occurs throughout the overall slope with a FOS of 1.72. Changing the ISA within the Rhyolite to 52 degrees and within the Volcaniclastic slopes to 52 degrees, results in a FOS of 1.46.

6.2.10 Section 10

Section 10 is located on the eastern side of the East Ridge pit. The cross section has a total wall height of approximately 1010 feet, a slope dip direction of approximately 298 degrees, and an overall slope angle of 53 degrees. Major rock units present in the model include the Rhyolite unit. The critical slip surface on the provided pit design occurs throughout the overall slope with a FOS of 1.61. Changing the ISA within the Rhyolite to 52 degrees results in a FOS of 1.58.

6.2.11 Section 11

Section 11 is located on the north side of the Jumbo pit. The cross section has a total wall height of approximately 800 feet, a slope dip direction of approximately 180 degrees, and an overall slope angle of 35 degrees. Major rock units present in the model include the Volcaniclastic, Epiclastic, and Rhyolite units. The critical slip surface on the provided pit design occurs throughout the overall slope with a FOS of 1.75. Changing the ISA within the Rhyolite to 51 degrees results in a FOS of 1.48.

6.2.12 Section 12

Section 12 is located on the west side of the East Ridge pit. The cross section has a total wall height of approximately 510 feet, a slope dip direction of approximately 90 degrees, and an overall slope angle of 39 degrees. Major rock units present in the model include the Volcaniclastic, Rhyolite, and fault zone units. The critical slip surface on the provided pit design occurs throughout the overall slope with a FOS of 0.91. Due to the extensive nature of the fault zones, any remediation design would likely remove the entire slope. CNI recommends removing

this “island” found between the East Ridge and Jumbo pits, or understanding that leaving the “island” in will likely result in remediation work at a later date.

6.2.13 Section 13

Section 13 is located on the eastern side of the Oro Belle pit. The cross section has a total wall height of approximately 1140 feet, a slope dip direction of approximately 270 degrees, and an overall slope angle of 45 degrees. Major rock units present in the model include the Rhyolite unit with small pieces of all other units. The critical slip surface on the provided pit design occurs throughout the overall slope with a FOS of 1.51. Changing the ISA for the overall slope to 52 results in a FOS of 1.28.

6.2.14 Section 14

Section 14 is located on the northwestern side of Oro Belle pit. The cross section has a total wall height of approximately 990 feet, a slope dip direction of approximately 138 degrees, and an overall slope angle of 45 degrees. Major rock units present in the model include the Epiclastic and Rhyolite units. The critical slip surface on the provided pit design occurs throughout the overall slope with a FOS of 1.52. Changing the ISA within the Rhyolite to 51 degrees and within the Volcaniclastic and Epiclastic slopes to 50 degrees, results in a FOS of 1.34.

6.2.15 Section 15

Section 15 is located on the southwestern side of JSLA pit. The cross section has a total wall height of approximately 834 feet, a slope dip direction of approximately 135 degrees, and an overall slope angle of 40 degrees. Major rock units present in the model include the Volcaniclastic, Epiclastic, and Andesite units. The critical slip surface on the provided pit design occurs throughout the overall slope with a FOS of 1.62. Changing the ISA within the Volcaniclastic and Epiclastic slopes to 51 degrees results in a FOS of 1.33.

7.0 BLASTING OPERATIONS

7.1 Production Blasting

The mining increment at Castle Mountain is expected to be 20 feet. A triple bench will be constructed leaving an adequate bench width to contain rock fall at 60-foot vertical intervals. For a 20-foot mining increment, a blasthole diameter of no more than 4 inches should be used to achieve optimum distribution of the explosive in the hole. Using a bench height to burden ratio (burden stiffness) of at least 2, and preferably 2.5 to 3.0, can be achieved with the 4-inch diameter hole. The burden should be no more than 10 feet, and 8 feet would be preferable. For the 10-foot burden, a spacing of 11.5 feet is reasonable. For the 8-foot burden, a spacing of 9.5 feet is reasonable. Sub-drilling 3 feet with 7 feet of stemming will provide good powder distribution to break the burden.

Explosive products are quite versatile and many suppliers can vary the specific gravity of the explosive product on the fly depending on the rock quality as measured by blast hole drilling parameters. Specific gravities ranging from 0.85 to 1.3 g/cc are available. Using a burden stiffness of 2, the range of powder factors that can be achieved with a 4-inch blasthole and the burden and spacing described above ranges from 0.87 lbs/yd^3 to 1.33 lbs/yd^3 (0.52- to 0.79-kg/m^3), which should handle the majority of rock conditions experienced at Castle Mountain. The explosive loads per hole would range from 75 to 115 pounds per hole. Using a burden stiffness of 2.5, a powder factor of 1.3 lbs/yd^3 is obtained using the lowest density explosive product and the stemming depth detailed above.

7.2 Controlled Blasting

Maintaining adequate catch bench widths for the recommended 48- to 52-degree interramp slope angles at the Castle Mountain Project will require carefully controlled blasting. It is recommended that the interramp slopes should be accomplished using pre-split blasting for a 60-foot-high triple bench. The pre-split should be drilled in a single pass to the full triple bench height and shot prior to the production shots on the first 20-foot mining increment of the triple bench.

Achieving the recommended interramp slope angles requires a bench face angle of 72 degrees that is reliable over 90 percent of the time for a 52-degree interramp slope angle. This

will result in a bench width of 27 feet, which is suitable for containing rock fall from the bench face above according to the modified Ritchie criterion. Past mining of the pits at Castle Mountain achieved these bench face angles with carefully controlled blasting even though the RQD of the rock mass is not exceptional. The jointing of the competent rhyolites and the chaotic nature of the clasts in the volcanoclastics and epiclastics was favorable to achieve steep bench face angles with pre-splitting. In some areas, the pre-split will not appear to have worked well, but in fact, it reduces the rock-mass damage and the benches will be more reliable.

Pre-split blasting initiates a crack defining the bench face and this linear blast pattern is initiated prior to the initiation of the production and buffer blast patterns. If a good crack forms, the vibrations of the main production blast are reflected back into the rock mass, protecting the rock forming the bench face.

Pre-split blasting adds cost to the blasting operation, but the benefit achieved by allowing steeper interramp angles with higher bench reliability is far greater than the additional cost. The cost of pre-splitting is a linear function based on the length of the pre-split blast patterns. The savings in stripping costs resulting from the steeper interramp slope angles that are achievable with the careful pre-split blasting increase as a geometric function (cubic volumetric function). Figure 7-1 displays this concept. This figure was generated in 2004, so the costs are outdated; however, the savings resulting from pre-splitting by increasing the interramp slope angle from 40 degrees to 45 degrees over a 1000-foot-long sector of a pit is significantly greater than the cost of pre-splitting.

7.2.1 Initial Pre-Split Blasting Recommendation

Drills using down-hole hammers have worked well for the pre-split operations. The Atlas Copco ROC L6 is quite flexible and is capable of drilling 3.5- to 5.125-inch-diameter holes. These rigs can drill angled holes, and many times steeply inclined pre-split holes function better than vertical holes. Rigs that can drill accurately for a full 60-foot-high triple bench height should be obtained. In some cases, the drill rigs used for production blasting can drill vertical holes over the full triple bench height at hole diameters less than 5 inches. These rigs may work quite well for the pre-splitting operation and allow the operator to use the same equipment for pre-splitting and production. However, when estimating the capital costs for drill machines, the pre-split operation must be considered to obtain adequate availability of rigs for this operation.

Experimentation of several pre-split blast patterns will have to be performed to arrive at the optimum pattern at Castle Mountain. The pattern may change as a function of wall orientation and the orientation of the geologic fabric. An initial recommendation for a pre-split pattern would consist of 4-inch-diameter holes drilled with a spacing of 5 feet. The triple bench pre-split should be drilled at -80 degrees from horizontal with 2 feet of sub-drill for a total of 63 feet, accounting for the hole inclination. A 1.125-inch-diameter packaged pre-split explosive such as Orica's Powersplit is recommended to provide good charge distribution. It is recommended to not load the bottom of a large diameter hole with an equivalent charge and detonate with a booster, as this does not provide a good pre-split. This pre-split product is an emulsified explosive in continuous tube packaging.

The Orica product has a 10 g/m detonating cord running through the center of the product to ensure fast detonation of the product. The upper 3.5 feet of the hole should not be charged. To avoid a hard toe, double over the packaged explosive to double the charge in the lower 5 feet of the hole. If stemming is used, a hole plug should be set at roughly 3.5 feet of depth and good stemming material should be placed on top of the plug. Using the 1.125-inch-diameter continuous pre-split product would provide a load of roughly 35 pounds per hole. This design should provide a shear factor of 0.10 lbs/ft^2. This charge should work well but may have to be adjusted depending on the rock quality. As mentioned above, the pre-split should be shot well before the production and buffer row shots. A minimum of 5 pre-split holes should be fired on the same delay.

7.2.2 Initial Buffer Blasting Recommendation

Buffer blasting should be performed to minimize damage to the bench faces. Ideally, a blast damage zone around the typical production blast should be defined by near-field vibration monitoring and by drilling some holes in proximity to (but not within) the blast pattern, to measure crack dilation with a pre- and post-blast televiewer survey (a dummy tool should be run before the televiewer to make sure the holes are safe to run the televiewer tool). McKenzie and Holley (2004) authored a paper detailing damage related to blasting. They drilled holes near vibration monitoring stations and used video cameras to record the pre- and post-blast crack development to be correlated with measured particle velocities. Their conclusions included the following:

1. "Observable damage, in the form of new or open cracks, appears to commence at around 200 mm/s (7.9 ips)."
2. "Once levels increase to around 400 mm/s (15.7 ips), observable damage can become intense."
3. "Damage in the inspection holes was observed over the full depth of the holes."
4. "With large diameter blast holes, normal charge weights and normal stand-off distances from the designed pit wall, this level of control cannot be achieved."

Ideally, vibration levels behind the pre-split line at the designed mid-bench should be lower than 15 inches per second.

Although pre-splits will help cushion the blast vibrations from the production shot, the damage zone should be estimated to help develop a buffer blast pattern to make sure damage to the bench face, and particularly the bench crest, are minimized. The buffer blast should be shot as a four-row rind shot to a free face. The shovel or loader should make a pass to develop this rind shot, which should consist of three buffer rows and one production row. With a 20-foot mining increment, the production hole diameter should be no greater than 4 inches to achieve good explosive distribution and optimum breakage of the rock. The burden and spacing is reduced to give good breakage of the beam of rock in the blast burden. With the recommended burdens and spacings for the rind shot given below, there is good charge distribution for breaking the rock and imparting minimal damage to the bench face. A burden stiffness of 2.5 for the three buffer rows as a starting point recommendation is described below.

1. The buffer shot pattern in order from pre-split line:
    a. First buffer row: 8.0 feet from pre-split, 9.5-foot spacing, 51 pounds of charge (0.85g/cc SG of explosive), hole plug set at 7 feet with good quality stemming in a 4-inch-diameter drill hole, **no sub drilling on third increment**. Otherwise, use 3 feet of sub-drill.
    b. Second buffer row: 16 feet from pre-split, 9.5-foot spacing, 51 pounds of charge, hole plug set at 7 feet with good quality stemming in a 4-inch-diameter drill hole, **no sub drilling on third increment**. Otherwise, use 3 feet of sub-drill.
    c. Third buffer row: 24 feet from pre-split, 9.5-foot spacing, 51 pounds of charge, hole plug set at 7 feet with good quality stemming in a 4-inch-diameter drill hole, **no sub drilling on third increment**. Otherwise, use 3 feet of sub-drill.
    d. Standard production charge set at 32 feet from pre-split, 10-foot burden, 11.5-foot spacing, 87 to 96 pounds of charge (1.0 to 1.1 SG of explosive), 7 feet of good quality stemming in a 4-inch-diameter hole, **no sub drilling on third increment**. Otherwise, use 3 feet of sub-drill. On the third increment with no sub-drill, to get the required load, a 1.3 g/cc SG explosive will be used.

The layout for this initial controlled blast design is shown in Figure 7-2. The timing of the buffer shots should be designed such that there is a minimum of 12 milliseconds of delay between each blast hole being detonated, and 20 to 40 milliseconds between rows.

7.2.3 Controlled Blast Audits

The excavated benches should be audited on a routine basis to make sure that the bench widths and bench face angles are performing to expectations. Each blast design that impacts a final wall should be documented and data, including the rock type, alteration type, persistent joint systems, controlled blast design with spacing and burden dimensions for buffer and pre-split rows, vibration levels, and cumulative bench face angle plots derived from drone scans, should be collected. Overlapping drone imagery should be collected at a minimum of quarterly to generate three-dimensional point clouds that are used to audit the bench face angles and bench widths. Adjustments to the blast design will have to be made, if the bench face angles and catch bench widths are lower than predicted. Additionally, the drone scans will help determine if the design toes are accomplished. If hard toes are noticed, adding more powder the bottom of the pre-split row or increasing the sub-drill of the pre-split holes may be required. Figure 7-3 shows an example of a bench face angle audit compared to the expected bench face angle distribution determined by the Backbreak analysis.

REFERENCES

McKenzie, C.K. & Holley, K. 2004, 'A study of damage profiles behind blasts' in Proceedings of the 30th Annual Conference on Explosives and Blasting Techniques, International Society of Explosives Engineers, vol. 2.

CALL & NICHOLAS, INC.

2475 N. Coyote Dr.
Tucson, Arizona 85745 U.S.A.

Tel: 520.670.9774
Fax: 520.670.9251
E-Mail: cni@cnitucson.com

Principals
T. M. Ryan
R. W. Pratt
L. R. Standridge
N. A. Asbury
S. D. Cylwik

MEMORANDUM

To: Doug Moore, Project Manager / Equinox Gold Corp
Aren Hall, Environmental & Permitting Manager / Equinox Gold Corp

From: Daniel Childs, Geological Engineer / Call & Nicholas, Inc.
Scott Cylwik, P.E., Vice President / Call & Nicholas, Inc.

Date: 22 June 2023

Subject: Castle Mountain – South Extension Pit Slope Stability Update

1.0 EXECUTIVE SUMMARY

At the request of Aren Hall and Doug Moore of Equinox Gold Corp (EQX), the South Extension pit, as a portion of the 2020 Call & Nicholas, Inc. (CNI) report titled *Castle Mountain Geotechnical Feasibility Report*, was re-analyzed using updated groundwater conditions.

EQX was provided with a memo by Clear Creek Associates titled *Evaluation of Dewatering Requirements and an Updated Simulation of a Pit Lake* on May 18, 2023, that estimates pit dewatering conditions at various stages of the mining process. CNI used the estimated 2050 groundwater surface to update the overall slope stability models of the South Extension pit to investigate the potential impact that may be encountered.

Based on the provided data, the 2050 groundwater surface assumption does not impact the Factor of Safety (FoS) of the South Extension ultimate pit design model when considering global stability with two-dimensional limit-equilibrium. If groundwater conditions are different than what has been provided, then stability for the overall pit may be affected.

2.0 GROUNDWATER MODEL

Clear Creek Associates provided CNI with estimated three-dimensional groundwater surfaces for the end of each major mining stage, as follows:

- 2030 – JSLA
- 2033 – Jumbo/Oro Belle

- 2036 – Jumbo/Oro Belle (east)
- 2042 – South Extension
- 2050 – South Extension at Maximum

The original scope of work for the 2020 CNI study focuses on the stability of the final pit design, and the interaction of groundwater and slope stability at interim stages was not analyzed.

3.0 OVERALL SLOPE STABILITY ANALYSIS

Sections 1, 2, 3, 5, and 6 in the 2020 CNI study are located at key positions around the South Extension pit, as presented in Figure 6-1 from that report.

3.1 Results

The results from the updated analyses are presented in **Table 3-1**. The only change in FoS values from the 2020 study is the Section 5 as-designed model. A slight reduction in FoS from 1.35 to 1.31 was found when re-analyzing the model. The slip surface does not intercept the 2050 groundwater surface, so the change is attributed to changes in the Rocscience Slide2 optimization methods. FoS estimates still meet all design acceptance criteria.

Table 3-1. Overall Stability Analyses Results

Section	FOS	
	2020 Study Results	Updated Groundwater Results
1	1.34	1.34
2	1.56	1.56
3	1.32	1.32
5	1.35	1.31
6	1.59	1.59

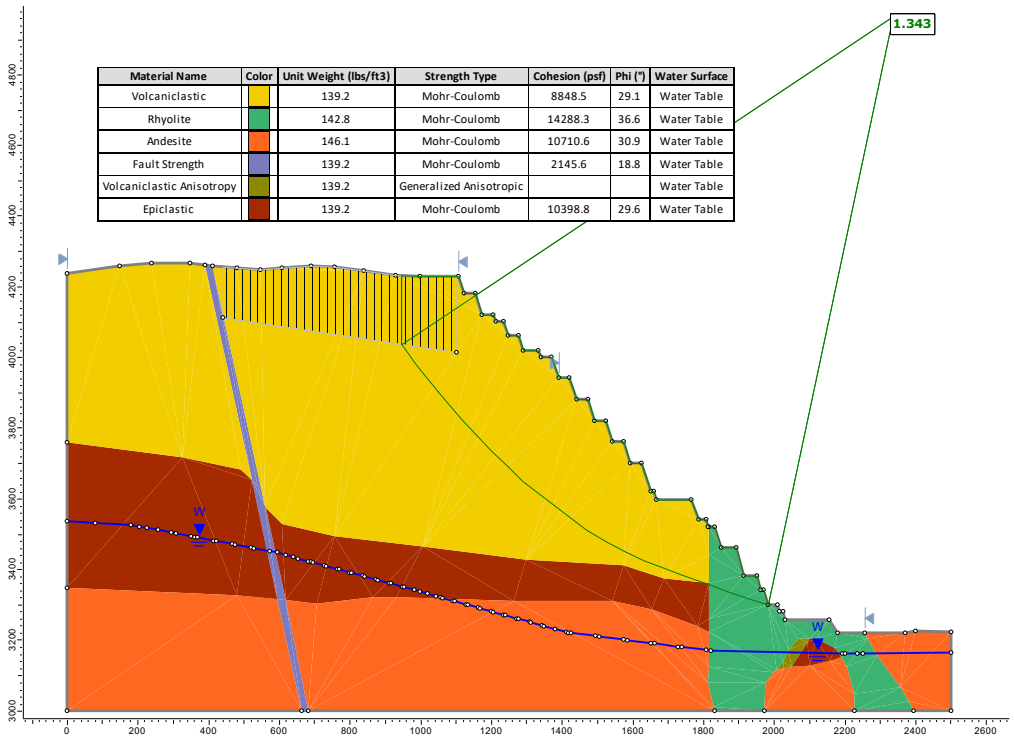


Figure 3-1. Section 1 – As Designed

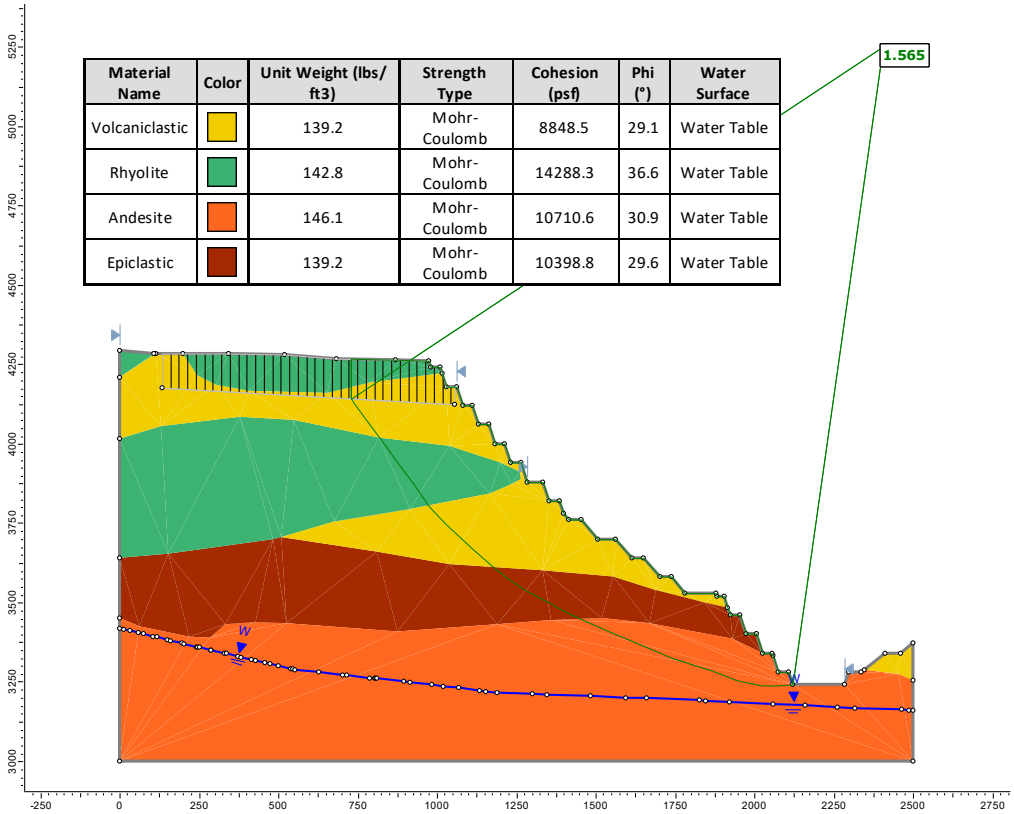


Figure 3-2. Section 2 – As Designed

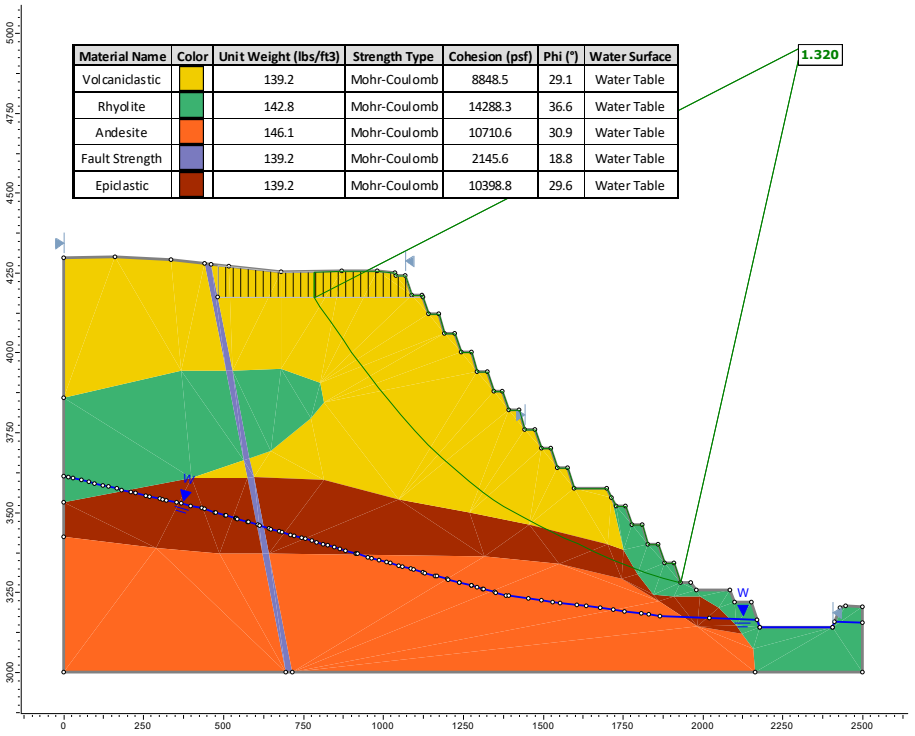


Figure 3-3. Section 3 – As-Designed

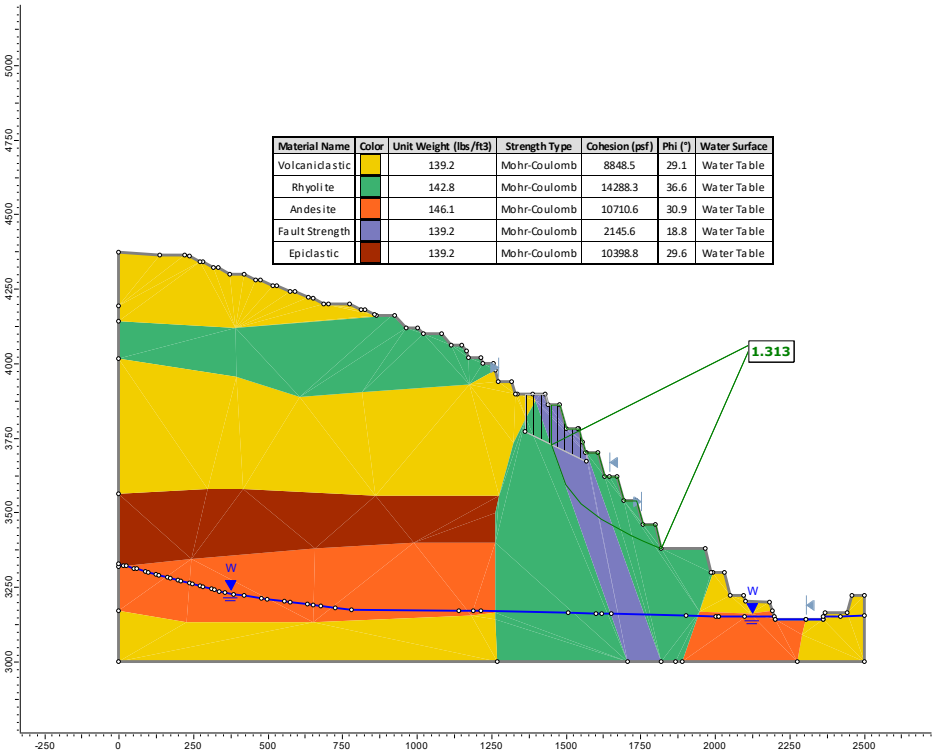
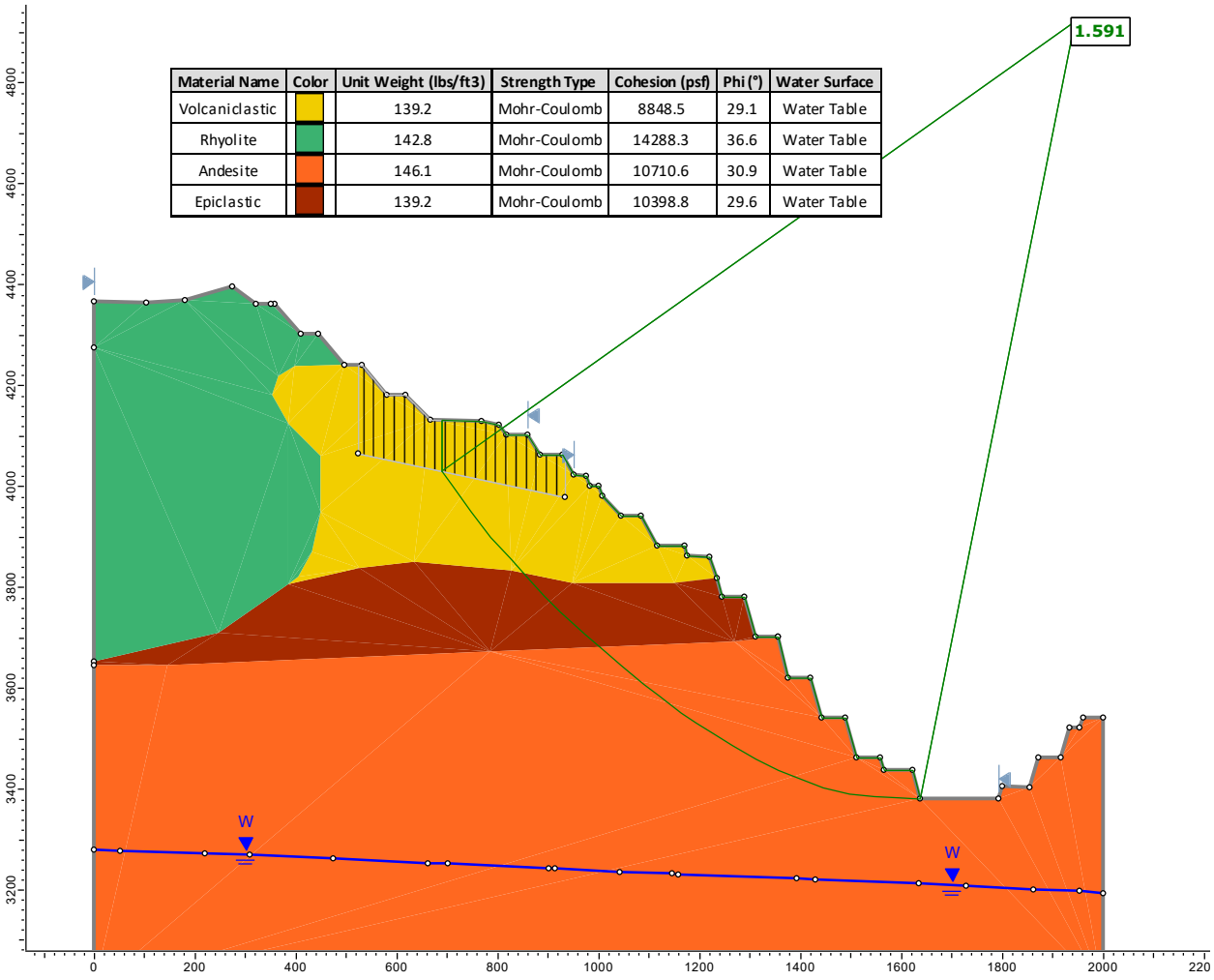


Figure 3-4. Section 5 – As-Designed



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Water Surface
Volcaniclastic		139.2	Mohr-Coulomb	8848.5	29.1	Water Table
Rhyolite		142.8	Mohr-Coulomb	14288.3	36.6	Water Table
Andesite		146.1	Mohr-Coulomb	10710.6	30.9	Water Table
Epiclastic		139.2	Mohr-Coulomb	10398.8	29.6	Water Table

Figure 3-5. Section 6 – As-Designed

CALL & NICHOLAS, INC.

2475 N. Coyote Dr.
Tucson, Arizona 85745 U.S.A.

Tel: 520.670.9774
Fax: 520.670.9251
E-Mail: cni@cnitucson.com

Principals
T. M. Ryan
R. W. Pratt
L. R. Standridge
N. A. Asbury
S. D. Cylwik

MEMORANDUM

To: Doug Moore, Project Manager / Equinox Gold Corp
Aren Hall, Environmental & Permitting Manager / Equinox Gold Corp

From: Daniel Childs, Geological Engineer / Call & Nicholas, Inc.
Scott Cylwik, P.E., Vice President / Call & Nicholas, Inc.

Date: 01 July 2024

Subject: Castle Mountain – March 2022 Pit Design Geotechnical Verification

1.0 EXECUTIVE SUMMARY

At the request of Equinox Gold Corp (EQX), Call & Nicholas, Inc. (CNI) has performed a geotechnical design verification of the March 2022 pit design. The design verification includes reviewing designed interramp slope angles to verify that design recommendations were followed from the 2020 CNI report titled *Castle Mountain Geotechnical Feasibility Report* and running two-dimensional limit-equilibrium (2DLE) models on critical cross sections to verify that Factor of Safety (FoS) estimates meet or exceed minimum design acceptance criteria. Additionally, groundwater surfaces provided by Clear Creek Associates were used to simulate groundwater conditions at the completion of various stages of mining and in a new scenario where the pits are not backfilled and pit lakes are allowed to form.

Based on the data available to CNI at the time of analysis, all analyzed slopes (except "Section 6 – East" which is in the "ISA_ISLAND" domain) meet or exceed a 1.20 FoS. Reducing the slope in Section 6 - East from the 4470-foot elevation to a 4410-foot elevation increases the FoS from 1.11 to 1.20 and meets the minimum FoS requirements. Additionally, plans provided by EQX to CNI indicate that the critical infrastructure near the south extension pit is located outside the recommended 300-foot exclusionary boundary and the updated 2DLE model does not indicate that the critical infrastructure will be impacted by potential overall slope instabilities.

2.0 GROUNDWATER MODEL

Clear Creek Associates provided CNI with estimated three-dimensional groundwater surfaces for the end of each major mining stage, as follows:

- 2030 – JSLA
- 2033 – Jumbo/Oro Belle
- 2036 – Jumbo/Oro Belle (east)
- 2042 – South Extension
- 2050 – South Extension at Maximum

The relevant groundwater surfaces used in each analyzed cross sections is presented in Table 2-1.

Table 2-2. Overall Stability Analyses Results

Section	Zone	Mining Stage	Estimated Year of Mining Stage Completion
1	South Extension Pit	6F	2042
2	South Extension Pit - North	6B	2030
3	JSLA Pit	6B	2030
4	JSLA Pit	6B	2030
5	Oro Belle Pit	6D	2036
6 - East	Oro Belle Pit	6D	2036
6 - West	Jumbo Pit	6C	2033
7	Jumbo Pit	6C	2033
8	Oro Belle Pit	6D	2036
9	Oro Belle Pit	6D	2036

3.0 OVERALL SLOPE STABILITY ANALYSIS

Sections 1 through 9 were selected based on results from the 2020 CNI study and were modified based on the updated pit geometry. The cross sections located on a plan map are presented in Figure 3-1.

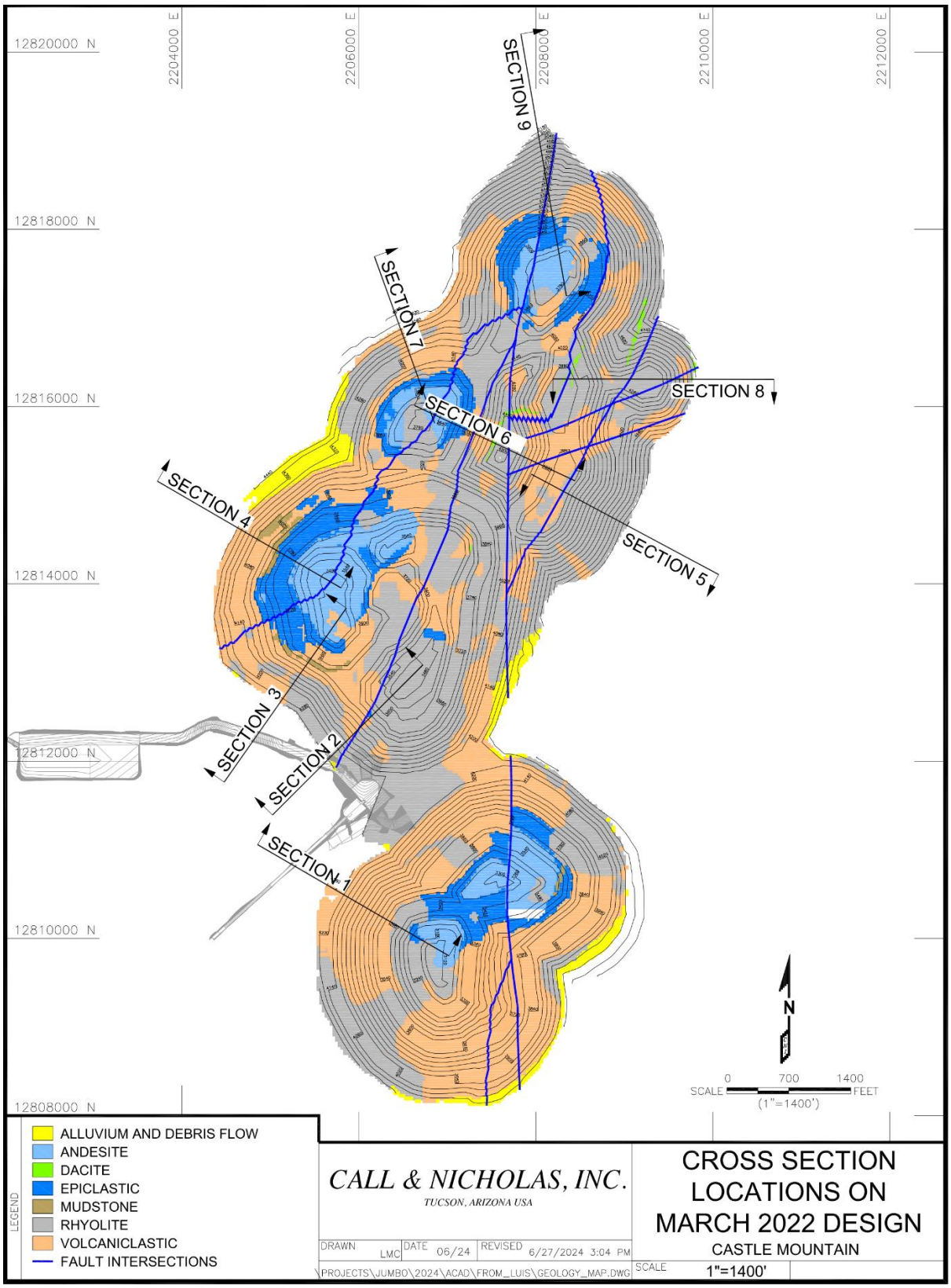


Figure 3-1. Cross Section Locations on March 2022 Design

3.1 Results

The results from the 2DLE analyses are presented in Table 3-1. Using the provided design, Section 6 – East results in a FoS of 1.11 for both water scenarios; however, by reducing the slope elevation from 4470 feet to 4410 feet, the FoS increases to 1.20. Assuming this design change takes place, all FoS estimates will meet design acceptance criteria of having an FoS of greater than or equal to 1.20 for both the estimated water conditions and pit lake conditions. The estimated FoS values are highly dependent on the interpreted location of fault planes. The locations of modeled faults should be updated regularly once mining begins, and slope stability analyses will need to be updated accordingly if modeled fault locations change or new faults are identified.

Table 3-1. Overall Stability Analyses Results

		Factor of Safety	
Section	**Zone**	**At Estimated Water**	**Pit Lake Scenario (2023 Water)**
1	South Extension Pit	1.26	1.31
2	South Extension Pit - North	1.55	1.50
3	JSLA Pit	1.24	1.43
4	JSLA Pit	1.29	1.59
5	Oro Belle Pit	1.60	1.60
6 - East	Oro Belle Pit	1.20*	1.20*
6 - West	Jumbo Pit	1.61	1.60
7	Jumbo Pit	1.48	1.48
8	Oro Belle Pit	1.94	1.94
9	Oro Belle Pit	1.45	1.45

* The FoS for this section assumes that the elevation of this slope is reduced from the 4470-foot elevation to 4410-foot elevation

3.1.1 Section 1

Section 1 is located on the northwestern portion of the South Extension Pit. The critical infrastructure of interest is located roughly 570 feet from the crest of the slope and no slip surfaces extended beneath it. For the 2042 and 2023 (Pit Lake) water condition scenarios, the FoS is 1.26 and 1.31, and the resulting slip surfaces are presented in **Figure 3-2** and **Figure 3-3**, respectively.

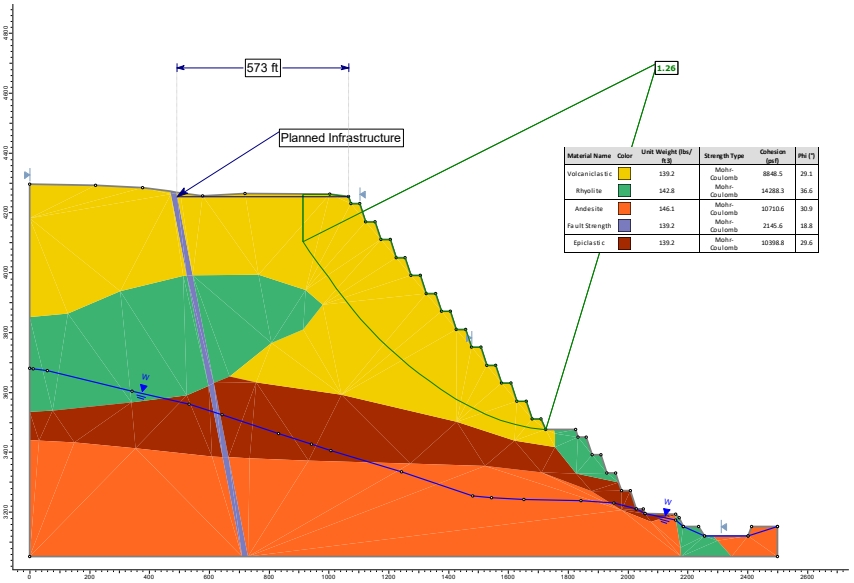


Figure 3-2. Section 1, Assuming 2042 Water Surface

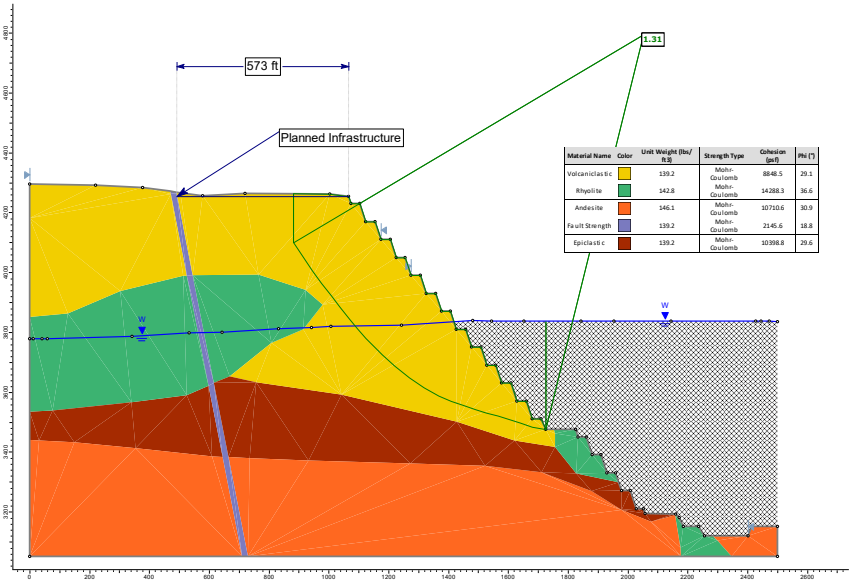


Figure 3-3. Section 1, Assuming 2023 Water Surface

3.1.2 Section 2

Section 2 is located on the southwest wall of the northern end of the South Extension Pit. For the 2030 and 2023 (Pit Lake) water condition scenarios, the FoS is 1.50 and 1.55, and resulting slip surfaces are presented in Figure 3-4 and Figure 3-5, respectively

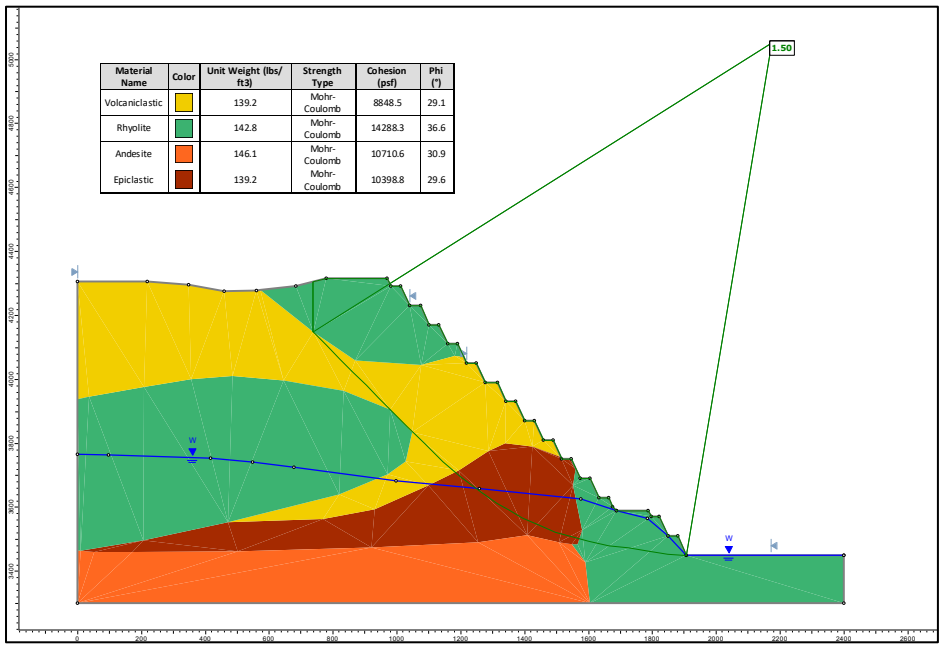


Figure 3-4. Section 2, Assuming 2030 Water Surface

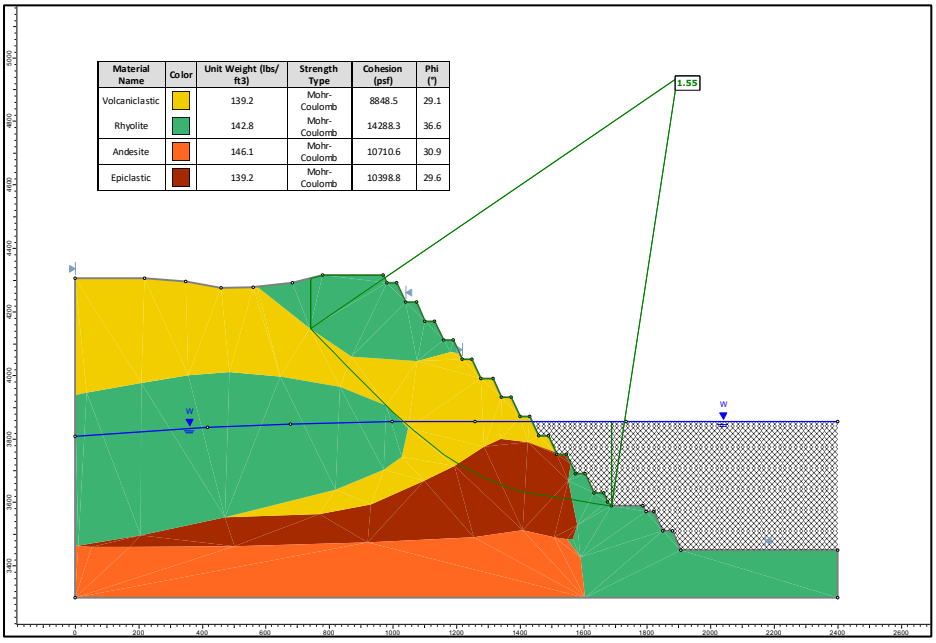


Figure 3-5. Section 2, Assuming 2023 Water Surface

3.1.3 Section 3

Section 3 is located on the southwest wall of the JSLA Pit. For the 2030 and 2023 (Pit Lake) water condition scenarios, the FoS is 1.24 and 1.43, and resulting slip surfaces are presented in Figure 3-6 and Figure 3-7, respectively.

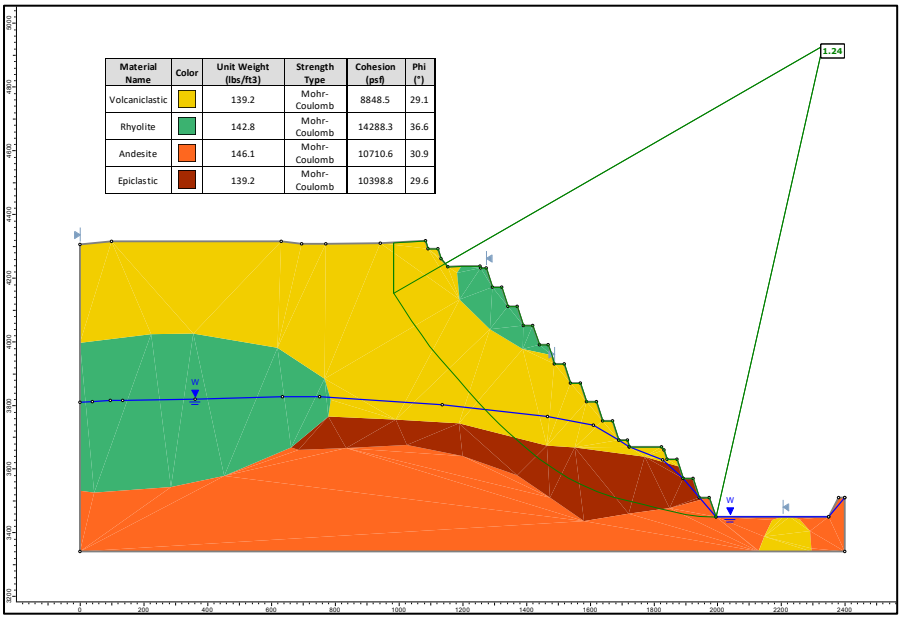


Figure 3-6. Section 3, Assuming 2030 Water Surface

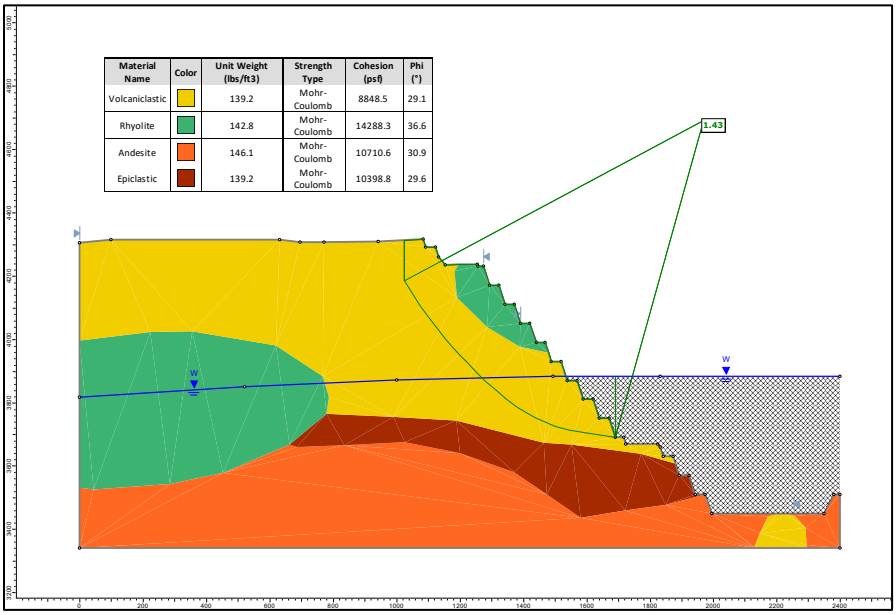


Figure 3-7. Section 3, Assuming 2023 Water Surface

3.1.4 Section 4

Section 4 is located on the northwest wall of the JSLA Pit. For the 2030 and 2023 (Pit Lake) water condition scenarios, the FoS is 1.29 and 1.59, and resulting slip surfaces are presented in **Figure 3-8** and **Figure 3-9**, respectively.

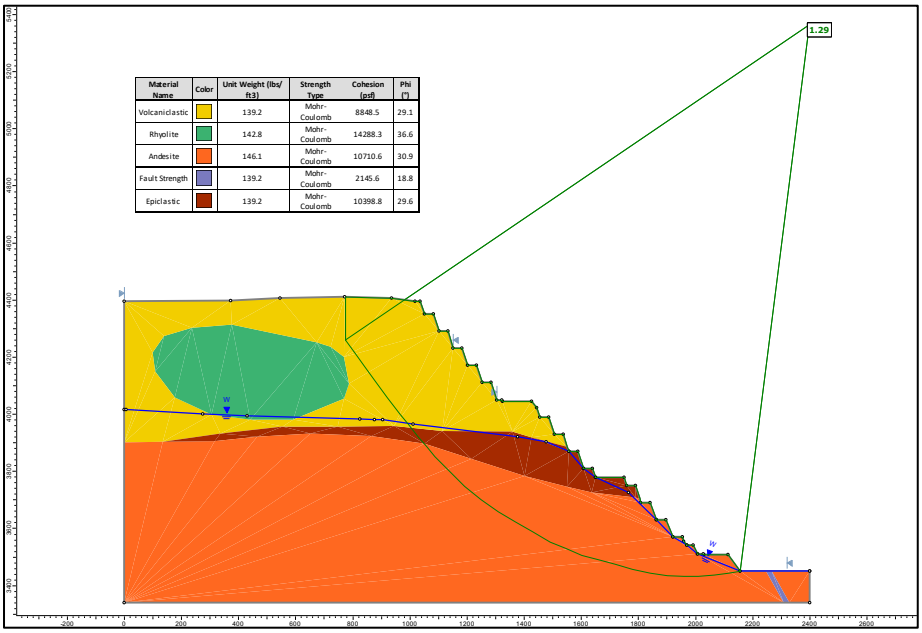


Figure 3-8. Section 4, Assuming 2030 Water Surface

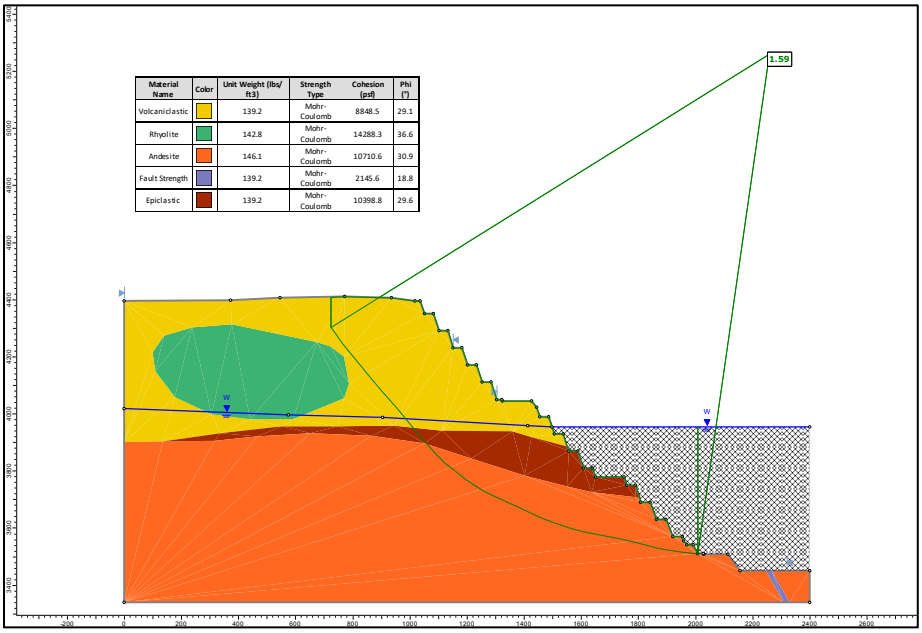


Figure 3-9. Section 4, Assuming 2023 Water Surface

3.1.5 Section 5

Section 5 is located on the southeast wall of the Oro Belle Pit. For the 2036 and 2023 (Pit Lake) water condition scenarios, the FoS is 1.60 and 1.60, and resulting slip surfaces are presented in **Figure 3-10** and **Figure 3-11**, respectively.

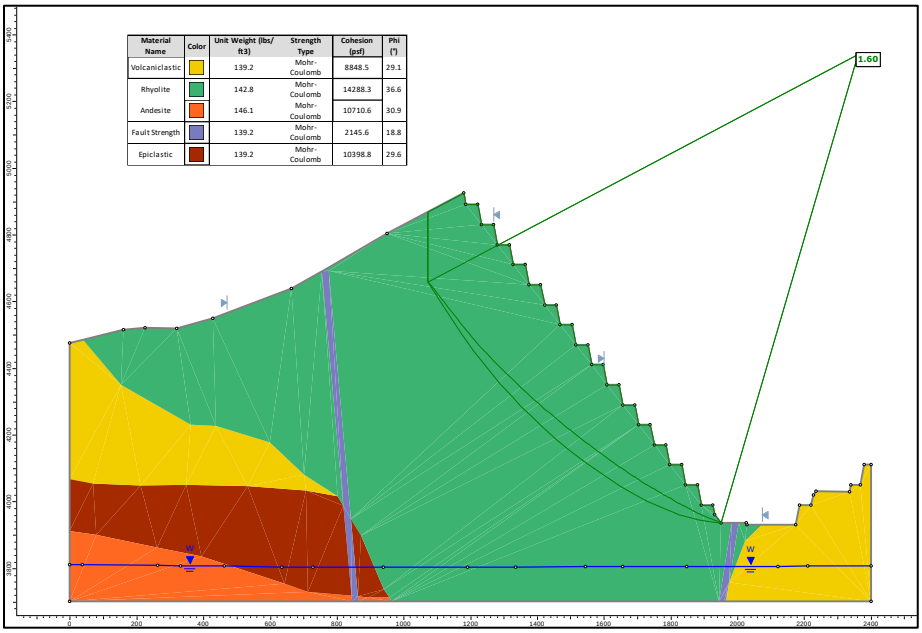


Figure 3-10. Section 5, Assuming 2036 Water Surface

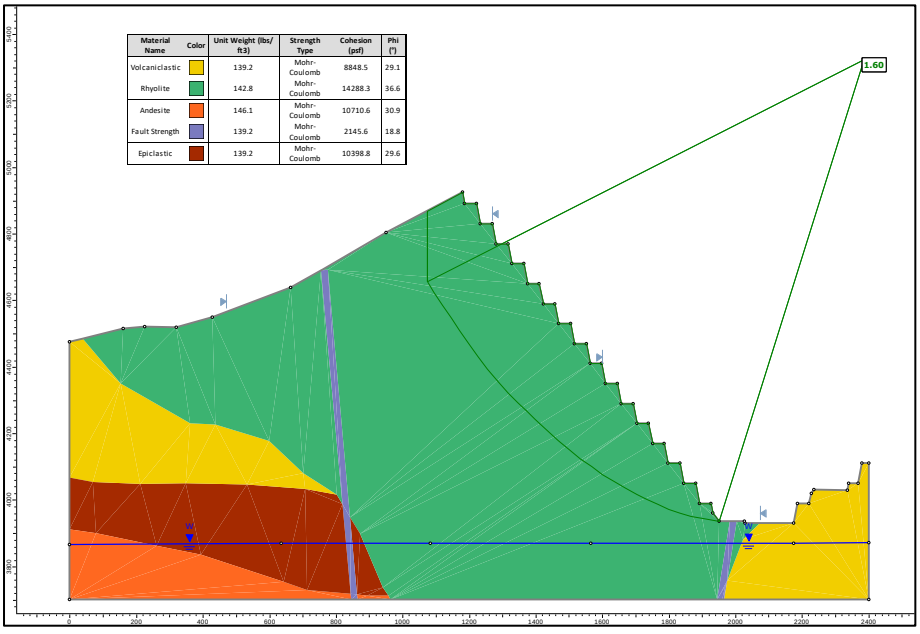


Figure 3-11. Section 5, Assuming 2023 Water Surface

3.1.6 Section 6 - East

Section 6 - East is located on the west wall of the Oro Belle Pit. For the 2036 and 2023 (Pit Lake) water condition scenarios, the FoS of the provided design is 1.11 and 1.11, and resulting slip surfaces are presented in **Figure 3-12** and **Figure 3-13**, respectively. By decreasing the slope height to 4410 feet instead of 4470 feet, the FoS is increased to 1.20, as shown in **Figure 3-14**.

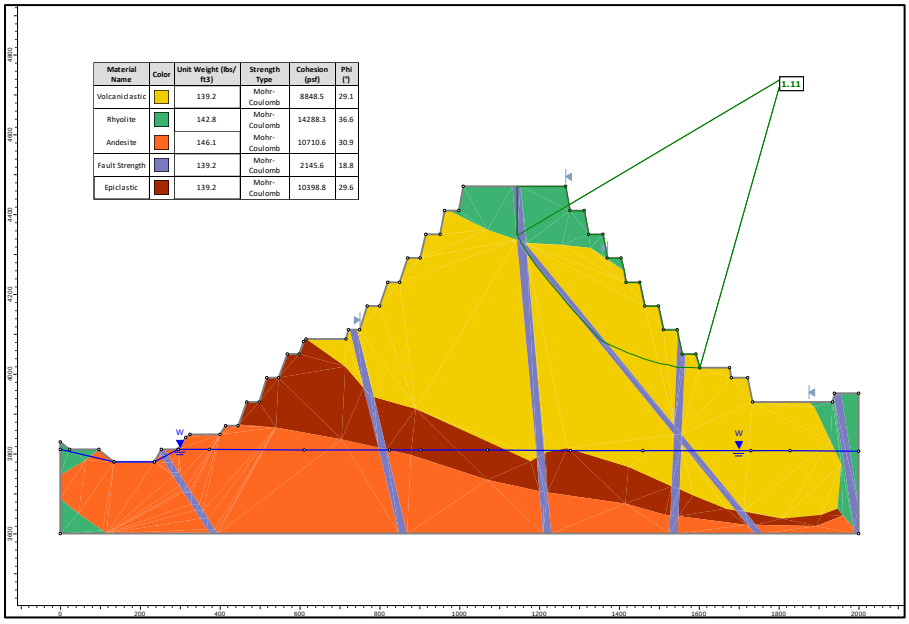


Figure 3-12. Section 6 – East, Assuming 2036 Water Surface

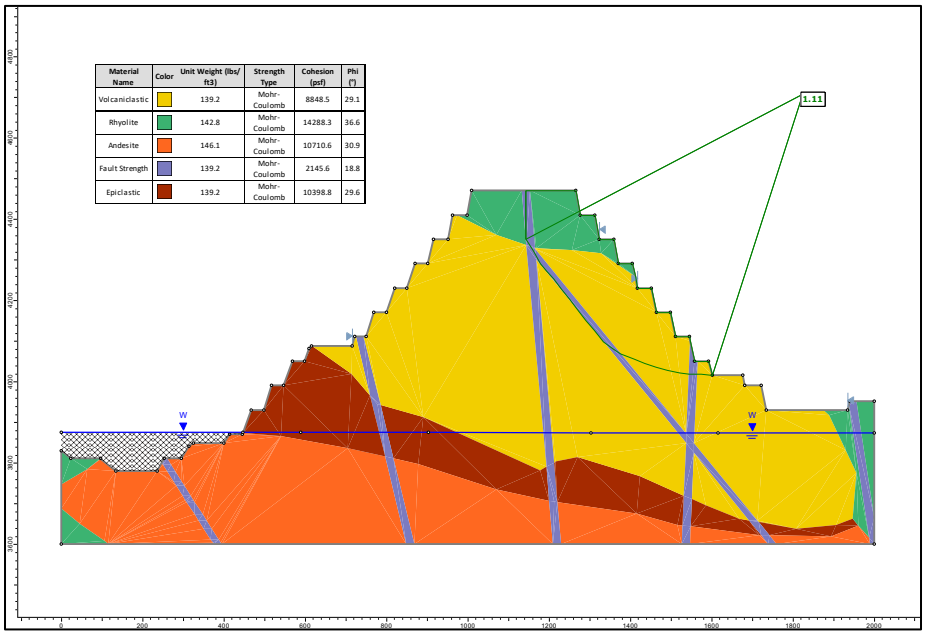


Figure 3-13. Section 6 – East, Assuming 2023 Water Surface

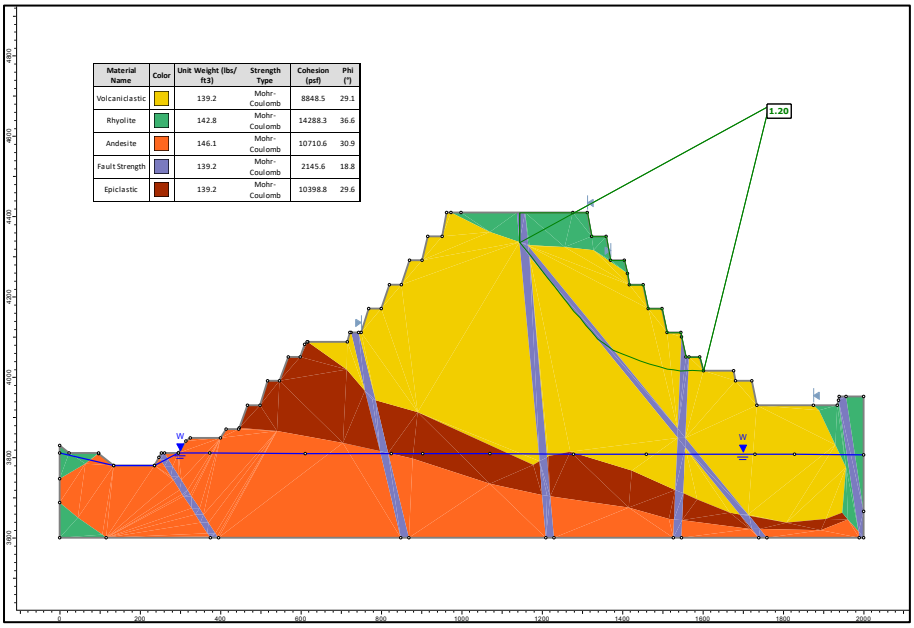


Figure 3-14. Section 6 – East, Assuming 2036 Water Surface (Modified Design)

3.1.7 Section 6 - West

Section 6 - West is located on the eastern wall of the Jumbo Pit. For the 2033 and 2023 (Pit Lake) water condition scenarios, the FoS is 1.61 and 1.60, and resulting slip surfaces are presented in **Figure 3-15** and **Figure 3-16**, respectively.

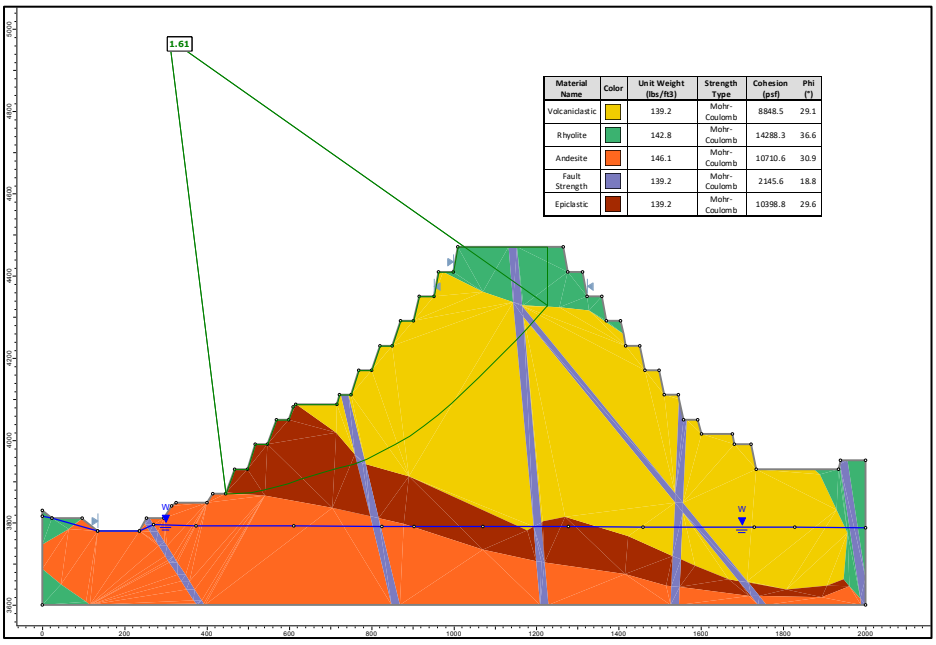


Figure 3-15. Section 6 – West, Assuming 2033 Water Surface

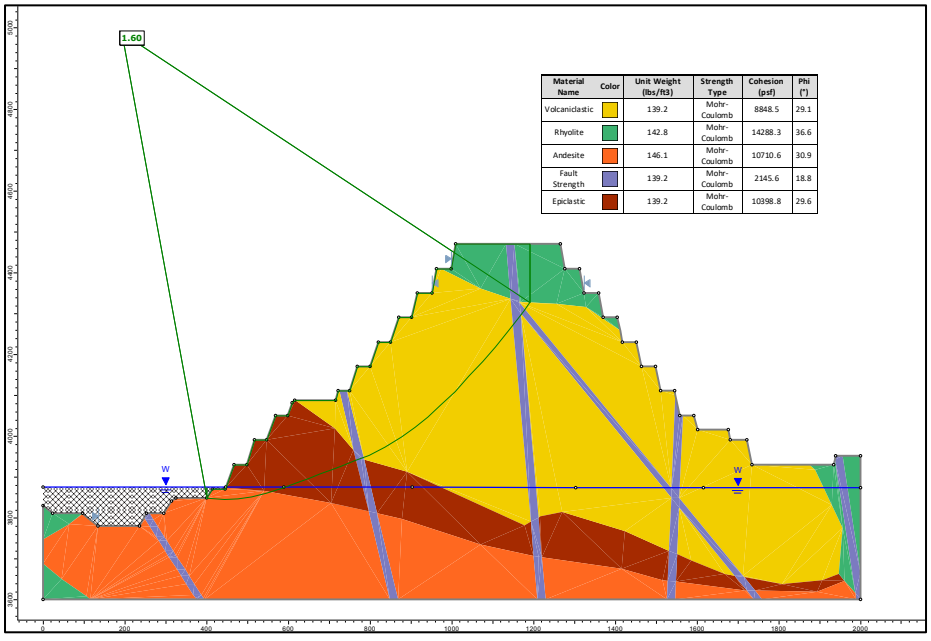


Figure 3-16. Section 6 – West, Assuming 2023 Water Surface

3.1.8 Section 7

Section 7 is located on the northwest wall of the Jumbo Pit. For the 2033 and 2023 (Pit Lake) water condition scenarios, the FoS is 1.48 and 1.48, and resulting slip surfaces are presented in **Figure 3-17** and **Figure 3-18**, respectively.

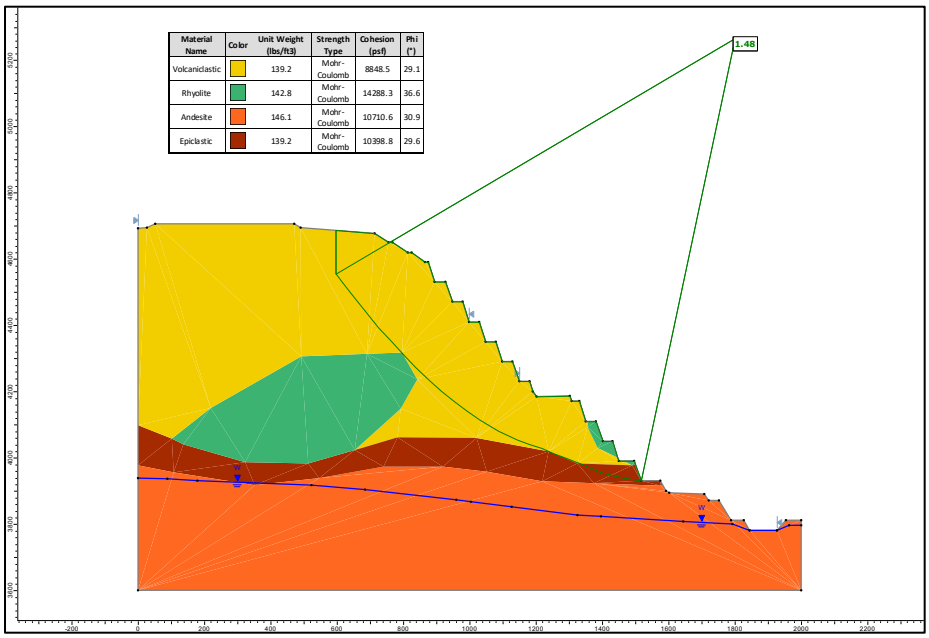


Figure 3-17. Section 7, Assuming 2033 Water Surface

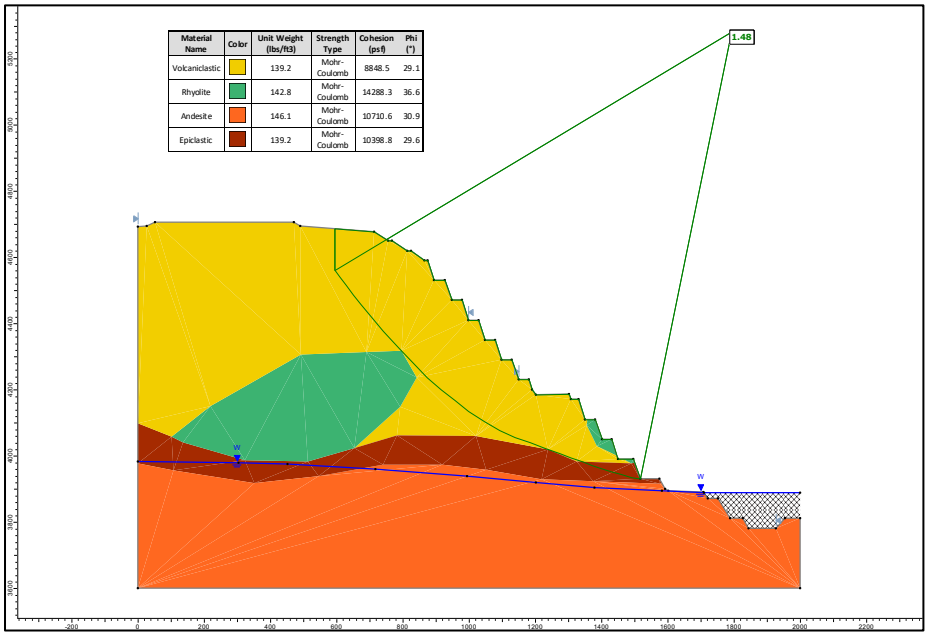


Figure 3-18. Section 7, Assuming 2023 Water Surface

3.1.9 Section 8

Section 8 is located on the east wall of the Oro Belle Pit. For the 2036 and 2023 (Pit Lake) water condition scenarios, the FoS is 1.94 and 1.94, and resulting slip surfaces are presented in **Figure 3-19** and **Figure 3-20**, respectively.

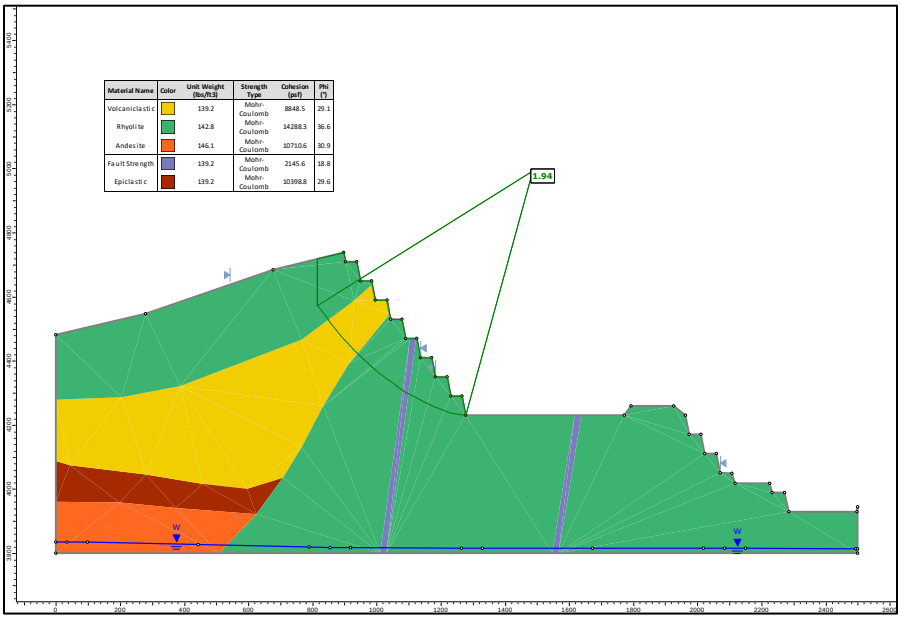


Figure 3-19. Section 8, Assuming 2036 Water Surface

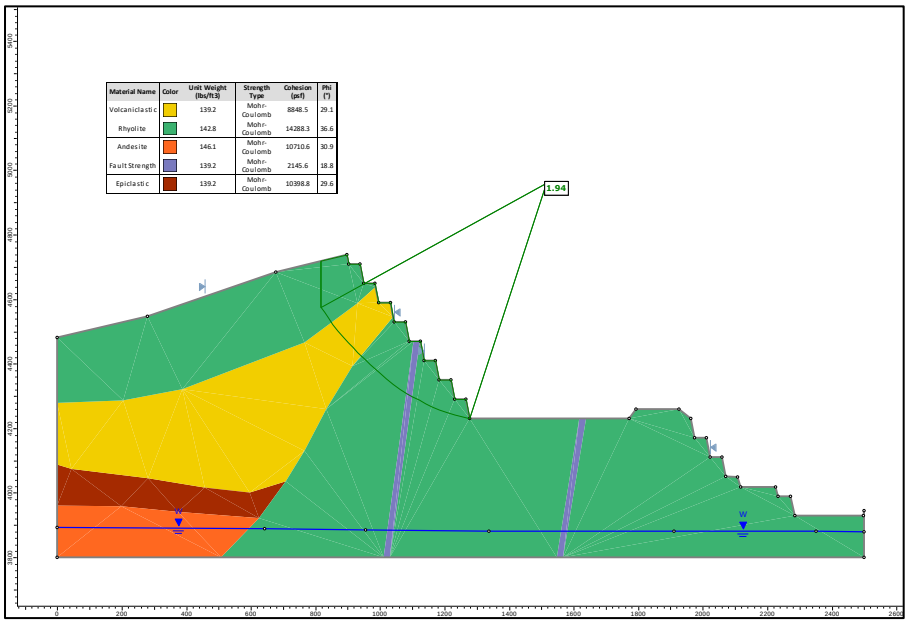


Figure 3-20. Section 8, Assuming 2023 Water Surface

3.1.10 Section 9

Section 9 is located on the north wall of the Oro Belle Pit. For the 2036 and 2023 (Pit Lake) water condition scenarios, the FoS is 1.45 and 1.45, and resulting slip surfaces are presented in **Figure 3-21** and **Figure 3-22**, respectively.

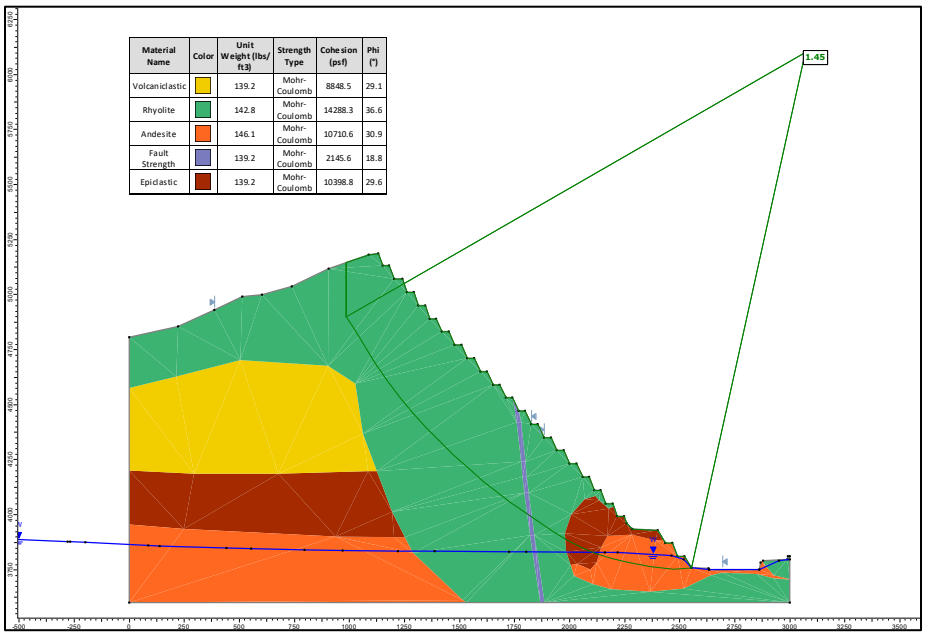


Figure 3-21. Section 9, Assuming 2036 Water Surface

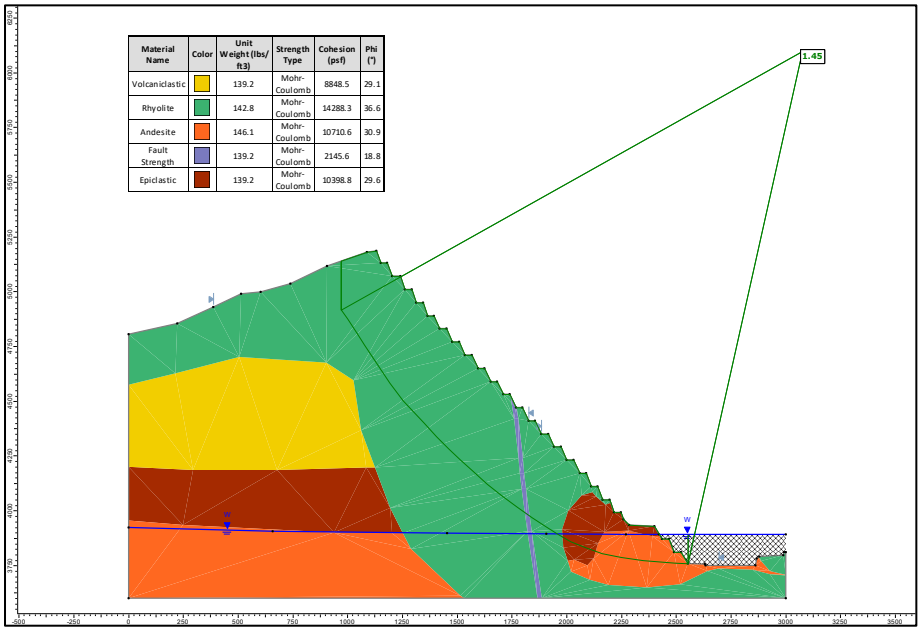


Figure 3-22. Section 9, Assuming 2023 Water Surface

EIR APPENDIX 8

Technical Report on the Feasibility Study (M3 2021)

Effective Date:
February 26, 2021
Issue Date:
March 17, 2021
Revision 0

ARCHITECTURE
ENGINEERING
CONSTRUCTION MANAGEMENT

Castle Mountain Project



Technical Report on the Castle Mountain Project Feasibility Study

San Bernardino County, California, USA

Gabriel Secrest, P.E.
Laurie M. Tahija, P.E.
Eleanor Black, P. Geo
Trevor Rabb, P. Geo
John Nilsson, P.Eng.
R. Douglas Bartlett, PG, CPG

Prepared For:

EQUINOX GOLD

DATE AND SIGNATURES PAGE

The effective date of this report is February 26, 2021. The issue date of this report is March 17, 2021. See Appendix A, Feasibility Study Contributors and Professional Qualifications, for certificates of qualified persons.

(Signed) "*Gabriel Secrest*"	March 17, 2021
Gabriel Secrest, P.E.	Date
(Signed) "*Laurie M. Tahija*"	March 17, 2021
Laurie M. Tahija, P.E.	Date
(Signed) "*Eleanor Black*"	March 17, 2021
Eleanor Black, P. Geo	Date
(Signed) "*Trevor Rabb*"	March 17, 2021
Trevor Rabb, P. Geo	Date
(Signed) "*John Nilsson*"	March 17, 2021
John Nilsson, P.Eng.	Date
(Signed) "*R. Douglas Bartlett*"	March 17, 2021
R. Douglas Bartlett, PG, CPG	Date

CASTLE MOUNTAIN PROJECT
TECHNICAL REPORT ON THE CASTLE MOUNTAIN PROJECT FEASIBILITY STUDY

TABLE OF CONTENTS

SECTION PAGE

DATE AND SIGNATURES PAGE II
TABLE OF CONTENTS III
LIST OF FIGURES AND ILLUSTRATIONS XIV
LIST OF TABLES XXI
LIST OF APPENDICES XXVII
1 SUMMARY 1-1
1.1 INTRODUCTION 1-1
1.2 PROPERTY LOCATION AND INFRASTRUCTURE 1-1
1.3 PROPERTY OWNERSHIP 1-3
1.4 CLIMATE AND PHYSIOGRAPHY 1-4
1.5 HISTORY 1-5
1.6 GEOLOGICAL SETTING 1-5
1.7 EXPLORATION AND DRILLING 1-6
1.8 SAMPLING AND VERIFICATION 1-6
1.9 MINERAL PROCESSING AND METALLURGICAL TESTING 1-8
1.10 MINERAL RESOURCE ESTIMATES 1-8
1.11 MINERAL RESERVE ESTIMATES 1-10
1.12 MINING 1-11
1.13 RECOVERY METHODS 1-15
1.14 PROJECT INFRASTRUCTURE 1-18
1.15 ENVIRONMENTAL PERMITTING AND REQUIREMENTS 1-20
1.16 CAPITAL AND OPERATING COST 1-21
1.17 ECONOMIC ANALYSIS 1-23
1.18 CONCLUSIONS 1-29
1.18.1 General 1-29
1.18.2 Geology and Mineral Resource Estimate 1-29
1.18.3 Mining and Mineral Reserve Estimate 1-29
1.18.4 Mineral Processing and Metallurgical Testing 1-30
1.18.5 Project Infrastructure 1-30
1.18.6 Environmental Studies and Permitting 1-31
1.18.7 Cost Estimates 1-31

1.19 RECOMMENDATIONS 1-32
2 INTRODUCTION 2-1
2.1 ISSUER AND PURPOSE 2-1
2.2 SOURCES OF INFORMATION AND QUALIFIED PERSONS 2-1
2.2.1 Qualified Persons 2-1
2.2.2 Notable Personal Inspection Details 2-2
2.2.3 Other Sources of Information 2-2
2.3 UNITS OF MEASURE 2-2
2.4 TERMS OF REFERENCE 2-2
3 RELIANCE ON OTHER EXPERTS 3-1
4 PROPERTY DESCRIPTION AND LOCATION 4-1
4.1 LOCATION 4-1
4.2 PROPERTY AND TITLE IN SAN BERNARDINO, CALIFORNIA 4-2
4.2.1 Mineral Rights 4-2
4.2.2 Acquisition of Castle Mountain Venture 4-3
4.3 CALIFORNIAN LAND RIGHTS 4-3
4.3.1 Annual Claim Maintenance Payments to BLM 4-3
4.3.2 Annual Property Tax Payments to San Bernardino Country, CA 4-3
4.3.3 Title Report 4-4
4.4 ROYALTIES 4-4
4.5 PERMITTING 4-5
4.6 ENVIRONMENTAL LIABILITIES 4-7
4.7 LAND SUMMARY & SIGNIFICANT RISK FACTORS 4-7
5 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY 5-1
5.1 ACCESSIBILITY 5-1
5.2 CLIMATE 5-2
5.3 LOCAL RESOURCES AND INFRASTRUCTURE 5-3
5.4 PHYSIOGRAPHY 5-5
6 HISTORY 6-1
6.1 HISTORICAL MINING 6-1
6.2 HISTORICAL GOLD EXPLORATION 6-1
6.2.1 Vanderbilt Gold Corporation, 1968 – 1980 6-1
6.2.2 Vanderbilt Gold Corporation – B&B Mining, 1981 – 1984 6-1
6.2.3 Freeport Mineral Ventures, 1980 – 1985 6-2
6.2.4 B & B Mining / Viceroy Gold, 1984 – 1985 6-2

6.2.5 Hemlo / Noranda Exploration, 1987 – 1990 6-2
6.2.6 Viceroy Gold, 1985 – 1991 6-2
6.2.7 Viceroy Gold/MK Gold, 1991 – 2001 6-3
6.3 PAST PRODUCTION 6-5
6.4 EQUINOX MINERAL RESOURCE ESTIMATES 6-9
6.4.1 Pre-Feasibility Mineral Resource Statement 6-9
7 GEOLOGICAL SETTING AND MINERALIZATION 7-1
7.1 REGIONAL GEOLOGICAL SETTING 7-1
7.2 LOCAL GEOLOGY 7-2
7.3 PROJECT GEOLOGY 7-5
7.3.1 Lithology 7-6
7.3.2 Trachydacite (Dacite) Dikes 7-7
7.3.3 Structure 7-15
7.3.4 Mineralization 7-16
8 DEPOSIT TYPES 8-1
9 EXPLORATION 9-1
9.1 SURVEYING 9-1
9.2 MAPPING 9-1
9.3 GEOCHEMICAL SAMPLING 9-1
9.4 GEOPHYSICS 9-4
10 DRILLING 10-1
10.1 VICEROY LEGACY HARD ROCK DRILLING 10-5
10.2 EQUINOX HARD ROCK DRILLING 10-5
10.2.1 Hard Rock Exploration Drilling 10-5
10.2.2 Metallurgical Drilling 10-7
10.2.3 Geotechnical Drill Holes 10-7
10.2.4 Condemnation Drill Holes 10-7
10.3 EQUINOX BACKFILL & WASTE DUMP DRILLING 10-8
10.3.1 Equinox 2017 RAB Drilling 10-8
10.3.2 Equinox 2018 RC Drilling 10-9
10.3.3 Equinox 2018 RAB Drilling 10-9
10.4 EQUINOX DRILLING METHODS & PROCEDURES 10-9
10.4.1 Drilling Methodology 10-9
10.4.2 Drilling Procedures 10-10
11 SAMPLE PREPARATION, ANALYSES AND SECURITY 11-1
11.1 VICEROY HARD ROCK SAMPLING METHODS 11-1
11.1.1 Sampling and Security 11-1
11.1.2 Analyses 11-1

11.1.3 Quality Assurance and Quality Control 11-2
11.1.4 Production Blasthole Samples 11-2
11.2 EQUINOX SAMPLING 11-2
11.2.1 Sampling and Security 11-2
11.2.2 Analyses 11-3
11.2.3 Quality Assurance and Quality Control 11-4
11.3 BULK DENSITY 11-6
11.4 DATABASES 11-6
11.5 DATA ADEQUACY 11-7
12 DATA VERIFICATION 12-1
12.1 RESOURCE DATA VERIFICATION 12-1
12.2 DRILL HOLE LOCATION DATA 12-1
12.2.1 Drill Hole Collar Location Verification 12-1
12.2.2 Drill Hole Downhole Survey Verification 12-1
12.3 RESOURCE ASSAY RESULT VERIFICATION 12-2
12.3.1 Performance of the Equinox Hard Rock & Backfill QA/QC Samples 12-2
12.4 VICEROY SAMPLE RESULTS 12-6
12.4.1 Twin Hole Analysis 12-7
12.4.2 Downhole Contamination of RC Samples 12-9
12.4.3 Composite Pair Analysis 12-12
12.5 BULK DENSITY 12-18
12.6 DATA ADEQUACY 12-18
13 MINERAL PROCESSING AND METALLURGICAL TESTING 13-1
13.1 INTRODUCTION 13-1
13.2 SUMMARY OF TESTWORK 13-1
13.3 METALLURGICAL TESTWORK SAMPLING ORIGIN AND COMPOSITES 13-4
13.4 SAMPLE ELEMENT ANALYSIS 13-10
13.5 HEAP LEACH TESTING 13-13
13.5.1 2015 ROM and Crushed Ore Column Testing 13-13
13.5.2 2018 ROM Column Leach and Crushed Ore Bottle Roll Testing 13-14
13.5.3 2020 Testing 13-16
13.5.4 Heap Leach Ore Gold Recovery 13-24
13.6 MILL GRADE ORE TESTING 13-28
13.6.1 2015 and 2018 Testing 13-28
13.6.2 2020 Testing 13-29
13.6.3 Mill Grade Ore Gold Recovery 13-33

13.7 MILL GRADE ORE MASTER COMPOSITE 2020 TESTING 13-37
13.7.1 Sample Prep and Grinding 13-37
13.7.2 Bulk CIL for Tailings Tests 13-37
13.7.3 Cyanide Detox Testing 13-38
13.7.4 Thickening 13-39
13.7.5 Filtration 13-40
13.8 OTHER TESTWORK AND ANALYSIS 13-41
13.8.1 Blast & Fragmentation Analysis 13-41
13.8.2 Sulfur Speciation 13-41
13.8.3 Carbon Adsorption Rate and Capacity 13-43
13.8.4 Oxygen Uptake Rate 13-45
13.8.5 Compacted Permeability Testing 13-46
13.8.6 Mineralogy 13-47
13.8.7 Viscosity 13-51
13.8.8 Ore Sorting Tests 13-52
13.9 PRODUCTION DATA 13-53
13.10 RECOVERY SUMMARY 13-55
13.10.1 Overall Heap Leach Recovery 13-55
13.10.2 Overall Mill Grade Ore Recovery 13-55
14 MINERAL RESOURCE ESTIMATES 14-1
14.1 INTRODUCTION 14-1
14.2 METHODOLOGY 14-1
14.3 DRILL HOLE DATABASE 14-2
14.4 GEOLOGICAL MODELLING 14-3
14.4.1 Topography 14-3
14.4.2 Lithology Model 14-3
14.4.3 Alteration Model 14-4
14.4.4 Oxidation Model 14-7
14.4.5 Fault Models 14-8
14.4.6 Grade Shell Domains 14-10
14.4.7 JSLA Backfill Model 14-12
14.5 COMPOSITING AND CAPPING 14-13
14.5.1 Hard Rock Model 14-14
14.5.2 Backfill Model 14-17
14.6 CONTACT ANALYSIS 14-17
14.7 STATISTICAL ANALYSIS 14-20
14.8 VARIOGRAPHY 14-22
14.9 BULK DENSITY 14-27
14.10 BLOCK MODEL AND GRADE ESTIMATION METHODOLOGY 14-28
14.11 MODEL VALIDATION 14-31

14.11.1 Swath Plots 14-31
14.11.2 Cross Validation 14-37
14.11.3 Comparisons to Historical Production and Production Drilling 14-40
14.11.4 Comparisons to Other Estimation Techniques 14-40
14.12 MINERAL RESOURCE CLASSIFICATION 14-41
14.13 MINERAL RESOURCE STATEMENT 14-43
14.14 COMPARISON WITH 2018 RESOURCE ESTIMATE 14-47
14.15 FACTORS THAT MAY AFFECT THE MINERAL RESOURCE 14-48
15 MINERAL RESERVE ESTIMATES 15-1
15.1 INTRODUCTION 15-1
15.2 OPEN PIT OPTIMIZATION 15-1
15.2.1 General 15-1
15.2.2 Economic Parameters Applied to Mine Design 15-2
15.2.3 Metallurgical Parameters 15-4
15.2.4 Block Model 15-6
15.2.5 Pit Limit Analysis 15-11
15.3 MINERAL RESERVE SUMMARY 15-18
16 MINING METHODS 16-1
16.1 INTRODUCTION 16-1
16.2 SUMMARY 16-1
16.2.1 Project Description 16-1
16.2.2 Resources and Mineable Reserves 16-1
16.2.3 Open Pit Mine Plan 16-3
16.2.4 Waste Rock Storage and Stockpile Plan 16-5
16.3 OPEN PIT DESIGN 16-5
16.3.1 General 16-5
16.3.2 Design Summary 16-5
16.3.3 Waste and Low-Grade Storage 16-10
16.3.4 Haulage Roads 16-12
16.4 MINE PRODUCTION SCHEDULE 16-13
16.4.1 Summary 16-13
16.4.2 Cut-off Grade Selection 16-13
16.4.3 Pit Sequencing 16-14
16.4.4 Production Schedule Summary 16-15
16.4.5 Mine Development Pre-Production and Year 4 16-18
16.4.6 Mine Development Year 5 16-20
16.4.7 Mine Development Year 6 to Year 8 16-21
16.4.8 Mine Development Year 9 to Year 12 16-22
16.4.9 Mine Development Year 13 to Year 16 16-23
16.4.10 Mine Development Year 17 to Year 19 16-24

16.4.11 Engineering and Grade Control 16-25
16.5 MINE EQUIPMENT 16-26
16.5.1 Summary 16-26
16.5.2 Major Mine Equipment Operating Parameters 16-27
16.5.3 Drilling & Blasting 16-27
16.5.4 Loading 16-28
16.5.5 Haulage 16-28
16.5.6 Mine Support Equipment 16-29
16.5.7 Manpower 16-30
16.6 MINE ANCILLARY FACILITIES 16-32
16.6.1 Service Complex 16-32
16.6.2 Mine Electrical Power 16-32
16.6.3 Mine Dispatch 16-32
16.6.4 Mine Water Management 16-32
16.6.5 Fuel Storage 16-32
16.7 MINE OPERATING COST ESTIMATE 16-33
16.7.1 Summary 16-33
16.7.2 General 16-34
16.8 MINE CAPITAL COSTS 16-35
16.8.1 Capital Cost Estimate Summary 16-35
16.9 OPPORTUNITIES 16-38
16.10 RECOMMENDATIONS 16-38
17 RECOVERY METHODS 17-1
17.1 INTRODUCTION AND GENERAL DESCRIPTION 17-1
17.2 MAJOR EQUIPMENT AND FACILITIES 17-5
17.3 PROCESS DESCRIPTION 17-6
17.3.1 Heap Leaching 17-6
17.3.2 Crushing and Crushed Ore Storage 17-15
17.3.3 Grinding and Gravity Concentration 17-17
17.3.4 Leaching 17-18
17.3.5 Tailings Management 17-19
17.3.6 Carbon Handling 17-20
17.3.7 Electrowinning, Retorting and Refining 17-22
17.3.8 Reagents and Grinding Media 17-24
17.3.9 Process Water Balance 17-27
17.3.10 Air Supply and Distribution 17-29
17.3.11 Electrical Power Requirements 17-29
17.3.12 Sampling 17-30
17.4 INSTRUMENTATION AND CONTROLS 17-30
18 PROJECT INFRASTRUCTURE 18-1
18.1 ACCESSIBILITY 18-1

18.1.1 Off-site Access Roads 18-1
18.1.2 Security Gatehouse 18-1
18.1.3 Site Fencing 18-1
18.1.4 On-site Access Roads 18-3
18.2 SITE DEVELOPMENT 18-3
18.2.1 Mill Siting Study 18-3
18.2.2 Topsoil Handling and Stockpile 18-4
18.2.3 Surface Plant Area Geotechnical Investigation 18-4
18.2.4 Mine Geotechnical Investigation 18-6
18.3 MINE INFRASTRUCTURE 18-6
18.3.1 Truck Shop 18-6
18.3.2 Truck Fuel Storage and Dispensing 18-7
18.3.3 Tire Pad 18-7
18.3.4 Truck Wash 18-7
18.4 PROCESS PLANT INFRASTRUCTURE 18-7
18.4.1 Administration and Offices 18-7
18.4.2 Process Maintenance Building 18-7
18.4.3 Warehouse and Reagents Storage Building 18-7
18.4.4 Laboratory 18-7
18.5 SITE WIDE WATER BALANCE AND SUPPLY 18-8
18.5.1 Climatic Data 18-8
18.5.2 Water Demand 18-9
18.5.3 Water Supply 18-10
18.5.4 Potable Water Distribution 18-13
18.5.5 Fire Water Protection System 18-13
18.5.6 Non-Contact Water Management 18-14
18.6 FILTERED TAILINGS FACILITY 18-17
18.6.1 Tailings Stacking Operation 18-17
18.6.2 Tailings Material Characterization 18-22
18.6.3 Tailings Facility Design 18-22
18.7 POWER 18-24
18.7.1 Power Supply 18-24
18.7.2 Alternative Power Supply 18-25
18.7.3 Project Electrical Loads 18-26
18.7.4 Power Distribution 18-26
18.8 SEWAGE AND WASTE 18-26
18.8.1 Sewage Handling 18-26
18.8.2 Solid Waste 18-26
18.8.3 Hazardous Waste 18-27
18.9 COMMUNICATION & CONTROLS 18-27
19 MARKET STUDIES AND CONTRACTS 19-1

20 ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT 20-1
20.1 ENVIRONMENTAL STUDIES 20-2
20.1.1 Flora and Fauna 20-2
20.1.2 Air Quality and Greenhouse Gas Emissions 20-4
20.1.3 Hydrology and Hydrogeology 20-5
20.1.4 Cultural Resources 20-7
20.1.5 Acid Rock Drainage Potential 20-8
20.1.6 Visual Impact 20-8
20.2 PROJECT PERMITTING AND PERMITTING PROCESS 20-9
20.2.1 Federal and State Environmental Reviews 20-9
20.2.2 Discretionary Operating Permits 20-9
20.2.3 Non-Discretionary Operating Permits 20-10
20.2.4 BLM Right-of-Way Permits 20-13
20.2.5 Local Air District 20-13
20.2.6 Water Extraction Rights 20-14
20.3 LAND USE AND PROPERTY 20-16
20.3.1 Mojave National Preserve 20-16
20.3.2 Castle Mountains National Monument 20-16
20.4 SOCIAL AND COMMUNITY IMPACT 20-16
20.5 MINE CLOSURE AND RECLAMATION 20-17
20.5.1 Financial Assurance 20-19
21 CAPITAL AND OPERATING COSTS 21-1
21.1 CAPITAL COST ESTIMATE 21-1
21.1.1 Design Basis 21-3
21.1.2 Installation Cost Basis (Labor Rates and Construction Equipment) 21-4
21.1.3 Process & Infrastructure Equipment Cost Basis 21-6
21.1.4 Bulk Commodities Cost Basis 21-6
21.1.5 Cost Basis (Freight) 21-8
21.1.6 Cost Basis (Indirect Costs) 21-8
21.1.7 Mining Capital Cost 21-11
21.1.8 Sustaining Capital Cost 21-12
21.1.9 Mining Sustaining Capital Cost 21-13
21.2 OPERATING COST ESTIMATE 21-15
21.2.1 Summary – Operating Cost 21-15
21.2.2 Mining Operating Cost 21-16
21.2.3 Process Plant Operating Cost 21-20
21.2.4 General and Administrative Costs 21-25
22 ECONOMIC ANALYSIS 22-1
22.1 INTRODUCTION 22-1

22.2 SUMMARY ECONOMIC ANALYSIS 22-1
22.3 MINE PRODUCTION STATISTICS 22-3
22.4 PLANT PRODUCTION STATISTICS 22-3
22.5 PRODUCTION SCHEDULE PARAMETERS 22-3
22.6 CAPITAL EXPENDITURE 22-4
22.6.1 Initial and Sustaining Capital 22-4
22.6.2 Working Capital 22-5
22.6.3 Salvage Value 22-5
22.6.4 Reclamation/Closure Costs 22-5
22.7 NET REVENUE 22-6
22.8 ROYALTIES 22-6
22.9 OPERATING COST 22-6
22.10 TAXATION 22-6
22.10.1 Depreciation 22-7
22.10.2 Depletion 22-7
22.11 PROJECT FINANCIAL INDICATORS 22-7
22.11.1 Sensitivity Analysis 22-10
23 ADJACENT PROPERTIES 23-1
24 OTHER RELEVANT DATA AND INFORMATION 24-1
24.1 PROJECT IMPLEMENTATION 24-1
24.1.1 Optimization and FEED 24-1
24.1.2 Basic and Detailed Engineering 24-1
24.1.3 Contract Development 24-2
24.1.4 Project Construction 24-2
25 INTERPRETATION AND CONCLUSIONS 25-1
25.1 CONCLUSIONS 25-1
25.1.1 General 25-1
25.1.2 Geology and Mineral Resource Estimate 25-1
25.1.3 Mining and Mineral Reserve Estimate 25-1
25.1.4 Mineral Processing and Metallurgical Testing 25-2
25.1.5 Project Infrastructure 25-2
25.1.6 Environmental Studies and Permitting 25-3
25.1.7 Cost Estimates 25-3
25.2 RISKS 25-4
25.2.1 Permitting 25-4
25.2.2 Gold Recovery 25-4
25.2.3 Water Supply 25-4
25.2.4 Filtered Tailings 25-5
25.2.5 Geotechnical 25-5

25.3 OPPORTUNITIES 25-5
25.3.1 Supplemental Solar Power 25-5
25.3.2 Exploration 25-6
25.3.3 Plant and Infrastructure Design 25-7
26 RECOMMENDATIONS 26-1
26.1 GENERAL 26-1
26.2 ASSAY MANAGEMENT AND GEOLOGIC MODELING 26-1
26.3 MINERAL RESOURCE 26-1
26.4 MINING 26-1
26.5 HEAP LEACH 26-1
26.6 METALLURGICAL AND PROCESS PLANT 26-1
26.7 PROJECT INFRASTRUCTURE 26-2
27 REFERENCES 27-1
APPENDIX A: FEASIBILITY STUDY CONTRIBUTORS AND PROFESSIONAL QUALIFICATIONS ..... A

LIST OF FIGURES AND ILLUSTRATIONS

FIGURE	DESCRIPTION	PAGE
Figure 1-1:	Site Location and Access Map	1-3
Figure 1-2:	Material Movement by Phase	1-12
Figure 1-3:	ROM Ore by Phase	1-12
Figure 1-4:	Mill Ore Processed	1-13
Figure 1-5:	Phase 1 to Phase 2 Timeline	1-14
Figure 1-6:	Process Plant 3D View Looking Northwest	1-18
Figure 1-7:	Overall Project Site Plan	1-19
Figure 1-8:	Phase 2 Schedule	1-24
Figure 1-9:	Initial Capital Spend Plan (Quarterly)	1-26
Figure 1-10:	Sensitivity Chart	1-27
Figure 4-1:	Location Map – Castle Mountain Project	4-1
Figure 4-2:	Tenure Map for the Castle Mountain Mine	4-2
Figure 4-3:	Map of Net Smelter Royalties	4-5
Figure 4-4:	Map of Permitted Work Area, Castle Mountain Project	4-7
Figure 5-1:	Property Access Map, Castle Mountain Project	5-2
Figure 5-2:	Site Infrastructure Map, Castle Mountain Mine (July 1st, 2020 Representation)	5-4
Figure 5-3:	Castle Mountain Phase 1 Process Plant Aerial View	5-5
Figure 5-4:	Site Typical Flora; Joshua Tree and Scrub Brush in the Foreground	5-6
Figure 6-1:	Map of Legacy Target Areas (dated 2002)	6-5
Figure 6-2:	Historic Viceroy Mining and Processing Infrastructure	6-7
Figure 7-1:	Location Map of Castle Mountains in SE California and SW Nevada	7-1
Figure 7-2:	Schematic Stratigraphic Section for the Castle Mountain Property	7-4
Figure 7-3:	Schematic Reconstruction of the Principal Lithologic and Stratigraphic Elements – Derived from Detailed Mapping and Logging at the Castle Mountain Project (Not to Scale)	7-5
Figure 7-4:	Castle Mountain Project Geology	7-8
Figure 7-5:	Cross Section of the Castle Mountain Project Geological Model	7-15
Figure 7-6:	Schematic Model for Zone of Gold Mineralization Found on the Castle Mountain Property	7-17
Figure 8-1:	High Sulfidation Epithermal (HSE) Deposits vs. Low Sulfidation Epithermal (LSE) Deposits	8-2
Figure 9-1:	Map of Castle Mountain Exploration Targets	9-3
Figure 10-1:	Map of Drilling by Operator	10-2

Figure 10-2: Map of Drilling by Drill Hole Type 10-3
Figure 10-3: Map of JSLA Backfill Drilling by Operator 10-4
Figure 10-4: Map of Drilling by Purpose 10-8
Figure 10-5: Equinox Drill Handling and Sampling Workflows 10-11
Figure 11-1: Box and Whisker Plot of the Bulk Density by Modelled Lithology for the Castle Mountain Project 11-6
Figure 12-1: Shewart Chart of CRM Performance by CRM type 12-3
Figure 12-2: Blank Performance for the Project 12-4
Figure 12-3: RMA Plot of the RC and RAB Field Duplicates 12-5
Figure 12-4: RMA Scatter Plot of Umpire Pulp Duplicates 12-6
Figure 12-5: Downhole Comparison of 20 ft Bench Composites 12-8
Figure 12-6: Twin Hole Analysis Showing Diamond Drill Holes in Red & RC Holes in Blue (CMM-030C and V1135, VDDH10 and V0156) 12-10
Figure 12-7: Twin Hole Analysis Showing Diamond Drill Holes in Red & RC Holes in Blue (VDDH26 and V0741, VDDH35 and V0718) 12-11
Figure 12-8: Twin Hole Analysis Showing Diamond Drill Holes in Red & RC Holes in Blue (VDDH02 and V0511) 12-12
Figure 12-9: Comparison of Drill Hole Orientations by Operator 12-13
Figure 12-10: Q-Q Plot, Summary Statistics, and Scatterplots of Equinox and Viceroy Sample Pairs Within 10 ft (3.05 m) 12-14
Figure 12-11: Q-Q plot, Summary Statistics, and Scatterplots of RC and Diamond Drill Hole Sample Pairs within 15 ft (4.6 m) 12-15
Figure 12-12: Q-Q Plot, Summary Statistics, and Scatterplots of RC and Diamond Drill Hole Sample Pairs Within 15 ft (4.6 m) Drilled by Equinox 12-16
Figure 12-13: Q-Q Plot, Summary Statistics, and Scatterplots of RC and Diamond Drill Hole Sample Pairs within 15 ft (4.6 m) Drilled by Viceroy 12-17
Figure 13-1: 2020 Heap Leach Grade Ore Composites: Calculated vs Assayed Head Grade 13-5
Figure 13-2: 2020 Mill Grade Ore Composites: Calculated vs Assayed Head Grade 13-6
Figure 13-3: Metallurgical Sample Locations 13-7
Figure 13-4: Castle Mountain Metallurgy Cross Section 1 13-8
Figure 13-5: Castle Mountain Metallurgy Cross Section 2 13-8
Figure 13-6: Castle Mountain Metallurgy Cross Section 3 13-9
Figure 13-7: Castle Mountain Metallurgy Cross Section 4 13-9
Figure 13-8: Castle Mountain Metallurgy Cross Section 5 13-10
Figure 13-9: ROM and Crushed Sample Leach Curves, 2015 13-14
Figure 13-10: JSLA ROM Column Test Leach Curves, 2018 13-16

Figure 13-11: 2020 Bottle Roll Tests – Calculated Gold Head Grade vs Recovery 13-18
Figure 13-12: Gold Recovery for Each Ore Zone by Lithology 13-19
Figure 13-13: Arithmetic Average Gold Recoveries by Lithology 13-19
Figure 13-14: Ore Zone: Fines and Saturation 13-23
Figure 13-15: Lithology: Fines and Saturation 13-23
Figure 13-16: NaCN Consumption by Gold Head Grade 13-24
Figure 13-17: Ore Zone Gold Recovery by Size 13-26
Figure 13-18: Recovery by Lithology All LG CLT 13-26
Figure 13-19: Calculated Head Grade by Gold Recovery 13-27
Figure 13-20: Grind Size vs Combined Recovery 13-32
Figure 13-21: 2020 Test Results – Recovery vs Leach Time 13-33
Figure 13-22: Calculated Head Grade vs Gold Recovery 13-34
Figure 13-23: Calculated Head Grade vs Gold Recovery (Adjusted Scale) 13-35
Figure 13-24: % Recovery Range by Lithology, 150 µm (2015-2020) Combined Results 13-35
Figure 13-25: Ore Size Distribution 13-41
Figure 13-26: Overall Gold Metallurgical Results, Carbon Adsorption Capacity Test 13-43
Figure 13-27: Carbon Adsorption Rate Test (4505-MC4-HG) 13-45
Figure 13-28: Gold Leach Rate Profiles, Oxygen Uptake Rate Test 13-46
Figure 13-29: Gold Grain Size Frequency Distribution in Head Samples 13-48
Figure 13-30: Gold Grain Size Frequency Distribution in Tails Samples 13-48
Figure 13-31: Gold Grain Exposure by Weight in Oro Belle Head and Tails Sample 13-49
Figure 13-32: Gold Grain Exposure by Product in South Domes Head and Tails Sample 13-49
Figure 13-33: Photograph and SEM Image of Gold-Bearing 'Porphyry' Particle. South Domes Head +4.5mm Fraction 13-50
Figure 13-34: Yield Stress vs Percent Solids 13-52
Figure 14-1: Castle Mountain Lithology Model (View Towards Northwest) 14-4
Figure 14-2: Castle Mountain Alteration Model for Clay and Silica (View to Northwest) 14-6
Figure 14-3: Castle Mountain Oxidation Model (View to Northwest) 14-7
Figure 14-4: Plan View Showing Modelled Faults 14-9
Figure 14-5: Low Grade Gold Domains (View to Northwest) 14-10
Figure 14-6: Medium Grade Gold Domains (View to Northwest) 14-11
Figure 14-7: High Grade Gold Domains (View to Northwest) 14-11
Figure 14-8: Composite Plan, Perspective & Long Section Views of Nested Grade Shell Domains 14-12

Figure 14-9: Composite Plan and Perspective View (Looking Northwest) of the JSLA Backfill Stage Domains 14-13
Figure 14-10: Top Cut Analysis of all Composite Samples 14-15
Figure 14-11: Top Cut Analysis of Composite Samples Within the High Grade Domain 14-15
Figure 14-12: Top Cut Analysis for Composite Samples Within the Medium Grade Domain 14-16
Figure 14-13: Top Cut Analysis for Composite Samples Within the Low Grade Domain 14-16
Figure 14-14: Grade Domain Boundary Analysis 14-19
Figure 14-15: Geochemical Weathering Boundary Analysis 14-20
Figure 14-16: Box and Whisker Plot of Composite Samples by Grade Domains 14-21
Figure 14-17: Box and Whisker Plot of JSLA Backfill Composite Samples by Stage Backfill Domains 14-22
Figure 14-18: Oro Belle Variogram Modelling for Production Blasthole Samples (left) and Bench Composite Samples (right) 14-24
Figure 14-19: Jumbo Variogram Modelling for Production Blasthole Samples (left) and Bench Composite Samples (right) 14-25
Figure 14-20: JSLA Variogram Modelling for Production Blasthole Samples (left) and Bench Composite Samples (right) 14-26
Figure 14-21: South Domes Variogram Modelling 14-27
Figure 14-22: Resource Areas Used for Validation 14-32
Figure 14-23: Swath Plots for JSLA-Big Chief Resource Areas 14-33
Figure 14-24: Swath Plots for Jumbo Resource Area 14-34
Figure 14-25: Swath Plots for Oro Belle Resource Area 14-35
Figure 14-26: Swath Plots for East Ridge – Egg Hill Resource Areas 14-36
Figure 14-27: Swath Plots for South Domes – Six 21 Resource Areas 14-37
Figure 14-28: Cross Validation of Composite Samples Against Block Estimates for Medium- and High-Grade Domains Within Measured and Indicated Classified Blocks 14-38
Figure 14-29: Cross Validation of Composite Samples Against Block Estimates for Medium- and High-Grade Domains within Measured Classified Blocks 14-38
Figure 14-30: Cross Validation of Composite Samples Against Block Estimates for Medium- and High-Grade Domains Within Indicated Classified Blocks 14-39
Figure 14-31: Cross Validation of Composite Samples Against Block Estimates for Medium- and High-Grade Domains Within Inferred Classified Blocks 14-39
Figure 14-32: Absolute Difference to Production Volumes as a Function of Drill Hole Spacing 14-42
Figure 14-33: Plan Map at 4,000 ft RL Showing Block Model Colored by Estimated Gold Grade (g/t) and Showing Resource and Reserve Pits 14-46
Figure 14-34: Cross Section Oriented at 020˚ Looking Northeast at Big Chief Area Showing Block Model Colored by Estimated Gold Grade (g/t) and Showing Resource and Reserve Pits 14-47

Figure 15-1: Royalty Locations....15-3
Figure 15-2: Aphyric Rhyolite Cross-over Analysis Heap Leach vs Milling....15-5
Figure 15-3: Waste Cut-off Grade....15-5
Figure 15-4: Cross-over from Heap Leach to Mill Cut-off....15-6
Figure 15-5: Slope Design Domains CNI....15-8
Figure 15-6: Slope Sector Bench Plan....15-10
Figure 15-7: Lithology Section....15-11
Figure 15-8: Operating Surplus – Pit Shells....15-13
Figure 15-9: Ore and Waste – Pit Shells....15-13
Figure 15-10: Contained Gold – Pit Shells....15-14
Figure 15-11: Cumulative Resource and Discounted Value – Pit Shells....15-14
Figure 15-12: Section 2206740 East Lerchs Grossmann Pit Limits....15-15
Figure 15-13: Section East Lerchs Grossmann Pit Limits....15-15
Figure 15-14: Bench Plan 3385 Lerchs Grossmann Pit Limits....15-16
Figure 15-15: Ultimate Reserve Pit Limits....15-17
Figure 16-1: JSLA Pit Design....16-6
Figure 16-2: Jumbo Pit Design....16-7
Figure 16-3: Oro Belle Design....16-8
Figure 16-4: East Ridge Pit....16-9
Figure 16-5: South Domes Phase 1....16-9
Figure 16-6: South Domes Phase 2....16-10
Figure 16-7: Waste Dump Configuration....16-11
Figure 16-8: Waste Dump Material Allocation....16-12
Figure 16-9: Haulage Road Width Guideline....16-13
Figure 16-10: Pit Phase Solids Perspective View....16-14
Figure 16-11: Bench Plan 4180 Phases and Gold Grade....16-15
Figure 16-12: Material Movement by Phase....16-16
Figure 16-13: ROM Ore by Phase....16-16
Figure 16-14: Mill Ore by Phase....16-17
Figure 16-15: Mill Ore Processed....16-17
Figure 16-16: ROM Ore Processed....16-18
Figure 16-17: Mine Development Mid-Year 4 - Contractor....16-19
Figure 16-18: Mine Development – End of Period Year 4....16-20
Figure 16-19: Mine Development Year 5....16-21

Figure 16-20: Mine Development – Year 8 16-22
Figure 16-21: Mine Development Year 12 16-23
Figure 16-22: Mine Development Year 16 16-24
Figure 16-23: Mine Development Year 18 16-25
Figure 16-24: Truck Operating Hours and Fleet On-site 16-29
Figure 16-25: Fuel Consumption 16-33
Figure 17-1: Overall Process Flowsheet 17-3
Figure 17-2: Process Plant Facility 17-4
Figure 17-3: Heap Leach Pad Solution Corridor 17-8
Figure 17-4: Heap Leach Pad Design Layers 17-9
Figure 17-5: Event Pond Layers 17-10
Figure 17-6: Stacking Cell 2A; (Phase 2 Years 1-4) 17-11
Figure 17-7: Stacking Cell 2B; (Phase 2 Years 5-7) 17-12
Figure 17-8: Stacking Cell 2C; (Phase 2 Years 7-10) 17-13
Figure 17-9: Stacking Cell 2D; (Phase 2 Years 11-14) 17-14
Figure 18-1: Overall Project Site Plan 18-2
Figure 18-2: South Processing Plant 3D View Looking Northwest 18-4
Figure 18-3: Phase 2 Test Pit Map (Process Plant) 18-6
Figure 18-4: Sitewide Water Balance (Annual Average) 18-8
Figure 18-5: Water Sourcing Map 18-13
Figure 18-6: Castle Mountain Watershed Summary 18-15
Figure 18-7: Stormwater Protection Plan 18-16
Figure 18-8: Tailings Stacking Cell V1 (Phase 2 Start-up) 18-18
Figure 18-9: Tailings Stacking Cell V1+V2 (Through Year 4) 18-19
Figure 18-10: Tailings Stacking Cell V1+V2+Ph. 1 Slopes (Through Year 7) 18-20
Figure 18-11: Tailings Stacking Cell V1+V2+Ph. 1+Ph. 2 Cell 2A Slopes (Through LOM) 18-21
Figure 18-12: Filtered Tailings Design Layers (Viceroy Heap Facility) 18-23
Figure 18-13: Site Plan Looking West 18-24
Figure 18-14: Power Transmission Line Route 18-25
Figure 20-1: Historical Borehole and Well Locations 20-15
Figure 21-1: Mining Labor Plan 21-18
Figure 22-1: Phase 2 Schedule 22-4
Figure 22-2: Initial Capital Spend Plan (Quarterly) 22-5
Figure 22-3: Phase 2 Cost and Revenue Summary 22-10

Figure 22-4: Sensitivity Analysis NPV @ 5%.....22-12
Figure 24-1: Anticipated Overall Project Schedule 24-3
Figure 25-1: Proposed Solar Plant Map 25-6

LIST OF TABLES

TABLE	DESCRIPTION	PAGE
Table 1-1:	Summary of Land Tenure by Type at the Castle Mountain Mine	1-4
Table 1-2:	Castle Mountain Open Pit Resources Exclusive of Reserves (Imperial units)	1-10
Table 1-3:	Castle Mountain Open Pit Resources Exclusive of Reserves (Metric units)	1-10
Table 1-4:	Mineral Reserve Statement	1-11
Table 1-5:	Phase 1 to Phase 2 Transition Plan	1-14
Table 1-6:	Mining Equipment Summary	1-15
Table 1-7:	Major Process Equipment	1-17
Table 1-8:	Phase 2 Capital Cost Summary	1-22
Table 1-9:	Operating Cost Phase 2 Summary	1-23
Table 1-10:	Phase 2 Cash Cost Estimate	1-23
Table 1-11:	Phase 2 Initial Capital Spend Plan	1-24
Table 1-12:	Financial Summary	1-25
Table 1-13:	Financial Model Summary	1-28
Table 2-1:	List of Qualified Persons, Inspections and Responsibilities	2-1
Table 2-2:	Units of Measure	2-2
Table 2-3:	Non-Unit Abbreviations Used in this Report	2-3
Table 2-4:	Conversions for Common Units	2-7
Table 4-1:	Summary of Land Tenure by Type at Castle Mountain Mine, San Bernardino County, California	4-2
Table 4-2:	Township & Range in Castle Mountain	4-3
Table 4-3:	Distribution of Outstanding Net Smelter Royalties	4-4
Table 6-1:	Summary of Legacy Exploration Activity	6-3
Table 6-2:	Viceroy Past Production From 1991 to 2004	6-8
Table 6-3:	Viceroy Annual Production	6-8
Table 6-4:	Pre-Feasibility Study Mineral Resource Estimate Inclusive of Reserves (Imperial Units)	6-9
Table 6-5:	2018 Pre-Feasibility Study Mineral Resource Estimate Inclusive of Reserves (Metric Units)	6-10
Table 6-6:	2018 Pre-Feasibility Study Lerchs-Grossman Parameters	6-11
Table 7-1	Castle Mountain Lithology	7-6
Table 7-2:	Photograph Examples of Castle Mountain Rock Types	7-9
Table 10-1:	Summary of Castle Mountain Hard Rock Drilling by Operator & Drill Type	10-1

Table 10-2: Summary of Castle Mountain Backfill Drilling by Drill Type....10-1
Table 11-1: Summary of QA/QC Samples....11-5
Table 11-2: Summary of CRM Samples....11-5
Table 11-3: Resource Database Delivery....11-7
Table 12-1: CRM Performance for the Equinox Samples....12-3
Table 12-2: Duplicate Values and Statistics....12-4
Table 12-3: Comparison of Twin Drilling....12-7
Table 12-4: Summary of the Bulk Density Data for the Project....12-18
Table 13-1: Metallurgical and Physical Testwork – Cyanide and Leach Testing....13-2
Table 13-2: Metallurgical and Physical Testwork – Other Testing....13-3
Table 13-3: Heap Leach Grade Ore Composites....13-4
Table 13-4: Mill Grade Ore Composites....13-5
Table 13-5: Multi-Element Analysis for Heap Leach Grade Ore Composites....13-11
Table 13-6: Multi-Element Analysis for Mill Grade Ore Composites....13-12
Table 13-7: Mercury Analysis Results – Heap Leach Grade Ore Composites....13-13
Table 13-8: Mercury Analysis Results – Mill Grade Ore Composites....13-13
Table 13-9: Summary of Metallurgical Results, ROM and Crushed Ore Column Tests, 2015....13-14
Table 13-10: Summary Metallurgical Results, ROM, and Crushed Ore Column Tests, 2018....13-15
Table 13-11: Summary of 2020 Heap Leach Material Testing....13-17
Table 13-12: Summary of Bottle Roll Tests on Low-Grade Composites....13-17
Table 13-13: Average Bottle Roll Test Results by Ore Zone....13-18
Table 13-14: Summary of Column Tests on Heap Leach Composites....13-20
Table 13-15: 2020 Column Leach Test Results by Size and Ore Zone....13-21
Table 13-16: 2020 Column Leach Test Results Summary....13-21
Table 13-17: Heap Leach Grade Ore Sample Saturation and Retained Moisture....13-22
Table 13-18: Average Gold Recovery Summary....13-25
Table 13-19: Average Gold Recovery by Lithology....13-27
Table 13-20: Abrasion Index and Crusher Impact Test Results (2015 results)....13-29
Table 13-21: SMC and Drop Weight Test Results....13-30
Table 13-22: Crusher Work Index Test Result....13-30
Table 13-23: Abrasion Index, Bond Rod & Ball Mill Work Index Test Results....13-30
Table 13-24: Summary of WOL and Grav/CN Tests on Mill Composites....13-31
Table 13-25: 2020 Testwork – Average Recovery vs Time....13-33
Table 13-26: Weighted Average Recoveries by Lithology – 150 µm (2015-2020)....13-36

Table 13-27: Weighted Average Recoveries by Ore Zone – 2015, 2018, 2020 Testwork.....13-36
Table 13-28: Main Pit Mill Grade Ore Master Composite Make-up.....13-37
Table 13-29: South Domes Mill Grade Ore Master Composite Make-up.....13-37
Table 13-30: CIL Initial and Residual Cyanide Concentration.....13-38
Table 13-31: Bulk Bottle Roll Tests (CIL) Recoveries.....13-38
Table 13-32: Ore Material Fragmentation Summary for Each Lithology.....13-41
Table 13-33: Heap Leach Composites Sulfur Content.....13-42
Table 13-34: Mill Composites Sulfur Content.....13-42
Table 13-35: Carbon Adsorption Capacity Test Results.....13-43
Table 13-36: Freundlich Isotherm Coefficients.....13-44
Table 13-37: Carbon Adsorption Rate Test, 10 g Carbon/L Pulp.....13-44
Table 13-38: Oxygen Uptake Results Summary.....13-45
Table 13-39: Frequency Count of Gold Occurrences.....13-47
Table 13-40: Recoveries as Estimated by Castle Mountain During Production for High-Grade Ore.....13-54
Table 13-41: Castle Mountain Mine Production Data.....13-55
Table 14-1: Summary of Drill Hole and Surface Data Used for Resource Estimate.....14-2
Table 14-2: Castle Mountain Lithology Codes.....14-4
Table 14-3: Summary of Modelled Faults.....14-8
Table 14-4: Summary of Domains.....14-10
Table 14-5: Summary of Backfill Stage Domains.....14-13
Table 14-6: Summary of Original and Composited Sample Capping Statistics.....14-17
Table 14-7: Summary of Original and Composited Backfill Samples.....14-17
Table 14-8: Summary of Treatment of Domain Contacts.....14-18
Table 14-9: Summary of Variogram Parameters for Area Based Variogram Modelling.....14-23
Table 14-10: Summary of Variogram Parameters Based On Blasthole Sampling for Mined Deposits.....14-23
Table 14-11: Summary of Bulk Density and Tonnage Factor Values by Lithology.....14-28
Table 14-12: Castle Mountain Block Model Definitions.....14-28
Table 14-13: Summary of Interpolation Parameters for Hard Rock, JSLA Backfill and Waste Dumps.....14-29
Table 14-14: Mean Search Directions by Lithology.....14-30
Table 14-15: Comparison of Current Resource Model to Historical Production and Production Blasthole Model Estimates.....14-40
Table 14-16: Summary of Estimation Technique Comparison.....14-41

Table 14-17: Summary of Hard Rock Resource Classification 14-42
Table 14-18: Summary of JSLA Backfill Resource Classification 14-42
Table 14-19: Summary of Pit Optimization Parameters.....14-43
Table 14-20: Castle Mountain Open Pit Resources Exclusive of Reserves (imperial units)..14-44
Table 14-21: Castle Mountain Open Pit Resources Exclusive of Reserves (metric units).....14-44
Table 14-22: Castle Mountain Open Pit Resources Inclusive of Reserves (imperial units) ...14-45
Table 14-23 Castle Mountain Open Pit Resources Inclusive of Reserves (metric units).....14-45
Table 14-24: Comparison of Hard Rock Mineral Resources to March 29, 2018 Mineral Resource Estimate Inclusive of Reserves (imperial units) 14-48
Table 14-25: Comparison of Hard Rock Mineral Resources to March 29, 2018 Mineral Resource Estimate Inclusive of Reserves (Metric units).....14-48
Table 15-1: Castle Mountain Open Pit Optimization Parameters.....15-1
Table 15-2: Metallurgical Recovery Assumptions.....15-4
Table 15-3: Block Model Limits 15-7
Table 15-4: Geology Specific Inter-Ramp Slope Angles.....15-9
Table 15-5: Overriding Structural Controls 15-9
Table 15-6: Bench Design Parameters by Domain.....15-9
Table 15-7: Slope Code Summary 15-9
Table 15-8: Lerchs Grossmann Pit Shell Summary.....15-12
Table 15-9: Mineral Reserve Summary.....15-18
Table 16-1: Mineral Reserves by Phase (Imperial Units).....16-2
Table 16-2: Annual Mine Production Schedule.....16-4
Table 16-3: Production Fleet Requirement by Phase 2 Year.....16-26
Table 16-4: Mine Salaried Positions.....16-30
Table 16-5: Mine Staff and Hourly Employees 16-31
Table 16-6: Summary of LOM Unit Operating Costs 16-34
Table 16-7: Mine Equipment Capital (Ongoing Additions and Replacements).....16-36
Table 16-8: Mine Capital Cost Summary.....16-37
Table 17-1: Phase 2 and LOM Gold Production.....17-2
Table 17-2: Major Process Design Criteria Summary – Heap Leach.....17-4
Table 17-3: Major Process Design Criteria Summary – Mill.....17-5
Table 17-4: Major Process Equipment – Heap Leach 17-5
Table 17-5: Major Process Equipment – Mill 17-6
Table 17-6: Major Process Equipment – Carbon Handling and Refining 17-6

Table 17-7: Summary of Process Area Consumables 17-27
Table 17-8: Summary of Heap Leach Water Demands 17-28
Table 17-9: Mill Water Demand Summary 17-28
Table 17-10: Summary of Process Area Power Consumption 17-29
Table 17-11: Sampler Location & Type 17-30
Table 18-1: Modelled Monthly Climate Data Summary 18-9
Table 18-2: Project Total Water Demands 18-10
Table 18-3: Water Source Summary 18-12
Table 18-4: Filtered Tailing Facility Design Criteria 18-22
Table 18-5: Summary of Process Area Power Consumption 18-26
Table 20-1: Castle Mountain Mine Permit Requirements 20-11
Table 20-2: Active Water Rights 20-14
Table 21-1: Capital Cost Summary 21-1
Table 21-2: Summary of Initial Capital Costs by Area 21-2
Table 21-3: Summary of Process Plant Initial Capital Costs by Commodity[1] 21-3
Table 21-4: Reference Documents Summary 21-4
Table 21-5: Labor Rates 21-5
Table 21-6: Blended Crew Rate 21-5
Table 21-7: Earthworks and Liner Unit Rates 21-6
Table 21-8: Structural Steel Unit Rates 21-7
Table 21-9: EPCM Indirect Costs 21-9
Table 21-10: Owner's Cost Summary 21-10
Table 21-11: Project Contingency Basis 21-11
Table 21-12: Mining Initial Capital Summary 21-12
Table 21-13: Mining Equipment Summary 21-12
Table 21-14: Summary of Sustaining Capital Costs 21-13
Table 21-15: Mining Sustaining Capital Cost Summary 21-14
Table 21-16: Operating Cost Phase 2 Summary 21-15
Table 21-17: Summary of Annual Operating Cost 21-15
Table 21-18: Operating Cost Summary 21-17
Table 21-19: Mine Staffing (Peak – Year 9) 21-18
Table 21-20: Drilling and Blasting Unit Costs 21-19
Table 21-21: Loading, Hauling, Roads & Dumps Unit Costs 21-20
Table 21-22: Summary of Process Operating Costs by Area (Typical Processing Year) 21-20

Table 21-23: Summary of Process Operating Cost by Use ($M/y) 21-21
Table 21-24: Process Plant Staffing 21-22
Table 21-25: Power Cost Summary 21-23
Table 21-26: Reagent Cost Summary 21-24
Table 21-27: Consumables Cost Summary 21-24
Table 21-28: General and Administrative Cost Summary 21-25
Table 21-29: General and Administrative Staffing 21-25
Table 22-1: Summary Phase 2 Financial Results 22-2
Table 22-2: Phase 2 Ore, Waste and Metal Grades 22-3
Table 22-3: Marketing Terms 22-3
Table 22-4: Phase 2 Initial Capital Spend Plan 22-4
Table 22-5: Initial Capital Cost Summary 22-4
Table 22-6: Royalties Summary 22-6
Table 22-7: Operating Cost Summary 22-6
Table 22-8: Phase 2 Detail Financial Model 22-8
Table 22-9: Gold Price Sensitivity – After Taxes 22-10
Table 22-10: Operating Cost Sensitivity – After Taxes 22-10
Table 22-11: Initial Capital Sensitivity – After Taxes 22-11
Table 22-12: Cyanide Consumption Sensitivity – After Taxes 22-11
Table 22-13: Heap Leach Recovery Sensitivity – After Taxes 22-11

LIST OF APPENDICES

APPENDIX	DESCRIPTION
A	Feasibility Study Contributors and Professional Qualifications • Certificate of Qualified Person (“QP”)

1 SUMMARY

1.1 INTRODUCTION

Equinox Gold Corp. (Equinox, or the Company) retained independent consultants to prepare a Feasibility Study Technical Report (the Report, or the Study) for the Castle Mountain Project (the Project) in the state of California, USA. Equinox, through its indirect wholly owned subsidiary NewCastle Gold Ltd (NewCastle), has 100% of the right, title, and beneficial interest in and to Castle Mountain Venture (CMV) which owns the Castle Mountain Mine (or the Property).

The Castle Mountain Project is being developed in two stages, Phase 1, and Phase 2. The Phase 1 project, completed in 2020 and currently operating, consists of a double-lined run of mine (ROM) heap leach facility to treat 14,000 short tons of ore per day (ton/d). The Phase 2 project will consist of the expansion that is described within this Report.

Key aspects included in the Study for Phase 2 are further advancement on metallurgical testwork, updates to the mineral resource and mineral reserve estimates and pit design, updated mine schedule, expanded heap leach operations, the addition of a mill to process higher-grade ore, a filtered tailings facility, infrastructure development, cost estimates, and a financial model.

This Study includes supporting engineering and design to provide a feasibility level of accuracy in the project estimates and includes detailed assessments of resources and reserves, metallurgy, mining, processing, environmental and other relevant considerations that demonstrate the viability of the expansion of the project. Mineral resource and reserve estimates disclosed within this Report supersede all previous estimates for the Castle Mountain Project. The following companies contributed to the study:

- M3 Engineering & Technology (M3), Arizona, USA – Mineral processing, metallurgical testing, recovery methods, process infrastructure, economic evaluation and analysis, environmental and permitting studies.
- Equity Exploration Consultants Ltd. (Equity), Vancouver, British Columbia, Canada – Mineral resources, geology.
- Nilsson Mine Services Ltd. (NMS), Vancouver, British Columbia, Canada – Mineral reserves, pit designs, waste designs, mining costs.
- Geo-Logic Associates (GLA), California, USA – Heap Leach pad design and water balance.
- The MINES Group Inc. (MINES), Nevada, USA – Filtered tailings facility design and meteoric analysis.

This executive summary highlights the work on the feasibility study between 2019 and 2021 and outlines the planned transition from current operations (Phase 1) to the proposed Phase 2 expansion of the Project.

1.2 PROPERTY LOCATION AND INFRASTRUCTURE

The Project is in the historic Hart Mining District, at the southern end of the Castle Mountains, San Bernardino County, California, located 60 miles (100 km) directly south of Las Vegas,

Nevada. The Project is in a high desert area near the Mojave National Preserve and Castle Mountains National Monument.

Year-round road access is available from the city of Las Vegas, Nevada approximately 70 miles (113 km) by road north of the Project. The road access is paved highway from Las Vegas to Walking Box Ranch Road, and then by an 18 mile (29 km) unpaved two-lane road to the Project area. This existing access road is well maintained and of good quality for necessary vehicular access as required for construction and operation of the Project.

Existing site infrastructure includes:

- Administration and modular mine offices,
- Main haul road connecting the backfilled JSLA pit with the ROM heap leach pad,
- Phase 1 processing plant which includes solution handling pumps, solution storage tanks a carbon column plant and cyanide unloading and storage area,
- A 24 M gal (90 ML) lined event pond,
- A diesel power generation plant, and
- An assay and metallurgical laboratory.

Many of these currently operating facilities will continue to operate into Phase 2. A location and access map of the project is presented in Figure 1-1.



Figure 1-1: Site Location and Access Map

1.3 PROPERTY OWNERSHIP

The Property includes eight patented claims and 1,226 unpatented lode, placer and mill site claims which are registered under the Castle Mountain Venture and Viceroy Gold Corporation,

which are wholly owned subsidiaries of Equinox. Many of the claims overlap and as such the total area of the individual claims is not representative of the overall total area covered.

Table 1-1: Summary of Land Tenure by Type at the Castle Mountain Mine

Type	Claims	Area (acres)	Area (hectares)
Patented lode	8	1,301	526
Unpatented lode	449	8,980	3,634
Unpatented mill site	723	3,598	1,456
Unpatented placer	54	3,639	1,473
Total	**1,234**		

Equinox acquired NewCastle on December 22, 2017 and NewCastle became a wholly owned subsidiary of Equinox. The transaction was a three-way merger between Trek Mining Inc, NewCastle Gold, and Anfield Gold Corp. with the resulting company renamed to Equinox Gold Corp. NewCastle has 100% of the right, title and beneficial interest in and to Castle Mountain Venture (CMV) which owns the Castle Mountain Mine.

Throughout this summary, NewCastle (or CMV) are used when referring to the owner/operator of the Castle Mountain Mine. Equinox's ownership and control of NewCastle and CMV are implicit whenever they are mentioned. Where necessary for clarity, NewCastle and Equinox are explicitly named.

Equinox has full legal access to the Project with respect to surface and mineral rights. All claim maintenance payments to the United States Bureau of Land Management (BLM) and property tax payments to San Bernardino County are in good standing. There are no known dates of expiration to mining claims pertinent to the Project.

The Project is subject to several royalties which are payable to different parties. The Franco-Nevada royalty applies to all ounces from the Project, and the other royalties are area specific. Royalties payable include:

- 2.65% Franco-Nevada royalty applied to all ounces
- 5.00% Conservation royalty
- 2.00% American Standard royalty
- 5.00% Huntington Tile royalty

There are no known environmental liabilities on the Project.

1.4 CLIMATE AND PHYSIOGRAPHY

Castle Mountain experiences a desert climate with hot summers and cool winters, with temperatures attenuated by altitude and aridity relative to the surrounding valleys. Average daily lows and highs for the project site range from 28°F to 52°F (-2°C to 11°C) in the winter and 66°F to 93°F (19°C to 34°C) in the summer while annual average precipitation is just over 9 inches (in) (230 mm).

The Project is in the eastern Mojave Desert which transitions to the Basin and Range region to the north and the Colorado Desert to the south. The Castle Mountains are a relatively small range

extending north-northeast from the northern end of Lanfair Valley in California into Piute Valley in Nevada. The Project is located near the southern end of the Castle Mountain range with elevations at the Project site ranging from approximately 4,100 ft to 5,100 ft (1,250 m to 1,555 m).

1.5 HISTORY

The Hart Mining District covers the southern end of the Castle Mountains. Several hundred old prospects, pits, trenches, waste rock dumps and underground workings extend over an approximate two square miles (5.2 km^2) area overlapping the Project area. In 1907, three underground gold mines were brought into production at Oro Belle, Big Chief and Jumbo, and by 1911, the mined veins were exhausted.

A resurgence in exploration activity commenced in 1968 until the early 2000's with a variety of operators. Viceroy Gold Corporation (Viceroy) together with MK Gold Corporation completed a feasibility study and commenced gold production at Castle Mountain in 1991. By 1996, the Jumbo South and Leslie Ann (JSLA) deposits were considered exhausted. JSLA was subsequently backfilled with waste rock from the Jumbo and Oro Belle pits. Mining from the Jumbo pit ceased in 2001 due to localized pit-wall stability issues resulting in the deepest bench mined approximately 200 ft (61 m) above the final depth of planned pit design. Mining from the Oro Belle and Hart Tunnel deposits ceased in 2001 due to low gold prices. Heap leaching continued until 2004, primarily in a rinsing operation to recover residual gold values and reduce the cyanide levels in the heap. Reclamation began in 2001 and by 2012 all criteria for successful reclamation had been met.

A total of 1.24 Moz was recovered from 36.2 Mton (32.8 t) processed at an average grade of 0.043 oz/ton (1.47 g/t) with a combined average recovery of 80% from milled and heap leached ore between 1991 and 2004.

Minimal exploration activity occurred between 2005 and 2011. NewCastle (then Castle Mountain Mining Company Limited) acquired the Project in 2012.

1.6 GEOLOGICAL SETTING

The Castle Mountain gold deposit is located in the Hart Mining District. Proterozoic metamorphic and plutonic rocks form the basement of the Castle Mountains; these are overlain by pre-volcanic sediments, and Miocene sedimentary and volcanic rocks.

The oldest known unit in the stratigraphic package is metamorphic Proterozoic basement rocks comprised of a massive sequence of biotite schist, biotite gneiss and meta-granite. Locally overlying the basement rocks is a Proterozoic sedimentary sequence of conglomerate with lesser sandstone. The regionally extensive Peach Springs Tuff unconformably overlies the Proterozoic units.

The Miocene-age Castle Mountains Volcanic Sequence (CMVS) includes all volcanic units above the Peach Springs Tuff and below the Piute Range volcanic rocks. The CMVS was emplaced during three intrusive-extrusive episodes between around 18.8 and 13.5 million years ago.

The CMVS is defined by the Jacks Well Formation characterized by epiclastic and volcanic rocks with minor mudstone, the Linder Peak rhyolitic volcanic and volcaniclastic rocks, and the Hart Peak rhyolite and late dacite dikes. Linder Peak is represented by a complex suite of volcanics

and volcaniclastics including flow-domes, and clastic tuffs comprised of monolithic breccia, polylithic breccia, and ashfall tuffs.

Castle Mountain Project is classified as a low-sulfidation epithermal gold deposit. CMVS rocks are the primary host of epithermal gold mineralization at the Project. Structure and associated rock porosity-permeability characteristics are the first-order control on the distribution of gold. Silica alteration and iron oxide minerals generally occur with gold mineralization. Gold and electrum are the dominant gold-bearing minerals identified from gold deportment studies.

1.7 EXPLORATION AND DRILLING

Exploration by NewCastle includes an airborne LiDAR survey, geophysical surveys including Transient Electromagnetic (TEM) and gravity, detailed mapping and surface grab and chip sampling. The deposit area exposures were mapped in detail and combined with a comprehensive geochemical and petrographic study of the rock types to evaluate the structural and stratigraphic setting. NewCastle exploration work was streamlined to create a framework for logging and relogging that was integrated into a refined geologic model including lithology, oxidation, structure, and alteration models for this study.

Grid-controlled rock sampling was conducted over seven prospective areas to expand on the rock and soil sampling completed by Viceroy. Future exploration should follow up on geochemical anomalies and mineralized trends on East Ridge, East Flats and Egg Hill, Northwest Rim and Benson.

Drilling on the Project is summarized by the material type intersected, the in-situ hard rock or the backfill and waste dump materials, respectively. Purpose designed drill holes have been completed to support the Feasibility Study, including drilling for samples for metallurgical testing, infrastructure condemnation, geotechnical study, and potential water sources.

Diamond, reverse circulation (RC) and conventional rotary (rotary), drilling methods have been used within the hard rock with a total of 1,557,140 ft (474,597 m) within 2,111 holes. The legacy drilling completed by Viceroy was completed entirely within hard rock material using rotary, RC and diamond drilling methods for a total of 1,184,180 ft (360,920 m) within 1,772 drill holes. NewCastle has completed an additional 372,960 ft (113,677 m) of hard rock drilling in 339 drill holes at the Project, primarily using angled RC and diamond core drilling to improve the geological understanding of the deposits.

The JSLA backfill and waste dumps have been drilled exclusively by NewCastle in 1,685 reverse air blast (RAB) and RC holes with a total footage of 370,212 (112,835 m).

Blastholes were used to monitor production during historical Viceroy operations. The blasthole samples cover the benches in the Jumbo and Oro Belle pits and a small portion of the benches in JSLA.

1.8 SAMPLING AND VERIFICATION

Samples from the Viceroy and NewCastle exploration drilling have been utilized in preparing the Mineral Resource Estimate. Core and RC sample intervals are a nominal 5 ft (1.5 m) length but range from 2 ft to 7 ft (0.6 - 2.1 m) in length.

Core and chip samples from diamond, RC, and RAB holes were transported to the secure on-site logging facility where they were processed and prepared for shipment by NewCastle. NewCastle maintained a Quality Assurance/Quality Control (QA/QC) sampling program, including insertion and review of coarse blanks, certified reference materials (CRM), and duplicates. Samples were shipped directly to the independent laboratory for preparation and analyses.

NewCastle drill hole samples were prepared and assayed by ALS Global (ALS) or Bureau Veritas (BV), formerly Inspectorate, at their facility in Reno or Elko, Nevada. Check assays were completed at American Assay Laboratories in Sparks, Nevada. All the laboratories are International Standards Organization (ISO) accredited operations which are independent of Equinox.

Gold was assayed by 1.06 oz (30 g) fire assay with atomic absorption spectroscopy finish (AAS). Gold assays returning greater than 0.2917 oz/ton (10.00 g/t) gold were re-assayed by fire assay with a gravimetric finish and gold assays returning greater than 0.006 oz/ton (0.2 g/t) gold were analyzed for gold cyanide solubility.

Viceroy drill hole samples were collected at 5 ft (1.5 m) intervals over the entire length of each drill hole. Routine pulp duplicate analyses were performed at the primary lab. The QA/QC practices implemented by Viceroy do not have current records; however, check assay samples submitted to umpire commercial labs and the Castle Mountain Mine lab (that was in operation at the time that Viceroy operated the mine) did not indicate systematic bias or accuracy issues with the original assays from the primary labs (Temkin, 2012).

Legend and Rocky Mountain Geochemical (RMG) in Reno, Nevada were the primary laboratories used by Viceroy. Both laboratories were independent of Viceroy; however, neither was accredited.

Viceroy drill hole samples were analyzed for gold and silver by fire assay on a one-assay ton (29.166 g) subsample followed by AAS finish, with samples returning gold values greater than 0.100 oz/ton (3.43 g/t) being re-assayed by fire assay on a one-assay ton subsample with a gravimetric finish.

NewCastle collected 647 bulk density measurements which have been converted to tonnage factors and coded to the lithological model.

NewCastle operations followed a standard operating procedure for processing, data collection, and sampling of the drill holes. All samples had adequate security and tracking measures employed during preparation and transport. Records of the drilling and samples were retained at the Property and at the Vancouver office.

The data used in the resource models and resource estimation was reviewed for critical errors and to evaluate the quality of the data. Location data for the collars and downhole survey measurements were checked for gross errors and coordinate conversion accuracy. The assay data was checked for ranking accuracy and the QA/QC results were evaluated statistically and plotted for visual evaluation. Given the high proportion of Viceroy samples within the hard rock database, the results were reviewed in twin drill hole analysis, sample pair analysis and an evaluation for downhole contamination. The bulk density measurements were verified against the lab certificates. It is the QP's opinion that the sample preparation, security, and analytical procedures are adequate. The results of the data verification demonstrate the data is adequate for use in Mineral Resource estimation and preparation of Mineral Reserves.

1.9 MINERAL PROCESSING AND METALLURGICAL TESTING

Significant metallurgical testwork has been performed on Castle Mountain samples from 2015-2020. As the plan is to process lower grade ROM ore on a leach pad and higher grade ore using conventional milling with Carbon-in-Leach (CIL), there was a need to carry out a wide extent of testing for each process route and on a wide variety of samples. Data from this work along with historical production data has formed the basis for the project process design criteria.

Testwork performed in 2020 has supplemented extensive test programs previously conducted in 2015 and 2018. Drill core samples were used, and the focus was on expanding the metallurgical understanding of the material to be processed through increased spatial and lithological representation within the mineral resource. The key testwork carried out included:

- Column leach tests on heap leach grade ore using the same parameters as in prior testing to verify and supplement the results,
- Column load permeability tests, and
- Gravity concentration followed by leaching of the gravity tails and whole ore leaching of higher-grade mill feed samples.

Additional test programs conducted in 2020 to support the feasibility study include:

- Mineralogical analysis and gold deportment study,
- Materials handling and comminution tests,
- Carbon loading and oxygen uptake tests,
- Cyanide detoxification tests,
- Thickening, tailing filtration and slurry rheology tests,
- Filtered tailings geotechnical stability analysis, and
- Testwork to determine the potential amenability to ore sorting.

Castle Mountain ore in general can be characterized as friable but moderate to relatively hard based on the testwork considered. Based on the testwork, bond ball work indices ranged from 12.3 to 18.0 kWh/ton (13.6 to 19.8 kWh/t). A weighted average of 15.2 kWh/ton (16.7 kWh/t) based on lithology was selected for the design of the grinding circuit. The Axb results from seven SMC tests ranged from 38.1 to 56.1 while the 80th percentile was 43.0.

The arithmetic average gold recovery from all column leach tests was 80%, while the weighted gold recovery based on ounces per lithology type was 82%. The historical production data from 1992 to 2004 was over 76% recovery specifically for the heap leach ore. Considering lab and historical operating data combined with the plan to leach ROM size ore, the permeability, and effective leaching of the side slopes, the expected LOM heap leach gold recovery is expected to be 67% during the LOM operation and 74% after final rinsing.

For mill grade ores processed through the mill with gravity concentration and a leach/CIL circuit with 30 hours of retention time, an overall gold recovery of 94% is expected.

1.10 MINERAL RESOURCE ESTIMATES

Equity completed a Mineral Resource estimate update for Equinox's Castle Mountain Project, inclusive of both Phase 1 and Phase 2 resources and includes both the JSLA pit backfill material and in-situ hard rock mineral resources.

The Mineral Resources presented herein conform with the most recent CIM Definition Standards (CIM, 2014), have been prepared according to CIM Best Practice Guidelines (CIM, 2019), and are reported in accordance with Canadian Securities Administrators' National Instrument 43-101 Standards of Disclosure for Mineral Projects (BCSC, 2016).

Equity is satisfied that the resource estimates and classification of resources reported herein represent a reasonable estimate of the gold contained in the Castle Mountain Project. Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability. There is no certainty that all or any part of the mineral resources will be converted into mineral reserves. Inferred resources have a greater amount of uncertainty as to their existence and whether they can be mined legally or economically. It is reasonably expected that the majority of Inferred resources could be upgraded to Indicated (or Measured) with continued exploration.

The CIM Definition Standards on Mineral Resources and Reserves (CIM, 2014) state that:

"A Mineral Resource is a concentration or occurrence of solid material of economic interest in or on the Earth's crust in such form, grade or quality and quantity that there are reasonable prospects for eventual economic extraction."

In order to sufficiently test the reasonable prospects for eventual economic extraction by an open pit, pit shells were generated using the variable slope Lerchs Grossmann algorithm in Hexagon's MinePlan® software. The results of the pit optimization partially form the basis of the Mineral Resource Statement and are used to constrain the Mineral Resource with respect to the CIM Definition Standards. Pit optimization does not constitute an attempt to estimate reserves. A summary of the Measured, Indicated and Inferred Resources exclusive of Reserves are summarized in Table 1-2 and Table 1-3 for imperial and metric units, respectively.

Areas of uncertainty that may materially impact the Mineral Resource estimate include commodity price assumptions, metal recovery assumptions, mining and process cost assumptions, pit slope angles and applied top cut values. In the opinion of the QP there are no known environmental, permitting, legal, title, taxation, socio-economic, marketing, political, or other relevant factors which would materially affect the Mineral Resource estimate.

Table 1-2: Castle Mountain Open Pit Resources Exclusive of Reserves (Imperial units)

Classification	Au Cut-off	Tons	Au	Contained Au
	(oz/ton)	(kton)	(oz/ton)	(koz)
Measured	0.005	861	0.020	17
Indicated	0.005	80,975	0.018	1,453
Measured and Indicated	0.005	81,836	0.018	1,470
Inferred	0.005	77,048	0.018	1,422

Notes:
1. Mineral Resources are reported exclusive of reserves.
2. Mineral Resources are reported using gold price of $1,500/oz gold.
3. Open pit Mineral Resources are reported using a cut-off grade of 0.005 oz/ton (0.17 g/t) gold and are constrained using an optimized pit generated using Lerchs Grossmann pit optimization algorithm with parameters summarized in Table 14-19.
4. The Mineral Resource statement has been prepared by Trevor Rabb, P.Geo. (Equity) who is a Qualified Person as defined by NI 43-101.
5. Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability.
6. Any discrepancies in the totals are due to rounding.
7. Mineral resources from the Castle Mountain Project presented herein have an effective date of June 30, 2020.

Table 1-3: Castle Mountain Open Pit Resources Exclusive of Reserves (Metric units)

Classification	Au Cut-off	Tonnes	Au	Contained Au
	(g/t)	(kt)	(g/t)	(koz)
Measured	0.17	781	0.68	17
Indicated	0.17	73,452	0.62	1,453
Measured and Indicated	0.17	74,233	0.62	1,470
Inferred	0.17	69,890	0.63	1,422

Notes:
1. Mineral Resources are reported exclusive of reserves.
2. Mineral Resources are reported using gold price of $1,500 /oz gold.
3. Open pit Mineral Resources are reported using a cut-off grade of 0.005 oz/ton (0.17 g/t) gold and are constrained using an optimized pit generated using Lerchs Grossmann pit optimization algorithm with parameters summarised in Table 14-19.
4. The Mineral Resource statement has been prepared by Trevor Rabb, P.Geo. (Equity) who is a Qualified Person as defined by NI 43-101.
5. Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability.
6. Any discrepancies in the totals are due to rounding.
7. Mineral resources from Castle Mountain Project presented herein have an effective date of June 30, 2020.

1.11 MINERAL RESERVE ESTIMATES

The Proven and Probable Mineral Reserves at the Castle Mountain Project have been classified in accordance with the CIM Definition Standards for Mineral Resources and Mineral Reserves. The Project Mineral Reserves are based on the conversion of the Measured and Indicated Resources within the Feasibility Study mine plan, with open pit phase designs guided by Lerchs-Grossmann optimized pit shells.

The Mineral Reserve estimate for the Castle Mountain Project, effective June 30, 2020 is summarized in Table 1-4. The Mineral Reserves have been reported using a cut-off grade of 0.005 oz/ton (0.17 g/t) gold.

Table 1-4: Mineral Reserve Statement

Imperial	Tons (kton)	Gold Grade (oz/ton)	Gold (koz)
Proven	93,600	0.016	1,498
Probable	190,690	0.014	2,670
Total Proven and Probable	**284,290**	**0.015**	**4,168**
Metric	**Tonnes (kt)**	**Gold Grade (g/t)**	**Gold (koz)**
Proven	84,910	0.55	1,498
Probable	172,990	0.48	2,670
Total Proven and Probable	**257,900**	**0.51**	**4,168**

Notes:
1. The Mineral Reserve estimate with an effective date of June 30, 2020 is based upon the Mineral Resource estimate prepared for Equinox Castle Mountain Venture by Trevor Rabb P.Geo, and described in Section 14, with an effective date of June 30, 2020.
2. The Mineral Reserve was estimated by Nilsson Mine Services Ltd. with supervision by John Nilsson P.Eng. who is a Qualified Person as defined under NI 43‑101.
3. Mineral Reserves are reported within the ultimate reserve pit design with overall economics developed for $1350/oz gold with appropriate royalties applied.
4. Mineral Reserves are reported using a cut-off grade of 0.005 oz/ton (0.17 g/t) gold.
5. The mining costs average $1.78/ton ($1.96/t) mined, processing costs are $1.33/ton ($1.47/t) for ROM and $12.62/ton ($13.91/t) for milling. G&A was $0.72/ton ($0.79/t) ore processed.
6. The average process recovery was 73.9% for ROM and 94.5% for milling.
7. Ore tons are reported in thousands of short tons (kton) and ounces for Imperial.
8. Mineral Resource is exclusive of Mineral Reserves.

1.12 MINING

Mining will be an open pit operation using conventional diesel-powered truck and shovel mining equipment. The current Phase 1 operation consists of a 14,000 ton/d (12,700 t/d) ROM operation with a focus on mining backfilled material that was placed in the JSLA pit from the previous mining operation 20 years ago. The Phase 2 expansion will increase production to 53,500 ton/d and extract hard rock material from open pits which will be drilled, blasted, and loaded to mine trucks using hydraulic shovels and wheel loaders. Phase 2 mine production is split with 50,000 ton/d (45,400 t/d) to the heap leach and 3,500 ton/d (3,200 t/d) to the mill.

The Phase 2 mine plan includes 14 years of operation expanding the overall life of mine (LOM) to 19 years and delivering 266.6 Mton (241.9 Mt) of ROM heap leach ore with an average diluted grade of 0.012 oz/ton (0.40 g/t) gold to the leaching operation. The mill will commence operation one year later and will process 17.7 Mton (16.1 Mt) of ore with an average diluted grade of 0.067 oz/ton (2.28 g/t) gold. In some years, a small portion of ROM ore will be crushed and re-directed to the mill when availability permits.

Five pit areas are considered in the reserve statement with pits at JSLA (3 phases), Jumbo, Oro Belle, East Ridge (2 phases) and South Domes (2 phases). There is a total of nine phases of open pit mining starting with JSLA backfill and moving north, and then to South Domes to complete the operation. The material movement by mining phases, ROM leach material and

milling ore processed are shown in Figure 1-2 to Figure 1-4 below. The mining sequence of the phases allows for backfilling of waste as the pit reaches final limits.

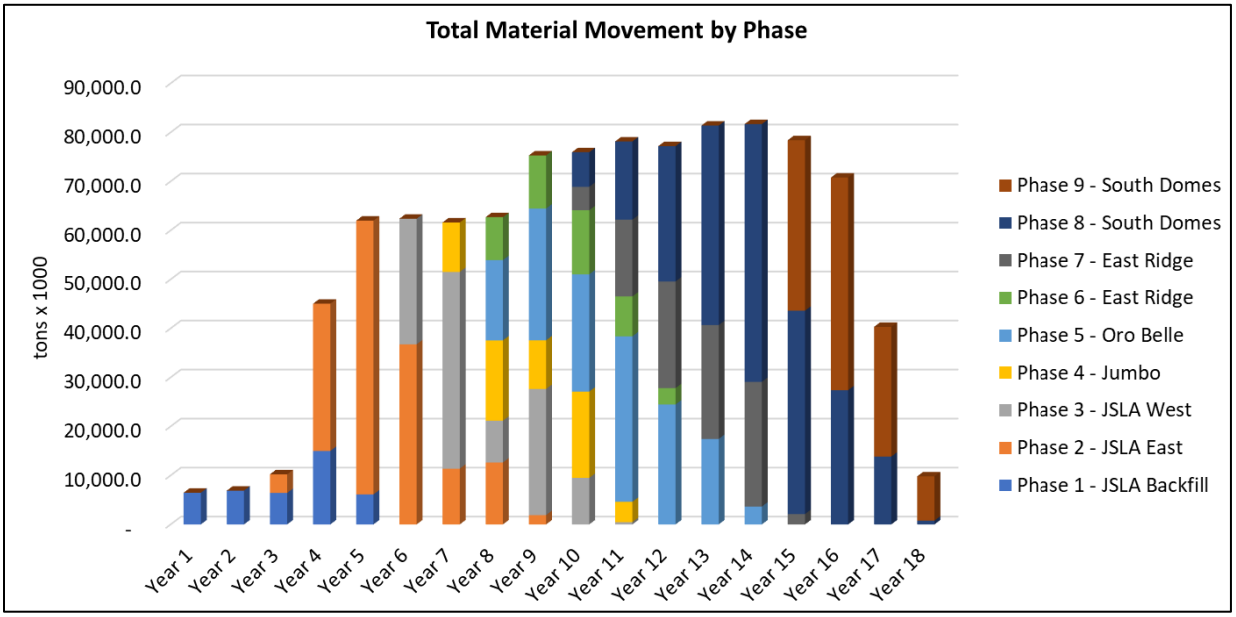


Figure 1-2: Material Movement by Phase

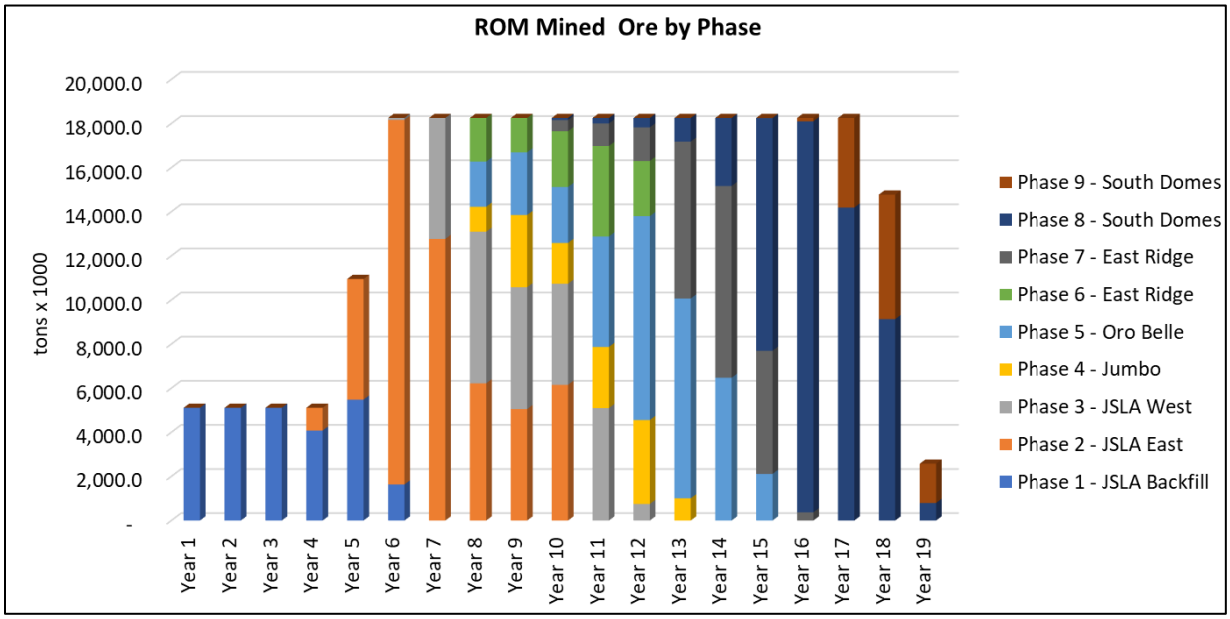


Figure 1-3: ROM Ore by Phase

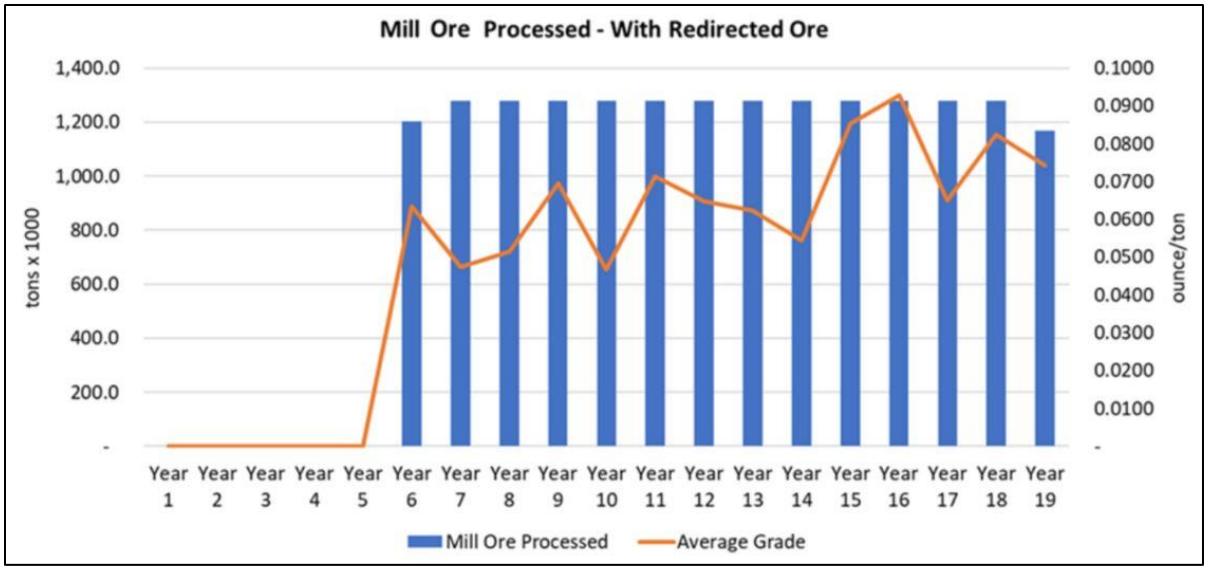


Figure 1-4: Mill Ore Processed

The mine plan incorporates the following elements:

- Staggered mining equipment deliveries in Year 4 and Year 5,
- Ramp up of overall mining rate to 60 Mton/y (54 Mt/y) through to Year 8 then expand gradually to 80 Mton/y (73 Mt/y) through to Year 16 when production begins to drop through Year 19,
- Overall sequence of development in the JSLA, Jumbo, Oro Belle and East Ridge area is clockwise development to final pit limits in each area to allow for an orderly sequence of backfilling waste as pits are completed,
- Sequence at South Domes is an initial southwest pit with an expansion to the northeast, and
- The resource block model was developed on 20 ft (6.1 m) benches. The mine design was developed using the 20 ft bench height with triple benching to 60 ft between design catch benches or berms. Operations are planned for a 30 ft (9.1 m) bench height. Sinking rates in the schedule were limited to 300 ft/y (91 m/y) or the equivalent of 10 benches/year. Drills, loading units and support equipment appropriate for mining a 30 ft bench height have been selected for the mine plan and associated cost estimates.

Phase 1 mining is being conducted by contract mining services. Mine supervision and technical management are handled by the CMV mining team while all other mining functions are the contractor's responsibility. A transition to operator owned mining services or fleet will start prior to Year 5 in parallel with Phase 2 mining. Full Phase 2 mining production coincides with the start of the fully expanded processing facilities, estimated to be in Year 6.

Table 1-5 shows the transition in production of ore and waste over this period. Figure 1-5 illustrates the anticipated project transition from Phase 1 to Phase 2 start up for mining operations.

Table 1-5: Phase 1 to Phase 2 Transition Plan

Operational Phase	LOM Production Year	Phase 2 Expansion	Ore Production (kton)	Waste Production (kton)	Total Production (kton)
Phase 1	1	-5	5,200	1,260	6,460
Phase 1	2	-4	5,160	1,730	6,890
Phase 1	3	-3	5,140	1,960	7,100
Phase 1 + Phase 2 Pre-strip	4	-2	5,140	13,100	18,240
Phase 1 to 2 Ramp-up	5	-1	11,150	42,630	53,780
Phase 2	6	1	19,300	43,830	63,130
Phase 2	7-19	2-14	233,200	597,400	830,600
Subtotal Phase 2			**252,500**	**641,230**	**893,730**
Total Phase 1 + Phase 2			**284,300**	**701,920**	**986,220**

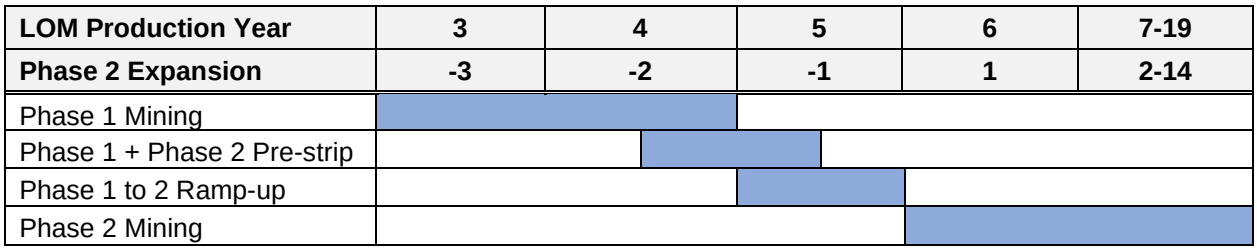


Figure 1-5: Phase 1 to Phase 2 Timeline

The total in-pit waste is 701.9 Mton (636.8 Mt) which is to be placed in the various waste rock management facilities and within open pits once final pit limits are reached. The waste includes 15.0 Mton (13.6 Mt) of Inferred Mineral Resources within the ultimate reserve pit limits which presents an opportunity for future resource classification conversion. The overall strip ratio is 2.47:1. Final waste dump slopes are 2H:1V or 26.5°. There is a northwest waste dump and southeast waste dump designed within the Mine Property boundary.

The mining equipment will operate on 30 ft (9.1 m) high benches with double benching in waste, up to 60 ft (18.2 m) high. Berms will be left on alternate benches in hard rock. Wall slope design recommendations have been implemented for inter-ramp slopes with variable berm widths and bench face angles. Inter-ramp slope angles which vary from 48 to 52° are determined by geological domains, with modified slope angles within structural domains of 40 to 46°. Bench face angles vary from 60 to 79° depending on the domain and host lithology.

Equipment sizing for ramps and working benches is based on the use of 250 ton rigid frame trucks. Haulage and in-pit access roads will be double lane access and have 100 ft (30m) width, which is three times the equipment width plus berm and ditch. The maximum ramp gradients are 10% in-pit but can be constructed to 8% to maximize productivity. Working benches were designed for 115 to 130 ft (35 to 40 m) minimum on pushbacks, although some push-backs do work in a retreat manner to facilitate access.

The initial mining fleet requirement for the Phase 2 expansion that will be purchased in the first three years is summarized in Table 1-6.

Table 1-6: Mining Equipment Summary

Equipment	Details	Total
Production Blasthole Drill	8 7/8"	2
Wall Control Drill	4 1/2' - 9"	2
Hydraulic Shovel	2996 hp 44.5 yd^3	2
Wheel Loader	1739 hp 28 yd^3	2
Haul Truck	2650 hp 250 ton	17
Track Dozer	600 hp	5
Wheel Dozer	620 hp	2
Grader	290 hp 16 ft	3
Water Truck	1450 hp 32,000 gal	2
Wheel Loader	541 hp 10 yd^3	1
Haul Truck	825 hp 61 ton	3
Excavator	524 hp 6 yd^3	1
Tire Manipulator	Large Tire	1
Vibratory Compactor	130 hp 7.5 ft	1
Backhoe	105 hp 1.3 yd^3	1
Articulated Truck	450 hp 40 ton	1
Fuel and Lube Truck	100 ton 8,000 gal	1
Tractor and Low Bed	160 ton	1
Flatbed Hiab Truck	10 ton	1
Rough Terrain Forklift	33 ton	1
Shop Forklift	18 ton	1

Alluvium, backfill, and waste dump material will be free-digging. Hard rock will require drilling and blasting. Ore grade control will utilize rotary blast holes drilled across a full bench height of 30 ft (9.1 m). Blastholes will be grid drilled to facilitate breakage and will be loaded with ammonium nitrate and emulsion explosives. The blastholes will be sampled to provide analytical results for grade control and mine planning. Drilling will be in advance of the mined benches to allow proper short-term planning.

Heap leach ROM ore is being hauled to the existing Phase 1 leach pad. In Phase 2 of the LOM plan, ROM will be hauled to a new, adjacent Phase 2 leach pad that will be developed progressing from South to North, then towards the West. Mill feed will be placed in a stockpile adjacent to the primary crusher and re-handled by wheel loaders to feed the crusher.

1.13 RECOVERY METHODS

The current operation consists of a 14,000 ton/d (12,700 t/d) run of mine (ROM) heap leach operation with gold recovery in carbon columns. The planned expansion for Phase 2 will include a 50,000 ton/d (45,350 t/d) ROM heap leach and a new 3,500 ton/d (3,175 t/d) crushing, milling and leach/CIL plant for recovering gold and silver from mill grade ore.

For Phase 2, the heap leach pad will be designed to process 18.2 million short tons (Mton) (16.5 Mt) annually at an average life of mine (LOM) grade of 0.012 oz/ton (0.54 g/t), while the mill will be designed to process approximately 1.3 Mton (1.2 Mt) annually at an average LOM grade of 0.068 oz/ton (2.28 g/t). Phase 2 expansion will extend operations to approximately 19 years with

an additional estimated three years of heap rinsing as part of reclamation where gold will continue to be leached and recovered.

ROM heap leach ore will be loaded into haul trucks and stacked in 25 ft (8 m) lifts on the heap leach pad to be leached with a dilute cyanide solution using a drip irrigation system for 80 days. After percolating through the ore, the pregnant gold and silver bearing solution will flow by gravity to a pregnant solution tank where it is pumped to a 12,000 gpm (750 L/s) carbon-in-column (CIC) circuit to recover the precious metal from solution. The carbon adsorption circuit will consist of two trains of five cascading carbon columns.

ROM mill ore will be loaded into haul trucks and dumped on the ROM storage pad for recovery by a front-end loader and feed to a two-stage crushing plant intended to reduce ore to 80% passing ½ in prior to feeding a single ball mill. The ball mill will be a 16.5 ft x 21 ft long (5 m x 6.4 m) mill equipped with a single 3,300 hp (2,460 kW) wound rotor induction motor with a VFD. The mill will process a nominal throughput of 162 ton/h (fresh feed), producing a final product P_{80} of 150 µm. A batch gravity concentrator will treat a portion of the grinding circuit circulating load to recover any gravity recoverable gold with the concentrate being processed in a batch intensive leach reactor (ILR).

Cyclone overflow will flow by gravity to a 68 ft (21 m) diameter high-rate pre-leach thickener which will thicken the slurry to 45-50% solids. Thickened slurry will be pumped to a hybrid leach/CIL circuit using a series of seven agitated tanks (30 hours retention time) using cyanide solution in the presence of activated carbon to extract the gold. The thickener overflow will flow by gravity to the non-cyanide solution tank to be used as make-up water in the grinding circuit.

The carbon handling circuit is designed to handle carbon from both the heap leach CIC circuit and the mill-CIL circuit in separate batch processes. Loaded carbon at an average of approximately 15 tons/day (13.6 t/d) will be washed with hydrochloric acid and stripped under pressure. An indirect propane-fired rotary carbon regeneration kiln will treat up to 18 tons (16 t) of carbon per day, equivalent to 100% regeneration of stripped carbon.

The resulting pregnant solution from the carbon handling and ILR circuits will undergo electrowinning (EW) in four cells operating in parallel and the recovered precious metal sludge will be dried in a retort furnace to recover any mercury present. The dried sludge will be refined in an induction furnace to produce gold and silver doré. Doré bars will be the final product and will be stored in a vault within a secure area prior to shipment.

Leached slurry from the leach/CIL circuit will report to a cyanide recovery thickener to recycle as much water and cyanide as possible back to the process. Flocculant will be added to aid in settling solids to produce a thickened product at approximately 60% solids, which will be treated in an SO_2/Oxygen cyanide destruction process.

The final tailings will be pressure filtered in two of three tailing filters (1 unit on standby). The filter cake at approximately 18% moisture will discharge to a stockpile to be reclaimed by front end loader and loaded into articulated trucks for haulage to the filtered tailings facility.

The major process equipment for gold recovery is summarized in Table 1-7.

Table 1-7: Major Process Equipment

Item	Quantity	Description	Power
Barren Solution Pump	4	12 in Vertical Turbine	1,000 hp
Pregnant Solution Pump	4	8 in x 10 in Horizontal Centrifugal	150 hp
CIC Column	10	18 ft. diam. 5 per train	-
Primary Crusher	1	49 in x 37 in Jaw	175 hp
Secondary Crusher	1	60 in Standard Cone	500 hp
Ball Mill	1	16.5 ft diameter x 21 ft F/F	3,300 hp
Gravity Concentrator	1	Centrifugal Bowl, 48 in bowl diam.	60 hp
Pre-leach Thickener	1	68 ft diam. High rate	-
Leach/CIL Tanks	7	37 ft diam. x 40 ft height; Agitated	100 hp
Cyanide Recovery Thickener	1	68 ft diam. High rate	-
Filter Feed Pump	2	10 in x 8 in Horizontal Centrifugal	350 hp
Tailing Filter	3	8.2 ft x 8.2 ft Pressure filter, 64 chambers, 16 min cycle	100 hp
Acid Wash Vessels	2	FRP construction	6 ton capacity
Strip Vessels	2	Pressure vessel; Stainless steel construction	6 ton capacity
Carbon Regeneration Kiln	1	5 ft diam. x 50 ft long, Horizontal Propane-Fired Indirect	1,500 lb/h 18 ton/day
Mercury Retort	1	3 ft^3 Electric	30 kW
Electrowinning Cells	4	Sludging, 2000 amps @ 6 volts	-
Smelting Furnace	1	Induction Furnace	450 kW

Reagents used within the plant will be mixed on-site and distributed via reagent handling systems. These reagents include:

- Lime (CaO)
- Sodium cyanide (NaCN)
- Hydrochloric acid (HCl)
- Caustic soda (NaOH)
- Sodium metabisulfite (SMBS)
- Copper sulfate ($CuSO_4$)
- Flocculant
- Antiscalant

Process water needs for the recovery plant will fluctuate seasonally. Make-up water for the heap leach will change with the amount of evaporation and precipitation each month. Net evaporative losses will range from 150 gpm to 700 gpm (10 L/s to 45 L/s), averaging approximately 400 gpm (25 L/s) annually, while ROM ore on the leach pad will need to be saturated with moisture at an average of 10% and this results in an average consumption of approximately 670 gpm (42 L/s).

Additional water is required for the mill process and will be largely made up with recycled water. The Project will mitigate water consumption by use of low evaporation buried drip emitters, limiting

the amount of water retained in ponds with larger evaporative losses, use of binders and dust collectors that limit water needs for dust suppression and by using extensive water recycling in the process.

The Phase 2 expanded Project is anticipated to produce 3,203,000 oz gold over the course of the mine life and rinsing of the heap leach pad.

Figure 1-6 shows the expanded Phase 2 process plant layout.

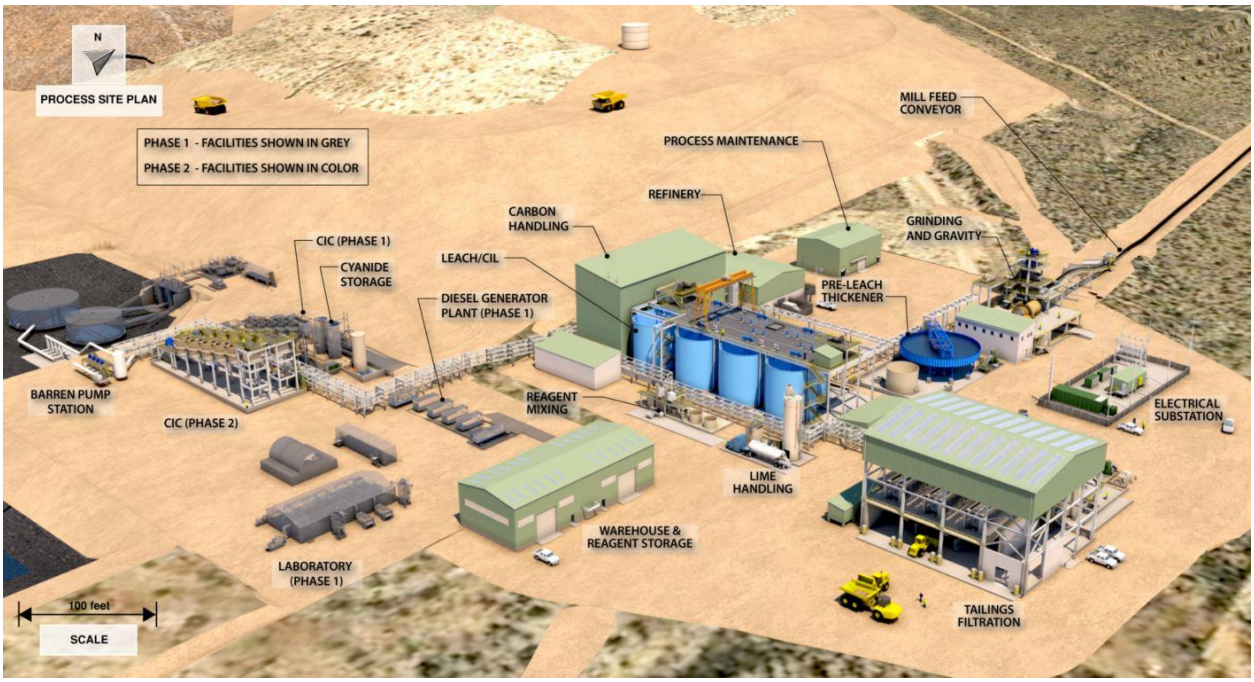


Figure 1-6: Process Plant 3D View Looking Northwest

1.14 PROJECT INFRASTRUCTURE

The Phase 2 expansion will continue to utilize existing facilities including the recently built Phase 1 facilities to the greatest extent possible. Phase 2 infrastructure will increase in size to meet the expanded project parameters and include new site improvements to support the operation of the required new process plant and mining facilities. The project supporting infrastructure will include:

- Site access, on site and service road access (most currently in operation)
- Mining haul roads (currently in operation and to be expanded)
- Truck service shop, fueling station, tire change pad and wash facility
- ROM ore stockpile area
- Water supply and distribution systems
- Surface water management infrastructure
- Lined filtered tailings facility
- Topsoil reserve areas
- Process plant maintenance building
- Reagents storage and warehousing building
- Security gatehouse including medical triage area and evacuation helipad
- Communications system and plantwide process control

Figure 1-7 shows the expanded Phase 2 site plan.

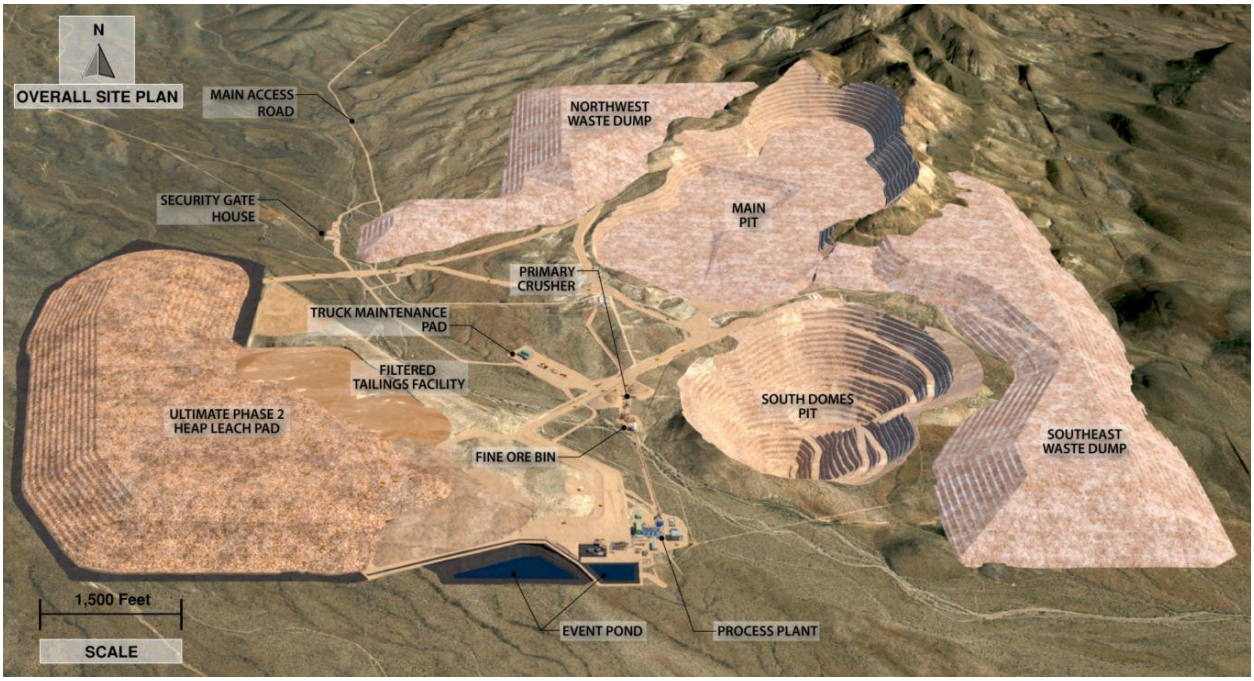


Figure 1-7: Overall Project Site Plan

The Castle Mountain mine will be a net zero discharge facility with regards to water with the main water loss occurring via evaporation from the surface of the heap leach pad and filtered tailings facility. Water is also used in saturating the heap leach pad and dust control mitigation for roads and site development, as necessary. The Project site-wide water balance indicates an expected make-up water demand to range from approximately 1,150 gpm to 1,900 gpm (72 L/s to 120 L/s) depending on the season. In addition to the water use mitigation measures mentioned above, further water demand reduction will be attained through greater use of onsite dust suppressants, strategic seasonal construction planning during wetter months, and optimizing the heap leach make-up water requirements through efficiency improvements.

Water supply at site currently includes three historical wells providing approximately 150 gpm (10 L/s) total and connected via existing underground pipelines to an existing 300,000 gal (1.1 ML) water tank, as well as two production wells, W-01 and W-02, with pumps installed in 2019 at the start of Phase 1 project. These production wells are located at the edge of the JSLA pit (W-01) and in the area of what will become the South Domes pit (W-02). These are bedrock wells which produce approximately 400 gpm (25 L/s) total and are connected to a recently constructed 300,000 gal (1.1 ML) raw water tank.

Additional water for the Phase 2 expansion is expected to be extracted from new wells. Recent water exploration has shown very good potential for both water near site and in a neighboring water basin. It is anticipated that once developed, wells in both areas will be able to produce between 500 and 1,000 gpm (32 and 64 lpm) of water each. The project expansion development includes the addition of new wells, and well pumps in both locations as well as an overland pipeline and booster pumps to meet the make-up water demands.

Electrical power requirements for Phase 2 are approximately 10 MW and this is to be provided by a connection to grid power which will be routed to site via a new transmission line from an existing Nevada Energy (NVE) sub-station near Searchlight, NV, similar to that previously used at the site and along the same right of way. Additional options including solar power have been investigated and could be developed as part of the project construction.

Filtered tailings from the mill will be produced at a moisture content of 19% to 22% by dry weight basis (16-18% wet basis) and will be delivered using 40 ton articulated dump trucks to a lined facility. Stacking of filtered tailings is considered best available technology for handling and placing this type of material.

The tailings will be spread by dozer atop the reclaimed former Viceroy heap leach pad. Development of the filtered tailings facility will occur in four stages to allow for both the placement of appropriate volumes of material to match production and the rinsing of heap leach side slopes which will be directly abutted to the final filtered tailings facility footprint. The heap leach and filtered tailings will form a co-deposited and integrated facility. Rinsing is required to allow for recovery of residual gold ounces within the heap as well as to reduce cyanide levels to compliant levels within the placed heap leach material prior to final reclamation.

By placing filtered tailings abutted to the new heap leach facility and on top of the historic leach pad, the area of disturbance on the site will be minimized. This will increase the long-term stability on the western edge of the facility and allow integrated management of solution between the tailings and heap leach facility, allowing for further recycle of cyanide.

1.15 ENVIRONMENTAL PERMITTING AND REQUIREMENTS

The mine operations encompass both public and private land, accordingly, the County of San Bernardino (County) and the United States Bureau of Land Management (BLM) have served as co-leading agencies for implementing environmental review. The 1990 Environmental Impact Statement / Environmental Impact Report (1990 EIS/EIR), the 1998 Castle Mountain Mine Expansion Project Environmental Impact Statement / Environmental Impact Report (1998 EIS/EIR), and the 2020 BLM Environmental Assessment cumulatively provided authorization for current mine operations.

The County approved minor revisions to the Mine and Reclamation Plan and issued a revised Mining Conditional Use Permit (CUP) and Reclamation Plan 90M-013 which expires December 31, 2035. The 2020 BLM NEPA analysis resulted in the BLM issuing a Decision Record and Finding of No Significant Impact (FONSI) and approved the revised Mine and Reclamation Plan on February 27, 2020.

The Phase 2 mine expansion is expected to require a new or updated environmental review (likely in the format of an EIS/EIR) as well as several new state and federal permits and amendments. The federal lead agency, the BLM, and the California state lead agency, the County, will cooperate to prepare a single environmental review document. Federal, state, county, and local agency officials will review and comment on the analysis provided through the environmental review process.

There will be public review and comment periods initiated by a Notice of Intent. Once the co-lead agencies complete their assessment and publish a Final EIS/EIR, then subsequently, each of the lead agencies prepare their respective approvals. The BLM issues a Record of Decision (ROD) and associated project stipulations to satisfy project specific mitigation measures adopted by the

agency to lessen project impacts. The County will ultimately vote to certify the EIR and approve (or deny) the CUP for the Project and associated conditions of approval, which like the BLM, provide mitigation to lessen project impacts.

Once lead agency operating permits have been granted, CMV can apply to remaining local, state, and federal agencies who issue further discretionary and non-discretionary permits.

1.16 CAPITAL AND OPERATING COST

Total initial capital cost is estimated at $389 million excluding the mining equipment fleet which is estimated at $121 million and expected to be leased to own over five years, or a total of $510 million considering the fleet purchased upfront. Capital costs are summarized in Table 1-8 along with the estimated sustaining capital needs of the Phase 2 project and closure costs. Sustaining capital costs for the project are primarily accounting for mining and additional stages of the heap leach pad and filtered tailings facility development. Total sustaining capital costs during production until closure are $147 million. Closure costs totaling $22 million are included separately for the end of mine life. Estimates are expressed in US dollars ($), Q4 2020 with no escalation.

Direct costs as well as all indirect costs and appropriate contingencies for all facilities have been included within the estimate and define the full projected cost to bring the Phase 2 expansion into production as defined by this report.

Initial mining capital costs are based on conversion to an Equinox owned mining fleet from the contract-based fleet being utilized for current operations, necessary parts, and spares for the fleet, as well as slope monitoring equipment and mine development and pre-stripping. A major part of the mining equipment fleet could be leased which results in a reduction of $121 million of initial capital. Leasing the mining equipment adds to the operating cost; however, the net impact is an improvement to the Internal Rate of Return (IRR).

The Project execution strategy is based on an engineering, procurement, and construction management (EPCM) implementation approach. Contingency has been estimated through an analysis of the level of detail in estimating each specific discipline and overall is included at 12.5% on plant and infrastructure items. The contingency has not been applied to mining or working capital as is typically the case. The accuracy of the estimate is defined as -10% to +15%.

Table 1-8: Phase 2 Capital Cost Summary

Item	Initial ($M)	Sustaining ($M)	Total ($M)
Mine Mobile Equipment[1]	154	70	224
Mine Development	41	11	52
Mine Total	**195**	**81**	**276**
General Siteworks	11	-	11
Heap Leach and Solution Handling	38	56	94
Process Plant	62	-	62
Tailings Filtration and Storage	16	1	17
Infrastructure	41	-	41
Freight	8	-	8
Direct Plant and Infrastructure Total	**176**	**57**	**233**
EPCM, Vendor Support and Other Indirects	51	-	51
Transmission Line	15	-	15
Owner's Cost, Working Cap and Taxes	40	-	40
Sub-total Plant and Infrastructure	**282**	**-**	**-**
Contingency	33	9	42
Total CAPEX	**510**	**147**	**657**
Less Leased Mining Equipment	***(121)***	**-**	***(121)***
Total CAPEX (with Leased Mining Equipment)	**389**	**-**	**536**

Note 1: Mining equipment includes all applicable sales tax.

M3 has assembled the capital cost estimate with consulting input from GLA, The MINES Group and NMS as well as Equinox. Utility Transmission Line costs are based on the 2018 PFS estimate from Nevada Energy.

Direct operating costs have been estimated for mining, processing and general and administrative (G&A) costs. Mining costs were developed by NMS, processing, and infrastructure costs by M3 and G&A by Equinox. Total operating costs for the expanded Phase 2 project are $9.32/ton ($10.28/t) of ore processed as described in Table 1-9. Mining equipment purchase costs are all considered capital costs and excluded from operating costs. Table 1-10 shows the estimated cash cost over the course of the expanded Phase 2 project for production of 3,187,000 ounces of payable gold.

Table 1-9: Operating Cost Phase 2 Summary

Description	Unit Cost ($/ton mined)
Mining	1.75
Description	**Unit Cost $/ton ore**
Mining	6.20
Processing (Total)	2.45
G&A	0.65
Sub-Total	**9.30**
Refining and Transportation	0.02
Total	**9.32**

Table 1-10: Phase 2 Cash Cost Estimate

Item	Total Cost ($M)	Unit Cost ($/oz)
Mining	1,567	492
Processing – Heap Leach	365	115
Processing – Mill/CIL	255	80
G&A	164	51
Operating Cost	**2,351**	**738**
Royalties	214	67
Refining and Transportation	5	2
Adjusted Operating Cost	**2,570**	**806**
Sustaining Capital	147	46
Salvage Value	(3)	(1)
Reclamation and Closure	22	7
All in Sustaining Cost (AISC)	**2,736**	**858**

1.17 ECONOMIC ANALYSIS

The economic analysis was completed primarily utilizing a discounted cash flow model. Currency is provided in US dollars, unless otherwise noted. Table 1-11 summarizes the spend plan for initial capital. Table 1-12 summarizes the resulting project economics at a gold price of $1,500/oz.

The Phase 2 project, from an economic analysis perspective, begins with detailed engineering activities and procurement of major equipment in preparation for construction which is expected to start 2.5 years ahead of start-up. The period of project execution resulting in significant capital spend with construction activities will begin approximately 2 years prior to full operations starting. Figure 1-8 illustrates the relationship Phase 2 project related activities through project start up.

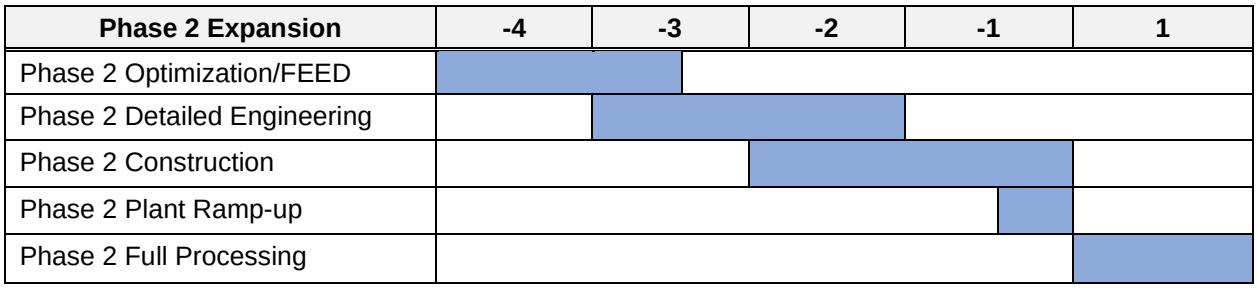


Figure 1-8: Phase 2 Schedule

Table 1-11: Phase 2 Initial Capital Spend Plan

Phase 2 Year	Ore Production (kton/y)	Mining Initial Capital Spend ($M)	Plant Initial Capital Spend ($M)	Working Capital	Total ($M)
Pre-Prod Year -3	5,150	-	28	-	**28**
Pre-Prod Year -2	5,150	109	204	-	**313**
Pre-Prod Year -1	11,150	62	68	14	**144**
Phase 2 Prod Year 1	19,300	24	-	1	**25**
Expanded Operations	19,500	Sustaining	Sustaining	N/A	-

The Phase 2 project cash flow is estimated to be $1,280 million over the 17-year operating life, 14 years of mining with an additional 3 years of rinsing. The Project after-tax NPV at a discount rate of 5% is estimated to be $639 million. The after-tax cash flow results in a 5.3-year payback period after start-up of commercial operation with an after-tax IRR of 17.5%. With leasing the mining fleet, the after-tax NPV remains at $639 million while the after-tax IRR improves to 18.3%, and the payback period is 5.4 years.

Table 1-12: Financial Summary

Category	Units	Value	
Production Summary			
Phase 2 Ore material mined	Mton	894	
Phase 2 Ore tons processed	Mton	253	
Phase 2 Life (Processing)	y	14	
Phase 2 Life (Processing + Rinsing)	y	17	
Heap Leach Ore	Mton	235	
Head grade	oz/ton	0.0119	
Recovery	%	74	
Recovered Gold	koz	2,095	
Mill Ore	Mton	18	
Head grade	oz/ton	0.0665	
Recovery	%	94	
Recovered Gold	koz	1,108	
Total Recovered Gold	koz	3,203	
Total Payable Gold	koz	3,187	
Capital Costs			
Phase 2 Initial Capital	$M	510	
Sustaining Capital	$M	147	
Operating Costs			
Mining	$/ton mined	$1.75	
Mining	$/ton processed	$6.20	
Processing	$/ton processed	$2.45	
G&A	$/ton processed	$0.65	
Refining and Transportation	$/ton processed	$0.02	
Total Operating Cost	$/ton processed	$9.32	
Total Production Cost	$/ton processed	$806	
All-In Sustaining Cost	$/oz Au	$858	
Economic Indicators			
		Without Leasing	**With Leasing**
Internal Rate of Return (IRR), Pre-tax	%	18.9	19.7
Internal Rate of Return (IRR), After-tax	%	17.5	18.3
Undiscounted Cashflow, Pre-tax	$M	1,550	1,539
Undiscounted Cashflow, After-tax	$M	1,280	1,268
Net Present Value (NPV) @5%, Pre-tax	$M	784	784
Net Present Value (NPV) @5%, After-tax	$M	639	639
Payback Period (Based on After-tax)	y	5.3	5.4

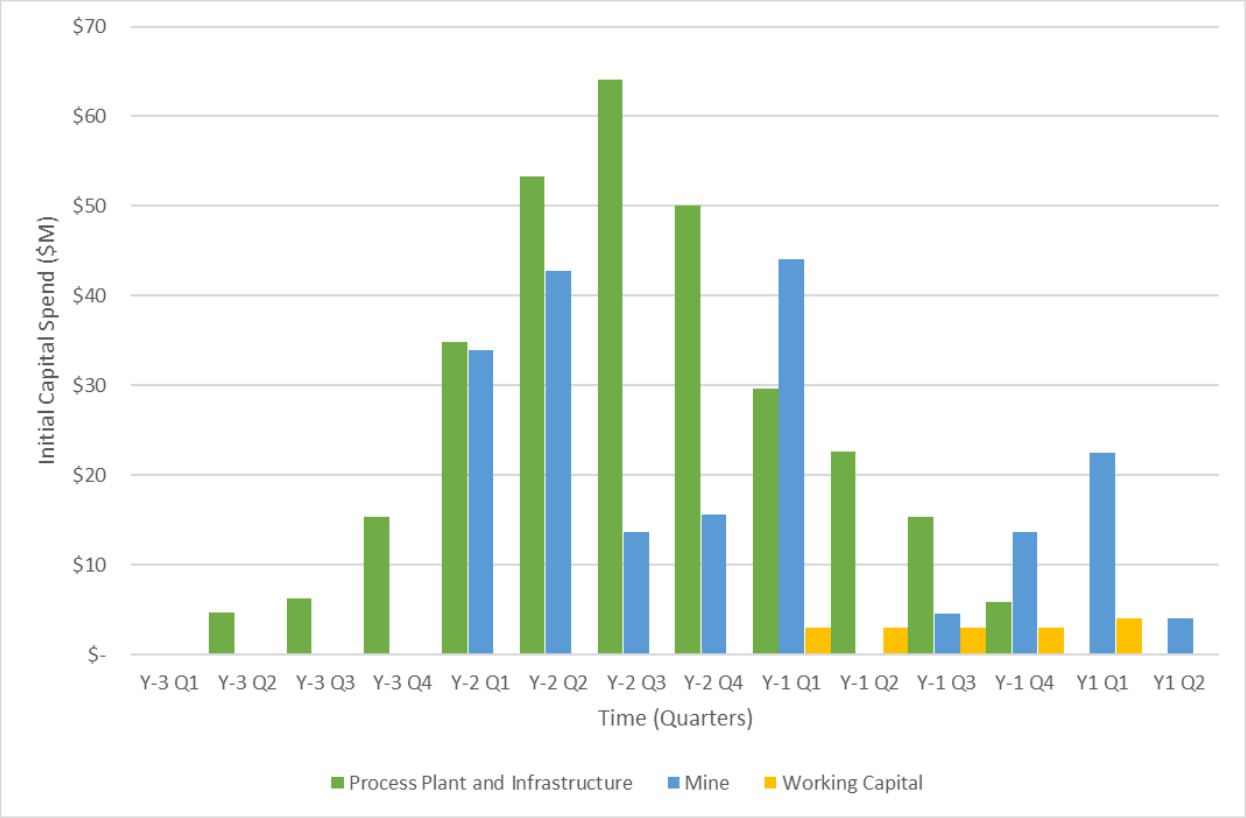


Figure 1-9: Initial Capital Spend Plan (Quarterly)

Figure 1-10 shows the results of the economic sensitivity analysis. The Project is most sensitive to overall operating cost and gold price, and least sensitive to cyanide usage.

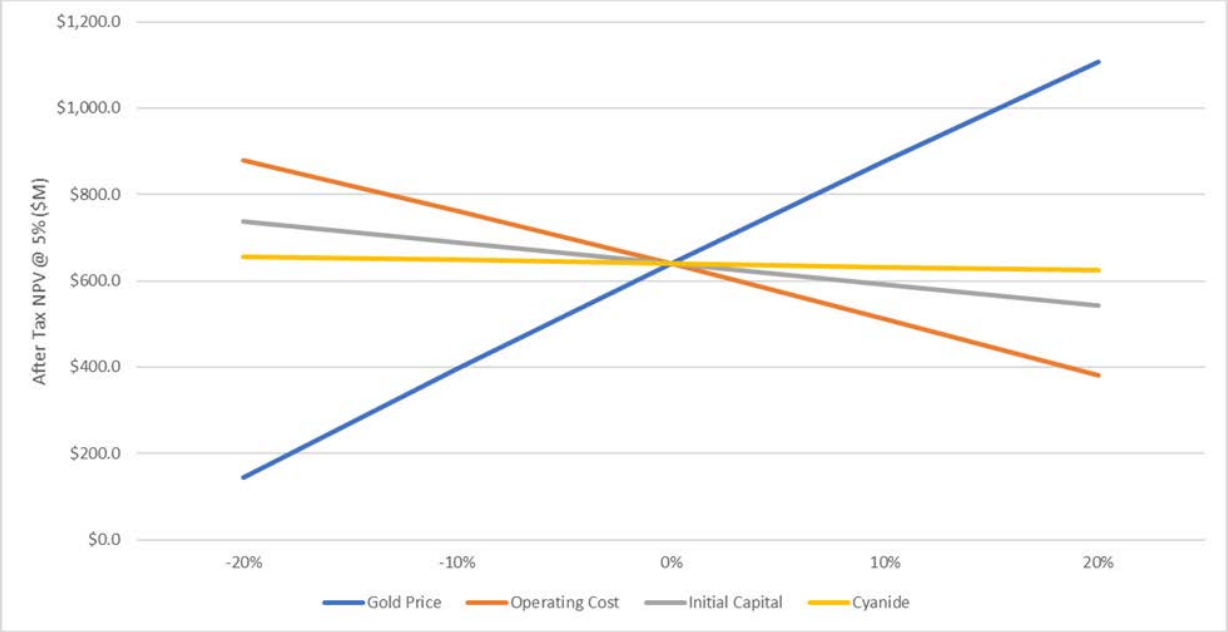


Figure 1-10: Sensitivity Chart

Table 1-13 summarizes the financial model.

Table 1-13: Financial Model Summary

Mining Operations			Total	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Total Material Mined (kton)			893,764	-	-	-	63,138	63,186	63,968	73,161	73,781	72,812	73,196	78,450	78,615	78,358	79,877	61,258	28,686	5,278	-	-
Total Ore (ROM & Mill)			252,910	-	-	-	19,453	19,527	19,528	19,528	19,343	19,506	19,528	19,528	19,294	19,527	19,528	18,825	16,052	3,745	-	-
Gold Grade (oz/ton)			0.0157	-	-	-	0.0140	0.0136	0.0138	0.0144	0.0124	0.0144	0.0161	0.0144	0.0145	0.0168	0.0188	0.0152	0.0238	0.0353	-	-
Contained Gold (koz)			3,982	-	-	-	273	265	270	282	240	281	315	282	279	327	366	287	382	132	-	-
Total Recovered Gold (koz)			3,203	-	-	-	203	194	199	213	177	213	233	210	206	249	278	215	285	177	86	65
Payable Metal																						
Payable Gold (koz)			3,187	-	-	-	202	193	198	212	176	212	232	209	205	248	276	214	283	176	86	64
Revenues																						
Net Revenues			$4,776,182	$0	$0	$0	$303,366	$289,475	$296,511	$317,346	$263,788	$317,518	$348,113	$313,672	$307,250	$371,178	$414,051	$320,208	$424,307	$263,961	$128,822	$96,617
Operating Cost	**$/ton mined**	**$/ton ore**																				
Mine	$1.75	$6.20	$1,566,941	$0	$0	$0	$100,003	$118,476	$120,933	$128,005	$130,418	$123,540	$121,970	$134,403	$137,146	$124,005	$128,523	$115,557	$69,164	$14,797	$0	$0
Process Plant - Heap Leach		$1.44	$365,189	$0	$0	$0	$27,259	$27,689	$27,562	$26,984	$27,303	$26,884	$27,401	$27,248	$27,241	$26,843	$26,919	$26,357	$23,179	$8,144	$4,672	$3,504
Process Plant - CIL		$1.01	$254,575	$0	$0	$0	$17,622	$17,793	$17,932	$18,520	$17,988	$18,615	$18,135	$18,299	$18,032	$18,725	$18,660	$18,381	$18,210	$17,664	$0	$0
G&A		$0.65	$164,102	$0	$0	$0	$11,444	$11,452	$11,452	$11,452	$11,433	$11,450	$11,452	$11,452	$11,428	$11,452	$11,452	$11,379	$11,092	$9,819	$3,368	$2,526
Total Operating Cost (Minus Refining)		$9.30	$2,350,808	$0	$0	$0	$156,328	$175,410	$177,879	$184,961	$187,142	$180,488	$178,958	$191,402	$193,848	$181,025	$185,553	$171,674	$121,645	$50,423	$8,040	$6,030
Cash Flow																						
Capital Expenditures																						
Initial Capital																						
Mine			$195,522	$0	$108,978	$62,397	$24,146	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Process Plant			$299,546	$28,126	$203,512	$67,909	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sustaining Capital																						
Mine			$80,872	$0	$0	$0	$1,846	$8,131	$13,570	$16,469	$3,342	$650	$7,351	$12,831	$15,473	$236	$662	$236	$75	$0	$0	$0
Process Plant			$66,555	$0	$0	$0	$3,404	$0	$1,295	$26,965	$0	$0	$22,249	$0	$0	$12,641	$0	$0	$0	$0	$0	$0
Total Capital Expenditures			$642,495	$28,126	$312,490	$130,306	$29,396	$8,131	$14,865	$43,434	$3,342	$650	$29,601	$12,831	$15,473	$12,877	$662	$236	$75	$0	$0	$0
Cash Flow before Taxes			$1,549,799	-$28,126	-$312,490	-$130,306	$106,685	$97,812	$93,487	$78,846	$65,860	$126,286	$130,006	$101,645	$88,419	$159,377	$199,090	$121,290	$261,629	$192,037	$110,385	$88,361
Cumulative Cash Flow before Taxes				-$28,126	-$340,616	-$470,922	-$364,237	-$266,425	-$172,938	-$94,091	-$28,231	$98,055	$228,061	$329,707	$418,125	$577,503	$776,593	$897,883	$1,159,512	$1,351,548	$1,461,933	$1,550,294
Taxes			$270,196	$0	$0	$0	$0	$1,602	$1,887	$2,282	$917	$2,927	$11,773	$12,529	$11,791	$27,983	$35,183	$18,578	$54,481	$43,247	$25,573	$19,443
Cash Flow after Taxes			$1,279,603	-$28,126	-$312,490	-$130,306	$106,685	$96,210	$91,600	$76,565	$64,943	$123,359	$118,233	$89,116	$76,628	$131,394	$163,907	$102,712	$207,148	$148,790	$84,812	$68,918
Cumulative Cash Flow after Taxes				-$28,126	-$340,616	-$470,922	-$364,237	-$268,027	-$176,427	-$99,862	-$34,919	$88,440	$206,674	$295,790	$372,418	$503,812	$667,719	$770,431	$977,579	$1,126,369	$1,211,181	$1,280,099

1.18 CONCLUSIONS

Based on evaluation of the data available and collected from the study conducted, the Qualified Persons (QPs) have drawn the following conclusions:

1.18.1 General

The level of investigation for all elements of this study, as confirmed by all Technical Report QPs, is consistent and typical of a feasibility level study.

As of the effective date of this Technical Report, Equinox holds a 100% interest in the Castle Mountain Project.

1.18.2 Geology and Mineral Resource Estimate

The deposits within the Castle Mountain Project are part of a low sulfidation epithermal system characterized by gold mineralization commonly occurring with silica alteration and iron oxide minerals. Mineralization is controlled by first order porosity and permeability of the lithological units that form the host volcanic complex and structural zones which can provide the conduit for hydrothermal fluids that carry mineralization.

The Project has a combined Measured and Indicated mineral resources exclusive of mineral reserves that are amenable to open pit mining that total 82 Mton (74 Mt) at 0.018 oz/ton (0.62 g/t) gold for 1,470 koz contained gold. These mineral resources occur dominantly within the oxide portion of the ore body and include portions of transition and sulfide ore. The Measured mineral resources exclusive of mineral reserves that are amenable to open pit mining total 861,000 tons (781,000 t) at 0.020 oz/ton (0.68 g/t) gold for 17 koz contained gold. Indicated mineral resources exclusive of mineral reserves that are amenable to open pit mining that total 81 Mton (73 Mt) at 0.018 oz/ton (0.62 g/t) gold for 1,453 koz contained gold.

Contributions to the changes to the current mineral resources are predominantly due to the differences between criterion used for Mineral Resource classification which relies dominantly on drillhole spacing.

1.18.3 Mining and Mineral Reserve Estimate

The current LOM plan was developed based upon Measured and Indicated Mineral Resources only and includes Proven and Probable Mineral Reserves of 284.3 Mton (257.9 Mt) with a grade of 0.015 oz/ton (0.514 g/t) at a cut-off grade of 0.005 oz/ton (0.17 g/t) Au. The total waste mined will be 701.9 Mton (636.8 Mt). The strip ratio average is 2.47:1 waste:ore tons.

Mining for the project expansion will be as an Owner-operated conventional diesel-powered truck and shovel operation. Current operations are focused on mining of previously backfilled material in the JSLA pit while expanded operations will focus on expansion of current pits and new pit development.

There is considerable potential to expand the Mineral Resources and Mineral Reserves as there are significant gold anomalies from the grab samples at East Ridge, East Flats and Egg Hill greater than 0.0292 oz/ton (1.00 g/t) gold. In addition, higher gold prices could make it economic to expand the Mineral Reserve pits shown in this feasibility study and ultimately connect the JSLA and South Domes pits.

1.18.4 Mineral Processing and Metallurgical Testing

Significant metallurgical testwork from 2015 to 2020 has been completed on both heap leach and mill material to establish the design criteria for the Phase 2 expansion. The testwork program completed provided the necessary data to define a process flowsheet and engineering parameters. This allowed for design and cost estimation of a conventional process plant for the feasibility study as well as defining the metal recoveries and operating consumables. Recovery methods proposed for the expansion consist of proven and well-known technologies in the industry.

After evaluating the column leach tests by feed size, ore zone and lithology, the arithmetic average gold recovery was 81%, 80% and 80% respectively. A weighted gold recovery based on ounces per lithology was calculated as 82%. The average gold recovery based on laboratory column testwork for Castle Mountain low grade ore was 80%.

To estimate the Castle Mountain gold recovery for the production heap leach from the lab data, operating and environmental conditions were considered. This includes ROM particle size distribution, permeability, effective leaching of the side slopes, etc. The ROM material for the Castle Mountain Project is predicted to have an F_{80} of 152 mm to 203 mm. When considering the ore size and other data, a lab to field deduction of 6% was applied to the average lab recovery of 80% for an expected LOM heap leach gold recovery of 74% after solution application is stopped. To account for the typical time impact in recovering gold from a large leach facility at closure, the expected gold recovery during LOM operations is considered to be 67% with a final recovery of 74% attained only after extracting residual gold values and reducing cyanide levels in the heap. This is expected to span a period of approximately three years after mining has ceased.

For this Feasibility Study, gravity followed by gravity tail leach in a CIL circuit was selected for the process plant based on economics. An overall gold recovery of 94% is expected from mill grade ores processed through the mill after 24-hour hybrid leach/CIL retention time. The plant has been sized conservatively with 30 hours retention time in the leach/CIL tanks.

1.18.5 Project Infrastructure

The existing infrastructure including current operations has been integrated into the proposed designs to support the expansion operations to the greatest extent possible. Further Phase 2 infrastructure developments include a security gatehouse, expanded site fencing, on site access roads, truck fleet service facilities, and dedicated process storage and warehousing facilities.

A site wide water balance was developed considering multiple scenarios based on historic and current climatic conditions at site and in the surrounding areas. Resulting make-up water demands were evaluated and used to inform water supply requirements. Recently completed groundwater studies on and off site indicate a high likelihood that sufficient capacity for fresh water can be attained through a combination of on-site and off-site sources.

Mill tailings were tested and analyzed, and it was concluded they are amenable to filtered stacking. To limit new land use on the property it was determined that adequate capacity is available on the historic Viceroy heap leach pad and adjacent to the expanded heap leach facility to serve the LOM requirement. This results in an optimized footprint while minimizing new disturbance on the property.

Several options for power supply were studied in detail with each being determined to provide viable alternatives for power supply to the expanded operations. The selected basis for the feasibility study is a connection to the grid via a new powerline serviced by NV Energy and SCE. Other alternatives including supplementing with renewable power, specifically solar, have been investigated and show potential opportunity.

1.18.6 Environmental Studies and Permitting

The Castle Mountain Mine is located on both public and private land, and historically has been environmentally permitted by co-lead agencies, the County of San Bernardino at the state level, and the United States Bureau of Land Management (BLM) at the federal level. The current operation was issued a revised Mining CUP by the County in August 2019 while the BLM issued a Decision Record and FONSI in February 2020 approving the revised Mine and Reclamation Plan. These key permits along with others provide the authorization for current mine operations at the project site.

Significant resource monitoring and environmental analyses have been conducted and continue to be completed on site to assure compliance and environmental stewardship of the project site.

The Mine has all permits required to conduct mining for Phase 1 and is permitted to operate within the Mine Permit boundary which has an area of 3,910 acres (1,583 ha). The Phase 2 Project will operate within the Mine Property boundary; however, modification to approved mine and reclamation plan elements, including increased mining and water extraction rates will require updates to existing permits.

Mine expansion as considered in this feasibility study is expected to require a new or updated environmental review (likely in the format of an EIS/EIR) as well as several new state and federal permits and amendments. Future amendments to the mine and reclamation plan to account for mine expansion are also expected and will include facility decommissioning, land recontouring, and revegetation.

1.18.7 Cost Estimates

Detailed capital and operating cost estimates have been developed including consideration for all direct and indirect costs associated with execution of the expansion project and required supporting infrastructure as well as sustaining costs, and reclamation and closure costs.

The cost estimate is based on preliminary engineering including 250 feasibility level design drawings covering all engineering disciplines, design criteria and detailed material take-offs. Mechanical and electrical equipment pricing were obtained for all major equipment (>$50,000) including 89% (or 140 items) through budgetary quotes. Bulk material pricing was estimated from recent projects budget quotes, local contractor budgetary review and actual pricing from Phase 1 construction. Mining equipment costs are based on quotes from major suppliers. Labor rates have been estimated using a weighted average of prevailing non-union shop wages from a published source (Davis-Bacon; 50%) and actual labor rates on site for Phase 1 construction (50%).

Project operating cost is based on a detailed build up of staffing requirements, reagent and fuel consumptions, mining activities, maintenance, and power demand. All major consumables have been specifically quoted with delivery to site.

The costs reflect a joint effort conducted by M3, NMS and specialist sub-consultants to adequately define project cost to a -10% to +15% accuracy level.

Analysis of the resulting economic parameters shows the expansion project to be economically viable.

1.19 RECOMMENDATIONS

The Castle Mountain Phase 2 expansion is a feasible project with good economics and should be progressed to the next stage which includes permitting along with optimization and front-end engineering ahead of detailed engineering.

2 INTRODUCTION

2.1 ISSUER AND PURPOSE

Equinox retained independent consultants to prepare a Feasibility Study Technical Report for the Castle Mountain Project in the state of California, USA. Equinox, through its indirect wholly owned subsidiary NewCastle, has 100% of the right, title and beneficial interest in and to Castle Mountain Venture which owns the Property.

The study includes updates to the mineral resource and mineral reserve estimates. Key aspects included in the study are further advancement on metallurgical testwork, pit design, updated mine schedule, proposed expanded heap leach operations, the addition of a high-grade processing mill including filtered tailings facility, infrastructure development, costs, and financial model. The findings and conclusions are based on information available at the time of preparation and data supplied by other consultants as indicated. The effective date of this Report is 26 February 2021, which represents the date of information used in the Report. The effective date of the mineral resource estimate for the Project is 30 June 2020, which represents the date of exploration information used for mineral resource estimation. The effective date of the mineral reserve estimate for the Project is 30 June 2020. There has been no material change to the information between the effective date and the signature date of the Report.

2.2 SOURCES OF INFORMATION AND QUALIFIED PERSONS

2.2.1 Qualified Persons

The following individuals, by virtue of their education, experience and professional association, are considered Qualified Persons (QP) as defined in NI 43-101 and are members in good standing of appropriate professional institutions. QP certificates of authors are provided in Appendix A. The QPs are responsible for the specific sections as shown in Table 2-1.

Table 2-1: List of Qualified Persons, Inspections and Responsibilities

Qualified Person	Company	Certification	Date of Site Visit	Section Responsibilities
Gabriel Secrest	M3	P.E.	November 19, 2019	Sections 1.1, 1.2, 1.3, 1.4, 1.14, 1.15, 1.16, 1.17, 1.18.1, 1.18.5, 1.18.6, 1.18.7, 1.19, 2, 3, 4, 5, 13.8.5, 17.3.1, 18 (except for 18.5.3), 19, 20, 21 (except for 21.1.7, 21.1.9 and 21.2.2), 22, 23, 24, 25.1.1, 25.1.5, 25.1.6, 25.1.7, 25.2, 25.3.1, 25.3.3, 26.1, 26.5, 26.7, and 27.
Laurie M. Tahija	M3	P.E.	November 19, 2020	Sections 1.9, 1.13, 1.18.4, 13, 17 (except for 17.3.1), 25.1.4, and 26.6.
Eleanor Black	Equity Exploration	P. Geo	August 13-15, 2019	Sections 1.5, 1.6, 1.7, 1.8, 6, 7, 8, 9, 10, 11, 12 (except for 12.4), 25.3.2, and 26.2.
Trevor Rabb	Equity Exploration	P. Geo	August 13-15, 2019	Sections 1.10, 1.18.2, 12.4, 14, 25.1.2, and 26.3.
John Nilsson	Nilsson Mine Services Ltd.	P.Eng.	N/A	Sections 1.11, 1.12, 1.18.3, 15, 16, 21.1.7, 21.1.9, 21.2.2, 25.1.3, and 26.4.
R. Douglas Bartlett	Clear Creek Associates	P. Geo	April 28, 2020	Section 18.5.3.

2.2.2 Notable Personal Inspection Details

Gabriel Secrest (M3) completed a site visit of the Castle Mountain property on November 19th, 2019, accompanied by Equinox representatives Mr. Kevin Scott and Mr. Travis O'Farrell as well as several M3 discipline lead engineers. During his site visit, Mr. Secrest visited the construction progress of the Phase 1 facilities including the heap leach pad as well as existing locations and planned locations for site infrastructure. These locations included current and potential future raw water well site locations, the existing access road, potential routing for permanent plant power through Walking Box Ranch, JSLA backfill pit, the historical heap facility and planned locations for the high-grade mill, process plant and refinery.

Eleanor Black and Trevor Rabb (Equity) completed a site visit of the Castle Mountain property on August 14th, 2019 and the Henderson, Nevada project office on August 15, 2019. The site visit was led by Equinox representatives Scott Heffernan and Owen Nicholls, and included a review of the Project geology, logging and storage areas, and a general property overview. The QPs were able to verify the logging and sampling procedures and to inspect several diamond drill holes to ensure sample intervals and logged data were accurately reflected in the Project's database. Legacy hard copy data including original drill hole logs and assay certificates were checked and the geological model criteria were presented at the Henderson, Nevada office.

2.2.3 Other Sources of Information

Qualified Persons utilized information from references listed in Section 27 of this report.

2.3 UNITS OF MEASURE

This report uses U.S. Customary Units expressed in short tons (2,000 lbs, abbreviated in this report as "ton" to differentiate from metric tons "t"), feet, and gallons consistent with U.S. Standards. For added reference, the International System of Units (SI) expressions are included throughout the report within parenthesis when appropriate.

Monetary units are expressed in United States Dollars ($) unless otherwise specified.

2.4 TERMS OF REFERENCE

Table 2-2 shows the units of measure used in this study, and other terms and abbreviations are shown in Table 2-3. Table 2-4 shows the conversions for common units.

Table 2-2: Units of Measure

Unit	Abbreviation	Unit	Abbreviation
Above mean sea level	amsl	Day	d
Billion Years	Ga	Days per week	d/w, dpw
Canadian Dollars	C$	Days per year (annum)	d/y(a), dpy(a)
Centimeter	cm	Degree	°
Centimeters per second	cm/sec	Degrees Celsius	°C
Cubic Feet	ft^3	Degrees Fahrenheit	°F
Cubic Feet per second	cfs	Dollars per short ton	$/ton
Cubic feet per minute	cfm	Dollars per ounce	$/oz
Cubic Meters	m^3	Feet	ft
Cubic Meters per second	cms	Feet above sea level	fasl
Cubic Yards	yd^3	Gallons	gal

Unit	Abbreviation
Gallons per minute	gpm
Gallons per minute per square foot	gpm/ft^2
Gram	g
Grams per metric ton	g/t
Greater than	>
Hectare	ha
Hertz (frequency)	Hz
Horsepower	hp
Hour	h
Hours per day	h/d, hpd
Hours per week	h/w, hpw
Hours per year	h/y(a), hpy(a)
Inch	in, “
Kilo (thousand)	k
Kilogram	kg
Kilometer	km
Kilovolt	kV
Kilowatt	kW
Kilowatt hour per short ton	kWh/ton
Kilowatt per short ton	kW/ton
Kilowatt-hour	kWh
Less than	<
Linear foot	LF
Liter	l or L
Liters per hour per square meter	L/h/m^2
Liters per minute	lpm
Liters per second	L/s
Megawatt	MW
Meter	m
Meters above sea level	masl
Micrometer (micron)	µm
Milligram	mg
Milligrams per liter	mg/L
Milliliter	mL
Millimeter	mm
Million	M
Million dollars	$M
Million gallons	M gal
Million ounces	Moz
Million liters per year	Ml/y
Million metric tonnes	Mt, Mtonnes

Unit	Abbreviation
Million metric tonnes per year	Mt/y
Million short tons	Mton
Million short tons per year	Mton/y
Million Years	Ma
Minute (time)	min
Month	mo
Ounce	oz
Ounces per ton	oz/t, (metric) oz/ton (short)
Parts per billion	ppb
Parts per million	ppm
Pascal (Newtons per square meter)	Pa (N/m^2)
Percent	%
Phase (Electrical)	ph
Pound	lb, lbs
Pounds per Square Inch	psi
Pounds per Square Inch gauge	psig
Pounds per cubic foot	pcf
Pounds per ton	lbs/ton
Qualified Person	QP
Specific gravity	SG
Square Feet	SF, ft^2
Square kilometer	km^2
Square mile	mi^2
Standard cubic feet per hour	ft^3/h, SCFH
Thousand troy ounces	koz
Thousands of metric tons	kt
Thousands of short tons	kton
Ton (short ton)	ton
Tonne (metric ton)	t
Tons per day	t/d (metric), mtpd (metric), ton/d (short), tpd (short)
Tons per month	tpm, (short) ton/mon (short)
Volt	V
Volume Percent	vol %
Weight Percent	wt %
Year (annum)	y (a)

Table 2-3: Non-Unit Abbreviations Used in this Report

Unit	Abbreviation
Acid rock drainage	ARD
Adsorption-Desorption-Recovery	ADR
ALS Global	ALS
American Assay Laboratories Inc.	AAL
American Society for Testing and Materials	ASTM

Unit	Abbreviation
Ammonium Nitrate / Fuel Oil	AN/FO
Antimony	Sb
Arsenic	As
Atomic Absorption	AA
Atomic Absorption Spectroscopy	AAS
Authorities to Construct	ATCs
Bed Volume	BV
Bismuth	Bi
Bond abrasion index	Ai
Bond crusher impact	CWi
Bottle Roll Test	BRT
Bureau of Land Management	BLM
Bureau Veritas	BV
California Environmental Quality Act	CEQA
California Regional Water Quality Control Board, Colorado River Basin Region	RWQCB
California Register of Historic Resources	CRHR
Call and Nicholas, Inc.	CNI
Canadian Institute of Mining, Metallurgy, and Petroleum	CIM
Carbon adsorption rate test	CAR
Carbon adsorption capacity test	CAC
Carbon in Column	CIC
Carbon in Leach	CIL
Castle Mountain Mine	CMM, or the Property
Castle Mountain Project	The Project
Castle Mountain Venture	CMV
Castle Mountains Volcanic Sequence	CMVS
Caustic (or caustic soda / Sodium Hydroxide)	NaOH
Certified Reference Materials	CRM
Closed side setting	CSS
Coefficient of determination	R^2
Coefficient of variance	CV
Comma Separated Values	CSV
Conditional Use Permit	CUP
Conventional Rotary Drill	CR, or rotary
Copper	Cu
Copper sulfate	$CuSO_4$
County of San Bernardino	County
Cyanide soluble gold	AuCN
Diamond Drill	DD
Digital elevation model	DEM
Drop Weight test	DWT
Eighty percent passing	P_{80}
Electrowinning	EW
Engineering, Procurement and Construction Management	EPCM
Environmental Impact Study and Environmental Impact Review	EIS/EIR
Equinox Gold Corp.	Equinox, or the Company
Equity Exploration Consultants Ltd.	Equity

Unit	Abbreviation
East Ridge	ER
Feasibility Study Technical Report	The Report, or the Study
Federal National Environmental Policy Act	NEPA
Fiber-reinforced plastic	FRP
Front-end loader	FEL
Geo-Logic Associates	GLA
Global Positioning System	GPS
Gold	Au
Gresham Savage Nolan & Tilden, PC	Gresham|Savage
Gresham, Savage, Nolan & Tilden LLP	Gresham Savage
High-density polyethylene	HDPE
High-sulfidation epithermal	HSE
Human machine interface	HMI
Hydrochloric acid	HCl
Induction	I
Inductively coupled optical emission spectrometry	ICP-OES
Intensive Leach Reactor	ILR
Internal Rate of Return	IRR
International Directional Services LLC	IDS
International Standards Organization	ISO
International System of Units	SI
Inter-Ramp Slope Angles	ISA
Inverse Distance Cubed	ID3
Inverse Distance Squared	ID2
Jumbo	JB
Jumbo South-Leslie Ann (Pit)	JSLA
Kappes, Cassiday and Associates	KCA
Laser	L
Lead	Pb
Lerchs-Grossman	LG
Life of Mine	LOM
Light Detection and Ranging	LiDAR
Lime	CaO
Linear low-density polyethylene	LLDPE
Liquid Natural Gas	LNG
Low-sulfidation epithermal	LSE
M3 Engineering & Technology Corporation	M3
McClelland Laboratories Inc.	MLI
Mercury	Hg
Milk of Lime	MOL
Mine Technical Services Ltd.	MTS
Mineral and Exploration Geochemistry	MEG
Mojave Desert Air Basin	MDAB
Mojave Desert Air Quality Management District	MDAQMD
Molybdenum	Mo
Motor control centers	MCC
National Historic Preservation Act	NHPA
National Pollutant Discharge Elimination System	NPDES
Nearest Neighbor	NN
Net Present Value	NPV

Unit	Abbreviation
Net Smelter Return	NSR
Network Intrusion Detection System	NIDS
New Source Review	NRS
NewCastle Gold Ltd	NewCastle
Nilsson Mine Services Ltd.	NMS
North American Datum	NAD
Ordinary Kriging	OK
Oro Belle	OB
Oxygen Uptake Rate	OUR
Pebble Quicklime	CaO
Permits to Operate	PTOs
Pre-Feasibility Study	PFS
Proterozoic	Pc
Proterozoic Basement	Pc Basement
Proterozoic sedimentary rocks	Pc Seds
Qualified Person	QP
Quality Assurance/Quality Control	QA/QC
Record of Decision	ROD
Reduction to Major Axis	RMA
Relative standard deviation	RSD
Reverse Air-Blast (Drilling)	RAB
Reverse Circulation	RC
Rock Quality Designation	RQD
Rocky Mountain Geochemical	RMG
Run of Mine	ROM
Scanning Electron Microscope equipped with an Energy Dispersive Spectrometer	SEM-EDS
Security Event Management	SEM
Semi-autogenous grinding	SAG
Silver	Ag
Sodium Cyanide	NaCN
Sodium metabisulfite	SMBS
South Dome	SD
Spill Prevention Control and Countermeasure Plan	SPCC
Steinert Combined Sensor	KSS FLI XT
Sulfur impregnated carbon	SIC
Surface Mining and Reclamation Act	SMARA
Surface recording gyro	SRG
Tellurium	Te
Thallium	Tl
The MINES Group Inc.	MINES
Three dimensional	3D
Transient Electromagnetic (survey)	TEM
Tungsten	W
Two dimensional	2D
Unified Threat Management	UTM
United States Bureau of Land Management	BLM
Universal Transverse Mercator	UTM
US Fish and Wildlife Service	USFWS
Variable frequency drives	VFD
Viceroy Gold Corporation	Viceroy

Unit	Abbreviation
Volcanoclastic	Vx
Volume weighted average price	VWAP
Weak Acid Dissociable	WAD
Weak acid dissociable cyanide	CN_{WAD}
Work Breakdown Structure	WBS
X-ray transmission sensors	XRT
Zinc	Zn

Table 2-4: Conversions for Common Units

Metric Unit	Imperial Measure
1 hectare	2.47 acres
1 metre	3.28 feet
1 kilometre	0.62 miles
1 gram	0.032 ounces (troy)
1 tonne	1.102 tons (short)
1 gram/tonne	0.029 ounces (troy)/ton (short)
1 tonne	2,204.62 pounds
Imperial Measure	**Metric Unit**
1 acre	0.4047 hectares
1 foot	0.3048 metres
1 mile	1.609 kilometres
1 ounce (troy)	31.1 grams
1 ton (short)	0.907 tonnes
1 ounce (troy)/ton (short)	34.28 grams/tonne
1 pound	0.00045 tonnes

3 RELIANCE ON OTHER EXPERTS

In preparing the report, M3 has relied upon contributions from a range of technical and engineering consultants as well as Equinox. M3 has reviewed the work of the other contributors and finds that this work has been performed to normal and acceptable industry and professional standards and can be relied upon for purposes of this report.

M3 is not an expert in legal and land tenure matters and has relied upon verification of land title and tenure as documented in an updated title report prepared by Gresham Savage Nolan & Tilden Corporation dated March 10th, 2020. This report is relied upon to determine land and claim ownership as it relates to the Castle Mountain Project.

4 PROPERTY DESCRIPTION AND LOCATION

4.1 LOCATION

The Project is located in the historic Hart Mining District, at the southern end of the Castle Mountains, San Bernardino County, California, approximately 70 mi (113 km) south of Las Vegas, Nevada by road (Figure 4-1). The Project is located in a high desert area near the Mojave National Preserve and Castle Mountains National Monument. The Project is located at latitude 35° 16' North and longitude 115° 06' West.

The Project survey control is based on a local coordinate system which is utilizes NAD 83 UTM zone 11 in imperial units (feet). The conversion from meters to feet is converted by dividing the UTM meter units by 0.3048, with four significant figures.



Figure 4-1: Location Map – Castle Mountain Project

4.2 PROPERTY AND TITLE IN SAN BERNARDINO, CALIFORNIA

4.2.1 Mineral Rights

The Project includes 1,301 acres of patented lode claims, 8,980 acres of unpatented lode claims, 3,598 acres of unpatented mill site claims, and 3,639 acres of placer claims (Table 4-1, Figure 4-2). The claims are registered under the Castle Mountain Venture and Viceroy Gold Corporation. Many of the claims overlap and as such the total area of the individual claims is not representative of the overall total area covered. The effective area for operation is covered in Section 4.5.

Table 4-1: Summary of Land Tenure by Type at Castle Mountain Mine, San Bernardino County, California

Type	Claims	Area (acres)	Area (hectares)
Patented Lode	8	1,301	526
Unpatented Lode	449	8,980	3,634
Unpatented Mill Site	723	3,598	1,456
Unpatented Placer	54	3,639	1,473
Total	**1,234**		

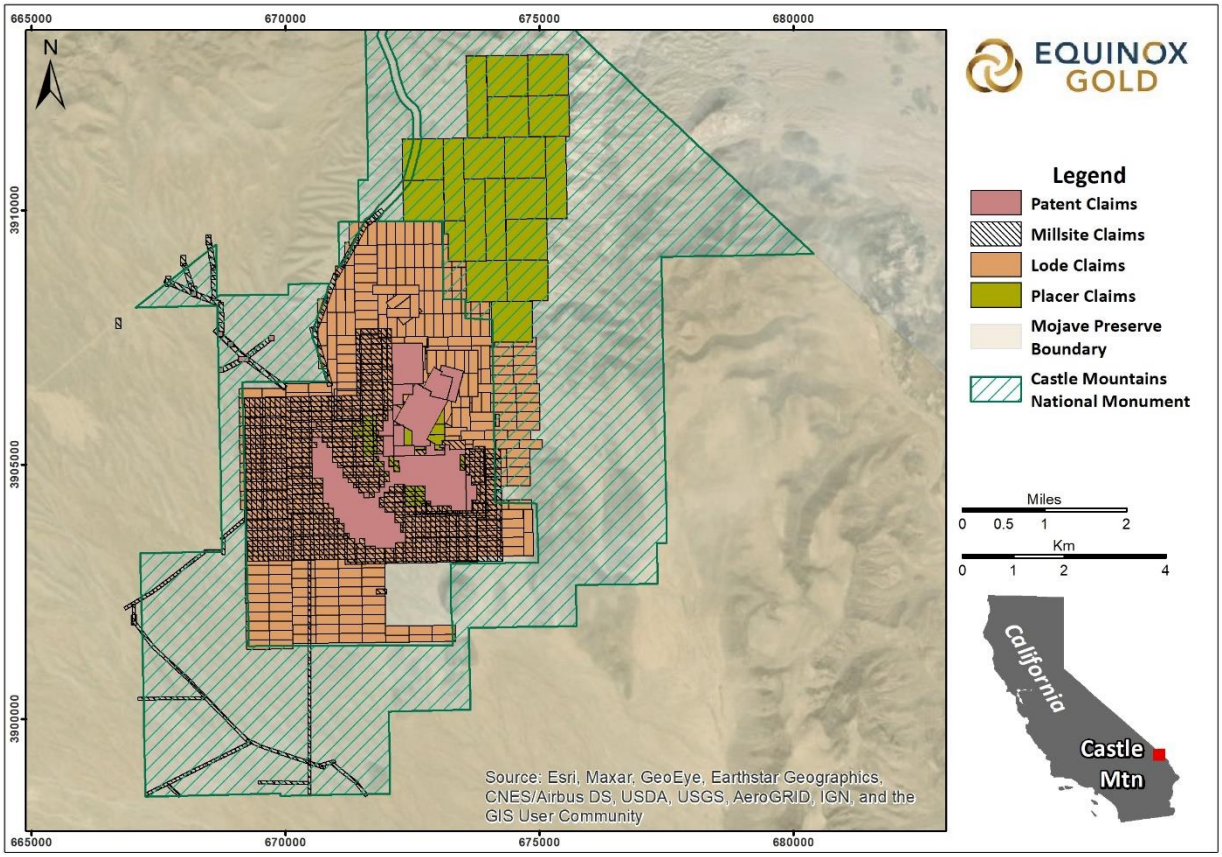


Figure 4-2: Tenure Map for the Castle Mountain Mine

Patented and unpatented claims are located in Townships, Ranges and Sections shown in Table 4-2.

Table 4-2: Township & Range in Castle Mountain

Township & Range, all San Bernardino Base & Meridian	Sections
T12N R18E	23
R13N R17E	13
T14N R17E	1, 9, 11-14, 17, 18, 22-27, 30, 32, 34-36

4.2.2 Acquisition of Castle Mountain Venture

Equinox (previously Trek Mining Inc.) acquired NewCastle Gold Ltd. (NewCastle) on December 22, 2017 and NewCastle became a wholly-owned subsidiary of Equinox. Subject to certain obligations, NewCastle has 100% of the right, title, and beneficial interest in and to Castle Mountain Venture (CMV) which owns the Castle Mountain Mine. NewCastle acquired its interest through its acquisition of Telegraph Gold Inc. (Telegraph), an Ontario corporation, on April 23, 2013. This followed Telegraph's acquisition of CMV on September 6, 2012.

NewCastle, formerly known as Castle Mountain Mining Company Limited, was incorporated under the Business Corporations Act (Ontario) on December 16, 2009 and commenced activities as a capital pool company on January 29, 2010 under the name of Foxpoint Capital Corp.

On April 25, 2013, NewCastle completed its acquisition of Telegraph by the way of an amalgamation of Telegraph with a subsidiary of NewCastle. At the time of the transaction, NewCastle changed its name from Foxpoint Capital Corp to Castle Mountain Mining Company Limited with a registered head office located in Toronto, Ontario, Canada.

At the time of Telegraph's purchase of CMV, it was 75% owned by Viceroy and 25% owned by MK Resources LLC (MKR). Viceroy was a wholly owned subsidiary of Sprott Resource Lending Corporation (Sprott) and MKR was a subsidiary of Leucadia National Corporation (Leucadia). Telegraph acquired both interests through concurrent transactions that each closed on September 6, 2012. MKR's 25% interest was acquired for $2,000,000, which was paid in cash. Telegraph acquired the shares of Viceroy and therefore the remaining 75% interest in CMV from Sprott.

4.3 CALIFORNIAN LAND RIGHTS

4.3.1 Annual Claim Maintenance Payments to BLM

NewCastle is required to pay an annual federal claim maintenance fee to the United States Bureau of Land Management (BLM) for each unpatented lode, mill site and placer mining claim in the amount of $165. These payments are due on September 1st of each year. Payments to the BLM are in good standing for 2020-2021.

4.3.2 Annual Property Tax Payments to San Bernardino Country, CA

Property taxes are payable to San Bernardino County (the County) for the 24 tax parcels (patented & unpatented lode claims, mill site claims and placer claims) that comprise the Project.

Payments are due on a semi-annual basis and have been remitted to the County. Total payments of $96,978.03 have been made by NewCastle for the 2020-2021 tax year.

4.3.3 Title Report

On March 10, 2020, Gresham, Savage, Nolan & Tilden LLP (Gresham Savage) of San Bernardino, California, prepared an updated title report (Gresham Savage, 2020), which related only to changes that had occurred since the date of the previous title report prepared by Gresham Savage Nolan & Tilden, PC (Gresham|Savage) on July 13, 2017, which was an update to previous title report prepared by Gresham|Savage on November 1, 2016 (the “November 2016 Update”), which was an update to the Supplemental Title Report/Update prepared by Gresham|Savage on May 9, 2016 (the “May 2016 Update”), which was an update to the Supplemental Title Report/Update prepared by Gresham|Savage on August 7, 2012 (the “2012 Update”), which was an update of the Supplemental Title Report/Update prepared by Gresham|Savage on February 25, 2004 (the “2004 Update”), which in turn was an update to the Title Opinion dated September 18, 1991, prepared by Harris, Trimmer & Thompson, Reno, Nevada (the "Harris Opinion," and collectively with the each of the other referenced Updates, the “Prior Reports”).

4.4 ROYALTIES

A number of net smelter return (NSR) royalty agreements are in place on the Project as shown in Table 4-3 and illustrated in Figure 4-3. Royalty outline data were provided by Equinox.

Table 4-3: Distribution of Outstanding Net Smelter Royalties

Claim/Patent	%	Owner
Turtle Back	5	Conservation Fund
Milma	5	Conservation Fund
Golden Clay	5	Huntington Tile
All Claims	2.65	Franco-Nevada
Pacific Clay	2	American Standard

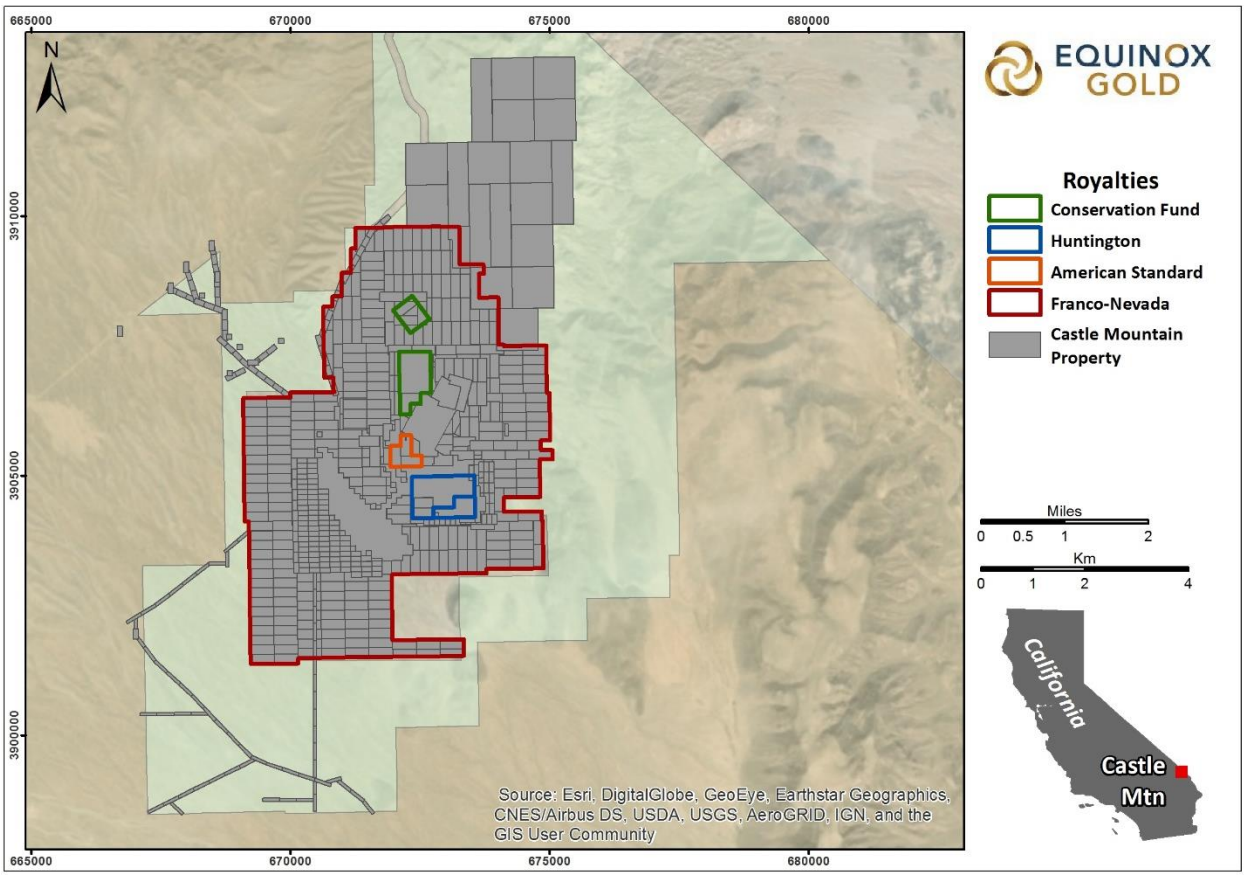


Figure 4-3: Map of Net Smelter Royalties

On April 11, 2016, NewCastle announced that it had arranged a royalty consolidation and private placement financing with Franco-Nevada Corporation (Franco-Nevada) for gross proceeds of $3.4 million of which $2,236,364 was ascribed to the royalty consolidation.

On June 16, 2016, NewCastle closed the royalty consolidation transaction, whereby NewCastle and Franco-Nevada agreed to create, in return for a cash payment of $2,236,364, a new 2.65% net smelter royalty covering all minerals produced from the Project. The new royalty overrides the five separate pre-existing royalties held by Franco-Nevada and covers the existing Project and extends ten miles from the boundary of the Project. The new royalty does not require any advanced minimum royalty payments.

4.5 PERMITTING

The Mine is currently active and retains all permits required to conduct mining for Phase 1; this includes compliance with all applicable federal, state, and local regulations and ordinances.

The Mine is permitted to operate within the Mine Property boundary which has an area of 3,910 acres (1,583 ha) (Figure 4-4), of which 1,375 acres are currently approved for mining and related activity. The Phase 2 Project will similarly operate within the existing permitted Mine Property Permit boundary; however, modification to approved mine and reclamation plan elements, including increased mining and water extraction rates will require updates to existing permits. The additional water is to be obtained from near site and off-site production water wells.

The project lead agencies are U.S. Bureau of Land Management for federal (project) lands, and the County of San Bernardino for private (project) lands. Both agencies are required to assess, analyze, and mitigate (to the extent possible) environmental impacts related to Phase 2 mine expansion plans. These required environmental assessments of the effects of mine expansion are required through the California Environmental Quality Act (CEQA) and the Federal National Environmental Policy Act (NEPA).

The County and BLM consult with each other to ensure that the Project meets applicable State laws, regulations, and local ordinances, as well as Federal laws, regulations, and agency specific policy, prior to approving development. The current lead agency permits (County and BLM) are shown below:

- San Bernardino County, Land Use Services Department: Conditional Use Permit. SAMR/88-003/DN585-1145N; Reclamation Plan 90M-013. The operational term has been extended from 2025 to 2035.

- Bureau of Land Management: Record of Decision, Castle Mountain Mine Expansion Project San Bernardino County, California Environmental Impact Statement No. DES 97-10 State Clearinghouse No. 95081031, March 13, 1998.

- Bureau of Land Management: Decision Record, Modification of Castle Mountain Mine Plan of Operations, DOI-BLM-CA-D090-2020-0002-EA, February 27, 2020. The operational term has been extended from 2020 to 2035.

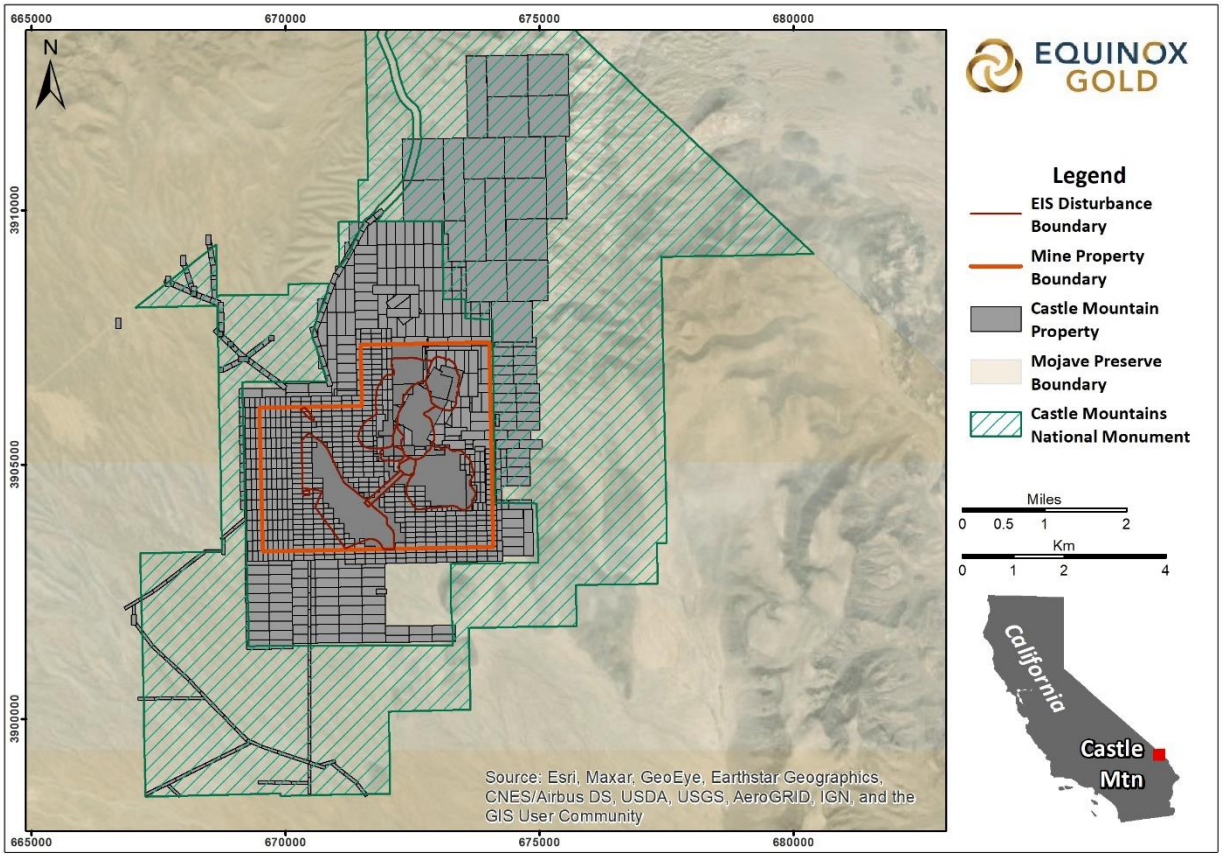


Figure 4-4: Map of Permitted Work Area, Castle Mountain Project

A comprehensive description of the existing permits and the permitting process is provided in Section 20.

4.6 ENVIRONMENTAL LIABILITIES

Aside from standard mine closure and reclamation, there are no known environmental liabilities on the Project.

4.7 LAND SUMMARY & SIGNIFICANT RISK FACTORS

All unpatented and patented claims are in good standing with respect to fees, taxes and levies for the 2020-2021 year. Equinox asserts that it has full legal access to the Project with respect to surface and mineral rights.

The QP is not aware of any significant factors and risks that may affect access, title, or the right or ability to perform the proposed work program on the Project. There is a risk that all the required permit modifications may not be approved for the Phase 2 operation. NewCastle has prepared applications for the permit modification and feels that the regulatory process is transparent and reasonable.

5 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

5.1 ACCESSIBILITY

Castle Mountain is being redeveloped in two stages, described as Phase 1 and Phase 2. The Phase 1 operation consists of a run of mine (ROM) heap leach facility to treat 14,000 short tons of ore per day (ton/d). The Phase 2 Castle Mountain Project will expand the current operation to allow a heap leach processing rate of 50,000 ton/d and a mill-CIL plant to process 3,500 ton/d.

The Project is accessible year-round by road. Las Vegas, Nevada, the closet major urban center, is located approximately 70 mi (113 km) north of the project area by road. Interstate US-95 is taken south from Las Vegas for one hour to Nevada State Route 164, which intersects the unpaved Walking Box Ranch Road approximately 5 mi west of Searchlight, Nevada. An 18 mi drive along the Walking Box Ranch Road provides access to the project area (see Figure 5-1). This existing access road is well maintained and of good quality for necessary traffic access as required for construction and operation of the project.



Figure 5-1: Property Access Map, Castle Mountain Project

5.2 CLIMATE

Castle Mountain experiences a desert climate with hot summers and cool winters, with temperatures attenuated by altitude and aridity relative to the surrounding valleys.

Average daily lows and highs for the project site range from 28°F (-2°C) to 52 °F (11°C) in the winter and 66°F (19°C) to 93°F (34°C) in the summer months, respectively. Most precipitation is received during the summer months via thunderstorm activity. Precipitation as snow during the winter months is common but ground accumulation is minimal and rarely lasts longer than a couple of days. Average annual total precipitation is just over 9 in.

5.3 LOCAL RESOURCES AND INFRASTRUCTURE

Site infrastructure supports current Phase 1 operations and includes the aforementioned access road from Nevada State Route 164, modular administration and mine offices, the main haul corridor connecting mining of the backfilled JSLA pit with the Phase 1 run of mine lined heap leach pad and collection channels, the Phase 1 processing plant which includes solution handling pumps and storage tanks, a 23.5 M gal lined event pond, a gold carbon-in-column plant and cyanide unloading and storage area, a diesel driven power generation plant and laboratory. Infrastructure from the previous Viceroy operations has been largely removed; however, three small wells and a 250,000 gal water holding tank continue to be utilized to support Phase 1 operations. The majority of Phase 1 make up water is sourced from two newer wells on site which feed to a 300,000 gal water holding tank enabling gravity water supply to the surrounding facilities.

An aerial representation of current Phase 1 infrastructure and historic heap leach pad and mine areas is presented in Figure 5-2.



Figure 5-2: Site Infrastructure Map, Castle Mountain Mine (July 1st, 2020 Representation)

Electrical power supply for the property has historically come from the Searchlight electrical substation via a high voltage (69 kV) powerline which followed a path parallel to Nevada State Route 164 and turned south along the project access road. Reclamation of former operations required removal of power poles and the installed power line from the project substation to a termination point near Walking Box Ranch. Power poles between the Searchlight substation and this point of termination remain largely intact for potential reutilization. The surrounding area also boasts a significant number of solar power generating stations on both the California and Nevada sides of the local border presenting the potential optionality for the use of renewable energy. Project phase 1 operations uses on-site power generation via diesel fired power generators. This main power plant, located adjacent to the carbon column plant, includes four (4) Tier 4F, 455 kW Diesel Generator Sets. In addition, there are another six (6) smaller generators at areas around the site ranging from 36 kW to 240 kW. Proximity to the Las Vegas/Henderson metropolitan area

provides good access to several fuel distribution sources for both diesel and natural gas. The Phase 1 process plant area can be seen in Figure 5-3.

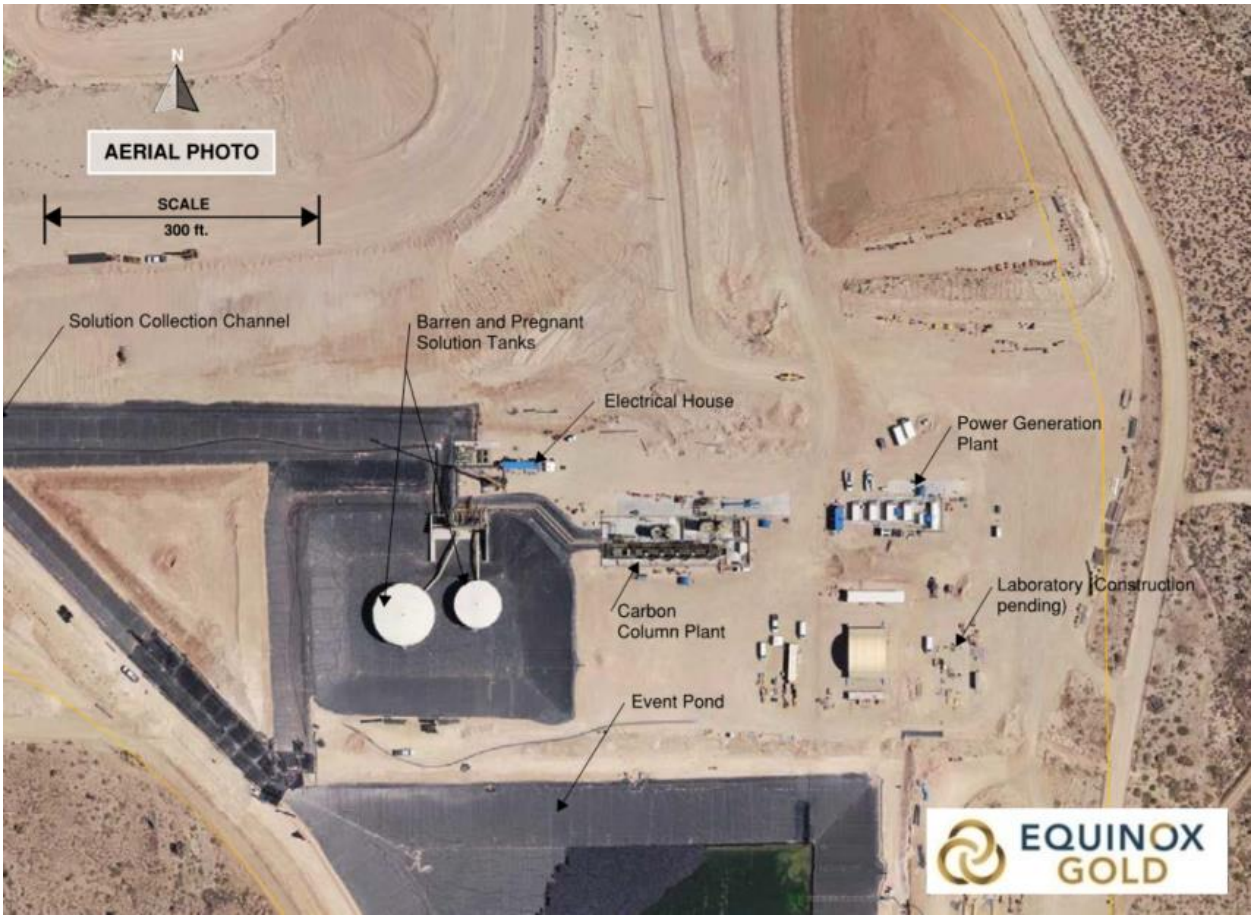


Figure 5-3: Castle Mountain Phase 1 Process Plant Aerial View

The southwestern United States is a major mining district with significant experienced mining labor and resources. These local resources have been utilized for start-up of phase 1 operations and will be used to a further extent to provide the necessary manpower for the Phase 2 expansion.

5.4 PHYSIOGRAPHY

The Project is located in the eastern Mojave subregion which gradually blends with the Basin and Range region to the north and the Colorado Desert to the south. Elevations are higher in the eastern Mojave compared to the other Mojave subregions, but differences in elevations are not as pronounced as those seen in Basin and Range terrains (Michaelsen, 2013).

The Castle Mountains are a relatively small range extending north-northeast from the northern end of Lanfair Valley in California into Piute Valley in Nevada. The range is about ten miles (16.1 km) in length and 2-3 miles (3.2 to 4.8 km) in width trending across the northern end of the Piute Range near the California-Nevada state borderline. The Project is located near the southernmost extent of the Castle Mountain range at an elevation of about 4,500 fasl (1,370 masl), and elevations at the Project site range from about 4,100 fasl (1,250 masl) to 5,100 fasl (1,554.5 masl).

Vegetation in the project area is typical of the Mojave Desert, with several cactus species (cholla and barrel) interspersed with woodlands of Joshua trees, blackbrush scrub, creosote bush scrub and desert grasslands (Figure 5-4).



Figure 5-4: Site Typical Flora; Joshua Tree and Scrub Brush in the Foreground

6 HISTORY

This section details exploration work conducted prior to Equinox. Recent exploration work carried out by Equinox is detailed in Section 9. Section 10 contains historical exploration drilling details.

6.1 HISTORICAL MINING

The Hart Mining District covers the southern end of the Castle Mountains. Several hundred old prospects, pits, trenches, waste rock dumps and underground workings extend over an approximate two square miles (5.2 km^2) area. In 1907, three underground gold mines were brought into production at Oro Belle, Big Chief and Jumbo. Mining activity decreased from 1910 to 1911 as the mineralized veins of interest were exhausted. The Big Chief Mine was reopened as the Valley View Mine and operated from 1932 to 1944 utilizing an old shaft. No production records are available for these historical operations.

In the 1920s, development began for the quarrying of kaolinite clay alteration zones associated with, but peripheral to the main gold deposit. Clay production was reported to have exceeded 200,000 tons (181,437 t) by 1957.

6.2 HISTORICAL GOLD EXPLORATION

Exploration in the Hart Mining District began in 1968 and carried through to the early 2000's. The following section is summarized from Temkin (2012) and the synopsis of the work carried out is presented in Table 6-1. Exploration target areas mentioned in this section are shown on Figure 6-1.

6.2.1 Vanderbilt Gold Corporation, 1968 – 1980

Systematic exploration in the Hart Mining District began in 1968 by Vanderbilt Gold. Their program was focused on sampling of historic mine dumps and underground workings. Encouraging results led to the acquisition of the Oro Belle patented claims in 1979 and staking of the Southern Belle 1-9 lode claims in 1980. Exploration drilling that was completed in 1980 included a 28-hole conventional rotary drilling program (DH 1-28) that indicated the presence of broadly disseminated low-grade gold mineralization in the vicinity of the Oro Belle shaft. The average depth of this drilling was about 150 ft (46 m).

6.2.2 Vanderbilt Gold Corporation – B&B Mining, 1981 – 1984

In 1981 B&B Mining acquired the Mountain Top lode claims, adjacent to the Vanderbilt holdings who drilled four conventional rotary drill holes (MT 1-4) on the southeast side of Egg Hill nearby the historic Green and Gold Mine. No significant gold mineralization was identified in these holes. In 1983, B&B Mining and Vanderbilt Gold signed a joint venture agreement to conduct exploration within and around the Hart Mining District.

Detailed geologic mapping was conducted during that year. Between 1983 and 1984, Vanderbilt operated the project and completed 64 conventional rotary drill holes (OBR 1-61) within the Oro Belle, Jumbo and Hart Tunnel areas, and an additional four conventional circulation holes (VVR 1-4) in the historic Valley View Mine area. The average depth of these 65 holes was approximately 250 ft (76 m). In late 1984 B&B Mining became the majority partner and operator on the Project as Vanderbilt Gold's interest eventually was reduced to less than 10% as Vanderbilt ceased involvement in the project.

6.2.3 Freeport Mineral Ventures, 1980 – 1985

In late 1980 and early 1981, Freeport Mineral Ventures (Freeport) staked 352 "MYO" lode claims in the southern Castle Mountains. During that time, they conducted regional-scale geologic mapping as well as grid-style rock chip sampling and geochemistry. Between 1982 and 1984, a total of 26 vertical conventional rotary drill holes were completed to an average depth of 450 ft (137 m). This work was conducted in the Northwest Rim area, a couple miles (3 km) north-northwest of the future JSLA open pit. Freeport failed to locate significant gold mineralization during this effort and after failing to reach agreements with other claim holders in better target areas, proceeded to drop their claims and terminate activities.

6.2.4 B & B Mining / Viceroy Gold, 1984 – 1985

In early 1984, B&B Mining amalgamated with Viceroy Petroleum Ltd. to form Viceroy Resource Corporation. B&B Mining was later renamed Viceroy Gold Corporation (Viceroy) and became the U.S. subsidiary to Viceroy Resource.

6.2.5 Hemlo / Noranda Exploration, 1987 – 1990

Noranda began mineral exploration in the Castle Mountains in 1987, including regional-scale geologic mapping and rock chip sampling. Their activities included geophysical survey work in the form of several lines of IP and biogeochemistry and microbial studies over Jumbo South, Lesley Ann and Northwest Rim. This work led to the drilling of RC holes HV 1 - 20, 23 - 28 and 30, in the Northwest Rim area in 1987 and 1988. Subsequently, RC holes HV 31 - 43, in 1988, and RC holes LH 4 – 8, were drilled west of Razorback Butte in 1990. No significant gold mineralization was identified during this work and consequently, Noranda/Hemlo dropped their interest in the Project in 1990.

6.2.6 Viceroy Gold, 1985 – 1991

Exploration conducted by Viceroy Gold included detailed geologic mapping, stream sediment sampling, grid-controlled rock sampling programs, geophysical surveys and biogeochemical sampling.

In the spring of 1984 Viceroy Gold gained a majority interest and became operator on the Project. In mid-1985, Viceroy Gold commenced drilling. The "OBR" collar designation, for Oro Belle rotary holes, was dropped from the hole numbers at this point and current records show future holes were designated simply by numbers only. Rotary holes 62 to 79 were completed by the end of 1985, with 16 holes at Jumbo and two holes at Oro Belle. The average depth of these holes was approximately 300 ft (91 m).

In 1986, Viceroy increased the scope of activities to accelerate its ownership of the Project. The program included extensive drilling to advance the understanding of the controls on mineralization. Drilling focused on testing known targets to greater depths with holes averaging 500 ft (152 m). Rotary holes 80 to 195 were drilled in eight separate areas and resulted in the identification of significant gold mineralization in the Jumbo South and Lesley Ann areas. The discovery of the Jumbo South deposit, (hole #91), encountered 175 ft (56 m) of 0.036 oz/ton Au (1.23 g/t) and 135 ft (41 m) of 0.153 oz/ton Au (5.24 g/t) with average grades greater than 0.015 oz/ton Au (0.514 g/t) continuing to a depth of 725 ft (221 m). The discovery of the Lesley Ann deposit (with hole #150) encountered 180 ft (55 m) of 0.076 oz/ton Au (2.60 g/t), which was completely blind and covered by as much as 250 ft (78 m) of post-mineral alluvium.

By the fall of 1986 Viceroy Gold had acquired 100% in the Project and initiated a feasibility study to determine the economics of producing from the Oro Belle, Jumbo, Jumbo South and Lesley Ann deposits. With confirmation of a positive feasibility study for production from these three deposits, Viceroy sought major financing with Hemlo Gold in 1987, providing for the development of the Project. Under this agreement Viceroy retained 100% interest in the central area while Hemlo acquired a 50% exploration share in the remainder of the Castle Mountains. The permitting process for the mine was initiated in 1987, and approval of the mine was granted by the United States Bureau of Land Management in 1990.

6.2.7 Viceroy Gold/MK Gold, 1991 – 2001

Early in 1991, MK Gold purchased a 25% interest in the Castle Mountain Project and became the contract mining operator. Later in 1991 construction began for mining the Jumbo South and Lesley Ann deposits as one open pit.

Minimal exploration activity beside reclamation of all previous exploration and development disturbance occurred between 2005 and 2011.

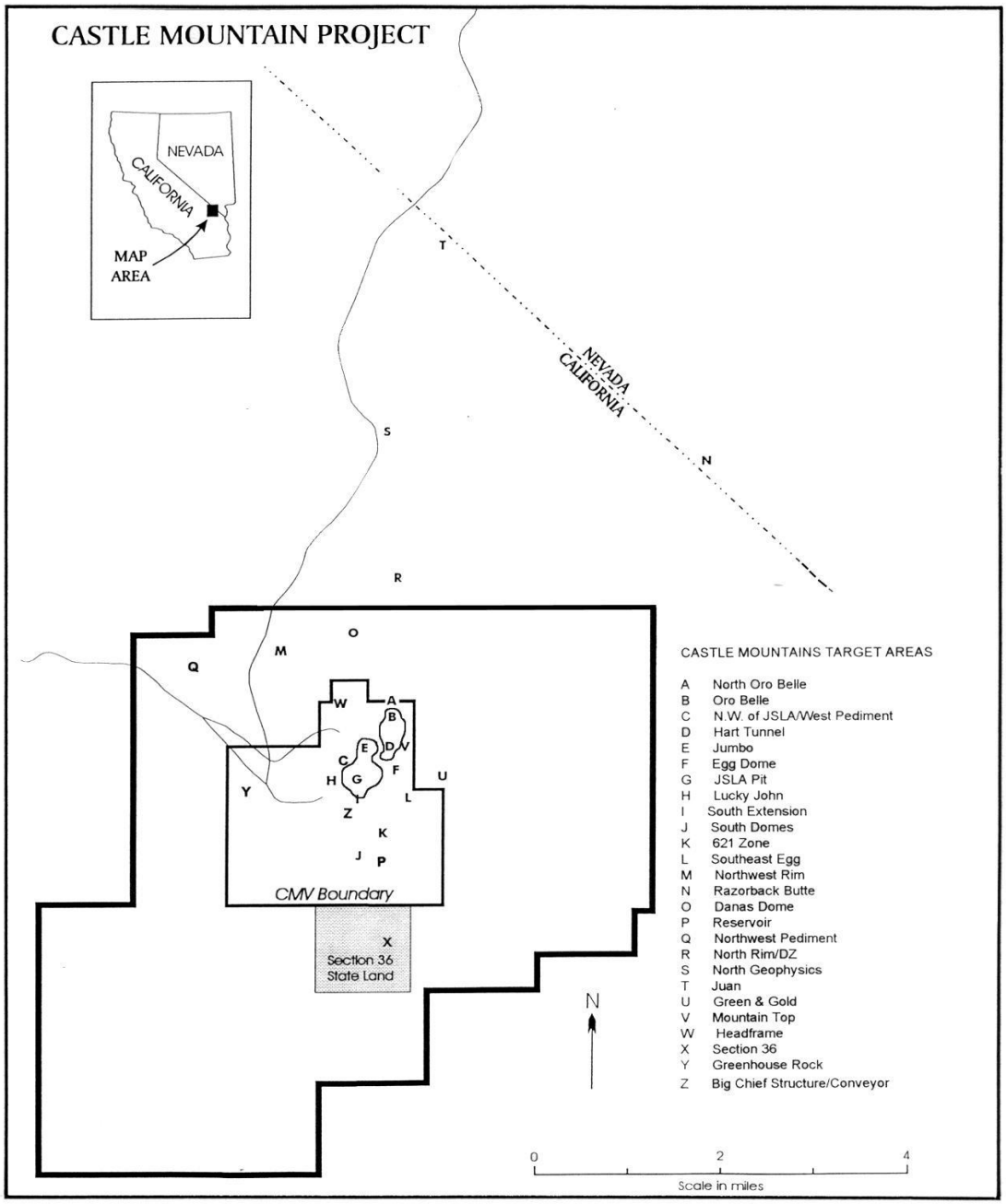
NewCastle (then Castle Mountain Mining Company Limited) acquired the Project in 2012. In December 2017, a three-way merger was completed between Trek Mining, NewCastle Gold, and Anfield Gold Corp., with the resulting company renamed to Equinox Gold Corp.

Table 6-1: Summary of Legacy Exploration Activity

Year	Company	Prospects	Summary of Exploration Activity
1907-1967	Unknown	Oro Belle, Big Chief, Jumbo	Underground mining operations
1968	VanderBilt Gold Corporation	Unknown	Sampled historical mine dumps and underground workings
1979		Oro Belle	Acquired Oro Belle patents
1980		Southern Belle	Staked 9 lode claims at southern belle, completed 28 conventional rotary (CR) holes and 1,980 ton bulk sample for vat-leach testing
1980-1981	Freeport Ventures	Regional	Staked 352 "MYO" lode claims, conducted regional-scale geologic mapping and grip rock chip and geochemical sampling
1981	B&B Mining and Vanderbilt Gold Corporation	Regional	Acquired lode claims adjoining the Vanderbilt land holdings, completed 4 CR holes
1982-1984	Freeport Ventures	Unknown	Drilled 26 CR holes, claims allowed to lapse; exploration ceased
1983	B&B Mining and Vanderbilt Gold Corporation	Unknown	Drilled 159 CR drill holes, completed surface geologic mapping, rock chip sampling, soil mercury survey, rehabilitation of underground working, underground mapping and rock chip sampling, surface magnetometer and very low frequency EM geophysical surveys
1984		Regional	B&B amalgamated with Viceroy Petroleum Ltd. To form Viceroy Gold Corporation. In late 1984, Viceroy became the majority partner and operator as Vanderbilt's interest reduced below 10% and ceased involvement in the JVA

Year	Company	Prospects	Summary of Exploration Activity
1984	Viceroy Gold	Regional	18 CR drill holes, geologic mapping, stream sediment and soil sampling, rock chip, channel and panel sampling, IP and magnetics surveys, biogeochemical surveys
1986		Oro Belle, Jumbo South, Leslie Ann	116 CR drill holes, geological mapping, Viceroy
1987-1989		Unknown	FS study for open pit heap leach mine, condemnation drilling with 420 CR and RC holes, discovery of South Extension, Jumbo, Hart Tunnel, South Dome. Additional microscopy, petrology, geochemistry
1987-1990	Hemlo Gold/Noranda Exploration	Regional (Outside of Viceroy-owned claims)	RC drilling, mapping and rock sampling, IP, biogeochemical and microbial surveys. Noranda dropped interests in 1990
1990	Viceroy Gold	Multiple targets (8)	16 RC holes, discovery of gold in North Oro Belle area
1991	Viceroy Gold and MK Gold Company	Multiple targets	MK Gold purchased a 25% interest in the mine and became contract mining operator, commercial production begins. Drilling resumes on Oro Belle, Jumbo, discovery of Lucky John and deep 621 Zone
1992-1993		Multiple targets (15)	Exploration, development and condemnation drilling with 263 RC holes at Jumbo, North Oro Belle, South Domes, discovery of Southeast Egg zone
1993-1994		Multiple targets (19)	252 RC holes mostly concentrated on Hart Tunnel, Oro Belle, Egg Dome, Lucky John, South Extension
1994-1995		Hart Tunnel, Oro Belle, Mountain Top	RC drilling, gold intersections at Hart Tunnel, Oro Belle, Mountain Top
1996		Multiple Targets	Intermountain Mine Services (IMS) contracted to design underground exploration program to further define mineralization from surface drilling, formulate plan to develop and mine mineralized material

Source: Temkin, 2012.



Source: Temkin, 2012. Note: Land boundaries shown on this figure are historic and do not reflect the Project's current boundaries.

Figure 6-1: Map of Legacy Target Areas (dated 2002)

6.3 PAST PRODUCTION

Viceroy Gold Corporation/MK Gold Corporation commenced gold production on the Project in 1991 (Figure 6-2). The JSLA open pit from the 1990 feasibility was exhausted in 1996. The Jumbo pit ceased production in 2001 due to local wall stability issues which left the deepest bench mined approximately 200 ft above the planned bottom mining elevation. Mining on the Oro Belle and Hart Tunnel deposits ceased later in 2001. Heap leaching continued until 2004.

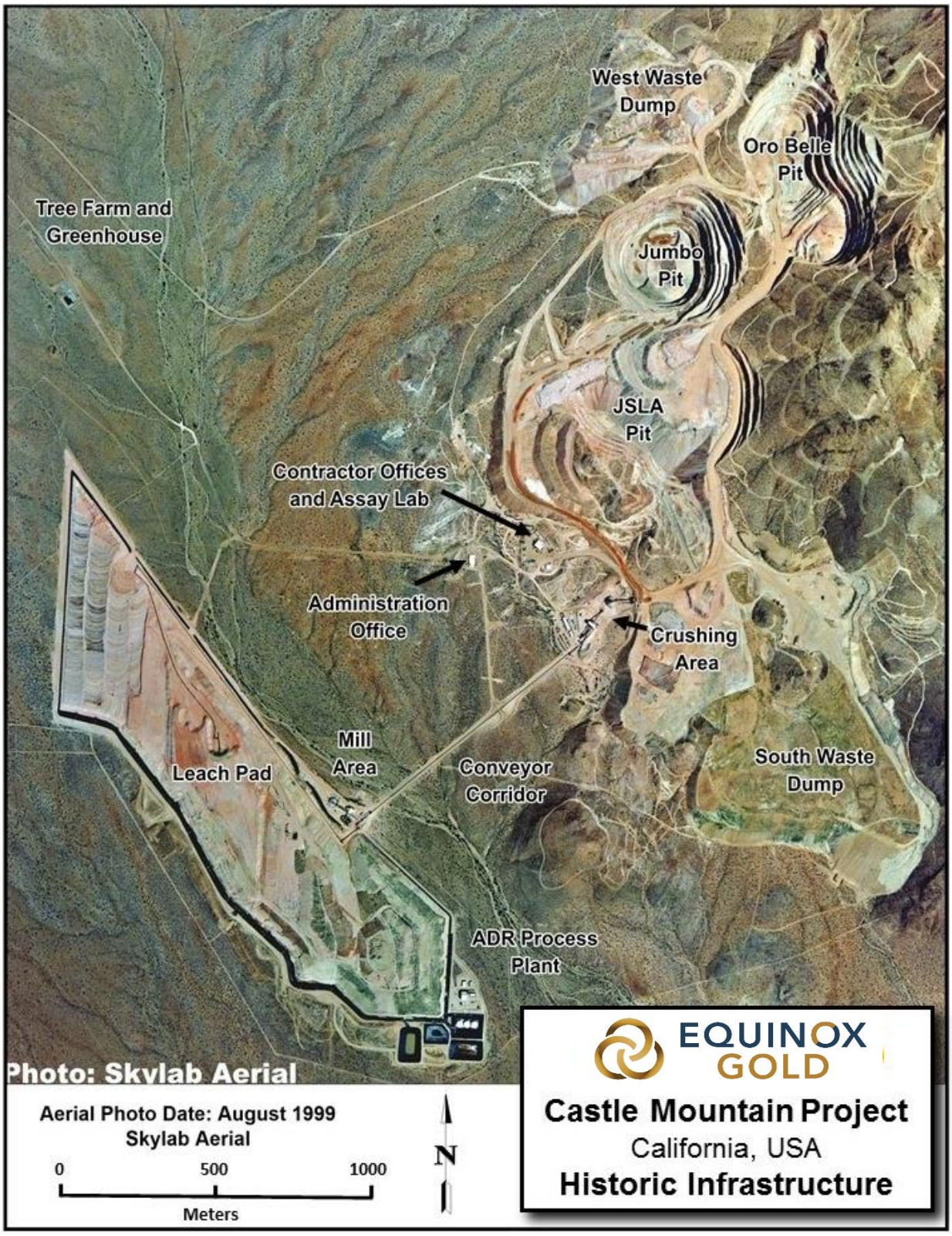
The mineral processing included two circuits:

- A conventional heap leach circuit where ore was crushed in three stages with the minus ⅜ in. (9.5 mm) product of the tertiary crushing delivered to the leach pad via conveyor system.
- A modified milling circuit to treat high-grade ore greater than 0.100 oz/ton (>3.43 g/t) where feed was ground to 100 mesh (149 µm) and treated with cyanide solution while still in the ball mill. Later in the mine life, a supplemental gravity circuit was added. Mill tailings were then agglomerated and conveyed to the heap leach pad where they were treated in the same manner as the heap leach feed.

Since the residence time in the ball mill was significantly less than the 24 hours required to achieve full cyanide dissolution, the initial gold recoveries were in the range of 33% to 40%. When the gravity circuit was added, gold recoveries exceeded 50%. The agglomerated tailings were estimated to achieve 91.3% gold recovery with an overall recovery for mill feed material of about 95% of the gold.

The leach cycle extended 43 months after pad loading ceased and resulted in the production of approximately 116,120 oz of gold which represents 12% of the total leach production.

Total gold production from all deposits was more than 1.24 Moz with an approximate silver production of 400,000 oz (Table 6-2). The annual production for the combined mill and leach ore the is presented in Table 6-3.



Source: Scott et al., 2018

Figure 6-2: Historic Viceroy Mining and Processing Infrastructure

Table 6-2: Viceroy Past Production From 1991 to 2004

Activity	Tonnage (000 ton)	Grade (oz/ton Au)	Contained Ounces Au (000s)	Recovered Ounces Au (000s)	Recovery (%)
Ore Mined	37,683	0.040	1,520		
Waste Mined	102,260	n/a			
Total Mined	**139,943**				
Ore Milled	1,967	0.144	283	269[1]	95.0[2]
Ore Leached	34,226	0.037	1,267	974[3]	76.9[4]
Total Processed	**36,193**	**0.043**	**1,550**	**1,243**	**80.2**

Notes:
1. A total of 269,000 oz Au comprises 120,000 oz Au recovered from mill circuit and 149,000 oz Au recovered from agglomerated tailings placed on the heap leach pad.
2. Recovery calculated as 269,000 oz Au recovered from 283,000 oz Au.
3. A total of 974,000 oz Au comprises 1,123,000 oz Au minus 149,000 oz Au recovered from agglomerated tailings sent to the heap leach circuit.
4. Recovery calculated as 974,000 oz Au recovered from 1,267,000 oz Au.
5. Totals may not sum due to rounding.

Table 6-3: Viceroy Annual Production

Item	Units	Total	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total, Leach Plus Mill															
Total to Pad	000s ton	36,193	2581	3658	4083	4204	4120	4103	3891	4123	4120	1308	-	-	-
Grade	oz/ton	0.043	0.051	0.058	0.056	0.05	0.037	0.038	0.027	0.034	0.04	0.037	-	-	-
Contained, Annual	000s oz	1,550	131.6	211.5	230	211.3	151.6	155.9	105.1	140.2	164.8	48.4	-	-	-
Recovered, Annual	000s oz	1,243	78	133.2	170.3	156.9	122.2	122.4	89.1	95	118.7	77.7 [1]	56.7	14.8	8.2

Notes:

1. Includes 36,487 oz Au recovered from clean up and closure activities.
2. Source: Pressacco, 2013.

6.4 EQUINOX MINERAL RESOURCE ESTIMATES

Equinox has completed numerous technical reports that include Mineral Resource Estimates completed in accordance with NI 43-101 (Wakefield and Tschabrun, 2017; Gray et al. 2016; Cox at al., 2014 and Pressacco, 2013). These Mineral Resource Estimates are no longer current and have been superseded by the Mineral Resource Estimate summarized in Section 14 of this Report.

6.4.1 Pre-Feasibility Mineral Resource Statement

The Pre-Feasibility (PFS) Mineral Resource Estimate with an effective date of March 29, 2018 was produced by Don Tschabrun, SME RM, Mine Technical Services Ltd. (Scott et al., 2018). This Mineral Resource Estimate is no longer current and has been superseded by the Mineral Resource Estimate summarized in Section 14 of this report.

The PFS Mineral Resource estimate utilized an inverse distance weighting method bounded by multiple grade shells and geologically interpreted domains. A resource classification was developed based on estimation pass. The PFS Mineral Resource Estimate is presented in Table 6-4 (imperial units) and Table 6-5 (metric units) at a gold cut-off grade of 0.005 oz/ton (0.17 g/tonne) for hard rock resources and 0.004 oz/ton (0.14 g/tonne) and contained within a Lerchs-Grossman (LG) shell based on a gold price of $1,400/oz.

Based on the assumptions provided in Table 6-6, the ROM breakeven gold cut-off grade was calculated to be 0.005 oz/ton (0.17 g/t).

Table 6-4: Pre-Feasibility Study Mineral Resource Estimate Inclusive of Reserves (Imperial Units)

	Measured			Indicated		
Cut-off (Au oz/ton)	Tons (million)	Gold Grade (oz/ton)	Gold Oz (million)	Tons (million)	Gold Grade (oz/ton)	Gold Oz (million)
Hardrock (0.005)	177.1	0.0169	2.99	71.7	0.0161	1.15
Backfill (0.004)	0.0	0.0000	0.00	18.0	0.0101	0.18
Total (0.005)	177.1	0.0169	2.99	89.7	0.0149	1.34
Hardrock (0.035)	13.4	0.0777	1.04	5.3	0.0765	0.40
	Measured + Indicated			Inferred		
Cut-off (Au oz/ton)	Tons (million)	Gold Grade (oz/ton)	Gold Oz (million)	Tons (million)	Gold Grade (oz/ton)	Gold Oz (million)
Hardrock (0.005)	248.8	0.0167	4.15	167.2	0.0121	2.02
Backfill (0.004)	18.0	0.0101	0.18	21.7	0.0081	0.18
Total (0.005)	266.8	0.0162	4.33	188.9	0.0116	2.20
Hardrock (0.035)	18.6	0.0774	1.44	5.8	0.0826	0.48

Notes:

1. The Mineral Resource is from the Castle Mountain Pre-Feasibility Study with an effective date of March 29, 2018 and is no longer current.
2. The Qualified Person for the estimate is Don Tschabrun, SME RM.

3. Mineral Resources are inclusive of Mineral Reserves; Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
4. Numbers in the table have been rounded to reflect the accuracy of the estimate and may not sum due to rounding.
5. The Mineral Resource is based on a gold cut-off grade of 0.005 oz/ton.
6. The Mineral Resource is contained within an LG shell limit using a $1,400 gold price as well as cost and recovery parameters presented in Table 6-6.
7. The source for this information is Scott et al., 2018.

Table 6-5: 2018 Pre-Feasibility Study Mineral Resource Estimate Inclusive of Reserves (Metric Units)

	Measured			Indicated		
Cut-off (Au g/t)	**Tonnes (million)**	**Gold Grade (g/t)**	**Gold Oz (million)**	**Tonnes (million)**	**Gold Grade (g/t)**	**Gold Oz (million)**
Hardrock (0.17)	160.6	0.579	2.99	65.1	0.552	1.15
Backfill (0.14)	0.0	0.000	0.00	16.3	0.346	0.18
Total (0.17)	160.6	0.579	2.99	81.4	0.511	1.34
Hardrock (1.20)	12.1	2.664	1.04	4.8	2.623	0.40

	Measured + Indicated			Inferred		
Cut-off (Au g/t)	**Tonnes (million)**	**Gold Grade (g/t)**	**Gold Oz (million)**	**Tonnes (million)**	**Gold Grade (g/t)**	**Gold Oz (million)**
Hardrock (0.17)	225.7	0.572	4.15	151.7	0.415	2.02
Backfill (0.14)	16.3	0.346	0.18	19.7	0.278	0.18
Total (0.17)	242.0	0.556	4.33	171.4	0.399	2.20
Hardrock (1.20)	16.9	2.652	1.44	5.2	2.832	0.48

Notes:

1. The Mineral Resource is from the Castle Mountain Pre-Feasibility Study with an effective date of March 29, 2018 and is no longer current.
2. The Qualified Person for the estimate is Don Tschabrun, SME RM.
3. Mineral Resources are inclusive of Mineral Reserves; Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
4. Numbers in the table have been rounded to reflect the accuracy of the estimate and may not sum due to rounding.
5. The Mineral Resource is based on a gold cut-off grade of 0.17 g/t.
6. The Mineral Resource is contained within an LG shell limit using a $1,400 gold price as well as cost and recovery parameters presented in Table 6-6.
7. The source for this information is Scott et al., 2018.

Table 6-6: 2018 Pre-Feasibility Study Lerchs-Grossman Parameters

Parameter	Unit	Value
Gold Price	$/oz	1,400
Marketing Cost	$/oz	5.00
Royalty – Jumbo, JSLA, Oro Belle	%	2.65
Royalty – South Domes	%$/ton	7.65
Mining Cost: ROM	$/ton	2.08
Mining Waste: Rock	$/ton	1.43
Mining Waste: Backfill & Overburden	$/ton	1.19
Process Cost: ROM	%	1.54
Process Recovery: ROM	$/ton	72.0
General & Administrative	%	1.00
Mining Dilution	°	0.0
Pit Slope		48

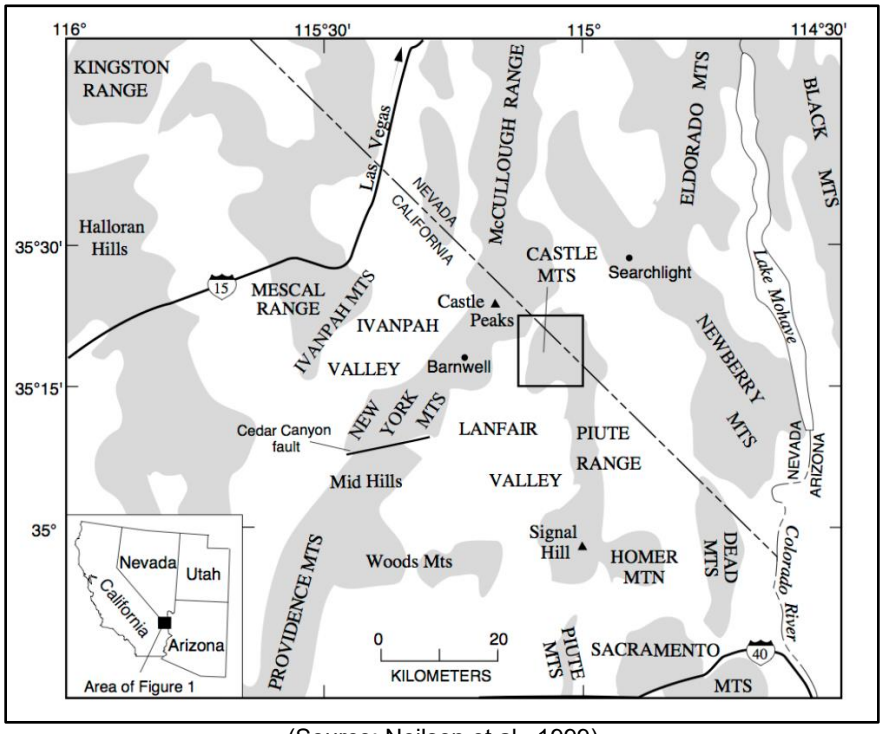
Note: All dollars are $ and tons are dry tons. (Source: Scott et al., 2018)

7 GEOLOGICAL SETTING AND MINERALIZATION

7.1 REGIONAL GEOLOGICAL SETTING

The Castle Mountain epithermal gold deposit is in the Hart Mining District (Tucker and Sampson, 1943; Wright, 1953; Hewett, 1956; Linder, 1989), at an elevation of approximately 4,500 ft (1,372 m) in the southern portion of the Castle Mountains Range, eastern San Bernardino County, California.

The Castle Mountains Range is in the eastern Mojave Desert within the southern Basin and Range Province (Theodore, 2007). The Castle Mountains comprise a small range of Miocene volcanic rocks at the northern end of the Lanfair Valley in eastern California and extend north into Nevada (Figure 7-1). Tectonically, the Castle Mountains are located along the northwestern margin of the Colorado River extensional corridor, a regional tectonic feature (Howard et al., 1994). Extension in the Colorado River corridor occurred in the mid-Tertiary and is characterized by detachment faulting in Nevada, California and Arizona that extends from south of the Las Vegas-Lake Mead shear zone to north of the San Andreas fault (Ausburn, 1991, 1995). Miocene volcanism and the structural trends of Miocene volcanic rocks and faults in the region are related to continental extension. While no regional low-angle normal (detachment) faults outcrop in the Castle Mountains (or in the Piute Range to the south), detachment faults are exposed to the west and east, in the Kingston Range and Black Mountains, respectively (Howard et al., 1994). These field relations suggest the Castle Mountains Range occur along the western margin of detachment faulting (Ausburn, 1991). Structures in the Castle Mountains are temporally and spatially consistent with crustal extension in the region but lack significant extension like that within the Colorado River Extensional Corridor to the east (Linder, 1989; Capps and Moore, 1991, 1997; Nielson et al., 1999; Spencer, 1985).



(Source: Neilson et al., 1999)

Figure 7-1: Location Map of Castle Mountains in SE California and SW Nevada

The southern portion of the Northern Colorado River Extensional Corridor experienced early Miocene calc-alkaline volcanism accompanied by weak to moderate north-south extension between ca. 20–16 Ma due to the collapse of the topographically elevated Kingman arch to the north (Faulds et al., 2001). By 15.5 Ma, east-west extension intensified and was accommodated on major easterly dipping normal faults and are represented by regionally extensive detachment faulting in the Castle Mountains area. Throughout the Northern Colorado River Extensional Corridor, the onset of east-west extension marked the transition from deposition of intermediate volcanic rocks to more bimodal to felsic dominated composition. The thickness of pre- and syn-extensional volcanic units indicate the bulk of the volcanic pile was deposited prior to, or immediately after the onset of east-west extension. Felsic volcanism spanned the entire duration of extension leading to accumulations of thick, complexly faulted, felsic volcanic piles in half-grabens formed during ongoing east-west extension.

Capps and Moore (1997) proposed multiple episodes of deformation in the Castle Mountains including Proterozoic deformation, Mesozoic deformation, and Miocene dilation. This deformational regime is associated with growth faults and hypabyssal dike emplacement and cryptic Miocene northwest-striking faulting. Proterozoic deformation is manifested by well-developed foliation commonly dipping to the northeast in basement rocks. Other structural events are manifested primarily as north-northeast striking normal faults with variable dips ranging from low to sub-vertical. Capps and Moore (1997) make note of a cryptic northwest fabric that crosscuts the prominent northeast structures.

7.2 LOCAL GEOLOGY

The Castle Mountain Range was mapped by R. C. Capps from 1987 through 1994. In 1997, a map and discussion of the geology was published by the Nevada Bureau of Mines and Geology, titled “Castle Mountains Geology and Gold Mineralization, San Bernardino County, California and Clark County, Nevada” (Capps and Moore, 1997). Unless noted, the following discussion of the regional geology of the Castle Mountains is derived from Capps and Moore (1997). An idealized, schematic stratigraphic section of the Castle Mountain geology is presented in Figure 7-2 and is discussed in detail below.

Proterozoic basement is exposed along the northeastern flank of the Castle Mountains and has been intersected in drilling below the northern Oro Belle Pit; to the west of the Jumbo Pit, and underneath shallow alluvium near the northern portion of the leach pad. Biotite schist, biotite gneiss and metamorphosed granite comprise the Proterozoic basement that is dated at approximately 1650 Ma (Wooden and Miller, 1990). Only narrow zones of hydrothermal alteration and weak gold mineralization have been encountered in basement rocks.

Locally overlying the metamorphic basement rocks is a poorly sorted, clast supported conglomerate with local well-bedded sandstone up to 181 ft (55 m) thick. Clasts are completely composed of rounded to sub-angular Proterozoic metamorphic rocks, ranging from pebble to cobble size. These Proterozoic sedimentary rocks are referred to as Pc. Seds and have been intersected by drill holes, notably in the northern Oro Belle pit area and below the JSLA pit.

Unconformably overlying the Pc. Seds, is the Miocene Peach Springs Tuff (Young and Brennan, 1974; Glazner et al., 1986; Nielson et al., 1990; Buesch, 1992), dated at around 18.8 Ma (Ferguson et al., 2013). The Peach Spring Tuff is a felsic welded ignimbrite tuff that is regionally extensive throughout the southwestern USA.

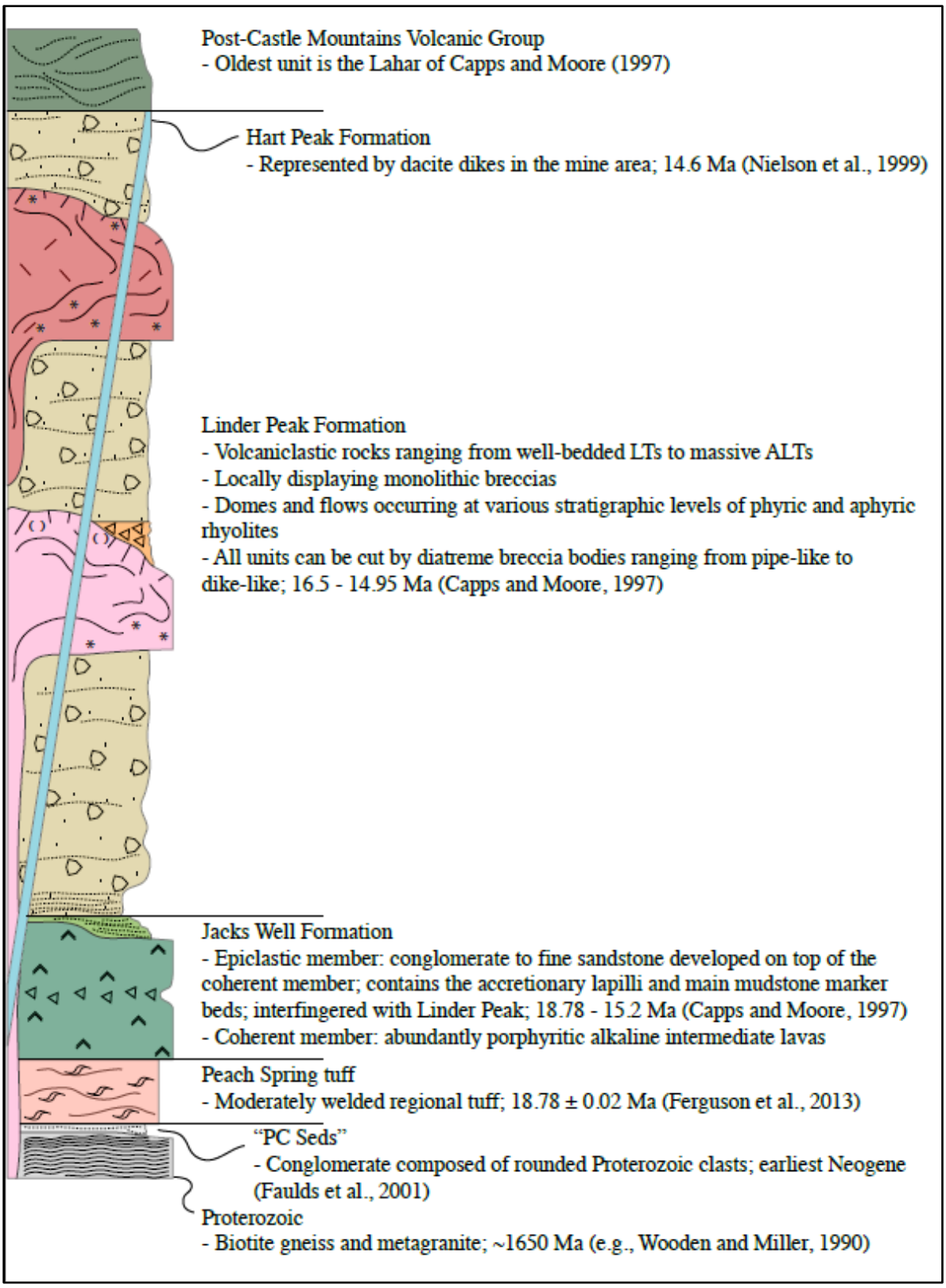
Overlying the Peach Springs Tuff are three formations that comprise the Miocene Castle Mountains Volcanic Sequence (CMVS), the Jacks Well formation (15.20 ±0.03 Ma), Linder Peak (14.90 – 16.5 Ma) and Hart Peak (13.8 – 16.3 Ma) formations. The CMVS consists primarily of rhyolitic domes, flows, and felsic tuff, and lesser andesitic, latitic, and basaltic lava emplaced during three main igneous episodes between around 18.8 and 13.5 Ma. The CMVS is the host sequence of the epithermal gold mineralization at the Project.

The Jacks Well formation is a mixed sequence of andesitic to basaltic lavas and associated volcaniclastic rocks. Common rock types include trachyandesite to basaltic-andesite flows, minor rhyolite ash-flow tuff locally displaying accretionary lapilli textures, and locally abundant debris flow and epiclastic deposits.

The Linder Peak formation overlays the Jacks Well formation and comprises abundant pyroclastic-surge tuff, and volcaniclastic rocks that include porphyritic and aphyric rhyolite that collectively form flow-dome complexes.

The Hart Peak formation is comprised of porphyritic rhyolite flows, plugs, welded ash-flow tuff; pyroclastic-surge tuff; rhyolite dikes and volcaniclastic rocks. The Heart Peak formation and intrusive equivalents post-date the Jacks Well and Linder Peak formation and was deposited after gold deposition at Castle Mountain.

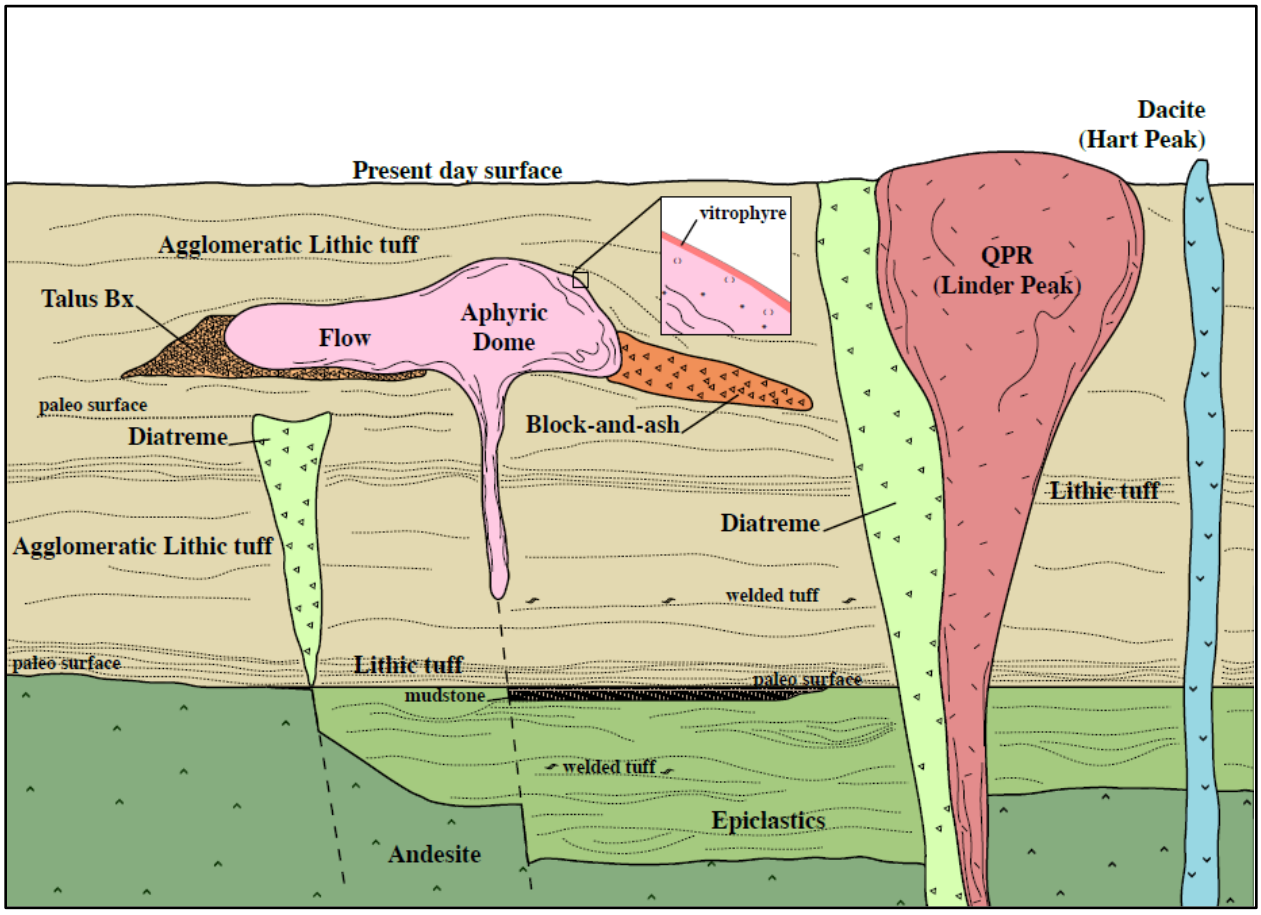
The Piute formation overlies the Hart Peak formation and is characterised by post mineralization volcanic flows and lahars of intermediate to mafic composition including trachyandesite to trachybasalt and associated volcaniclastic and epiclastic rocks aged 13-14 Ma (Nielson and Nakata, 1993; Capps and Moore, 1997).



(Source: modified from Tharalson, 2017)

Figure 7-2: Schematic Stratigraphic Section for the Castle Mountain Property

The Castle Mountain stratigraphy is dissected by north-south and northeast-southwest trending extensional faults interpreted to be both syn- and post-volcanic. Continuous extension and normal faulting focused protracted volcanism and hydrothermal activity. The CMVS is cut by Hart Peak formation dacite dikes that exploited pre-existing structures during emplacement. This is supported by their orientation and extent of mineralization on/near their margins. A schematic reconstruction of the principal lithostratigraphic elements at Castle Mountain Project is presented as Figure 7-3 (Tharalson, 2017).



(Modified from Tharalson, 2017)

Figure 7-3: Schematic Reconstruction of the Principal Lithologic and Stratigraphic Elements – Derived from Detailed Mapping and Logging at the Castle Mountain Project (Not to Scale)

7.3 PROJECT GEOLOGY

Mapping, drilling and extensive relogging campaigns carried out by Equinox, have been synthesized into a three-dimensional geological model to characterize the Project geology, structure, alteration, and mineralization. Equinox geologists have built on the work of Capps and Moore (1997) and Tharalson (2017) to model the Project geology. The geological mapping interpretation which incorporates the lithogeochemical and mapping studies reported by Barrett (2016a, b), Monecke (2017) and Nicholls et al. (2017) is presented in Figure 7-4. This interpretation forms the framework for the geological model (Figure 7-5).

7.3.1 Lithology

Table 7-1 presents a summary of the lithologies modelled at the Project. The Proterozoic Basement (Pc. Basement) and individual rock types that form the Jacks Well formation. are not volumetrically significant and the unit description within Section 7.2 adequately summarizes those rock types (Table 7-1 codes 23 through 31). Most of these units form flat lying stratigraphy that is locally offset by major faults. These units, the CMVS and overlying post mineralization cover units are described with photographic examples in Table 7-2.

Table 7-1 Castle Mountain Lithology

Lithology	Lithology Model Code	Model Code
Alluvium	02-Alluvium	2
Debris Flow	03-DebrisFlow	3
Dacite	05-Dacite	5
Hart Peak Rhyolite	05-HartRhy Migos	5
Rhyolite Breccia	07-RhyBx	7
Porphyrytic Rhyolite	09-RhyPorphyritic	9
Aphyric Rhyolite	11-RhyAphyric	11
Volcaniclastic Diatreme	14-VxDiatreme	14
Volcaniclastic	16-Vx	16
Mudstone	22-Mudstone	22
Epiclastics	23-Epiclastics	23
Andesite	27-Andesite	27
Peach Springs Tuff	29-PeachSpring	29
Proterozoic Sediments	30-PcSediments	30
Proterozoic Basement	31-PcBasement	31

Rhyolite rock types of the Linder Peak formation dominate surface exposures and comprise most of the drilling. Rhyolites are the most volumetrically abundant rock type at the Project. Rhyolite rocks occur as a complex package of flow-domes, and clastic tuffs comprised of monolithic breccia, polylithic breccia, and ashfall tuffs. Individual rhyolite flow-domes are identified using contact relationships with geometries that are vertically continuous and laterally restricted, by subtle compositional and textural variations, and in some cases vitrophyre or volcanic glass which mark the rapid cooling of molten rhyolite. Sub-types include quartz porphyritic, quartz-feldspar porphyritic, and aphyric rhyolites with an array of textures ranging from flow-banded, massive, vitrophyric/perlitic, spherulitic, and vesicular (Table 7-2 codes 07, 09, and 11). Geochemically, there is little to no chemical distinction between individual rhyolite bodies found in the Castle Mountain Project area which indicate a single magma source (Barrett, 2016a).

Volcaniclastic facies are the second most abundant rock types found on the Project. In contrast to the coherent rhyolite facies, volcaniclastic facies have a property-wide stratigraphy which provides some predictability and an overall better understanding of the depositional mechanism. Initial work established a massive matrix- to clast-supported polymictic breccia and an ash-dominated lithic and lapilli tuff (Monecke, 2016). Mapping has refined the basic stratigraphy to include a block-and-ash flow tuff unit, finer-grained stratified lithic and lapilli tuffs (formerly termed

LT), as well as both stratified and massive polymictic agglomerate tuffs (formerly termed ALT) (Table 7-2 code 16). On a property-scale, stratigraphy generally coarsens upward, with the exception of the basal block-and-ash flow tuff. The contacts appear to be generally conformable, and in some cases gradational.

Volcaniclastic diatreme consist of diatreme breccia facies and are exposed through the central portion of East Ridge as well as in the JSLA, Oro Belle and Jumbo pits. Diatreme facies have a limited surface expression due to being vertically continuous and having a laterally restricted geometry. Diatreme composition and textures closely resemble agglomerate tuffs leading to inconsistent identification at surface. Diatreme facies are polymictic, matrix supported breccia with a massive clay-rich rock flour matrix. Clast abundance ranges from 20-70%, with >90% rhyolite, 5% to 10% andesite, <1% gneiss and rare epiclastic mudstone clasts. Diatremes locally contain pumice fragments, but strong alteration typically obscures much of the original fine textures. Clasts range from <2 mm to over 2 m. The matrix is clay-altered ash and lesser very fine glass. There is no internal structure and clast orientations are random (Table 7-2 code 14).

Individual diatreme bodies range from <1 m to >100 m wide with smaller diatremes having well-defined contacts, whereas larger diatremes can have either sharp well-defined contacts or more erratic, hard to define contacts. At depth, diatreme bodies thin and pinch out into numerous narrower diatreme bodies and faults/fractures.

7.3.2 Trachydacite (Dacite) Dikes

Felsic rocks are crosscut by a series of unaltered, locally columnar-jointed intermediate dikes termed trachydacite to trachyandesite (Tiha) by Capps and Moore (1997), although historically and colloquially they are referred to as dacite dikes on the Project. Geochemically and mineralogically, these are trachydacite since they are high-potassium and contain approximately 20% quartz (Barrett, 2016a, b). Dacite dikes are biotite-feldspar phyric and have sharp, typically chilled margins where they contact the host rocks (Table 7-2 code 05). The dacite is interpreted to post-date the mineralizing event and are ascribed to the Hart Peak formation.

At least three distinct dacite dikes occur on the Property. The most prevalent dacite dike trends north-south and is exposed on the east side of East Ridge. A second major dike is recognized in the Oro Belle pit which trends approximately 045° (Table 7-2 code 03). A third less prominent dike trends 020° and is discontinuous along the top of East Ridge for approximately 984 ft (300 m).

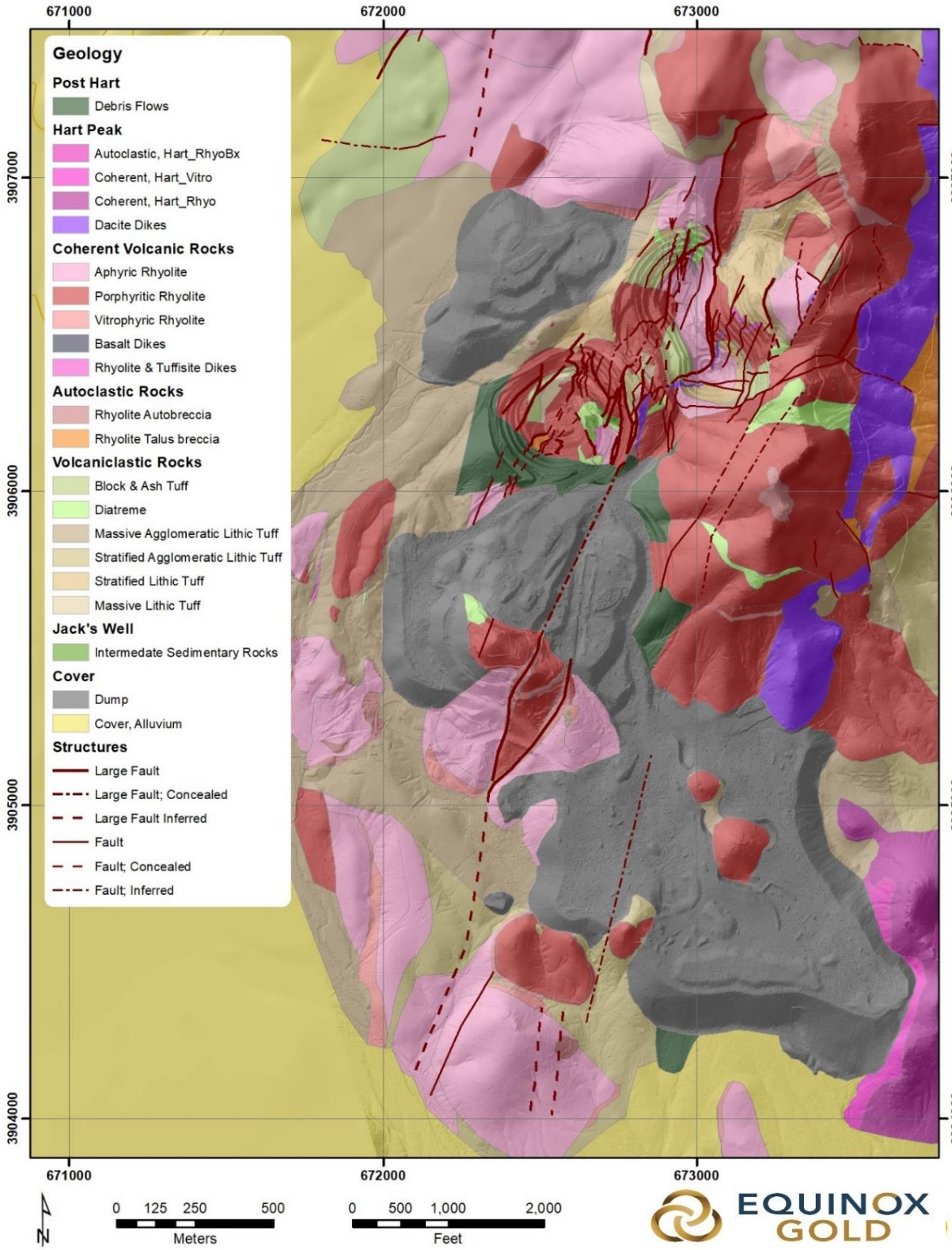
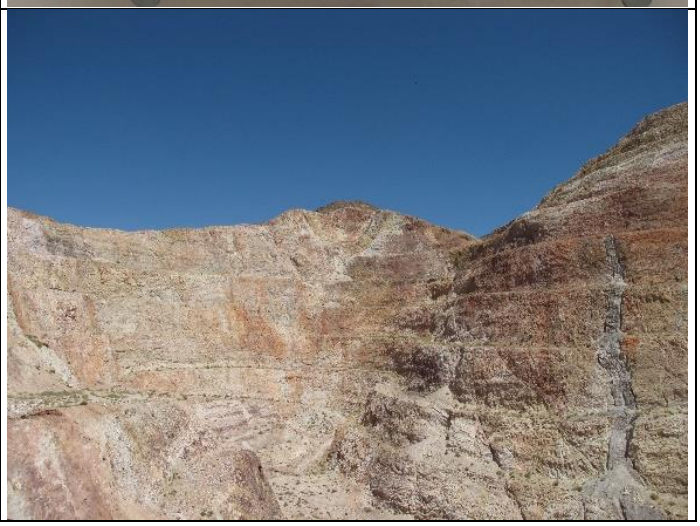


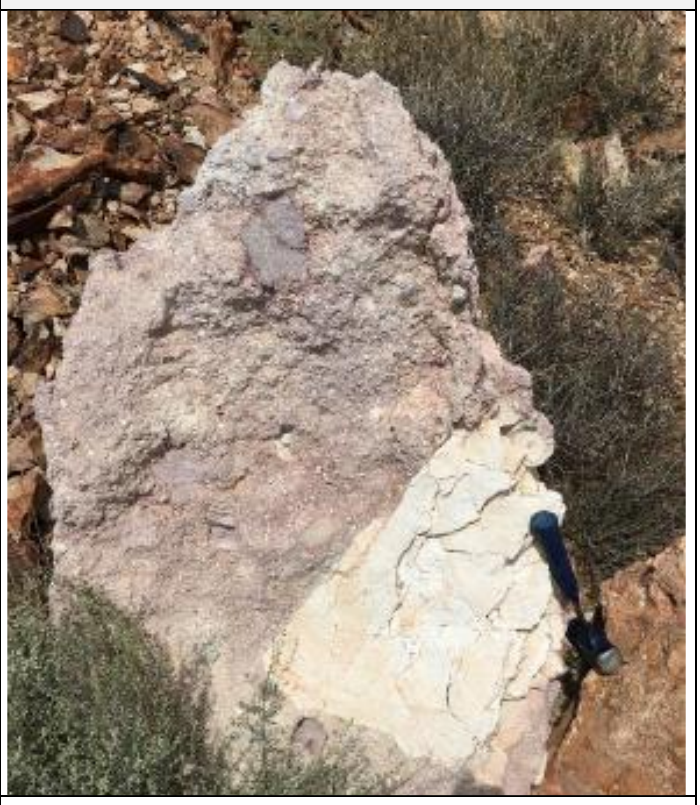
Figure 7-4: Castle Mountain Project Geology

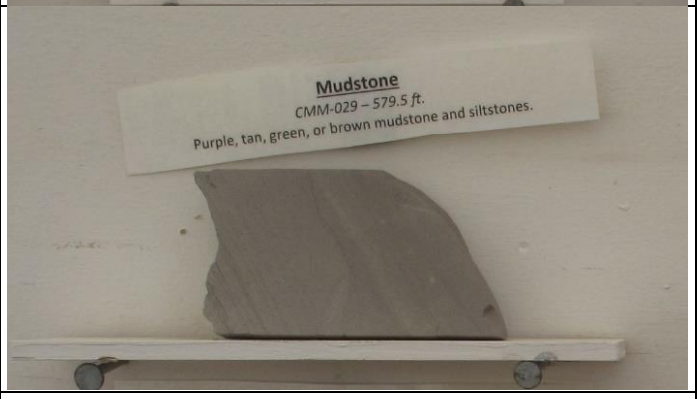
Table 7-2: Photograph Examples of Castle Mountain Rock Types

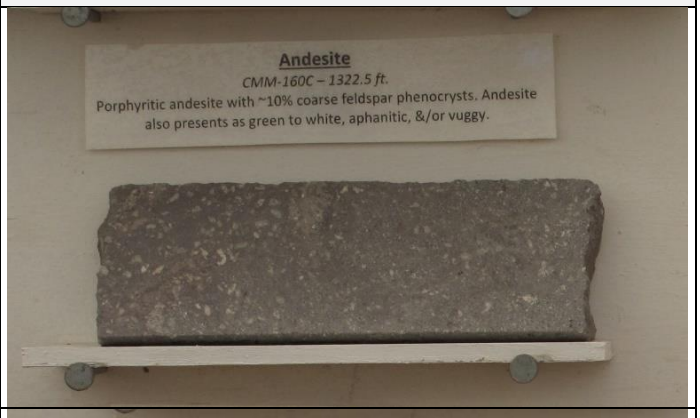
Code	Modelled Lithology (Model code) *Stratigraphic Unit* Description	Photograph
03	Debris Flow (03) *Piute Range* Heterolithic, coarse sandstone to pebble conglomerate.	
05	Dacite (05) *Hart Peak Formation* Dacite dyke (right side) cross-cutting Linder Peak formation rhyolites in the Oro Belle pit.	

Code	Modelled Lithology (Model code) *Stratigraphic Unit* Description	Photograph
07	Rhyolite Breccia (07) *Linder Peak Formation* Angular cm-scale rhyolite clasts (monomictic), varies from matrix to clast supported with silica infill.	
09	Porphyritic Rhyolite (09) *Linder Peak Formation* Weakly flow-banded quartz phyric rhyolites.	

Code	Modelled Lithology (Model code) *Stratigraphic Unit* Description	Photograph
11	Aphyric Rhyolite (11) *Linder Peak Formation* Monomict rhyolite breccia consisting of spherulitic quartz phyric rhyolite fragments in rock flour matrix.	
11	Aphyric Rhyolite (11) *Linder Peak Formation* Aphyric flow-banded rhyolites in core.	

Code	Modelled Lithology (Model code) *Stratigraphic Unit* Description	Photograph
14	Volcaniclastic Diatreme (14) *Linder Peak Formation* Diatreme with 70 cm clast of massive quartz phyric rhyolite and a 10 cm clast of andesite. The matrix contains numerous other clasts ranging from 3-6 cm in size.	
16	Volcaniclastic (16) *Linder Peak Formation* Bedded lithic tuff with stratified ash matrix and fine-grained lithic clasts <1 mm.	

Code	Modelled Lithology (Model code) *Stratigraphic Unit* Description	Photograph
16	Volcaniclastic (16) *Linder Peak Formation* Finely bedded lithic tuff.	
22	Mudstone (22) *Jack Well Formation* Mudstone	
23	Epiclastics (23) *Jack Well Formation* Sandstone with graded bedding.	

Code	Modelled Lithology (Model code) *Stratigraphic Unit* Description	Photograph
24	Andesite (24) *Jack Well Formation* Porphyritic andesite with 10% feldspar crystals.	
29	Peach Springs Tuff (29) Welded ignimibrite felsic tuff with fiamme.	
30	Pc. Sediments or Pc. Seds (30) Sandstone	
31	Pc. Basement (31) Biotite Gneiss, Meta-granite Foliated gneiss.	

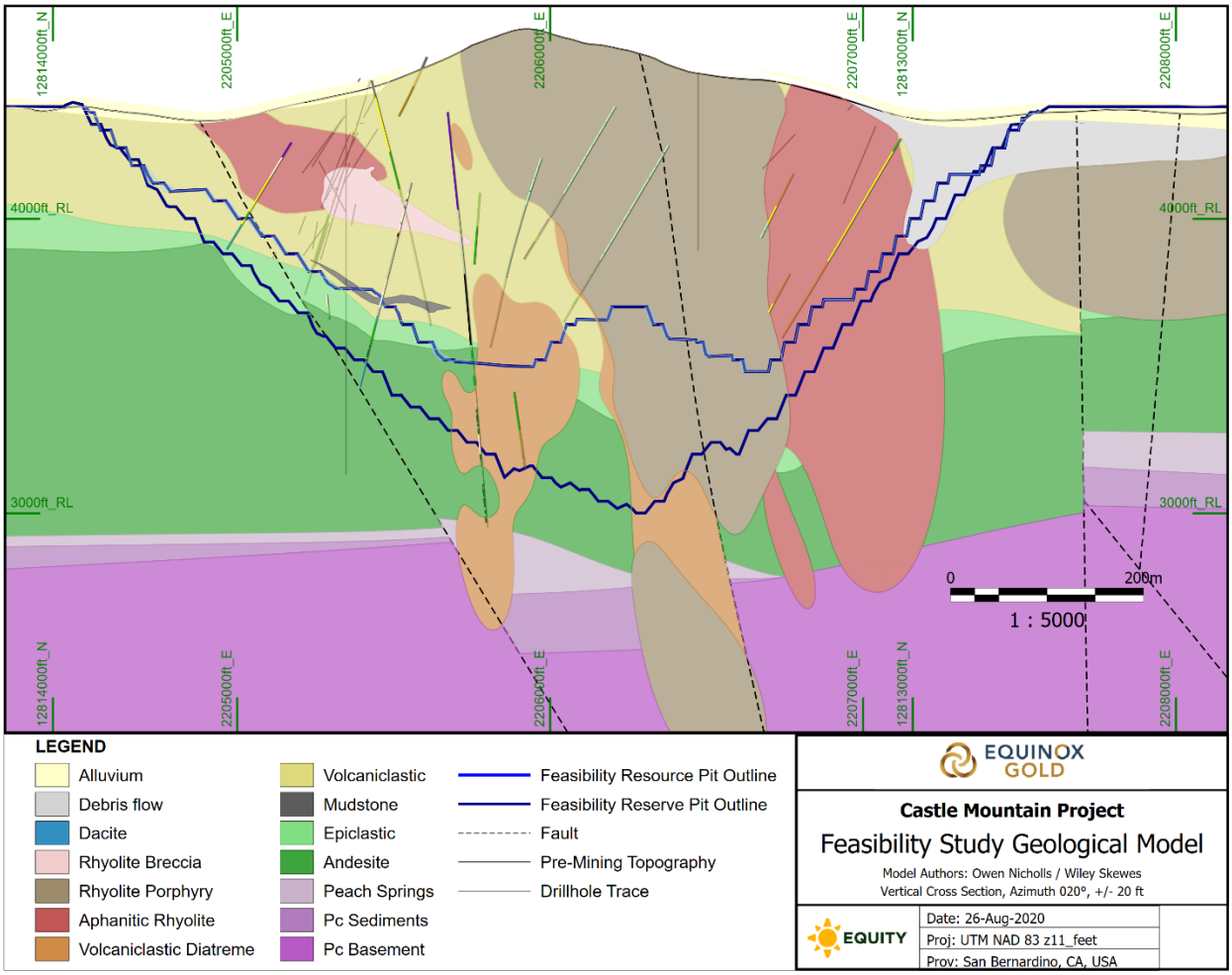


Figure 7-5: Cross Section of the Castle Mountain Project Geological Model

7.3.3 Structure

There are two dominant orientations of faults on the Project. The youngest generation of faults trend northeast-southwest and offsets earlier east-west trending faults. The moderately to steeply southeast dipping, northeast striking faults are the dominant structures. There are conjugate sets of northwest dipping faults. These commonly express “y” patterns in the field due to the southeast dipping set truncating and locally offsetting the northwest dipping sets. These are normal faults with a minor dextral strike-slip component. These faults have been mapped on surface and have also been modelled in 3D from drilling data and are named Maverick, Goose, Ice Man, Ripley, Dillon, McLane, Predator.

Capps and Moore (1997) recognized east-west faults which they interpreted to be pre- to syn-Linder Peak since they consistently cut Jack Wells rocks and locally extend into the Linder Peak rocks. The limited exposure of east-west faults mapped by Equinox geologists indicate these faults are truncated by the north-northeast trending faults. The cross-cutting relationships and limited exposure of east-west faults suggest these faults predate the more dominant north-northeast trending faults. Additional support for the early timing of east-west faults is the ubiquity of north trending faults through all lithofacies in Linder Peak, whereas the east-west faults have only been observed cutting aphyric rhyolite flow-domes and inferred to cut the surrounding

volcaniclastic rocks. Furthermore, the geometry of many of the mapped diatremes appear to have an east-west orientation suggesting the east-west faults could have acted as initial pathways for diatreme emplacement.

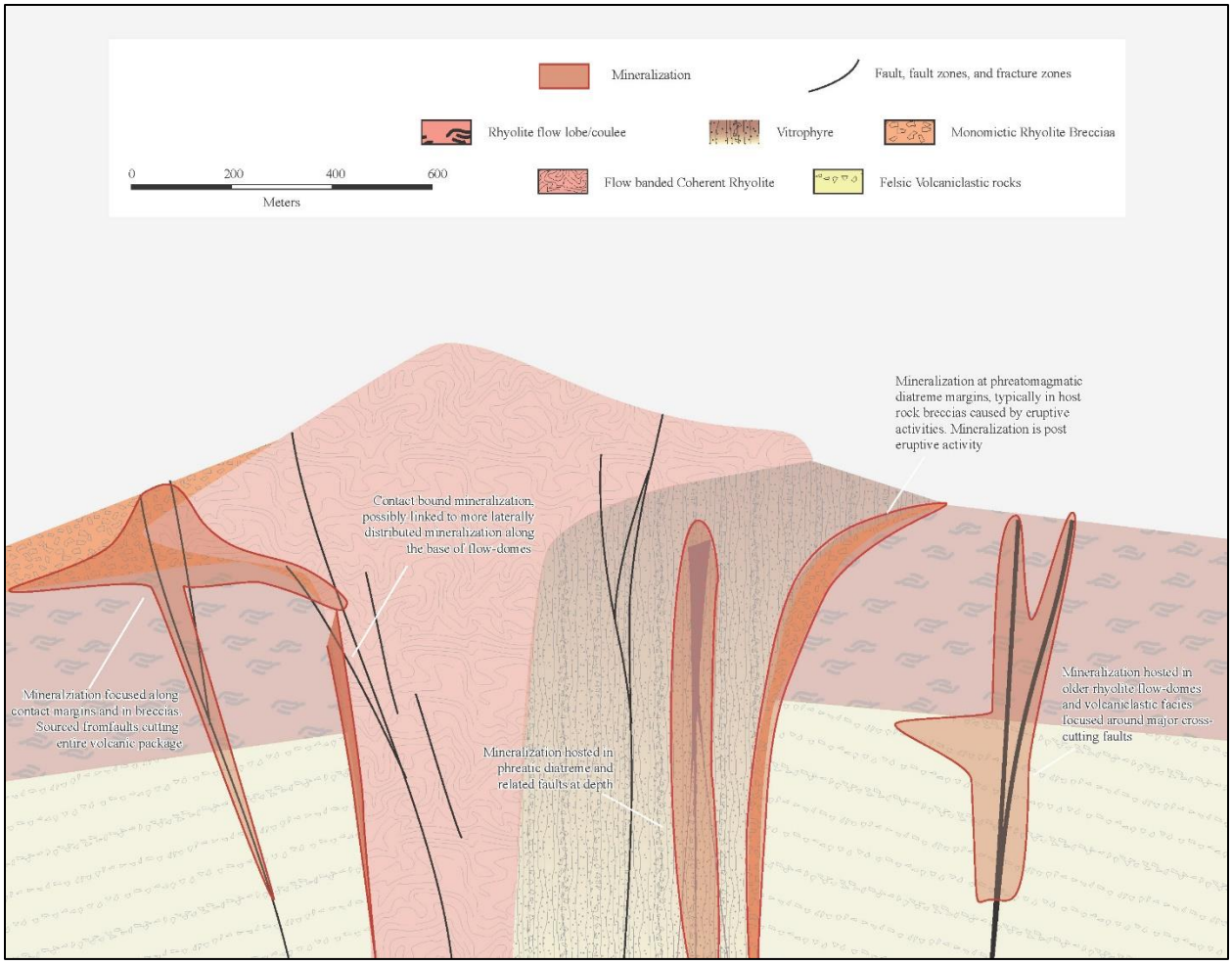
7.3.4 Mineralization

Structure and associated rock porosity-permeability characteristics are the first-order control on the distribution of gold. Flow-dome breccia margins, phreatic diatremes, fault cataclasite and fractures focused provided conduits for hydrothermal fluids and contain the highest gold grades. Unfractured coherent flow-dome facies, clay altered volcaniclastic facies, and clay altered phreatomagmatic diatremes with low or variable permeability are weakly mineralized due to lower fluid interaction. Lower permeability units that are mineralized have been cut by structures such faults, fractures, or phreatic diatremes that promoted hydrothermal fluid interactions.

Gold is focused along structures and margins of facies contacts. It is believed that sub-vertical structures acted as pathways for magma and are responsible for the emplacement of the felsic volcanic package. These same structures also acted as conduits for gold-bearing hydrothermal fluids. Intersections of the steep structures with more permeable volcanic rocks created an environment for enhanced gold precipitation from hydrothermal fluids, possibly due to processes of boiling and interaction with meteoric water.

Lithologic controls are dependent on the host rock texture. Tuff beds, auto-breccias, and hydrothermal breccias have permeable fragmental textures. Brittle rhyolite flows and intrusive equivalent rocks exhibit intense fracturing and are characterized by cooling joints, vesicular zones, spherulitic vugs, and flow foliations. Gold occurs within secondary silica in all these features. Major fault and fracture systems and intersections of fracture systems provided structural controls for mineralization. In the deposit area, north-northeast-striking, mineralized fracture zones are exposed in outcrop.

The morphology of mineralization follows two patterns. Firstly, gold is enriched along steep to vertical brecciated contacts of flow-domes and phreatomagmatic diatremes. Secondly, gold occurs in broad tabular zones that correlates with the general orientation bedding. The lateral extent of the mineralized bodies centered around fault zones are dictated by the intensity and extent of fracturing and faulting, in addition to the paleo-porosity of the host rocks (Figure 7-6).



(Source: Nicholls et al., 2017)

Figure 7-6: Schematic Model for Zone of Gold Mineralization Found on the Castle Mountain Property

Some faults and fracture zones are not gold-bearing since the structural regimes through the Project were active both pre- and post-mineralization. Gold seems to have precipitated during a single phase within a larger and longer-lived structural and hydrothermal event.

Silicification is commonly associated with gold occurring as pervasive silica flooding and quartz veining. Quartz veins can be vitric and “gel-like” or opaque white-gray opal. Vitric quartz veins typically occur in clusters as sheeted veins or stockwork in zones ranging from 3 to 35 ft (1 to 10 m) wide. Amorphous quartz occurs as discontinuous irregular veins and as open space filling quartz. The strongest silica alteration associated with gold is found along brecciated coherent rhyolite margins; this results in mosaic breccias where angular rhyolite clasts are within a hydrothermal-related silica matrix.

Gold on the Project occurs in oxidized fractures, faults, discontinuous veins, and breccia matrix. Gold mineralization correlates best with the deep red, red-brown and brown iron oxide that can range in color from pink to red-brown. The iron oxide intensity and appearance are commonly controlled by the volcanic facies occurring as discontinuous, fracture-controlled textures in coherent rhyolite facies, as matrix replacement in rhyolite breccias, wispy selvages and clast

haloes in volcaniclastic rocks, and pervasive or matrix selective in diatremes. These iron oxide textures can be cut by fracture and vein filling iron oxide that ranges in color from brown-tan to red.

Visible gold is rarely observed in hand specimen and core. In petrographic samples collected near JSLA, visible gold is associated with iron oxide and silica and proximal to illite and adularia alteration (Cline, 2016). Gold deportment studies from Oro Belle by Chudy and Lane (2020) indicate that mineralization is roughly 79% native gold, 17% electrum and 4% silver minerals by frequency of grain count. Quartz may be intergrown with iron oxides/hydroxides, most commonly as hematite, which have formed as oxidation products of former sulfide minerals. There is a low abundance of sulfides observed on the Project. The most common sulfide mineral is pyrite, and varies from nil to 1%, which occurs within clasts and matrix.

8 DEPOSIT TYPES

Castle Mountain is classified as a low-sulfidation epithermal gold deposit (Scott et al., 2018), a sub-type of the epithermal class of gold and silver deposits (Sillitoe and Hedenquist, 2003). Epithermal gold-silver systems are driven by magmatic activity and form high-level vein, stockwork, disseminated and/or replacement deposits that may be mined by open-pit and/or underground methods. Some deposits also contain substantial resources of Ag, Pb, Zn, Cu and/or Hg.

Epithermal deposits are generally of relatively recent (Cenozoic) age although there are also examples stretching back to 3.46 Ga (John et al., 2018). Bias towards young deposits likely reflects the generally poor preservation of these high-level deposits in tectonically unstable regions (John et al., 2018).

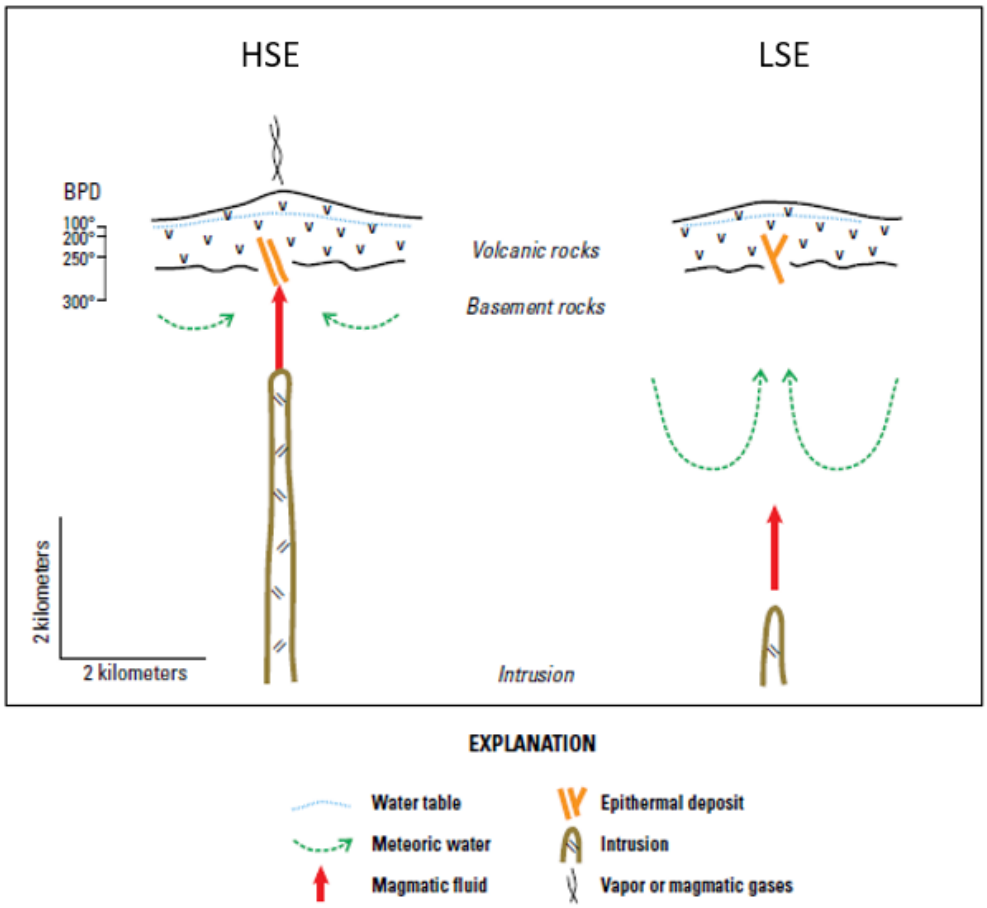
Most epithermal deposits are genetically related to hydrothermal systems formed from magmatic ± meteoric fluids (Sillitoe and Hedenquist, 2003). Igneous rocks parental to magmatic fluids range from calc-alkalic to alkalic andesite-dacite and bimodal basalt-rhyolite suites.

Mineralization occurs at depths of 50 to 1500 m below the paleowater table and at temperatures of 150 to 300ºC (John et al., 2018). Sulfur fugacity of the ore fluid is used to subdivide epithermal deposits into high- (HSE), intermediate- and low- (LSE) sulfidation types (Sillitoe and Hedenquist, 2003). HSE and LSE are endmembers with intermediate-sulfidation systems sharing features of both. The HSE to LSE spectrum is manifested in mineralogical changes, an increasing input of meteoric fluid (Figure 8-1) and increasing bimodal rhyolite-basalt magmatism (Sillitoe and Hedenquist, 2003; White and Hedenquist, 1995).

Epithermal deposits occur in mobile belts where they form in localized regions of neutral to extensional stress. LSE deposits favor regions under extensional stress such as intra-, near- and back-arc rifts as well as post-collisional rifts (Sillitoe and Hedenquist, 2003). Some of these rift settings also favor development of bimodal basalt and rhyolite suites. HSE deposits favor stress-neutral to mildly extensional regions with calc-alkalic magmatism.

The primary ore mineralogy in LSE systems consists of electrum (Au-Ag alloy with >20 wt% Ag) as well as silver-bearing sulfide, selenide and sulfosalt minerals, whereas HSE systems consist mostly of gold, Au-Ag alloy (<10 wt% Ag) and Cu-As sulfate (enargite) (John et al., 2018). Overall sulfide abundances are significantly higher in HSE deposits (5-90 vol%) than LSE (<1-20 vol%).

Epithermal deposits are typically formed by multiple pulses of hydrothermal activity, typically marked by cross-cutting structural features and localized to pervasive host rock alteration. Structural features that host mineralization include massive veins, vein swarms, vein stockworks, sheeted veins, hydrothermal breccia, residual vuggy silica, diatreme and fault intersections (Sillitoe, 1993; John et al., 2018). LSE deposits are more likely to form mineralized veins with classic comb and crustiform texture. HSE mineralization, on the other hand, occurs mostly in breccia, diatreme and replacement deposits (John et al., 2018). High-grade shoots may develop along structural intersections, as do lower-grade stockwork and/or breccia ores. Figure 8-1 is a schematic cross-section showing the difference between (left) high sulfidation epithermal (HSE) deposits, formed mostly from magmatic-hydrothermal fluids, and (right) low sulfidation epithermal (LSE) deposits formed by geothermal systems.



(Source: John et al., 2018; Simmons et al., 2005)

Figure 8-1: High Sulfidation Epithermal (HSE) Deposits vs. Low Sulfidation Epithermal (LSE) Deposits

Alteration assemblages are typically zoned laterally and vertically around ore bodies and relative to the paleowater table (John et al., 2018). Alteration in LSE systems is more restricted than HSE, with the idealized sequence comprising an outward gradation from a quartz-chalcedony ± adularia core through argillic and then propylitic assemblages (Simmons et al., 2005). HSE systems, on the other hand, comprise more pervasive quartz + alunite assemblages that grade outward through advanced argillic, argillic and propylitic assemblages (John et al., 2018). Alteration above paleowater table is marked by steam-heated acid and silica sinter assemblages, with argillic and advanced argillic assemblages typically spanning across the paleowater table.

The characteristics of epithermal deposits are amenable to a number of exploration methods. In areas of sufficient outcrop, geological mapping can be used to define the extent and high-flux regions of the hydrothermal system. Geochemical sampling, including rocks and soils, can rely on a large suite of pathfinder elements (Au, Ag, Cu, Zn, Pb, As, Sb, Bi, Se, Te, Tl, Mo, W, Sn, Hg) to vector into the more prospective parts of the system or identify systems under cover. Induced polarization surveys can be used to define sulfide-bearing rocks as well as resistive quartz-dominant alteration zones.

9 EXPLORATION

This section details exploration activity executed by Equinox (through its subsidiary NewCastle) from 2012 to the present. Details of exploration work conducted prior to Equinox are included in Section 6, History, and detail of the exploration drilling is provided in Section 10, Drilling.

9.1 SURVEYING

Heritage Surveying of Las Vegas, Nevada conducted an airborne LiDAR survey during 2012 to produce a detailed Digital Elevation Model (DEM) and capture the extent of previous mining. The results of the survey produced a 4 ft (1.2 m) contour map that covered 5,675 acres (2,300 ha).

Compass Tools of Denver, Colorado completed a high-resolution, drone- and fixed-wing based aerial photogrammetry survey during March 2017 to provide an updated topographic surface of the Project area. This survey was completed to increase resolution of the existing open pits and provide detailed locations of surface disturbance following the completion of the drill programs.

PhotoSat of Vancouver, British Columbia, Canada completed a follow up satellite survey and acquired detailed satellite imagery of the project area during December 2018. This survey produced a DEM with a 3 ft (0.9 m) contour interval and orthophotos of the project area.

9.2 MAPPING

Initial exploration in spring 2014 included detailed geologic mapping of the well exposed portions of the deposit areas and an evaluation of the deposit structure and stratigraphy. Further structural geology studies completed in spring 2015 focused on historic open pits and the relogging of diamond drill core to develop a new geological model. During the 2016 field season, a comprehensive mapping, sampling, petrographic and lithogeochemical program was initiated by NewCastle in an attempt to develop a deposit scale geological framework to assist future mapping and core logging. This study generated a detailed 1:2,000 scale geological map of the Project and assessed controls on gold mineralization as discussed in Section 7.3 (Nicholls et al., 2017).

9.3 GEOCHEMICAL SAMPLING

In tandem with the geological mapping, Equinox has taken 1,458 select and grid-controlled grab samples representing a suite of lithologies, structures and alteration. Selective sampling was undertaken in the Jumbo and Oro Belle pits as well as other areas with outcrop on the Project. Grid controlled sampling was completed over several prospective areas including East Ridge, East Flats, Egg Hill, Benson, North Jumbo, and Northwest Rim (Figure 9-1).

Several of these areas presented exploration potential with anomalous to significant gold from the grab samples. East Ridge, East Flats and Egg Hill were characterized by grab samples greater than 0.0292 oz/ton (1.00 g/t) gold. The target areas are located to the east of the Oro Belle pit and have not been drill tested. The Benson target hosts analogous rock types to Castle Mountain Project and twelve samples returned assays greater than 0.0292 oz/ton (1.00 g/t) gold. Northwest Rim was characterized as a 4.7 mi (7.5 km) long northeast striking area of quartz-carbonate veins with rock grab samples greater than 0.0146 oz/ton (0.50 g/t) gold.

All samples were assayed for gold by fire assay and multi-element by Inductively Coupled Plasma (ICP) analysis using a four-acid digest. In addition, 138 samples were analysed for whole rock using a lithogeochemical package. Barrett (2016a) carried out a lithogeochemical and

petrographic study to differentiate the volcanic, intrusive and volcaniclastic units observed during the mapping and to quantify the degree of hydrothermal alteration. This study and a follow-up investigation of South Domes drill core indicated that that enrichment in antimony, arsenic and bismuth occurs outboard from gold mineralization, but generally at shallower levels (Barrett, 2016b). The associated enrichment in antimony, arsenic and bismuth at relatively shallow levels may be used as an exploration vector pointing to zones of gold enrichment at deeper levels and/or laterally and may potentially be used as an effective tool to predict the occurrence of bonanza grade gold-bearing veins at depth.

Channel sampling was conducted within the East Ridge and Egg Hill target areas. A total of 4,401 ft (1.25 km) of sample was cut using a gas-powered diamond saw. 220 channel samples were taken at 20 ft (6.1 m) intervals. The channel samples were treated in the same manner as drill hole data (i.e. noting a starting point, the total channel length and orientations capturing the trace of the channel).

Rock and channel samples were submitted to ALS Global of Reno or Elko, Nevada for gold assay on a 30 g aliquot by fire assay with an atomic absorption spectroscopy (AAS) finish. Prior to analysis, the sample was weighed, dried (110°C), crushed to greater than 70% passing 2 mm, then split into a 0.250 kg fraction that was pulverized to >85% passing a 75-micron mesh. Whole rock was determined by fusion followed by ICP-AES for major oxides and a lithium-borate fusion followed by an acid digest and ICP-MS finish for trace and rare earth elements.

Equinox has not completed any soil sampling. Viceroy completed extensive soil sampling programs which covered the entire property and predate the anthropogenic disturbance from the open pit operations. A total of 5,383 samples were collected and have results for gold, arsenic, silver mercury and antimony. Soil samples were collected at a nominal 400 ft (122 m) grid spacing.

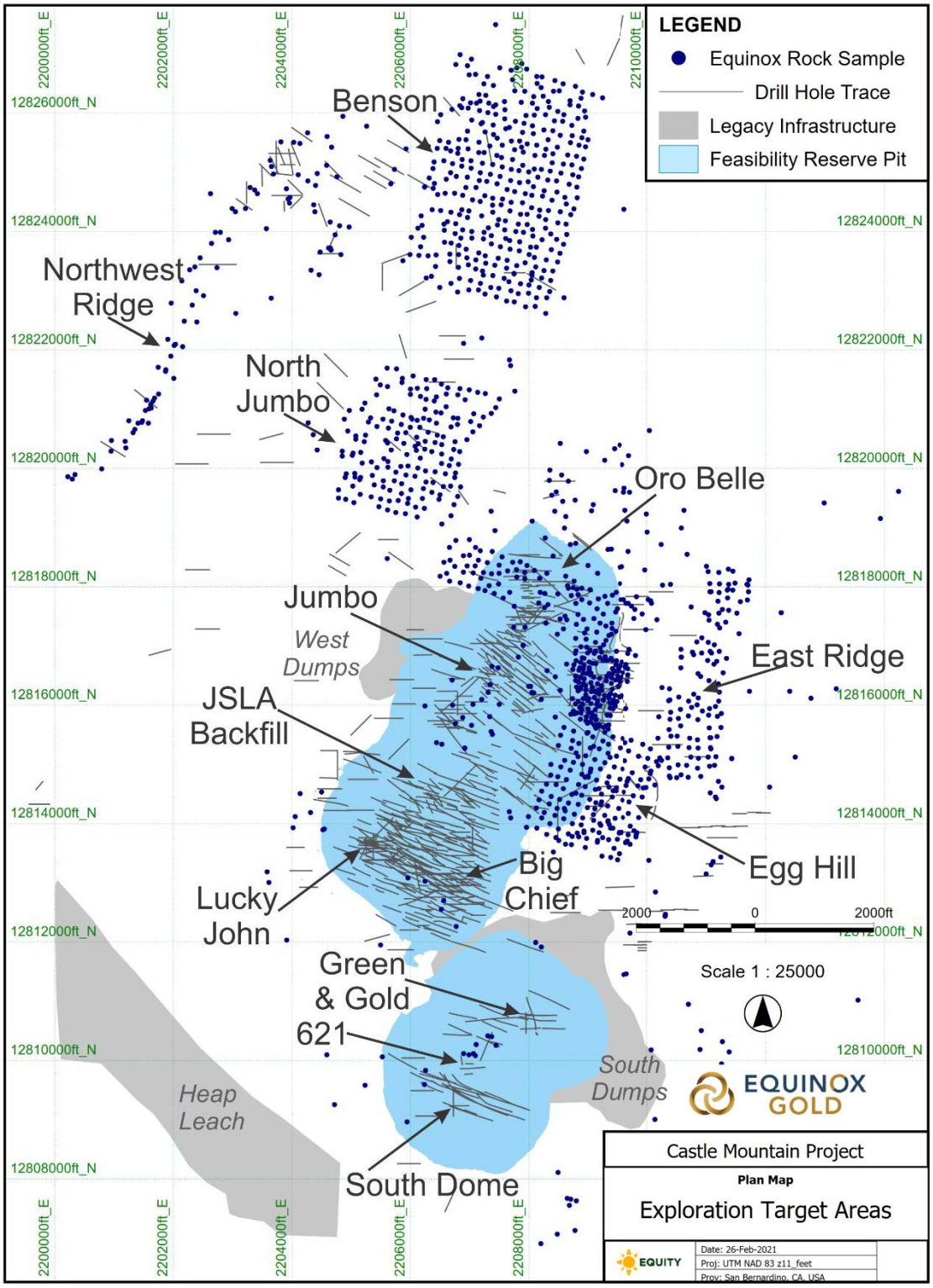


Figure 9-1: Map of Castle Mountain Exploration Targets

9.4 GEOPHYSICS

Equinox completed a Transient Electromagnetic survey (TEM) using instruments from Zonge International of Tucson, Arizona from February 2 to February 9, 2015. The survey design included soundings at 50 locations to evaluate alluvial material and assist in defining the groundwater level southwest of the mine. The TEM survey appears to show a strong resistivity contrast between the highly resistive alluvial material and bedrock that exhibits lower resistivity. Correlating with historic water wells, several inversion sections indicated gradual thickening of alluvial material to the west and a possible geophysical marker defining the top of the water table.

A ground-based gravity survey was completed to assist in determining the depth of alluvial cover. The Phase I survey was conducted from December 19 to December 30, 2014 and totaled 615 stations over a 984 x 984 ft (300 x 300 m) survey grid (Magee, 2014; Wright, 2015a). Within the eastern part of the survey area (closest to the mine), the gravity response is strongly influenced by bedrock geology and coincides where alluvial cover is thinnest. Correlating with drill hole geology, gravity highs strongly suggested the presence of near surface of the Proterozoic basement. A prominent northeast trending gravity low correlated to increasing rhyolite thickness and conformed to the modeled rhyolite-andesite contacts.

A Phase II gravity survey was performed over the deposit area from June 14 to June 16, 2015 to increase the geophysical resolution of the volcanic stratigraphy and mineralization. The survey totaled 779 stations on a 328 x 328 ft (100 x 100 m) grid (Wright, 2015b). The survey interpretation suggested a steeply dipping normal fault, with a west-side down offset, on the eastern side of the survey grid.

10 DRILLING

Extensive drilling has been completed on the Castle Mountain Project by Viceroy and Equinox (Table 10-1, Figure 10-1). Diamond, RC, and rotary drilling methods have been used within the hard rock portions of the deposit with a total of footage of 1,557,140 (474,597 m) within 2,111 holes (Figure 10-2). Recent drilling completed by Equinox accounts for total footage of 372,960 (113,677 m) within 339 drill holes. The drilling executed by Equinox represents 24% of the total hard rock footage drilled on the Project. The Equinox hard rock drilling represents dominantly angled drill holes and diamond drill core.

To support the Feasibility Study additional holes were drilled in 2019 and 2020 for geotechnical and condemnation purposes. Four HQ geotechnical diamond drill core holes were drilled for a total of 4,242 ft (1,293 m). To test for mineralization in infrastructure sites, 26,995 ft (8,228 m) was drilled in 31 RC condemnation holes. Portions of the condemnation drilling were within the waste dumps, but the majority of the holes are within the hard rock.

Equinox drilled 1,685 holes within the JSLA backfill and waste dumps with a total footage of 370,212 (112,835 m) (Table 10-2, Figure 10-3). The backfilled JSLA pit was drilled in 2017 and 2018 by RC and RAB to support the backfill resource estimate. Equinox hard rock drill holes that transect the backfilled JSLA pit were drilled as RC pre-collars followed by diamond drilling within the hard rock. The drill holes within the backfilled JSLA pit are summarised in Table 10-2. All drilling of the backfilled JSLA pit was executed by Equinox.

The legacy drilling completed by Viceroy is included herein, as it is material information to the hard rock portion of the resource estimate. Viceroy drilling was completed entirely within hard rock using conventional rotary, RC and diamond drilling methods for a total footage of 1,184,180 (360,920 m) within 1,712 drill holes.

Table 10-1: Summary of Castle Mountain Hard Rock Drilling by Operator & Drill Type

Operator/Hole Type	Hole Count	Total Footage (ft)	Total Meterage (m)
Equinox	**339**	**372,960**	**113,677**
Core	121	134,929	41,126
RC	195	210,237	64,080
RC-Core	23	27,794	8,471
Viceroy	**1,772**	**1,184,180**	**360,920**
Core	66	44,339	13,514
RC	1,227	881,031	268,525
Rotary	479	258,810	78,881
Total	**2,111**	**1,557,140**	**474,597**

Table 10-2: Summary of Castle Mountain Backfill Drilling by Drill Type

Operator/Hole Type	Hole Count	Total Footage	Total Meterage
Equinox	**1,685**	**370,212**	**112,835**
RAB	1,265	26,842	8,181
RC	278	212,937	64,900
RC-Precollars	29	340	104
Diamond Core	113	130,093	39,650

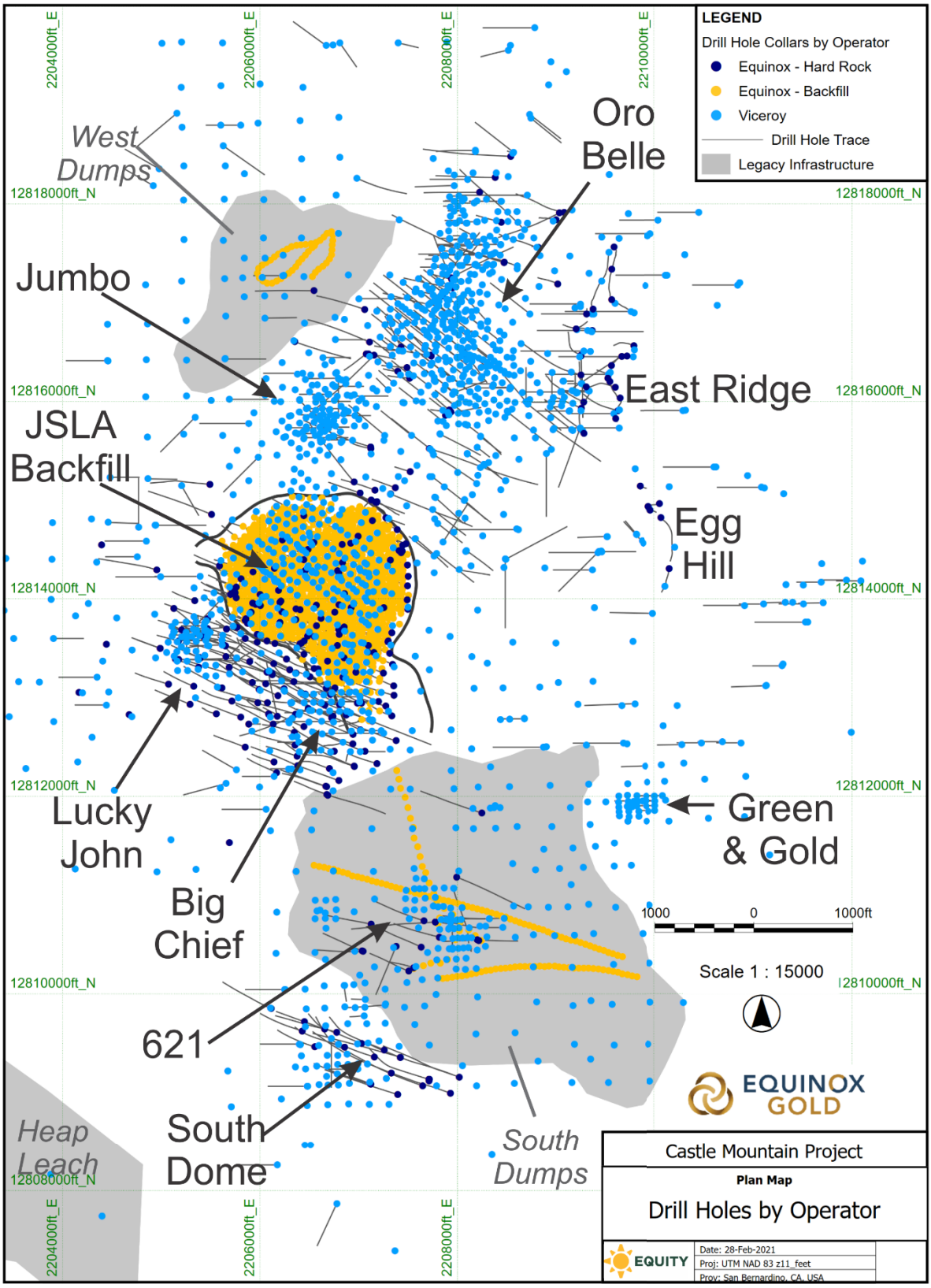


Figure 10-1: Map of Drilling by Operator

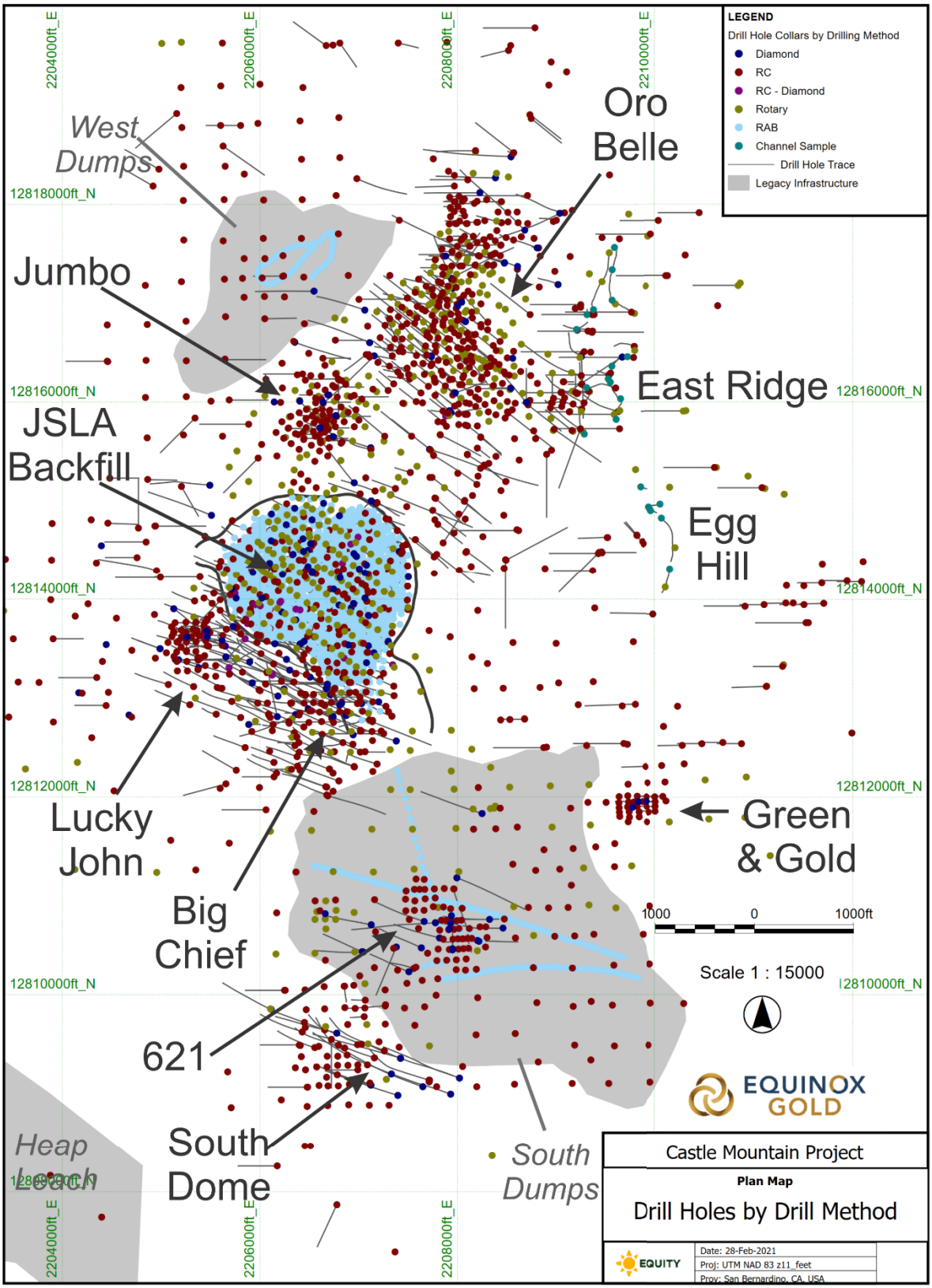


Figure 10-2: Map of Drilling by Drill Hole Type

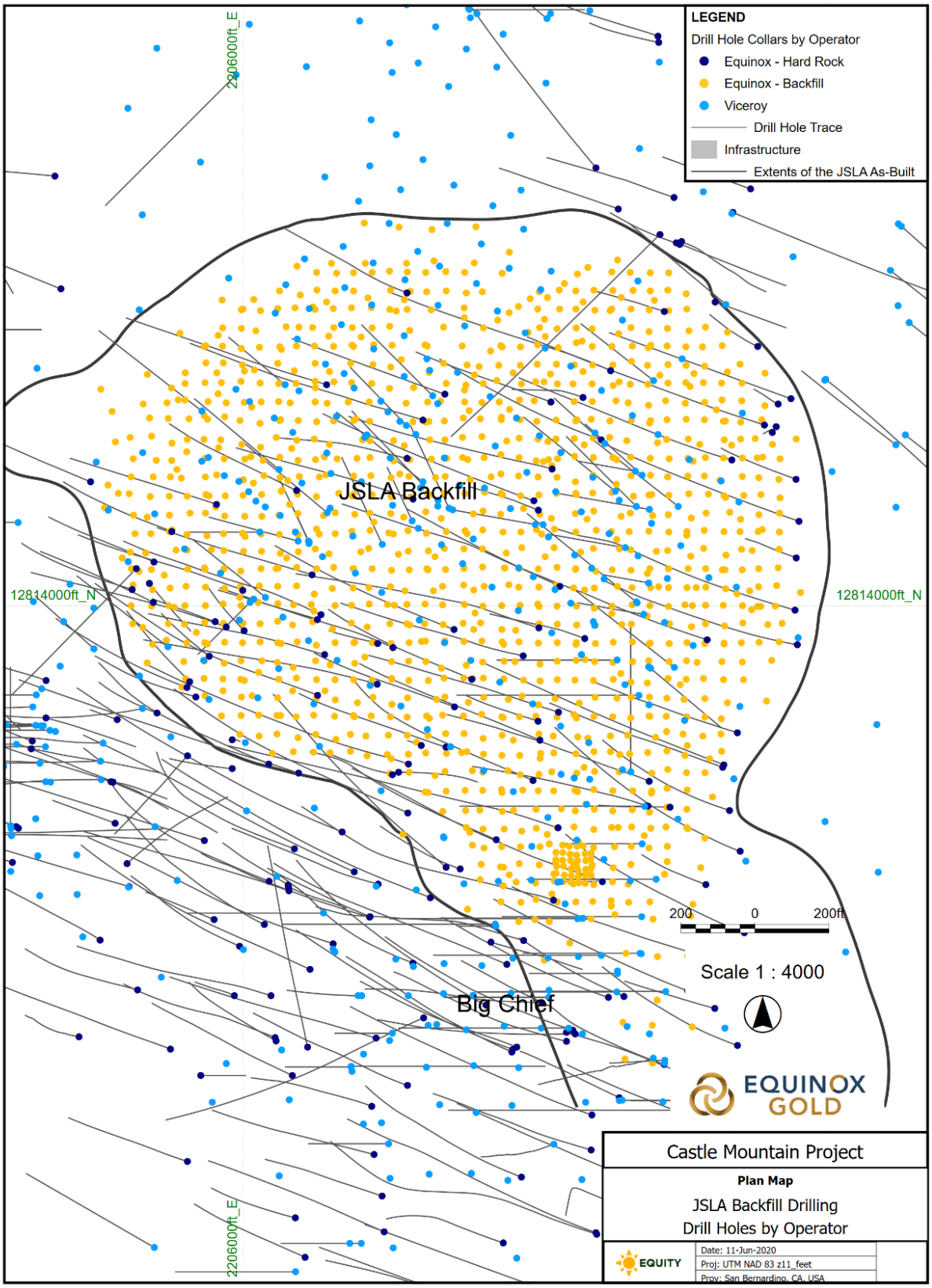


Figure 10-3: Map of JSLA Backfill Drilling by Operator

10.1 VICEROY LEGACY HARD ROCK DRILLING

Between 1984 and 1993, Viceroy completed a total of 1,712 drill holes on the Castle Mountain Project which accounts for drilling footage totaling 1,184,180 (360,920 m). The legacy drilling on the project included a mix of vertical rotary drilling and dominantly vertical RC and diamond drilling. Few inclined holes were drilled.

Blastholes were used to monitor production during historical Viceroy operations (1990 to 1996). Legacy samples digitized by Equinox geologists cover all benches in the Jumbo and Oro Belle pits and a small portion of the benches in JSLA. Production blasthole data has not been verified by the QP and only the de-surveyed bench sample and result are available for review.

The Viceroy drilling data was compiled from digital records and verified by Equinox staff using hardcopy records that are currently stored at the Project's office in Henderson, Nevada. Verification included spot checking and rectification of inconsistent records. Viceroy drill hole collar location data were originally recorded using Viceroy's Castle Mountain Mine Grid projection. All original Viceroy drill hole collar coordinates have been re-projected to UTM NAD 83 UTM zone 11 meters and then converted from meters to feet to match the current methods that Equinox uses to survey drill hole collar locations.

10.2 EQUINOX HARD ROCK DRILLING

10.2.1 Hard Rock Exploration Drilling

Drilling by Equinox has been completed using primarily angled drill holes to delineate targets, advance the geological models and increase the confidence of resource classification. Drilling executed by Equinox was oriented and drilled at lower angles in an attempt to intersect the structures associated with, and controlling, the deposit geometry as well as the local lithologic and stratigraphic controls of economic mineralization (Gray et al., 2016).

10.2.1.1 Equinox Phase 1.1-1.3 Drilling; 2013-2015

In March 2013, Equinox initiated a three-phased exploration and resource definition drilling program on the Project. A total of 70,570 ft (21,510 m) of RC and diamond core drilling was completed over 77 drill holes.

Phase 1.1 comprised 18,092 ft (5,514 m) of diamond core drilling and 6,785 ft (2,068 m) of RC drilling over 30 drill holes. The Phase 1.1 drill program was designed to follow-up on historical drill holes within and proximal to previously mined pits as well as test mineralization in selected exploration targets. The primary goal was to verify and validate the historical drill hole database and to collect data to be used for an initial resource estimate.

Previous exploration focused on northeast-trending structures and margins of rhyolite domes for the principal control on the mineralization. Early in the 2013 drill program this concept was tested but the results highlighted that the intersection of the north-south and northeast-trending structures as a significant control for gold mineralization. Later drill testing was modified to test the intersection of structures.

Phase 1.2 commenced in 2014 and included 33,254 ft (10,136 m) in 41 drill holes. Drilling targeted areas between and under the existing open pits. Mineralization encountered in the Lucky John target area demonstrated exploration potential for strike and depth extensions to known zones

and near surface mineralization occurring adjacent to and on trend of the existing mineral resources. Broad intervals of gold mineralization were encountered around the south end of the existing JSLA pit. This phase included four PQ diameter (85.1 mm) diamond holes drilled specifically for metallurgical column tests.

Phase 1.3 program commenced in early 2015 and included 6,549 ft (1,996 m) of RC and 5,889 ft (1,795 m) of HQ core in 10 deep holes to further follow up on the drilling that returned high-grade intervals within the Lucky John target area.

10.2.1.2 Equinox Phase 2.1 2016 Drilling

The Equinox Phase 2.1 RC and diamond drilling program was undertaken from June to October 2016 and consisted of 46 exploration and infill resource drill holes. Total footage for RC and diamond drilling amounted to 39,470 ft (12,030 m) and 26,744 ft (8,151 m), respectively. One 1,000 ft (305 m) hydrogeological test hole was drilled. Phase 2.1 drilling totaled 65,423 ft (19,941 m).

The program targeted the southern part of the current resource area, in the Big Chief and South Domes areas. These targets were historically sparsely drilled and occur adjacent to previously mined areas. They were considered to have good potential for near-term mineral resource expansion as well as possible strike extensions of the Lucky John high-grade gold mineralization encountered in 2014 and 2015 (Gray et al., 2016).

10.2.1.3 Equinox Phase 2.2 2016-2017 Drilling

The Equinox Phase 2.2 drilling began in late October 2016 with the objective of expansion and infill of the existing published measured and indicated resource estimate as defined by the 2015 Technical Report and Updated Mineral Resource Estimate (Gray et al., 2016). Additional drill holes were added to the program to support ongoing metallurgical testwork, to source clay for the leach pad liner, and to test for additional water sources for mine development.

A total of 148 RC and diamond core drill holes were completed comprising 136 resource expansion and infill drill holes, four water well test holes, four PQ metallurgical test holes, and four PQ geotechnical holes to test for clays amenable to use as a leach pad liner. The four geotechnical holes were each completed to a depth of 150 ft (45.7 m) for a total of 600 ft (183 m). The holes were drilled immediately to the west of Big Chief Hill in an area that has historically been excavated for sources of clay on the periphery of strongly altered rhyolite flows or domes.

The total footage drilled was 169,944 ft (51,799 m) including 160,341 ft (48,872 m) of resource and infill drilling; 5,620 ft (1,713 m) of water well test drilling; 3,383 ft (1,031 m) of PQ metallurgical drilling; and 600 ft (183 m) of clay test hole drilling.

10.2.1.4 Equinox Phase 2.3 2017-2018 Drilling

In late 2017, Equinox completed a drilling program aimed at infill drilling at South Domes and exploration drilling in several other areas on the Project. A total of 29,447 ft (8,978 m) in 31 RC and diamond core holes was drilled.

10.2.2 Metallurgical Drilling

Eight PQ metallurgical specific holes were drilled for a total of 7,306 ft (2,227 m) (Figure 10-4). Four holes were drilled for metallurgical column testing for an aggregate 3,923 ft (1,195.6 m), with two holes under the Jumbo pit, one hole into the Lucky John zone, and one hole into the southern margin of JSLA in 2014. In 2018, three holes twinned the diamond drill holes CMM-033, CMM-161 and CMM-212 all within JSLA backfill. A fourth metallurgical hole was pre-collared but the JSLA dump backfill proved too deep to successfully complete the drill hole and was abandoned at 440 ft (134 m). Additional metallurgical tests have utilized sample material from the exploration drilling.

10.2.3 Geotechnical Drill Holes

Four HQ geotechnical diamond drill holes were drilled for a total of 4,242 ft (1,293 m) in November and December 2019, to support a slope stability study to update recommended inter-ramp slope angles and bench design parameters. All four holes were oriented to pierce the Feasibility Reserve pit shell (Figure 10-4).

10.2.4 Condemnation Drill Holes

In April of 2020, an RC condemnation drill program totalling 26,995 ft (8,228 m) was undertaken to determine if there was untested economic potential within areas designated for mine facilities and within the waste dumps. Assay results confirmed there is little to no significant economic potential under the proposed infrastructure sites (Figure 10-4). Several holes were collared on historic dumps and intersected gold mineralization, including up to 55 ft (17 m) of 0.0272 oz/ton (0.93 g/t) in CMM-294 highlighting the potential for mineralization within the legacy waste dumps.

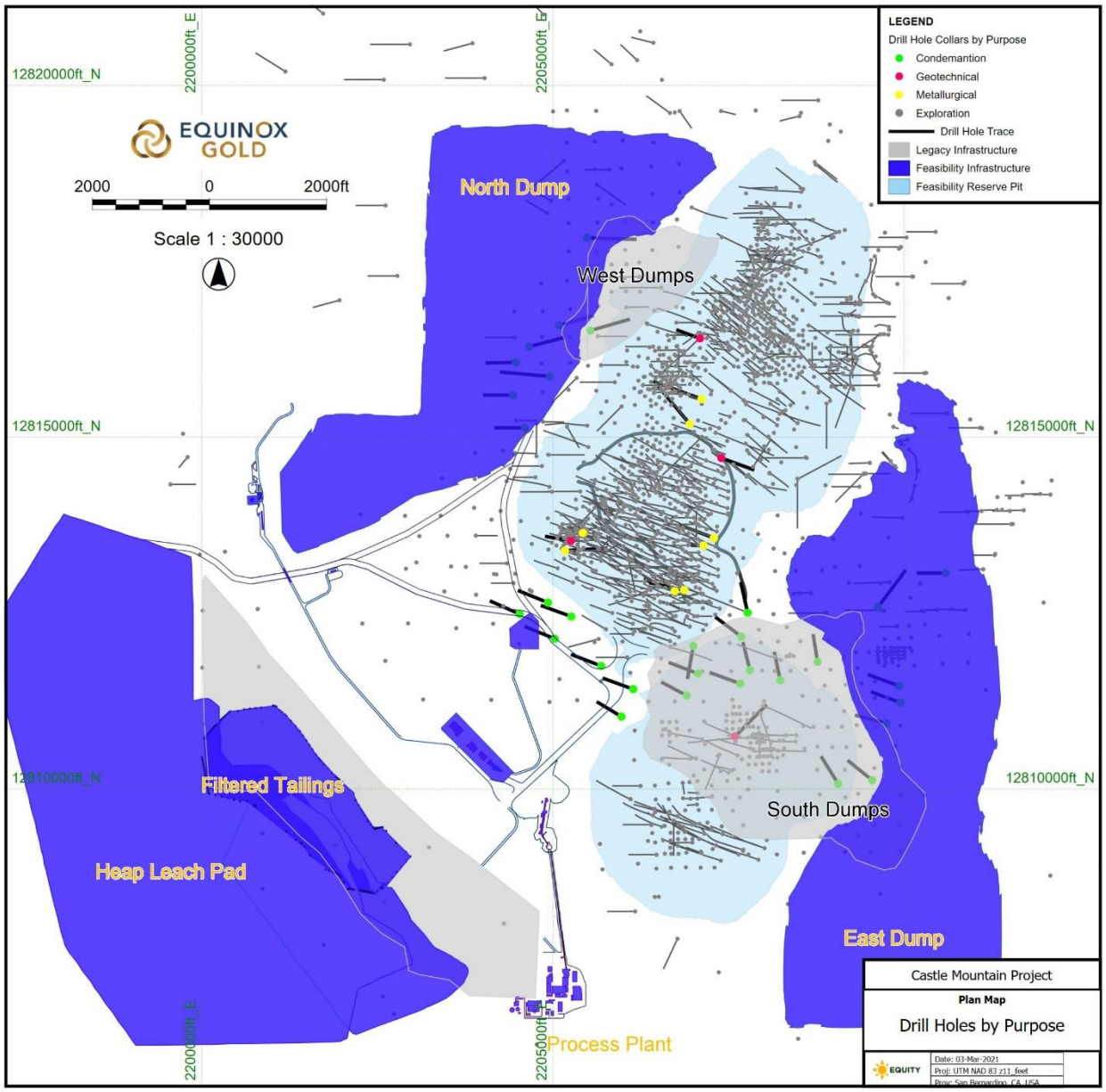


Figure 10-4: Map of Drilling by Purpose

10.3 EQUINOX BACKFILL & WASTE DUMP DRILLING

10.3.1 Equinox 2017 RAB Drilling

In January and February 2017, a RAB drill program was carried out across the JSLA backfill and south waste dumps. The goals of the program were for condemnation purposes and to test for low-grade mineralization. A total of 7,002 ft (2,134 m) from 273 RAB drill holes were drilled, including 242 drill holes within the backfilled JSLA pit were drilled with 100 ft (30 m) spacing and 31 drill holes completed in lines across the south waste dumps. RAB drill holes were drilled to depths between 18 ft (5.5 m) and 30 ft (9.1 m) depending on the stability of the dump material and the amount of material recovered for sampling.

10.3.2 Equinox 2018 RC Drilling

A 52-hole RC program totalling 9,510 ft (2,899 m) within the backfilled JSLA pit was completed over a two-week period in January 2018. Drilling was completed using a Shramm T450 RC drill rig. Termination depth for the drill holes was selected at the 4,300 fasl (1,311 m) level, yielding an average hole depth of approximately 182 ft (55.5 m). In the fall of 2018, 66 additional RC holes were completed for a total of 23,445 ft (7,146 m) with an average hole depth of 355 ft (108 m).

10.3.3 Equinox 2018 RAB Drilling

A RAB drill program consisting of 617 holes totalling 12,340 ft (3,761 m) was drilled in February 2018. The drill program was designed to test the top 20 ft (6.1 m) of the JSLA pit backfill material on a 50 ft (15.2 m) grid-spacing. An infill grid consisting of 32 holes was drilled on 20 ft grid-spacing to evaluate grade control drilling practices. The infill grid was centered on RC hole RC18-1-2.

The RAB program was extended to include portions of the north and south waste dumps, with 46 holes drilled on the north dump as an initial test of ROM material. An additional 107 samples were collected across two lines at the southern end of the south dump, following up on the 2017 RAB program. The extended RAB drilling program was completed in March 2018 for a total of 375 drill holes in 7,500 ft (2,286 m).

10.4 EQUINOX DRILLING METHODS & PROCEDURES

Exploration drilling at the Castle Mountain Project site is managed by trained Equinox personnel using established Project specific procedures. The operations are supported from the site facilities that includes offices, a secured laydown area including a covered, open-air, logging facility and a core storage facility.

The exploration manager and project geologists are responsible for ensuring logging geologists and technicians are aware of, and follow the logging, sampling, and sample shipment procedures. From 2012 to 2017, all logging, sampling, and shipment data were recorded on Excel templates. Starting in 2017, this data was entered directly into a tablet computer using MX Deposit logging software, which also serves as the database and QA/QC monitoring platform. All drill depths and drill runs were recorded in feet.

10.4.1 Drilling Methodology

10.4.1.1 Diamond Core Drilling

Diamond drilling was completed using conventional PQ (3.35 in/85.1 mm) and HQ (2.5 in/63.5 mm) tooling. Where necessary to complete the drill hole to target depth, holes were reduced to NQ (1.875 in/47.6 mm). Diamond tipped face-discharge drill bits were used to increase productivity and recovery. In late January 2017, the tooling was converted to HQ3 drill bits and triple tube tooling using inner core tube splits to further improve recovery and preserve core condition. Metallurgical holes were drilled with conventional PQ tooling using face-discharge diamond core drill bits.

10.4.1.2 Reverse Circulation Drilling

RC drilling was conducted conventional RC air-hammer and tricone drilling. Two drill rigs used center return, face sampling air hammer RC drilling in dry to minimal-water conditions but switched to conventional RC or tricone conditions when water inundated the air-hammer. For deeper holes, a Shramm 685 drill rig using Symmetrix casing and center return, face sampling air hammers was utilized. The Symmetrix RC casing system was used in drill holes where greater than 400 ft (122 m) of backfill was anticipated; the deepest cased hole utilized up to 800 ft (244 m) of Symmetrix casing within the JSLA pit.

10.4.1.3 Reverse Air-Blast Drilling

The RAB drill programs utilized an Atlas-Copco D-65 blast hole drill rig. The RAB drilling used a downhole air-blast button or tricone bit to drill a hole through unconsolidated, dry material. The RAB drill collects the sample direct from the top of the drill hole outside the drill string and then directs the chips to a cyclone where the sample is recovered and bagged. Material with a high clay content used the tricone while more rocky material required the use of the button bit. Drilling foam was added to lubricate the bit and suppress dust. The JSLA RAB drill holes were drilled on an approximate 50 ft by 50 ft grid.

10.4.2 Drilling Procedures

The procedures implemented by Equinox are detailed in Sections 10.4.2.1 through 10.4.2.8 and summarized in Figure 10-5 (Equinox, 2018). All downhole measurements and logging were recorded in feet.



Source: (Equinox, 2018)

Figure 10-5: Equinox Drill Handling and Sampling Workflows

10.4.2.1 Transportation Procedure

Equinox personnel are responsible for transporting the diamond drill core or RC/RAB samples from the drill site to the logging facility. Core or chips samples are secured in pickup trucks and transported along project roads to the logging facility. The drill chips and core are unloaded, organized by hole depth, and examined for drilling errors or irregularities.

10.4.2.2 Location Procedure

Drill collar locations are initially located using hand-held Garmin or Trimble GPS receivers. Fore- and back-sights for drilling azimuth were located using hand-held Brunton compass employing a magnetic declination correction of 11.51º east. An azimuth orientation line was sprayed on the ground with fluorescent orange paint prior to arrival of the drill rig. Inclination was checked by either hand-held inclinometer or by Brunton compass inclinometer.

When drilling is complete, the collars are marked with a cement monument and a labelled stake. Periodically throughout the program, Mineral Exploration Services of Reno, Nevada collected survey quality differential GPS locations for drill collars using a Trimble R2 dual frequency GPS with a horizontal accuracy of 0.79 in (2 cm). All hole locations were collected in UTM NAD83 zone 11 meters and converted to feet.

10.4.2.3 Downhole Surveys

Downhole surveys for the drilling were provided by International Directional Services LLC (IDS) of Chandler, Arizona. All downhole surveys including core and RC holes were conducted using a surface recording gyro (SRG); collected at 50 ft (15.3 m) intervals inside the drill string. The SRG corrects for the magnetic declination (11.51º east) at the time of data collection. Survey measurements were provided on paper and as digital files. No down hole surveys were performed on the RAB drilling due to the shallow depths and vertical drilling orientation.

10.4.2.4 Core Photos

All cores were photographed prior to cutting using a high definition digital camera. All core photographs are labelled with the hole ID number, box number and from-to depth. The digital archive of photographs is maintained at the site office with a back-up stored at the Henderson, Nevada and Vancouver, BC, Canada offices.

10.4.2.5 Geotechnical Logging

Geotechnical logging was performed on all core drilled, including footage drilled, core recovery, RQD, fracture frequency and joint condition. Each category value was determined for each core tube pulled, or block to block. Aluminum tags labeled with the beginning and ending footage of the box and hole number are stapled into the core box to denote sample intervals.

10.4.2.6 Geologic Logging

Geologic logging was carried out on all core and all RC or RAB chips. Reference chip trays are collected, washed, and geologically logged using a binocular microscope. Logging was carried out either at the logging facility or at the Henderson office. Geologic data was digitally recorded into a logging template developed specifically by Equinox geologists for the Project. Principal data fields collected included lithology, mineralogy (iron oxide, manganese oxide, pyrite and gold), alteration (silica, clay, and chlorite). Structural including fractures, faults, veins, and contacts are collected for core.

10.4.2.7 Core, Pulp and Reject Sample Storage

All Equinox drill core is stored at the core storage facilities on the Project site. The pulps and coarse rejects returned by the laboratory are stored in shipping containers at the storage facility for reference and future testwork.

10.4.2.8 Data Adequacy

It is the QP's opinion that the drilling procedures are adequate to support mineral resource estimation. There are no drilling or sampling factors that could materially impact the accuracy and reliability of the results.

11 SAMPLE PREPARATION, ANALYSES AND SECURITY

The sample preparation, analysis, and quality assurance/quality control (QA/QC) has been reviewed for samples assayed for gold that are used in preparing the Mineral Resource Estimate presented in Section 14. Gold assays from cyanide leach have been routinely assayed and have been reviewed for their use to support the weathering domains. Silver and other elements were analyzed in various drill campaigns; however; assaying methods used are not considered representative.

11.1 VICEROY HARD ROCK SAMPLING METHODS

The following description of Viceroy sampling was modified from the Preliminary Feasibility Study for the Castle Mountain Project (Scott et al., 2018) and Temkin (2012). The QA/QC data has not been digitally compiled and was not reviewed by the QP.

11.1.1 Sampling and Security

All legacy drill core sampling was collected systematically on 5 ft (1.5 m) intervals over the entire length of the drill hole. The core was sawn into equal halves utilizing a standard lapidary blade, then measured and marked into 5 ft (1.5 m) intervals. Individual samples were prepared utilizing one-half of the sawn core. Samples were prepared and submitted in batches for shipment to the laboratory.

RC and rotary samples were collected at 5 ft (1.5 m) intervals over the entire length of each drill hole. All dry drill cuttings were split through a Gilson splitter, retaining a sample size of approximately 15 lbs (7 kg). A single sample was collected for each interval, which was sent to the commercial lab for analysis. Wet drill cuttings were split through a revolving wet splitter that was continuously adjusted to collect approximately 15 lbs (7 kg) of material. Individual samples were collected in 5 gal (19 L) buckets lined with an oversized sample bag into which flocculent was added. Samples were left to settle for 20 to 30 minutes, and then were decanted before being secured and laid out to dry. Reference samples were collected in plastic chip containers for logging purposes.

All drill samples were either retrieved directly from the Project by the primary laboratory, Legend of Reno, Nevada, or were shipped directly to Legend via a contract shipping company.

11.1.2 Analyses

Sample preparation at Legend consisted of crushing the entire sample to -10 mesh, splitting out a 200 g (7.05 oz) subsample, and grinding the subsample to greater than 80% passing -150 mesh. Gold and silver were determined by fire assay on a one-assay ton (29.166 g) subsample followed by atomic absorption spectroscopy finish (AAS). Assay values were reported in oz/ton units, and the lower detection limits for gold and silver were 0.001 oz/ton (0.034 g/t) and 0.050 oz/ton (1.714 g/t), respectively. Assays returning gold values greater than 0.100 oz/ton (3.428 g/t) were re-assayed by fire assay on a one-assay ton subsample with a gravimetric finish.

A subset of Viceroy drill hole samples was assayed by Rocky Mountain Geochemical (RMG) in Sparks, Nevada. The sample preparation procedure used by RMG is unknown. Gold and silver were determined by fire assay followed by AAS or gravimetric finish. Assay values were reported in oz/ton units and the lower detection limits for gold and silver were 0.005 and 0.100 oz/ton (0.017 and 3.428 g/t), respectively.

Legend and RMG were not certified nor accredited ISO 17025 laboratories for analysis by fire assay with AAS finish at the time they were performing analytical services for the Project.

At the culmination of mining activities, all samples including core, rotary cuttings, rejects, and pulps were destroyed during the reclamation activities.

11.1.3 Quality Assurance and Quality Control

Automatic intra-laboratory pulp duplicates were performed for any sample that either contained visible gold or had an original assay value of greater than 0.100 oz/ton (3.42 g/t) gold. The standard check assay procedure consisted of three steps. The first was to analyse the original pulp with a full one-assay ton fire assay with a gravimetric finish. The second step was to produce a coarse reject duplicate and perform a full one-assay ton fire assay with a gravimetric finish. The final analysis was for a metallic screen fire assay. This data is not available and is not presented in further detail.

The QA/QC for Viceroy data is not available, and this section was taken from Temkin (2012), which summarized the practices undertaken by Viceroy. Routine duplicate analyses were performed on the rotary, RC and diamond drill holes utilizing the same pulp as that used for the initial analyses. The duplicate analyses were conducted on every tenth sample for approximately 60% of the drill sample population, and every twentieth sample, for approximately 30% of the samples. The remaining approximate 10% of the drill samples had duplicate analyses performed at intervals of every fifth sample or every fifteenth sample.

Assay precision from the pulp duplicates was variable with gold grade, but generally acceptable. Approximately 80% of low-grade < 0.010 oz/ton gold (0.343 g/t) samples reported precision of ±10%. Medium-grade (0.010 to 0.100 oz/ton / 0.343 to 3.428 g/t Au) samples reported precision of ±17% and 90% of the high-grade (> 0.100 oz/ton / 3.428 g/t Au) samples reported precision of ±25%.

Check assay samples submitted to other commercial labs and the Castle Mountain Mine lab did not indicate any systematic bias or accuracy issues with Legend's original assays (Temkin, 2012).

11.1.4 Production Blasthole Samples

There are no details of the Viceroy sampling procedure or the QA/QC. The data was not used in the Mineral Resource Estimate within Section 14, except to cross validate the mined-out portions of the model against the blasthole production data.

11.2 EQUINOX SAMPLING

This section summarizes the Project specific standard operating procedures outlined by Equinox (Equinox, 2018).

11.2.1 Sampling and Security

Once the core has been washed, checked for drilling errors and prepared with meter marks by technicians, Equinox geologists determined sample intervals based on observed changes in lithology, alteration and mineralization features. Sample intervals are nominally 5 ft (1.5 m) in length, but range between 2 ft (0.6 m) and 7 ft (2.1 m). Metal sample tags are stapled on to the left side of the core and folded over onto the corresponding sample break on the core. Tyvek

sample tags are filled out in a sample book including sample intervals and QA/QC insertions. One part of the sample tag placed into the box and the tag book is retained for reference if required. The sample intervals and inserted QA/QC samples are recorded in a digital sample cut sheet and used for drill hole sample intervals within the Project's drill hole database and laboratory sample submittal.

For core drilling executed between 2013 and 2016, the core was marked for sampling as described above and sent to the ALS Global (ALS) in Reno or Elko, Nevada where it was sawn in half and bagged for sample preparation and analysis. The remaining half of the sawn core was returned to the site for storage in the core storage facility. Starting in 2017, the drill core was sawn in half, sampled, and bagged by Equinox personnel using an electric saw at the logging facility at the Project site.

RC drill cuttings are collected in labelled sample bags by the drill contractor on continuous 5 ft (1.5 m) intervals from a rotary cyclone splitter. The rotary splitter is set for 50:50 splits to collect half of the material which is bagged, labelled and submitted to the laboratory as the original sample. The remaining portion is discarded except when a field duplicate sample is collected. RC sample weights typically range from 4.4 to 22 lb (2 to 10 kg) and average about 13 lb (6 kg). At the end of a sample run, the sample bag opening is secured and laid out on plastic ground liner to facilitate drying of the sample. After approximately three to seven days, Equinox personnel collect the samples from the field and transport them to the secured laydown yard.

The RAB drill collects the sample directly from the top of the drill hole outside the drill string, and then directs the chips to a cyclone where the sample is recovered and subsequently laid out on a clean tarp to air dry. The material is quartered, and original samples are generated from material in opposite quadrants (one and three). Field duplicates, when inserted, are prepared using material from adjacent quadrants (two and four). Each sample was collected on 18-foot and 30-foot intervals in the 2017 campaign, and each sample was collected on 20-foot intervals in the 2018 campaign. Following collection at the drill, bagged samples are stored in the laydown yard where they are organized to be shipped to the laboratory. Samples from the bags are sufficiently mixed to get a representative sample for the drilling interval.

The individual sample bags are placed in large bins with lids. The laboratory collects palletized core and sample shipment bins directly from the logging facility. Shipments are secured to the commercial laboratory service truck and transported directly to the laboratory facility in Reno or Elko, Nevada. Each shipment is accompanied with a physical sample list and laboratory requisition form that is also submitted to the laboratory via email.

11.2.2 Analyses

Drill samples were assayed at either the ALS in Reno or Elko, Nevada, or the Bureau Veritas (BV), formerly known as Inspectorate, in Sparks or Reno, Nevada. ALS laboratories in the USA have International Standards Organization (ISO) 17025:2005 and ISO 9001:2008 accreditation. BV has ISO 9001 and ISO/IEC 17025 accreditation since 1996. In 2017, the BV accreditation was covered under ISO ISO/IEC 17025:2017 and RG-MINERAL:2017 regulations. Condemnation sampling and umpire pulp check assays were completed at American Assay Laboratories Inc. (AAL) in Sparks, Nevada which is accredited under ISO 17025:2005.

11.2.2.1 ALS

Samples submitted to ALS are prepared by drying and then crushing to 70% passing 0.08 in (2 mm). An 8.82 oz (250 g) sub-sample is taken from the crushed material and pulverized to 85% passing 200 mesh (75 µm) (PREP-31). A 30 g aliquot of pulverized material (pulp) is then assayed for gold and silver by conventional fire assay methods followed by AAS analysis (Au-AA23). Gold assays returning greater than 0.292 oz/ton gold (10 g/t) are re-assayed by fire assay and gravimetric finish on a separate 30 g aliquot (Au-GR21). Starting in 2017, gold assays returning greater than 0.006 oz/ton (0.2 g/t) gold are analyzed for gold cyanide solubility by mixing a 30 g aliquot of pulp with dilute cyanide solution and agitating for one hour and finishing by AAS (Au-AA13).

11.2.2.2 Bureau Veritas

Samples submitted to the BV facility are dried and crushed to 70% passing 0.08 in (2 mm). An 8.82 oz (250 g) sub-sample is taken from the crushed material and pulverized to 85% passing 200 mesh (75 µm) (PRP70). A 1.06 oz (30 g) aliquot of pulverized material (pulp) is then assayed for gold by conventional fire assay methods followed by AAS analysis (FA430). Gold assays returning greater than 0.292 oz/ton (10 g/t) gold are re-assayed by fire assay and gravimetric finish on a separate 30 g aliquot. Gold assays returning greater than 0.006 oz/ton (0.2 g/t) gold were analyzed for gold cyanide solubility by mixing a 30 g aliquot of pulp with dilute cyanide solution and agitating for one hour and finishing by AAS (CN403).

11.2.2.3 American Assay

The condemnation RC chip samples were submitted to AAL for the primary analysis by fire assay of a 50 g aliquot with inductively coupled optical emission spectrometry (ICP-OES) finish (FA-PB50-ICP) and a multi-element geochemical suite of 53 elements by aqua regia digestion and analysis by inductively coupled mass spectrometry (ICP-5AM48). Samples with values over 0.0044 oz/ton (0.15 g/t) gold were analyzed by mixing a 50 g aliquot with hot cyanide solution and analyzing with an ICP-OES finish (CN50). Check assays were completed on pulps using conventional fire assay methods on a 50 g aliquot with gold analysis by ICP-OES. Gold assays returning greater than 0.292 oz/ton (10 g/t) gold were reanalyzed by fire assay with gravimetric finish.

11.2.3 Quality Assurance and Quality Control

Equinox has conducted QA/QC monitoring of gold assays on its drill programs by inserting blanks, certified reference materials (CRM), RC field duplicates, pulp duplicates, and umpire pulp duplicates (Table 11-1). CRMs, blanks and duplicates were inserted into the sample stream consistently; however, insertion rates varied between campaigns. A selection of samples from mineralized intervals were submitted to an umpire laboratory for check assay at the completion of each drill campaign.

Table 11-1: Summary of QA/QC Samples

Sampling Program	Number of Samples	Field Blanks	Certified Reference Materials	Field Duplicate	Pulp Duplicate	Pulp Duplicate External	Total QA/QC Samples
Bedrock	62,606	1,431	2,869	1,985	49	447	6,781
Backfill	7,666						
Total	70,272						

Coarse blanks were sourced locally from coarse crushed construction rock to monitor the sample preparation. Blanks were inserted at a 2% frequency within Equinox drilling. Equinox used ten CRMs sourced from Mineral and Exploration Geochemistry (MEG) of Reno, Nevada to monitor the accuracy of a range of expected gold values. Table 11-2 summarizes the CRM samples submitted by Equinox which were inserted at a 4% frequency rate.

Table 11-2: Summary of CRM Samples

	CRM Expected Values			Original CRM Insertion			
CRM	Expected Average Gold (oz/ton)	Expected Average Gold (g/t)	Standard Deviation	Number of Samples	Average Gold (oz/ton)	Average Gold (g/t)	Average Z-Score
Total				**2,869**			
Au.10.03	0.0018	0.06	0.006	678	0.0018	0.06	0.002
Au.12.11	0.0438	1.50	0.081	468	0.0437	1.497	-0.032
Au.12.32	0.0181	0.62	0.017	682	0.0181	0.622	0.14
Au.17.05	0.0015	0.05	0.004	19	0.0016	0.054	1.066
NBM-2a	0.0002	0.007	0.002	20	0.0002	0.006	-0.425
NBM-4a	0.0022	0.075	0.007	23	0.0024	0.081	0.858
NBM-5b	0.0481	1.65	0.225	66	0.0493	1.689	0.172
S105006X	0.1313	4.50	0.099	647	0.1312	4.497	-0.028
S107007X	0.0438	1.50	0.068	234	0.0456	1.563	0.92
S107009X	0.1371	4.70	0.194	32	0.1438	4.93	1.184

The QA/QC analyses for gold are reviewed on a batch by batch basis by the Equinox geologists. A series of protocols are followed to define QA/QC failures and determine the type of follow up action required. If a control sample result falls outside acceptable limits, the assay laboratory is instructed to re-assay the batch of samples or a selection of samples around the QA/QC sample. If the re-analysis passes the criteria, then it replaces the results from the original certificate within the Project database.

Field duplicates were collected with a 3% frequency rate for all Equinox exploration samples to monitor the sample variability. RC field duplicates were collected from the second half of the sample created by the cyclone rotary splitter at the drill rig. RAB field duplicates were collected from the two unsampled quadrants adjacent to the quadrants used for the original sample.

The RC condemnation drilling had a total sample submission of 6,634 original and QA/QC samples including 418 blanks, 276 CRMs, and 540 field duplicates. The insertion rates are within industry standard and respectively are 8%, 5% and 10%. All the CRM performed with ±3 standard deviation criteria except one which was re-analyzed with surrounding samples making the effective failure rate nil. The blanks consisted of 361 coarse crush and 57 certified silica blanks which all performed below warning level. Analysis of field duplicates was done by calculating the coefficient of variance (CV) for each sample, which averages 18% for all sample pairs. The QA/QC results from this sampling are adequate; however, the results were not available for inclusion within the Mineral Resource in Section 14 and as such are not included the summary of sampling in Table 11-1 and Table 11-2.

11.3 BULK DENSITY

Bulk density samples were measured for 647 samples from multiple drill holes to provide measurements from a variety of rock types (Figure 11-1). Samples were selected at the logging facility by Equinox geologists. 4-6 in (10-15 cm) long core samples were selected, marked with markers and tags and submitted in the core box to ALS for wax immersion bulk density measurements. Measurements were conducted on split HQ or PQ size core using the water immersion method after coating with paraffin wax (ALS method OA-GRA08a). The bulk density measurements were converted to imperial units as a tonnage factor.

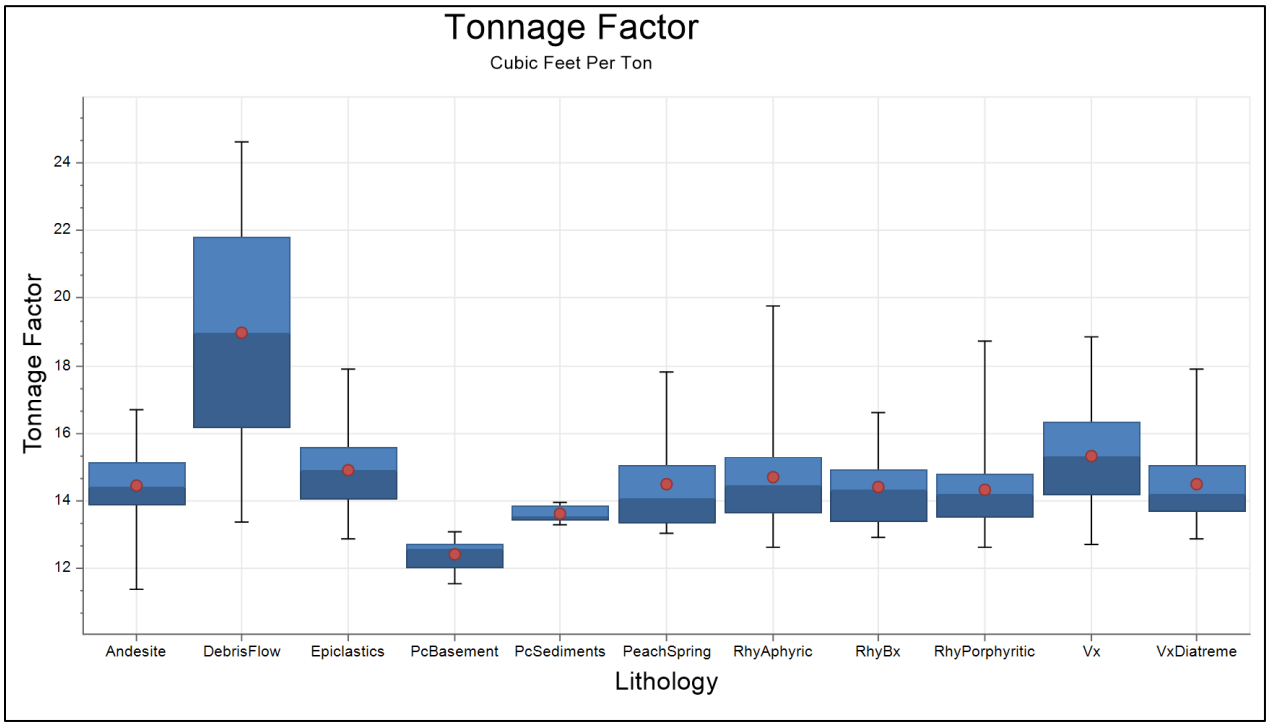


Figure 11-1: Box and Whisker Plot of the Bulk Density by Modelled Lithology for the Castle Mountain Project

11.4 DATABASES

Beginning in 2018, the Project's drilling data was stored in an MX Deposit database hosted on a cloud platform with secure socket layer encryption. Prior to 2018, the data was managed in an Access database. Two databases were provided by Equinox as individual CSV files. All drill hole

data received was provided in imperial units, with the exception of drill hole collar locations which were in metric units (metres). Collar locations were all converted from metres to feet in a manner that is consistent with the Castle Mountain local grid which is NAD83 UTM zone 11 North feet (imperial units). The values are converted from meters to feet by dividing the meter values by 0.3048, with four significant figures. Original Viceroy drilling incorporated into the drill hole database had original coordinates recorded in Viceroy's Castle Mountain imperial mine grid. The Viceroy drill hole collar coordinates were subsequently converted from the Castle Mountain Mine grid to metric UTM NAD83 zone 11 projection and then to imperial units. Independent hard rock backfill and production blasthole datasets were provided on delivery dates shown in Table 11-3.

Table 11-3: Resource Database Delivery

Resource Dataset	Delivery (Month/Day/Year)	Database	Export Type
Hard Rock	06/12/2019	MX Deposit	comma separated values files
Backfill	10/24/2019	MX Deposit	comma separated values files
Production Blasthole	08/20/2020	Excel file	comma separated values files

In the assay database compiled by Equinox, the assay results are each ranked by the preferred assay method of most to least representative using a python script. The methods are prioritized as follows: gravimetric finish fire assay followed by AAS finish fire assay. In cases where there is an original result and pulp repeat result, the repeat result is used in the preferred ranking.

11.5 DATA ADEQUACY

It is the QP's opinion that the sample preparation, security, and analytical procedures are adequate to support mineral resource estimation.

12 DATA VERIFICATION

12.1 RESOURCE DATA VERIFICATION

Two drill databases were received from Equinox representing hard rock and backfill drilling. Collectively the two databases are named the “Feasibility databases” in this chapter. The Feasibility databases were received as a series of CSV files. Each CSV file was imported into Micromine™ 3D software for validation and use. Spatial 2D and 3D files were provided in DXF format and as ArcGIS geodatabases. The PFS database was provided for validation and comparison purposes.

The following steps have been taken to verify the databases, including:

- Validation of the drill hole database using Micromine™ software drill database validation tools:
  - Follow up action to rectify sample/geological intervals beyond end of hole
  - Confirming translation of historical grid coordinates to current local grid coordinates
- Independently reviewing and plotting QA/QC results
- Verifying of bulk density determinations
- Comparing twinned drill hole results
- Selecting and comparing pulp check analyses

12.2 DRILL HOLE LOCATION DATA

The Feasibility databases contained information recording collar coordinates and downhole survey information. All drill hole coordinate data is located within the extents of the tenures described in Section 4.2.1.

12.2.1 Drill Hole Collar Location Verification

The surveyed collar locations for the Feasibility databases correlate well with the digital elevation model from the 2018 LiDAR survey, except where Viceroy holes in the JSLA pit have collar elevations representing the pre-mining topography.

The legacy Viceroy collar coordinate spread sheet was used to confirm that coordinate system translation was accurately completed. A point file was created using the legacy Viceroy mine grid surveyed drill hole locations which were re-projected by QGIS software to NAD 83 UTM zone 11 feet using the custom projections. These locations were compared with the locations from the Feasibility databases and found to be identical.

12.2.2 Drill Hole Downhole Survey Verification

Downhole survey data was reviewed for spurious readings determined by discrepancies greater than one degree per 30 ft for azimuth readings. Some discrepancies that were identified between the PFS database and the supplied datasets are explained by ongoing work undertaken by Equinox since 2018 to address and improve database integrity.

The database included 1,746 holes with no downhole surveys. The majority of the unsurveyed holes were drilled vertically where the deviation has a minimal effect on the location of the drill hole. There are 429 unsurveyed angled drill holes that have been projected straight from the collar orientation which represent 20% of the hard rock holes and 17% of total footage. A deviation

model was created for the angled RC drilling to test if a correction was required. Of the 47 surveyed angled holes, 41 steepen down hole at an average rate of -0.015°/ft. As such, the deviation model was applied to unsurveyed holes and implicit models were run using the deviation model data. Resulting changes did not affect unmined portions of the hard rock model. The unsurveyed drill hole data was therefore deemed acceptable.

12.3 RESOURCE ASSAY RESULT VERIFICATION

The following checks were completed for all drill holes:

- Sample intervals exceeding the total hole depth.
- Verification of the ranking of fire assay methods against the result in the hard rock gold "Au-FA&GRAV PPM" column and backfill the "Au ppm final" column, which are used in the resource estimate.
- Compilation and charting of QA/QC data to review assay result accuracy and reproducibility.
- Umpire pulp duplicate sample selection and comparison.
- Verifying conversion factors used to convert legacy assay results originally reported in ounces per short ton to grams per tonne.

No critical deficiencies were identified from these checks and several minor errors were corrected within the Feasibility databases. Core recovery for the Project averaged 90%. There is no relationship between core recovery and gold grade.

12.3.1 Performance of the Equinox Hard Rock & Backfill QA/QC Samples

The Equinox QA/QC program results for the hard rock and backfill feasibility databases were evaluated together. A Z-score for Certified Reference Materials (CRM) was calculated, and a "failure" criterion was defined as any CRM analysis returning a Z-score of >3 or <-3. Several failures were identified due to mishandling errors where the CRM types were likely swapped at the time of insertion. Table 12-1 provides CRM performance summaries with and without mishandling errors.

A total of 2,869 CRM samples, representing an insertion rate of 4%, were included within the Equinox sample stream. The insertion rate and expected CRM grades are appropriate for the deposit type and Project stage. A first pass calculation of Z-scores showed a failure rate of 3.6% (N = 102). Omitting samples with obvious mishandling or labelling errors resulted in reduction of the overall failure rate to 1.6% (Table 12-1). Plotting of the CRM results showed a degree of systematic bias depending on the CRM; however, the average values were acceptable overall (Figure 12-1). The "Au" series CRM showed a weak low bias whereas the "S" series CRM showed a weak to moderate positive bias depending on the specific CRM.

Table 12-1: CRM Performance for the Equinox Samples

CRM	Expected Average Gold (g/t)	Standard Deviation	Original CRM Insertion			Mishandled CRM Removed			Number of Failures
			Number of Samples	Average Gold (g/t)	Average Z-Score	Number of Samples	Average Gold (g/t)	Average Z-Score	
Total			**2,869**			**2,814**			**47**
Au.10.03	0.06	0.006	678	0.06	0.002	674	0.057	-0.542	0
Au.12.11	1.5	0.081	468	1.497	-0.032	465	1.494	-0.073	3
Au.12.32	0.62	0.017	682	0.622	0.14	664	0.611	-0.512	24
Au.17.05	0.05	0.004	19	0.054	1.066	19	0.054	1.066	2
NBM-2a	0.007	0.002	20	0.006	-0.425	20	0.006	-0.425	0
NBM-4a	0.075	0.007	23	0.081	0.858	23	0.081	0.858	0
NBM-5b	1.65	0.225	66	1.689	0.172	66	1.689	0.172	0
S105006X	4.5	0.099	647	4.497	-0.028	620	4.534	0.346	15
S107007X	1.5	0.068	234	1.563	0.92	231	1.577	1.131	3
S107009X	4.7	0.194	32	4.93	1.184	32	4.93	1.184	0

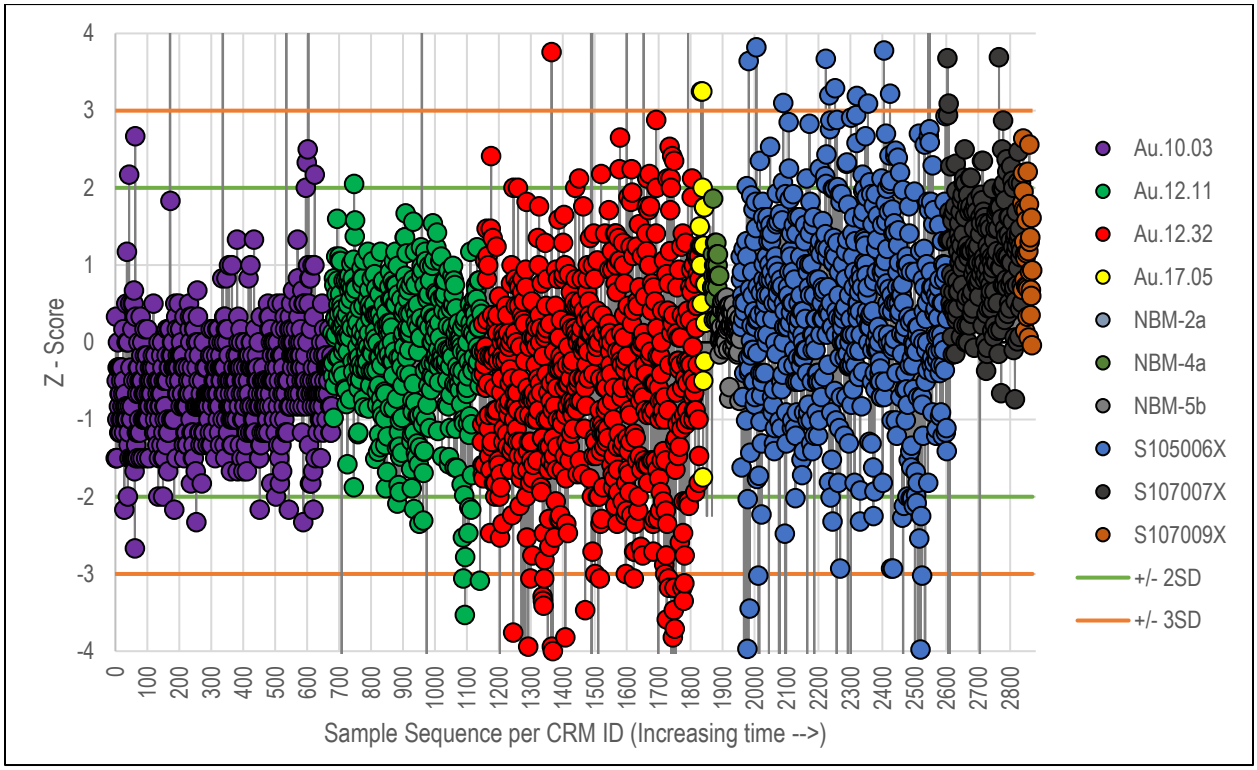


Figure 12-1: Shewart Chart of CRM Performance by CRM type

Blanks were reviewed for carry-over exceeding ten times the detection limit, equal to 0.0015 oz/ton (0.05 g/t) gold. There were 1,432 blank samples which represented a 2% insertion rate for Equinox drilling. While the expected values for the blank material were appropriate, the insertion rate was low compared to current industry best practices. Ten samples (<1%) exceeded a threshold of ten times the detection limit that was used to indicate contamination (Figure 12-2). No significant carryover contamination was observed in the blank results.

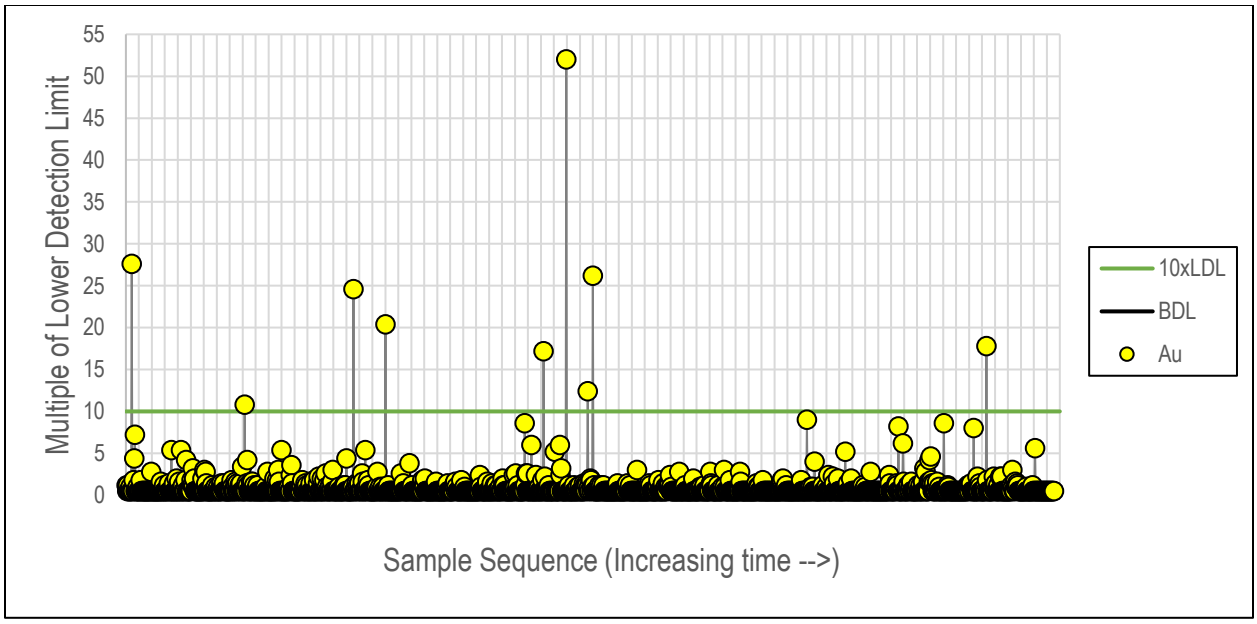


Figure 12-2: Blank Performance for the Project

The Project's quality control data included 2,481 duplicate sample analyses, including 1,972 field (RC/RAB) and 492 pulp duplicate samples (Table 12-2). Duplicates were paired using the duplicate's parent sample ID which was recorded with the duplicate sample. The pulp duplicate population was small and consisted primarily of laboratory pulp duplicates (N=49) that had not been reported due to insufficient population size and umpire laboratory duplicates (N=443). The duplicates were implemented at a 3% insertion rate for field duplicates and a 0.6% insertion rate for the umpire duplicates within Equinox drill programs. The field duplicate insertion rate was adequate for the Project stage. The intra-laboratory and umpire pulp duplicate insertion rate was low relative to the sample population compared to industry standard best practices.

The relative standard deviation (RSD) and coefficient of variation (CV) were calculated for each pair. The RSD was 15% and 12% for field and pulp duplicates, respectively which are within acceptable range. The field duplicates had an acceptable level of variance and subtle bias towards the duplicate results as shown in the Reduction to Major Axis (RMA) plot in Figure 12-3.

Table 12-2: Duplicate Values and Statistics

Duplicate Type	Number of Samples	Primary Sample - Average Gold (g/t)	Duplicate Sample - Average Gold (g/t)	CV (%)	RSD (%)
Field (RC)	1972	0.184	0.174	33	15
Pulp (Umpire)	443	0.626	0.607	30	12

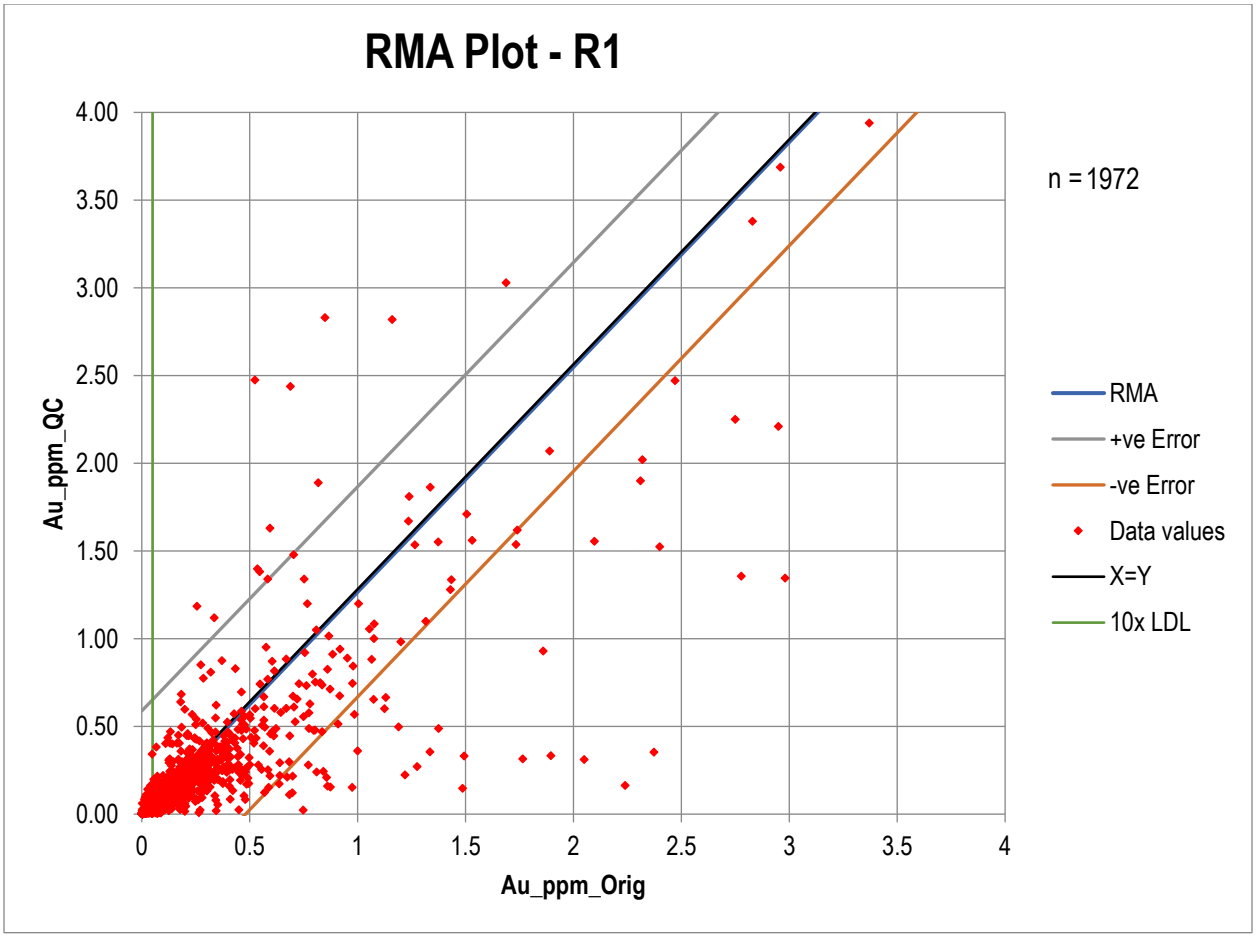


Figure 12-3: RMA Plot of the RC and RAB Field Duplicates

A total of 302 pulp duplicates were selected by Equinox to be analyzed at the umpire laboratory. An additional 141 pulps were selected from holes where the original assays were informing medium and high-grade resource domains. The umpire pulps were pulled from the storage facility and submitted to AAL for fire assay as described in Section 11.2.2.3. Pulp checks are used to quantify the reproducibility of results and to determine if there is any laboratory specific bias. All 443 umpire pulp duplicates are presented in Figure 12-4 which show the RMA plot for the original and umpire results. The comparison demonstrates that the results are reproducible and have a 3% bias toward the original results.

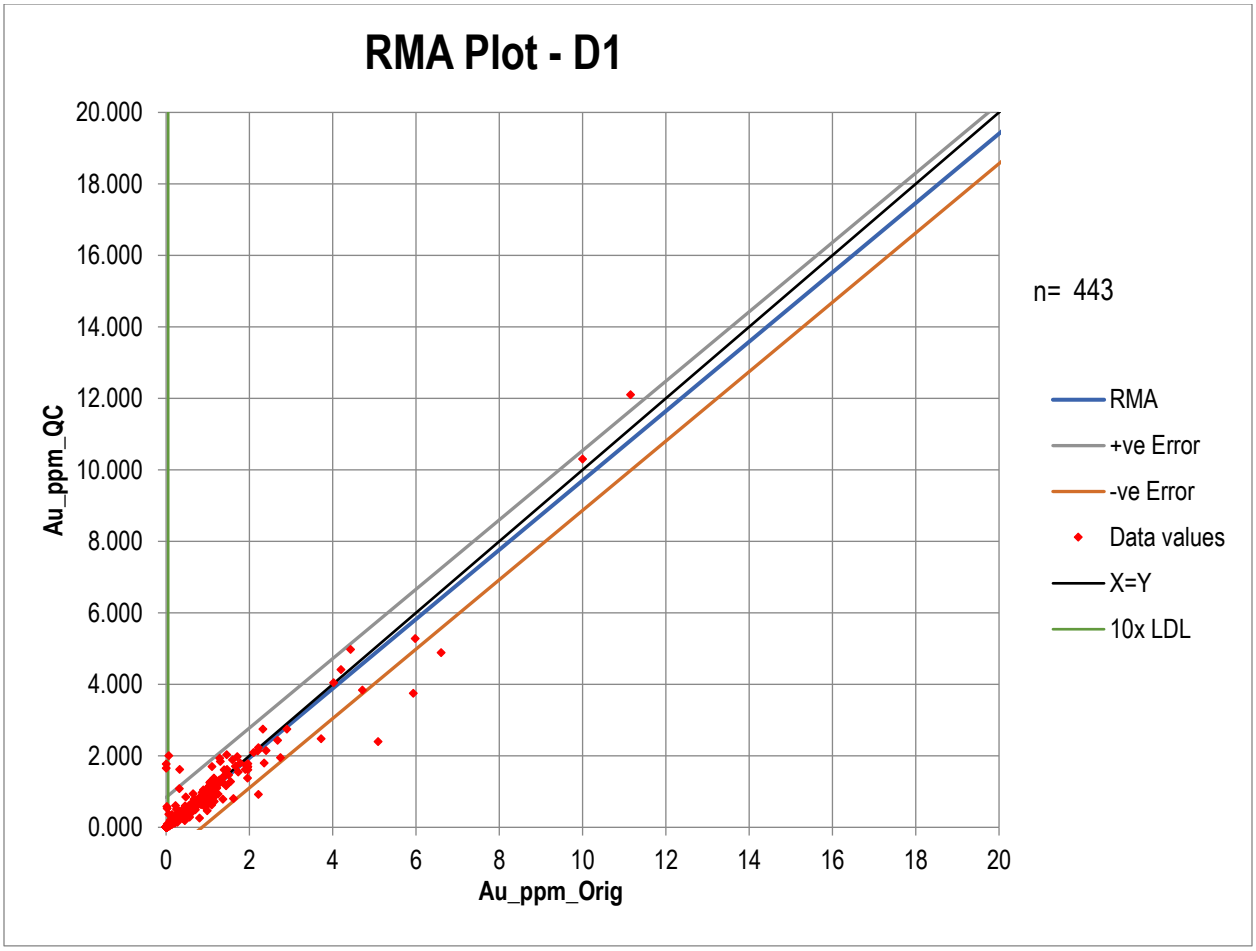


Figure 12-4: RMA Scatter Plot of Umpire Pulp Duplicates

The sample populations were sufficient to demonstrate that the quality of the assay results is acceptable. CRM results demonstrated that the gold assay values were reasonably accurate, and the failure rate was acceptable after mishandling errors were excluded. Results from the insertion of blanks showed that there were no systematic issues with carryover during sample preparation. The results from the duplicate analysis demonstrated reasonable reproducibility with no consistent, material grade bias between the original and umpire assay laboratories.

12.4 VICEROY SAMPLE RESULTS

The Viceroy QA/QC data was not available and thus could not reviewed. Additionally, the pulps and core samples were destroyed during reclamation efforts and as such no further verification is possible. With no other data available for the Viceroy assay verification within the Feasibility databases, the author used a variety of statistical and spatial comparisons to confirm that the results were digitized consistently using the PFS database (Scott et al., 2018) and legacy spreadsheets. Hardcopy Viceroy assay certificates were observed during the site visit and have been verified by the QP and checked in detail within previous technical reports (Cox et al., 2014 and Pressacco, 2013). The Viceroy assay data represented 80% of the sample population and was concentrated in the mined-out portions of Oro Belle, Jumbo and JSLA. To assess the degree of risk to the Mineral Resource estimation due to reliance on Viceroy samples, and the lack of associated legacy QA/QC data a series of checks were completed, including:

- Twin Hole Analysis,
- Assessment of downhole contamination, and
- Sample pair analysis.

12.4.1 Twin Hole Analysis

There are ten twin drill hole pairs that were identified using the criteria that the holes were oriented in the same orientation and had collars spaced no farther than 30 ft (9.1 m) apart. The holes were all drilled by Viceroy using rotary, RC or diamond methods to confirm an original rotary or RC hole. Only one twin pair representing a diamond hole drilled by Equinox and an RC hole drilled by Viceroy was present. A summary of the twin drill holes is provided in Table 12-3.

Table 12-3: Comparison of Twin Drilling

Hole ID	Type	Operator	Twin Hole ID	Twin Type	Twin Operator	Average Pair Distance (ft)	Average Pair Distance (m)	Quality of Twin	Comment
V0162	Rotary	Viceroy	V0001	Rotary	Viceroy	19.5	5.9	reasonable	
V0286	Rotary	Viceroy	V0047A	RC	Viceroy	2	0.6	reasonable	
V0023	Rotary	Viceroy	V0165	Rotary	Viceroy	10	3	reasonable	
V0170	Rotary	Viceroy	V0176	Rotary	Viceroy	20	6.1	reasonable	
V2093	RC	Viceroy	V0610	RC	Viceroy	23	7	reasonable	
CMM-030C	DDH	Equinox	V1135	RC	Viceroy	24.6	7.5	reasonable	
V2146	RC	Viceroy	V2145	RC	Viceroy	10	3	Very poor	Reject V2145
V0511	RC	Viceroy	VDDH02	DDH	Viceroy	10.5	3.2	Poor	Reject V0511
V0156	Rotary	Viceroy	VDDH10	DDH	Viceroy	22	6.7	Poor	Reject V0156
V0718	RC	Viceroy	VDDH35	DDH	Viceroy	9	2.7	Poor	Reject V0718

The twin pairs were compared for logged lithology, individual assays, and 20 ft (6.1 m) bench composite comparisons downhole. Overall, the logged lithological data was similar. The bench composites were compared downhole and statistically. The average RSD for the 20 ft bench (6.1 m) composites was 43% which compares reasonably for twin drilling. Rotary and RC twins or RC-RC twins had reasonable average comparisons. Diamond twins to original RC or rotary drilling generally had a poor comparison, indicating that there was possible downhole contamination during drilling. The four diamond twins were retained within the dataset and the original rotary or RC holes were excluded from the Feasibility database to prevent conflicting information during the estimation; the excluded holes were V2145, V0511, V0156, and V0718. Examples of the downhole comparison plots are shown in Figure 12-5 where independent drill holes are represented by blue and red lines, and sample pair distance is represented by the black line.

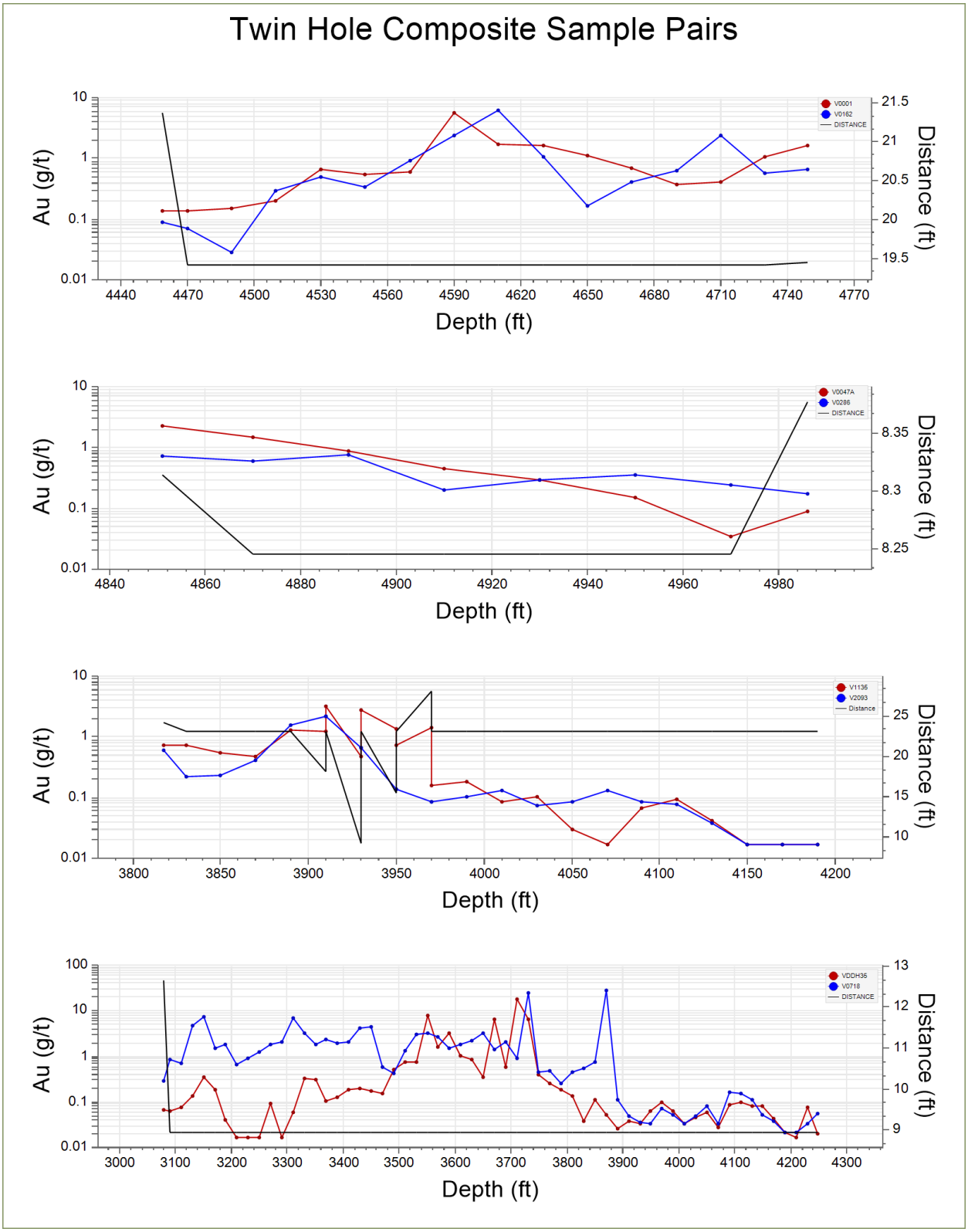


Figure 12-5: Downhole Comparison of 20 ft Bench Composites

12.4.2 Downhole Contamination of RC Samples

To determine the potential for downhole contamination of RC samples, five drill hole pairs representing a diamond drill hole and an RC drill hole were examined. Most of the drill holes included in this analysis occurred within the mined-out portions of the deposit. Figure 12-6 to Figure 12-8 show a comparison of the downhole grade with each hole represented by blue and red lines, and distance between samples represented by a black line. Where there is no line indicating sample pair distance, samples were within 10 ft (3.05 m).

The results of the analysis showed some potential for downhole contamination on a bench scale, in addition to high grade values likely to occur more frequently in the RC drill holes compared to diamond drill holes. This corroborated the DDH-RC sample pair data found in Section 12.4.3.

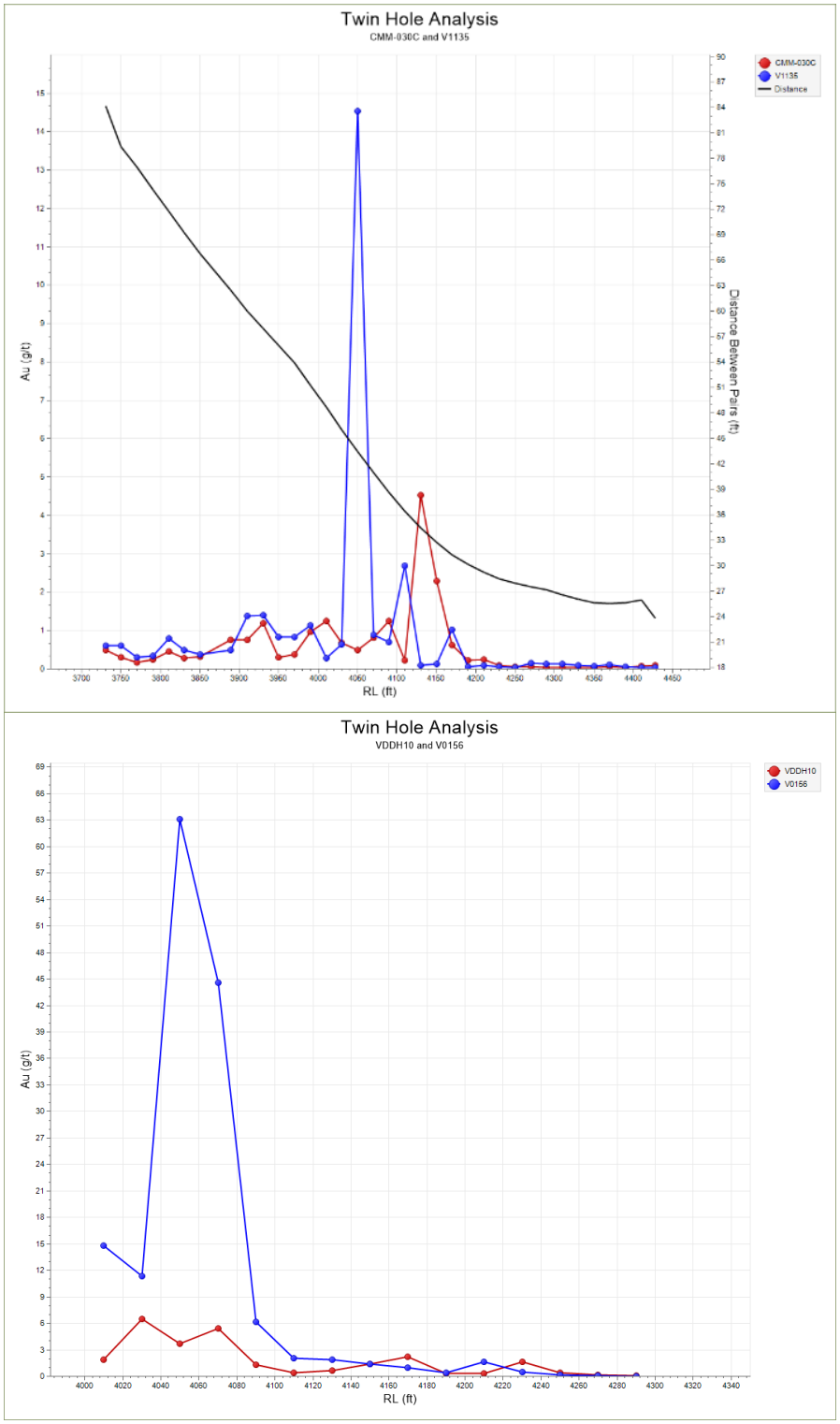


Figure 12-6: Twin Hole Analysis Showing Diamond Drill Holes in Red & RC Holes in Blue (CMM-030C and V1135, VDDH10 and V0156)

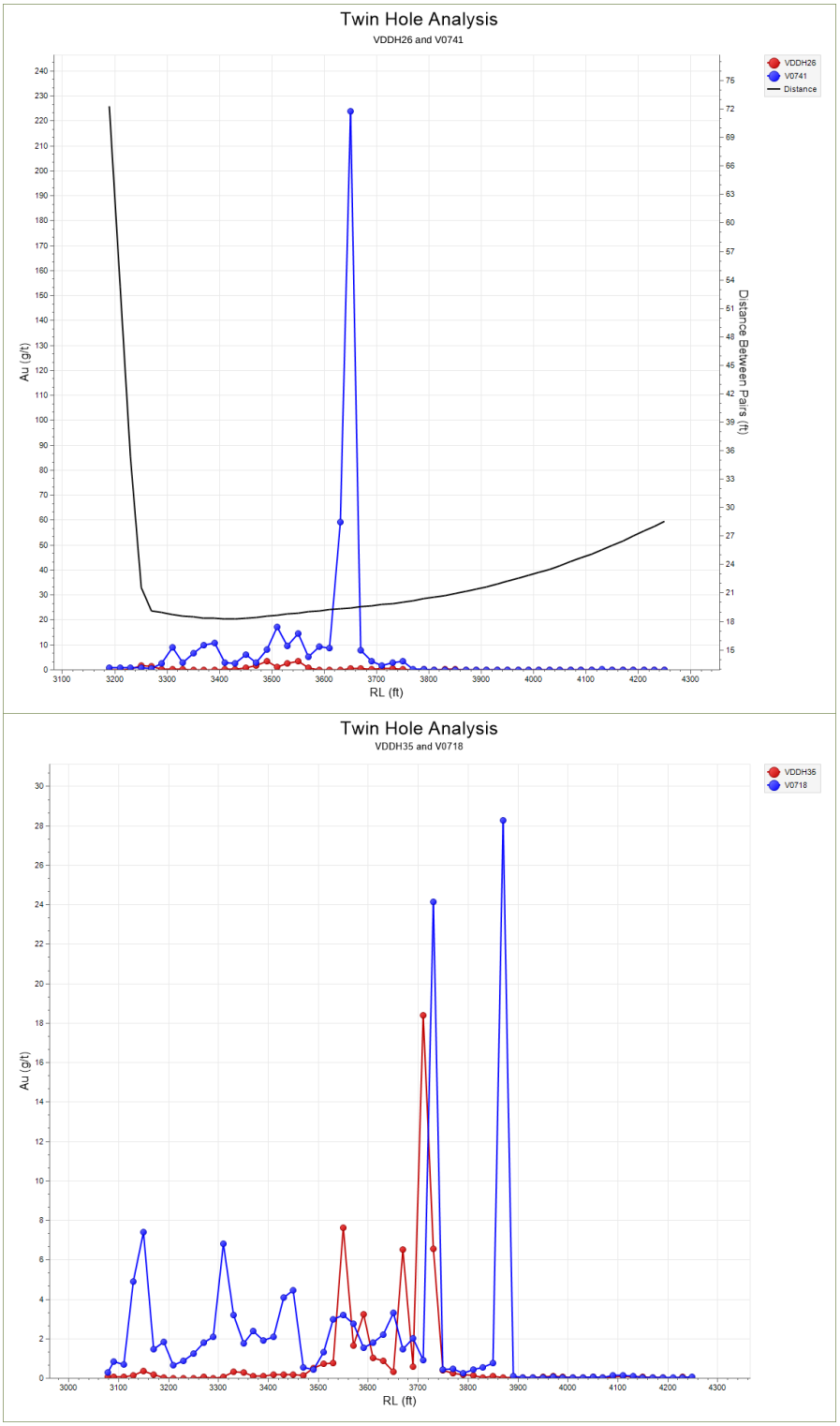


Figure 12-7: Twin Hole Analysis Showing Diamond Drill Holes in Red & RC Holes in Blue (VDDH26 and V0741, VDDH35 and V0718)

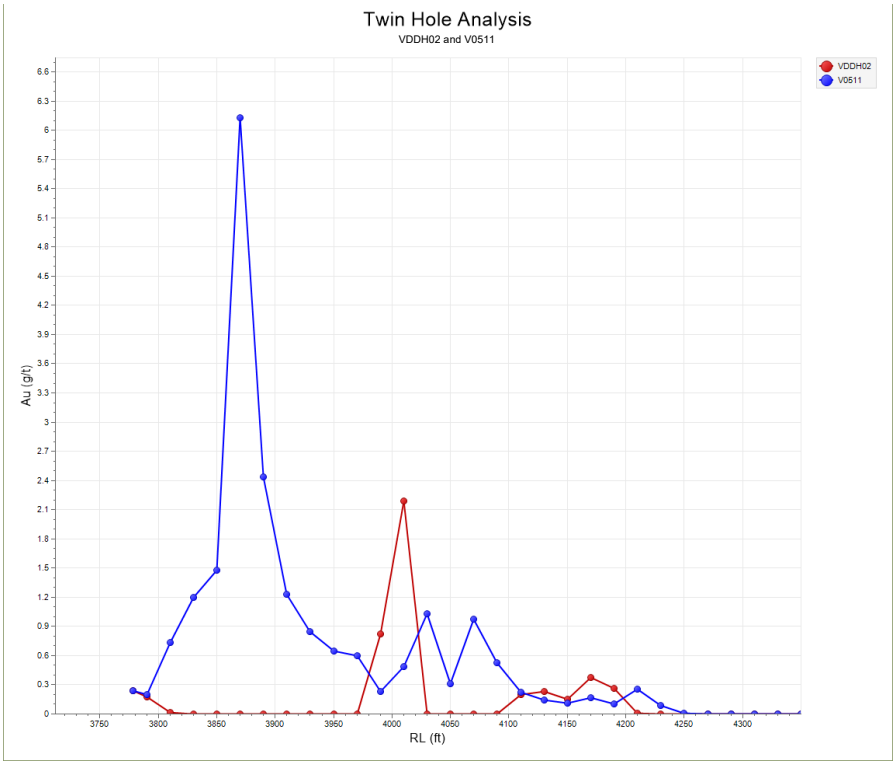


Figure 12-8: Twin Hole Analysis Showing Diamond Drill Holes in Red & RC Holes in Blue (VDDH02 and V0511)

12.4.3 Composite Pair Analysis

Bench composite sample pairs were generated based on operator and hole type to assist in determining the adequacy of legacy data. There are 138 20 ft (6.1 m) bench composites samples pairs. It should be emphasized that drilling direction was considerably different between holes drilled by Viceroy and those drilled by Equinox. Figure 12-9 shows a summary of drill hole orientations by operator. Holes drilled by Viceroy were dominantly vertical whereas holes drilled by Equinox (indicated by CMM in Figure 12-9) were inclined at an average of -65º.

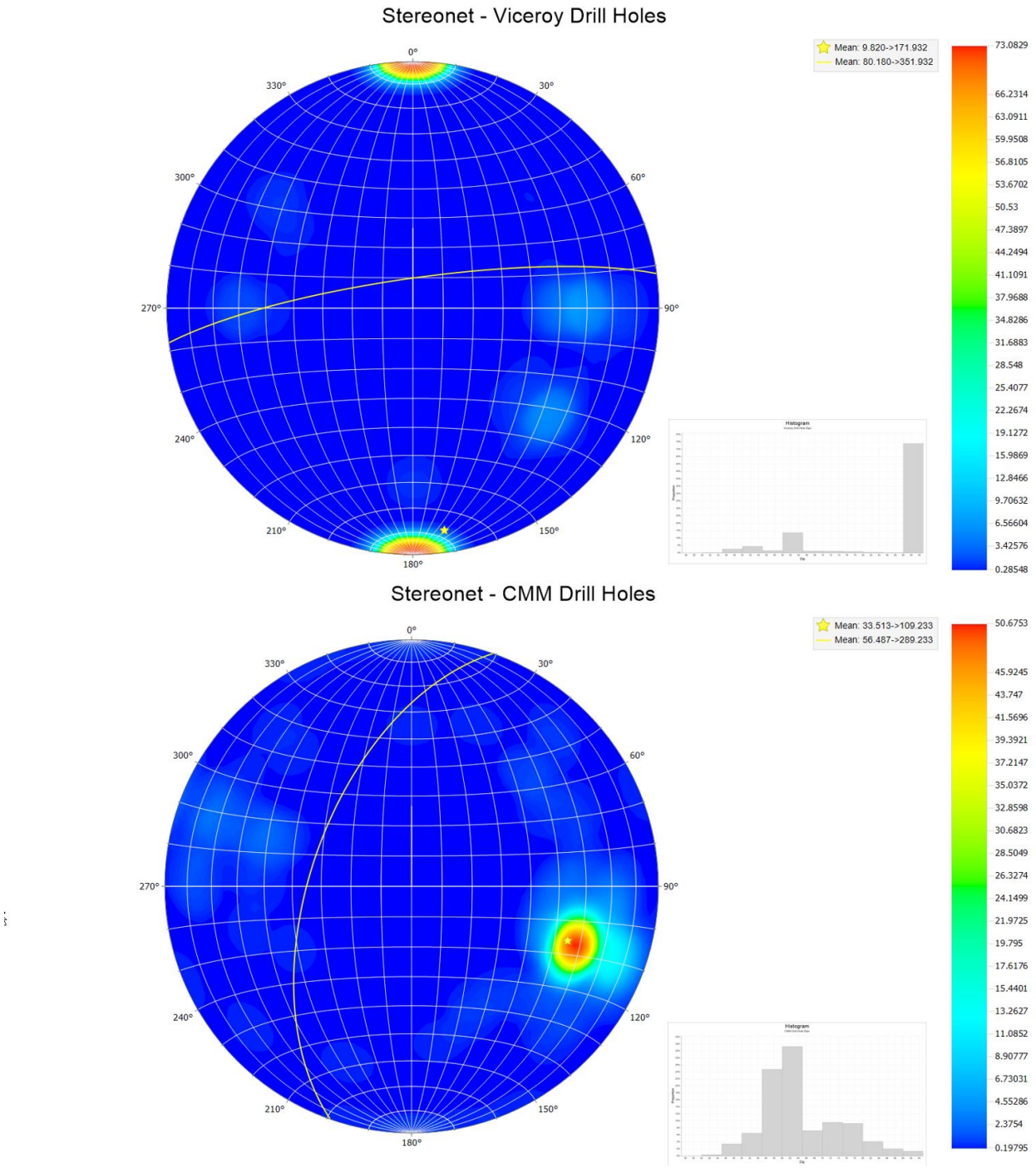


Figure 12-9: Comparison of Drill Hole Orientations by Operator

Composite sample pairs representing Equinox and Viceroy were generated for samples within 10 ft (3.05 m) irrespective of hole type (Figure 12-10). Sample pair data showed poor correlation of sample pairs, with some bias towards CMM holes greater than 0.0438 oz/ton (1.50 g/t) gold.

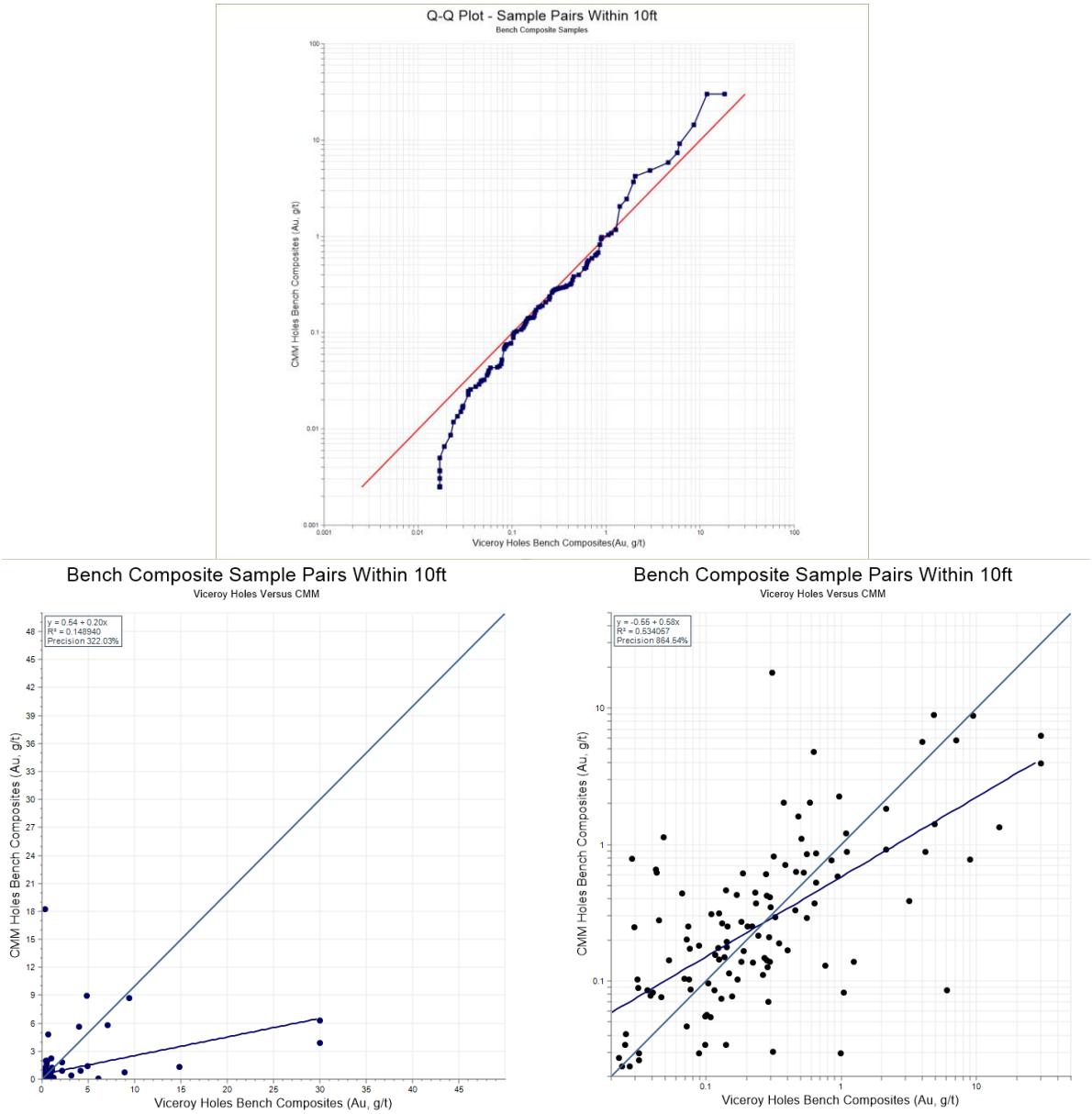


Figure 12-10: Q-Q Plot, Summary Statistics, and Scatterplots of Equinox and Viceroy Sample Pairs Within 10 ft (3.05 m)

Composite sample pairs were also generated comparing RC and diamond drill holes irrespective of operator (Figure 12-11). There was poor correlation between RC and diamond drill holes in addition to systematic bias observed within samples representing RC holes over the entire range of grades.

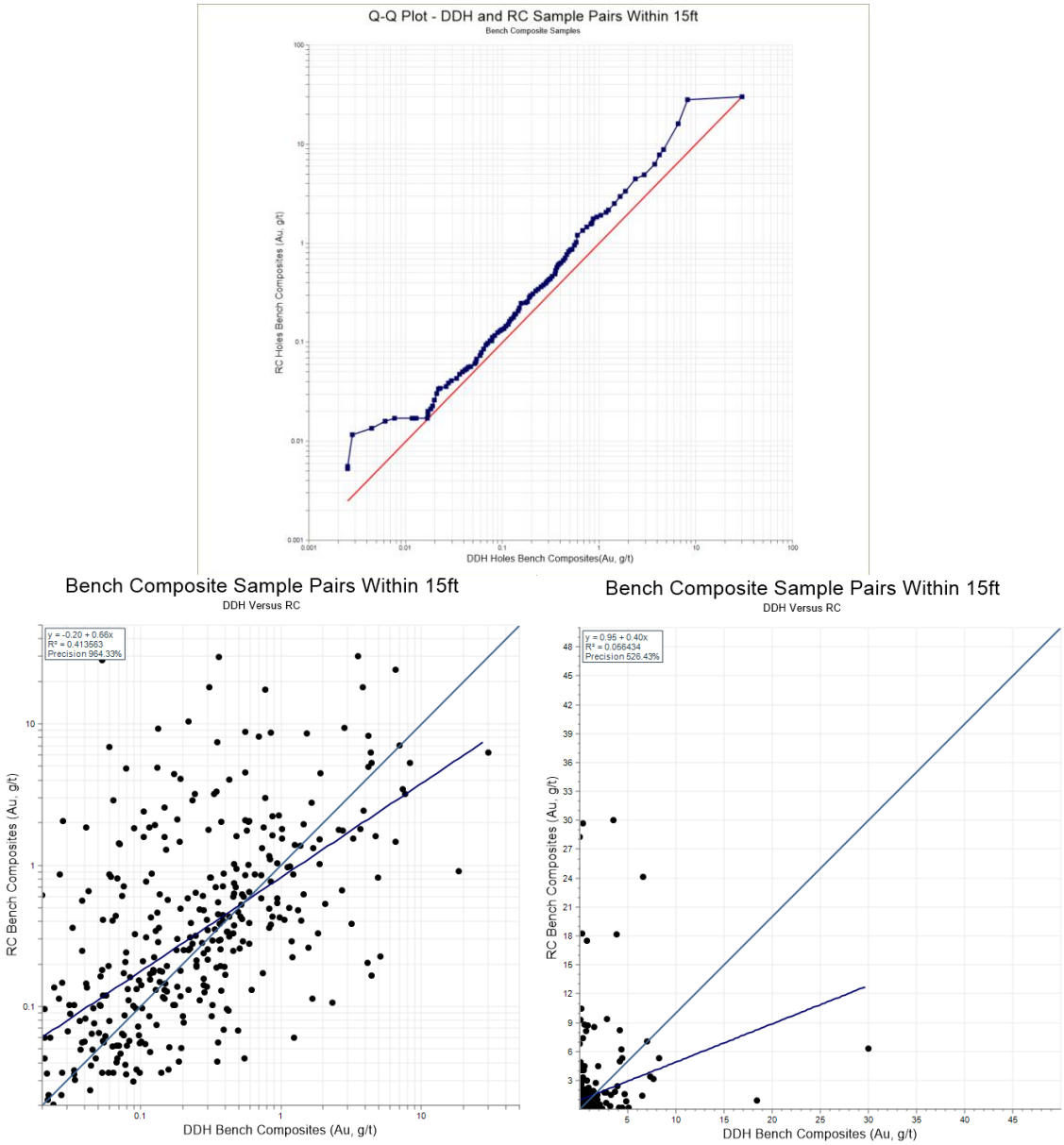


Figure 12-11: Q-Q plot, Summary Statistics, and Scatterplots of RC and Diamond Drill Hole Sample Pairs within 15 ft (4.6 m)

Lastly, composite sample pairs were generated comparing RC and diamond drill holes drilled by Equinox (Figure 12-12) and Viceroy (Figure 12-13). In both comparisons, there existed a bias towards samples representing RC holes.

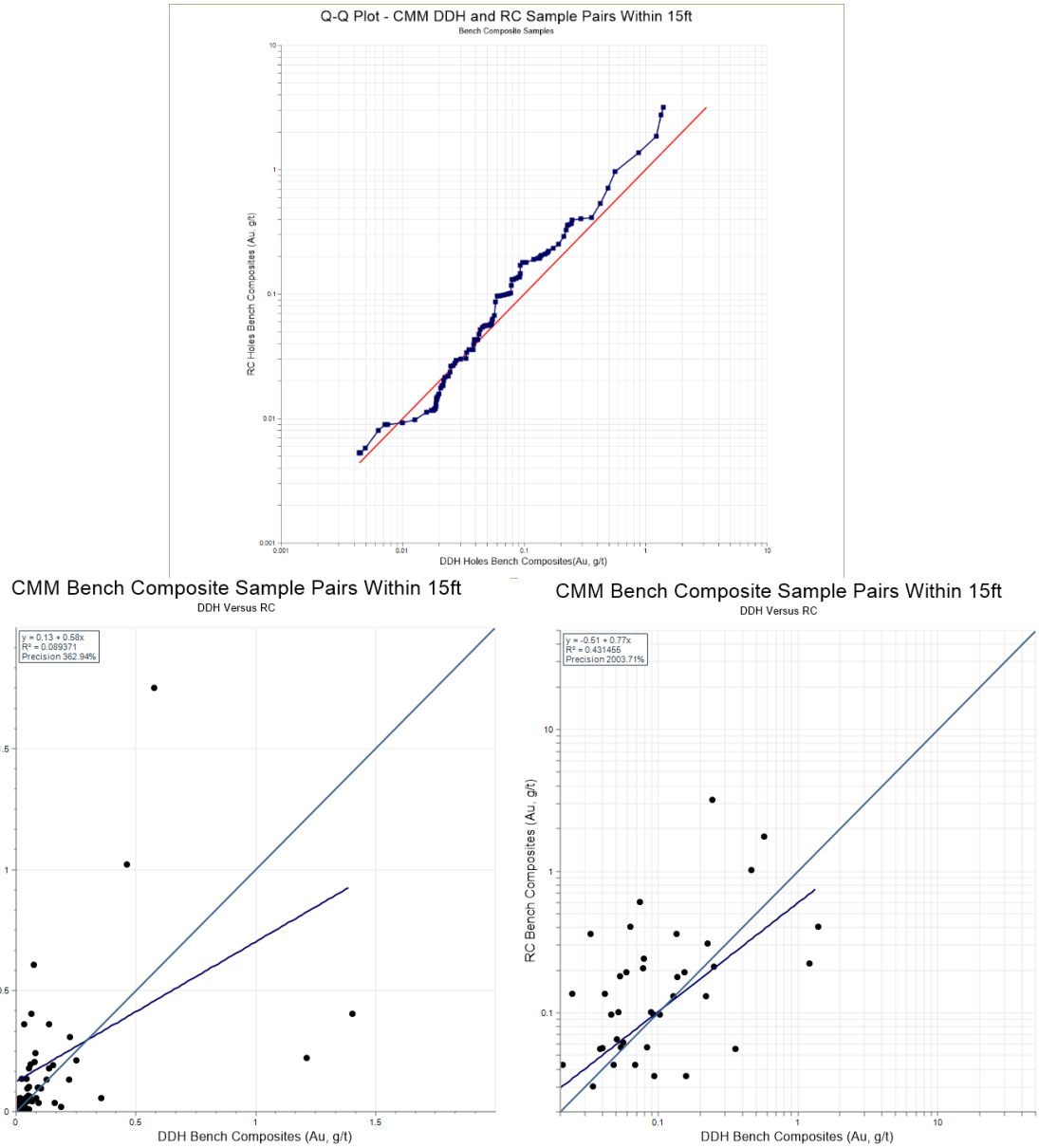
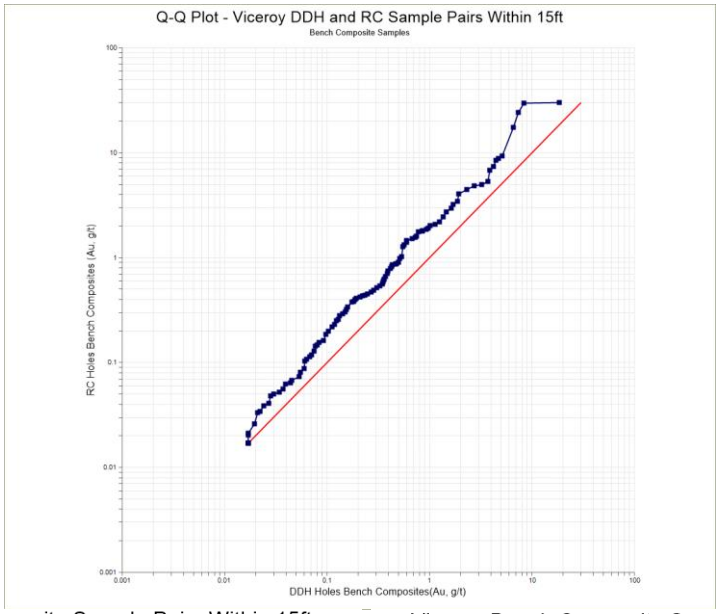


Figure 12-12: Q-Q Plot, Summary Statistics, and Scatterplots of RC and Diamond Drill Hole Sample Pairs Within 15 ft (4.6 m) Drilled by Equinox



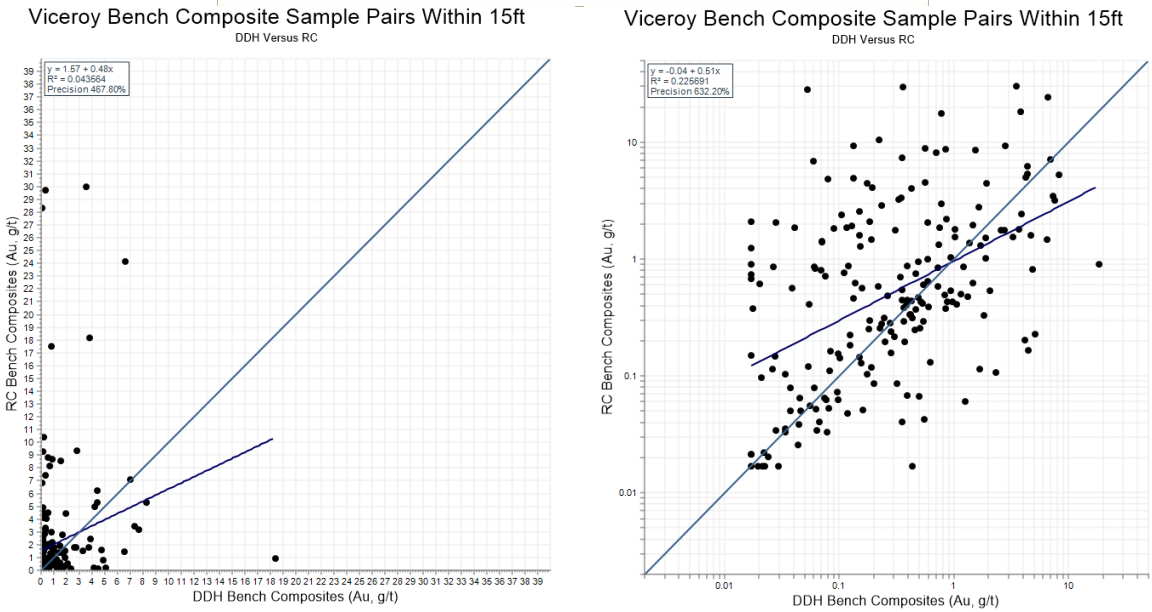


Figure 12-13: Q-Q Plot, Summary Statistics, and Scatterplots of RC and Diamond Drill Hole Sample Pairs within 15 ft (4.6 m) Drilled by Viceroy

In summary, RC drill holes tended to show some bias compared to diamond drill holes, irrespective of operator. Sample pair analysis between RC and diamond drill holes showed poor reproducibility due to different sampling methods and sample support. Holes drilled by Viceroy showed some bias up to 0.0583 oz/ton (2.00 g/t) gold, which was likely impacted due to drilling direction (Equinox holes were inclined, whereas Viceroy holes were vertical). Overall, the apparent issues in the Viceroy sample data (i.e. some bias in sample assay values from RC holes) were also apparent in the Equinox data and could be partially explained by the drill hole orientations.

12.5 BULK DENSITY

The laboratory certificates containing the 647 results for bulk density were reviewed (Table 12-4). Wax coated half core samples were observed in their core boxes during the site visit by the QP. The bulk densities were converted to tonnage factors. The tonnage factor for the dumps and JSLA backfill, 18.8 ft^3/ton (1.73 g/cm^3), was derived from work completed for the PFS which corresponds with an average bulk density of 14.43 ft^3/ton (2.24 g/cm^3) with a swell factor of 30% (Scott et al, 2018). Lithologies without bulk density measurements were assigned from comparable lithologies.

Table 12-4: Summary of the Bulk Density Data for the Project

Model Code	Lithology	Sample Count	Average Tonnage Factor (ft^3 per short ton)	Average Bulk Density (g/cm^3)
1	Backfill and Waste Dumps (1)	0	18.8	1.73
2	Alluvium	0	16.8	1.9
3	Debris Flow	2	17.3	1.85
5	Dacite	0	14.3	2.24
5	Hart Peak Rhyolite	0	14.2	2.25
7	Rhyolite Breccia	9	14.4	2.24
9	Porphyritic Rhyolite	158	14.3	2.25
11	Aphyric Rhyolite	112	14.7	2.2
14	Volcaniclastic Diatreme	79	14.5	2.22
16	Volcaniclastic	146	15.3	2.11
22	Mudstone	1	16.1	1.99
23	Epiclastics	33	14.9	2.16
27	Andesite	82	14.4	2.23
29	Peach Springs Tuff	9	14.5	2.23
30	Proterozoic (Pc) Sediments	7	13.6	2.36
31	Proterozoic (Pc) Basement	9	12.4	2.59
	Total	**647**		
	Average - Hard Rock		**14.43**	**2.24**

Note: 1. The density of the dumps and backfill is derived from the average bulk density of the hard rock material 14.43 ft^3/ton (2.24 g/cm^3) with a swell factor of 30%.

12.6 DATA ADEQUACY

It is the opinion of the QP that the drill hole collar locations, downhole surveys and assay data supplied by Equinox are of adequate quality for use in Mineral Resource and Mineral Reserve estimates. Viceroy sample data comprise the majority of the sample population and do not have accompanying QA/QC data however investigations indicate that the Viceroy results are reasonably comparable to the Equinox assay results.

13 MINERAL PROCESSING AND METALLURGICAL TESTING

13.1 INTRODUCTION

Significant metallurgical testwork has been performed on Castle Mountain samples from 2015 to 2020. A summary of all known metallurgical testwork for Castle Mountain was presented in the 2018 KCA PFS (Scott et al., 2018) and is presented again in this section of the report. Reports were issued with all results at the completion of all programs. Further testwork completed in 2020 in support of the FS is discussed in this section.

The plan is to process lower grade run of mine (ROM) ore on a leach pad and to process higher grade ore using conventional milling with Carbon-in-Leach (CIL). Testwork performed in 2020 has been completed using previous drill core samples with a focus on expanding the metallurgical understanding of the material to be processed through increased spatial and lithological representation within the mineral resource. The test objectives were to:

- Perform column leach tests on heap leach grade ore using the same parameters as in prior testing (i.e., size, cyanide concentration, application rate, etc.) and verify if the results were similar,
- Carry out additional testwork on heap leach grade ore including load permeability and mineralogy to support the feasibility study,
- Perform testwork on the mill grade ore using both gravity concentration followed by leaching of the gravity tails and whole ore leaching to select the process based on the expected recovery,
- Carry out further testwork on the mill grade ore to support the feasibility study design including materials handling tests, comminution (crushing, ball, and abrasion work indices as well as JK drop weight and SMC tests), carbon loading, detoxification of cyanide, oxygen uptake, thickening, tailing filtration, slurry rheology and filtered tailings geotechnical stability,
- Variability testing to verify optimum grind size for mill grade ore, and
- Testwork to determine the potential amenability to ore sorting.

The test programs were completed by various labs with the main work carried out by McClelland Laboratories Inc. (MLI), an independent commercial metallurgical lab located in Sparks, Nevada.

The 2015 and 2018 testwork analyzed the process using larger ROM material taken from JSLA backfill and has shown results similar to crushed material. M3 has utilized all available information to develop the Castle Mountain process flowsheet and provide expected plant performance results and recoveries. Data in sections and tables may be presented in metric or imperial units as provided in the original laboratory test reports. Where appropriate, both sets of units have been listed.

13.2 SUMMARY OF TESTWORK

Notable historical testwork includes activities performed prior to startup of the mine in 1992, as well as extensive testing and data recorded during the 12 years of production. More recent test programs occurred in 2014-2015 by MLI when the property was owned by NewCastle, in 2017-2018 by MLI when Equinox acquired the property, and then in 2019-2020 by MLI.

M3 also reviewed the Metallurgy and Processing sections (Sections 13 and 17) of the following Castle Mountain technical reports:

- Technical Reports prepared by RPA in 2013 and 2014,
- The Technical Report prepared by Advantage Geoservices in 2016, and
- The NI 43-101 Technical Report prepared by Kappes Cassidy & Associates in 2018 (Scott et al., 2018).

Reports containing all results were issued at the close of each metallurgical and physical testing program and are shown in Table 13-1 and Table 13-2. These reports, especially testwork completed since 2015, were used for developing the design criteria of the Castle Mountain feasibility.

Table 13-1: Metallurgical and Physical Testwork – Cyanide and Leach Testing

Date	Lab	Samples	BRTs	Sizes, mesh	Time, hrs	Column Tests	Sizes, in	Time, days	Reference
Cyanide / Leach Testing									
Pre-Historic Production									
February-87	Bateman	Jumbo South Bulk	3	100, 150, 200	72	5	3, 1½, 1, 3/4, 3/8	33	Bateman, 1987a
November-87	Bateman	87-7, 87-8, 87-9, 87-6A,6B,6C	6	100	24	15	2½, 1½, 3/4, 3/8	40 to 67	Bateman, 1987b
January-88	Bateman	Jumbo South DDH-3	3	100	24	6	3/4, 3/8	58 to 63	Bateman, 1988a
1988	Bateman	Leslie Ann DDH-1, DDH-2, DDH-8, DDH-10, DDH-11	7	100	24	19	2½, 1½, 3/4, 3/8, 1/4	67 to 118	Shoemaker 1988
September-88	Bateman	Leslie Ann DDH-10	---	---	---	10	3/8, ¼	69 to 105	Bateman, 1988b
July-89	McClelland	DDH-8, DDH-13, DDH-12, DDH-15, DDH-16, DDH-17, DDH-19, DDH-20	---	---	---	3	3/4	78	MLI, 1989
October-89	McClelland	DDH-18, DDH-3M, DDH-3U	1	100	72	4	3/8	68 +10 rinse	MLI, 1989b
Historic Production									
January-93	McClelland	HL Residue	6	100	24	---	---	---	MLI, 1993
March-95	McClelland	1994 Crusher Composites A: Jul-Sept, B: Apr-June, C: Jan-May	---	---	---	9	75%-3/8, 90%-3/8, 80%-¼	69	MLI, 1995a
May-95	McClelland	RC Cuttings - South Extension	4	As Received 100 mesh	120	---	---	---	MLI, 1995b
July-95	McClelland	Bulk Primary Crusher Product	---	---	---	1	6	85	MLI 1995
May-96	McClelland	141 South Ext DDH-56, DDH-57, DDH-58, DDH-59	3	80% -¼ in	240	2	¼	66 to 71	MLI 1996
Initial New Development Testing									
February-15	McClelland	Jumbo (CMM-012, 013), JSLA (CMM-014, 017) - All DDH-PQ	52	10 (1.7mm)		33	3/8(21), 3/4(6), 2(6)	75-168	MLI, 2015a
October-15	McClelland	ROM (Oro Belle South, JSLA Backfill)	2	10 (1.7mm)	96	4	ROM (2), 3/8 (2)	157-164	MLI, 2015b
PFS Testing									
June-17	RDI	ROM (JSLA Backfill)	15	6", 2", 3/8"	72	5	ROM	42	RDI, 2017

Date	Lab	Samples	BRTs	Sizes, mesh	Time, hrs	Column Tests	Sizes, in	Time, days	Reference
May-18	McClelland	ROM (JSLA Backfill)	---	---	---	4	ROM	130-140	MLI, 2018b
May-18	McClelland	JSLA, LG Master Composite	---	---	---	2	2, 3/8	120-130	MLI, 2018a
May-18	McClelland	Variability BRT Testing (S Domes, Oro Belle, JSLA Master, Andesite)	20	50 mm (1), 9.5 mm (19)	480 (20 days)	---	---	---	MLI, 2018a
May-18	McClelland	Variability Gravity / Leach Tests (S Domes, Oro Belle, JSLA HG Master, Andesite)	12	100	96	---	---	---	MLI, 2018a
May-18	McClelland	Gravity/Leach Tests, Variable Grind (JSLA HG Master)	4	48, 65, 100, 150	96	---	---	---	MLI, 2018a
August-18	KCA	Gravity / CIL Test, High Grade Comp.	4	100	variable	---	---	---	KCA, 2018c
FS Testing									
June-2020	McClelland	Low-grade - South Domes, Oro Belle, East Ridge, JSLA	12	10 (1.7mm)	96	21	1 1/4", 3/8"	1440 (60 days)	MLI, 2020a
June-2020	McClelland	Mill grade ore - South Domes, Oro Belle, East Ridge, JSLA, variable grind	30	200, 100, 48	96	---	---	---	MLI, 2020a

Table 13-2: Metallurgical and Physical Testwork – Other Testing

Date	Lab	Tests	Description	Reference
Other Testing				
Historic Production				
May-98	Glasgow	Compacted Permeability	Production samples	Glasgow, 1998
Initial New Development Testing				
February-17	McClelland	Comminution	Crusher Index (CWi) and Bond Abrasion (Ai) for Four PQ core samples	MLI, 2015a
PFS				
May-18	Pocock	Gravity Sedimentation, Vacuum and Pressure Filtration (JSLA HG Master)		MLI, 2018a
July-18	KCA	Compacted Permeability (JSLA LG/HG Master, Pulp Agglomerated)	High-Grade/Low-Grade blend of 1:4, at varying cement dosage	KCA, 2018a
July-18	KCA	Compacted Permeability (JSLA ROM w/ Mill Tails)	ROM / Mill Tails Varying Blends for Tailings Disposal Investigations	KCA, 2018b
FS				
2020	MLI/FLS	Comminution	Crusher Index (CWi), Bond Abrasion (Ai), Bond Abrasion (Ai), JKDropweight, SMC, Bond ball mill work index (BWi)	FLSmidth, 2020
2020	MLI/Pocock	Solid/Liquid Separation	Thickener (static and dynamic), Filtration (pressure and vacuum)	MLI, 2020a
2020	MLI/Pocock	Rheology		Pocock, 2020
2020	Cyanco	Detox	Caro's acid and SO_2/Air (SMBS)	Cyanco, 2020
2020	Steinert	Ore Sorting		Steinert, 2020
2020	PMC	Mineralogy	In-situ Gold Deportment Study of Column Leach Head and Residue	PMC, 2020
2020	MLI/Pocock	CIC and CIL	Sulfur Speciation, Carbon Adsorption Rate, Carbon Adsorption Capacity, Oxygen Update Rate	MLI, 2020b Addendum
2020	Call & Nicholas	Compacted Permeability	Simulated stack height of 400 ft.	CNI, 2020

13.3 METALLURGICAL TESTWORK SAMPLING ORIGIN AND COMPOSITES

Core samples from 2013-2018 exploration drilling were used for metallurgical testing. Intervals were selected from these samples to provide better representation of areas and lithology of the Castle Mountain deposit that had previously not been tested as extensively. Intervals from the half HQ core were used to make up 24 composites (12 heap leach and 12 mill-CIL) for metallurgical testing in 2020. Table 13-3 shows the composites used for testing on heap leach grade ore. In addition, a single blended master composite was generated from 3 of the heap leach composites. Table 13-4 shows the composites used for testing on mill grade ore.

One higher grade sample was tested as heap leach grade ore as a check on the improvement in recovery, and one lower grade sample was tested as mill grade ore to determine the impact of dilution.

Table 13-3: Heap Leach Grade Ore Composites

Composite	Zone	Hole ID	From	To	Length	Lithology	Avg Calc Head g/t Au
4505-001-LG	South Domes	CMM-122C	687.25	1237.5	550.25	Vx	1.39
4505-002-LG	South Domes	CMM-255C	80	193.5	113.5	Rhy-Aph	0.34
			257	333	76		
4505-003-LG	South Domes	CMM-242C	597	700	103	Diatreme	0.37
4505-007-LG	JSLA	CMM-229C	1042	1164	122	Andesite	0.35
			1213	1259.8	46.8		
			1282	1373	91		
4505-010-LG	Jumbo	CMM-273C	316	422	106	Vx	0.24
4505-015-LG	East Ridge	CMM-010C	250	325	75	Rhy-Aph	0.15
			430	670	240		
4505-017-LG	Oro Belle	CMM-119C	12.616	348	335.4	Vx	0.21
4505-018-LG	Oro Belle	CMM-119C	352	624	272	Rhy-Aph	0.44
4505-019-LG	Oro Belle	CMM-119C	1030	1125	116.8	Andesite	0.42
4505-020-LG	Oro Belle	CMM-120C	20	282	262	Vx	0.17
4505-021-LG	Oro Belle	CMM-120C	454	602	148	Rhy-Aph	0.28
		CMM-276C	0	129	129		
4505-025-LG	Oro Belle	CMM-120C	1267	1419	152	Epiclastic	0.19
4505 LG MC	Blend	Blend	-	-	-	See Note	0.82

Note: Blend consists of 24% South Domes (Vx), 19% East Ridge (Rhy-Aph), 57% Oro Belle (Vx)

Heap leach composite head assay results show that head grades determined by direct assay agreed reasonably closely (as can be seen by the trend line with an R^2 of 0.91) with the calculated head grades from the metallurgical tests, as shown in Figure 13-1.

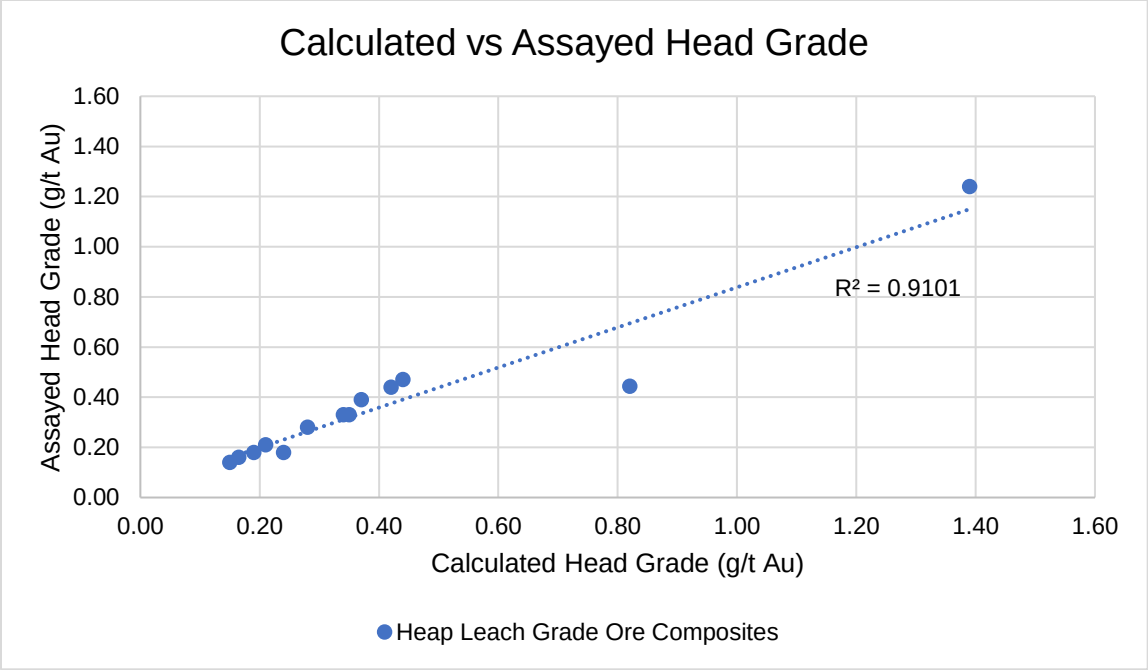


Figure 13-1: 2020 Heap Leach Grade Ore Composites: Calculated vs Assayed Head Grade

Table 13-4: Mill Grade Ore Composites

Composite	Zone	Hole ID	From	To	Length	Lithology	Avg Calc Head g/t Au
4505-004-HG	South Domes	CMM-248C	644	714.5	70.5	Vx	0.82
		CMM-252C	565	655.5	90.5		
4505-005-HG	South Domes	CMM-016C	717	895	178	Rhy-Aph	0.79
4505-006-HG	South Domes	CMM-250C	804.5	897	92.5	Vx	1.36
4505-008-HG	JSLA	CMM-070C	1440	1540	100	Diatreme	0.94
4505-009-HG	JSLA	CMM-033C	472	799	327	Rhy-Bx	0.68
4505-011-HG	Jumbo	CMM-021C	5	24	19	Rhy-Aph	0.28
4505-012-HG	Jumbo	CMM-283C	885	1038	153	Andesite	1.0
4505-013-HG	Jumbo	CMM-281C	753.6	786	32.4	Rhy-Porph	0.65
4505-022-HG	Oro Belle	CMM-119C	432.5	469	37.0	Rhy-Aph	1.04
			553	573	20		
4505-023-HG	Oro Belle	CMM-120C	433.5	454	20.5	Diatreme	1.12
4505-024-HG	Oro Belle	CMM-036C	603	661	58	Andesite	1.73
4505-026-HG	Oro Belle	CMM-036C	354	586	232	Vx	0.78

The arithmetic mean of the 12 mill grade samples in 2020 was 0.92 g/t which is lower than the LOM average mill grade of 2.3 g/t, but note that the mean from 5 mill grade samples in 2015 was 15.0 g/t and mean from 14 mill grade samples in 2015 was 3.47 g/t, so the entire range of mill grade ores has been tested in the various campaigns.

Mill grade ore composite head assay results show that head grades determined by direct assay agreed reasonably closely (as can be seen by the trend line with an R^2 of 0.92) with the calculated head grades from the metallurgical tests, as shown in Figure 13-2.

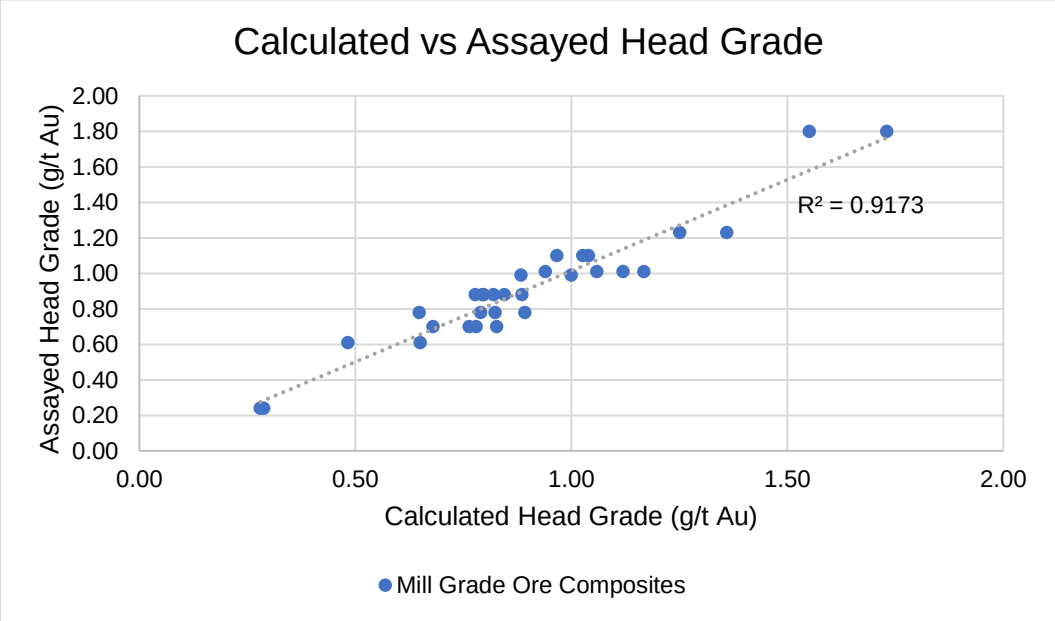


Figure 13-2: 2020 Mill Grade Ore Composites: Calculated vs Assayed Head Grade

The locations of the individual samples used to make up these composites are shown in plain view in Figure 13-3. Figure 13-4 to Figure 13-8 show cross-sections of the sampling effort. The ore bodies are composed of five main ore zones, namely JSLA, Jumbo, Oro Belle, East Ridge and South Domes. By the end of the mine life the northern four zones are combined and referred to as main pit.

Overall, samples used for testing completed for the Castle Mountain Project appear to be representative of the ore that will be processed.

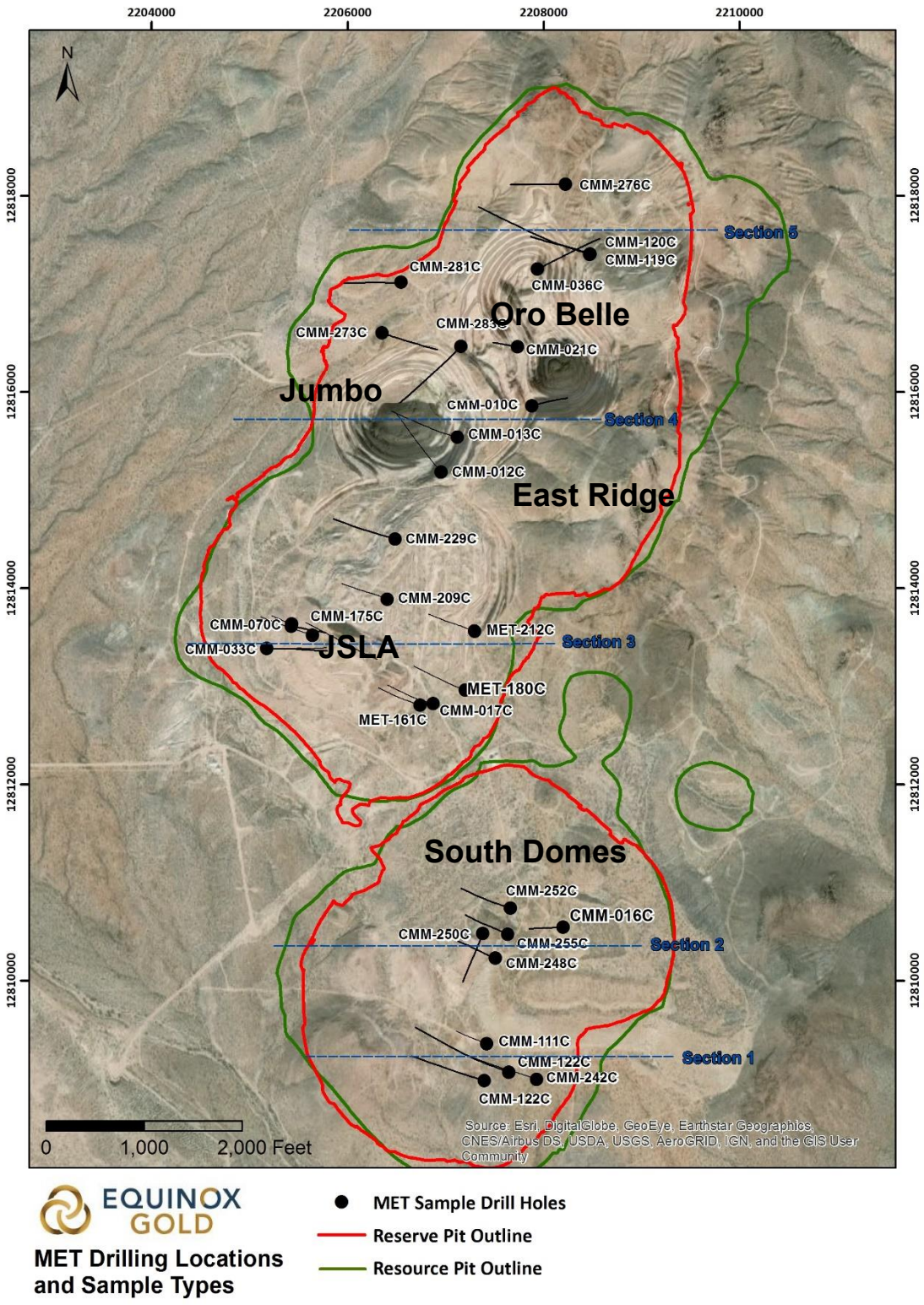


Figure 13-3: Metallurgical Sample Locations

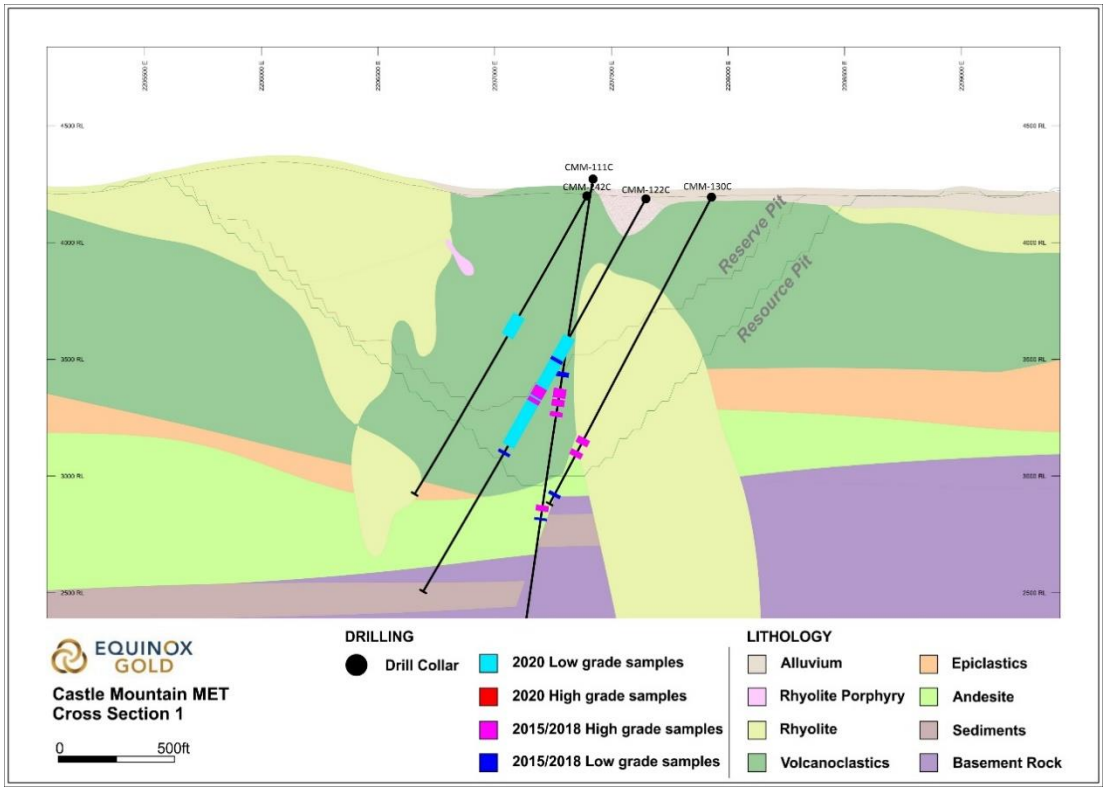


Figure 13-4: Castle Mountain Metallurgy Cross Section 1

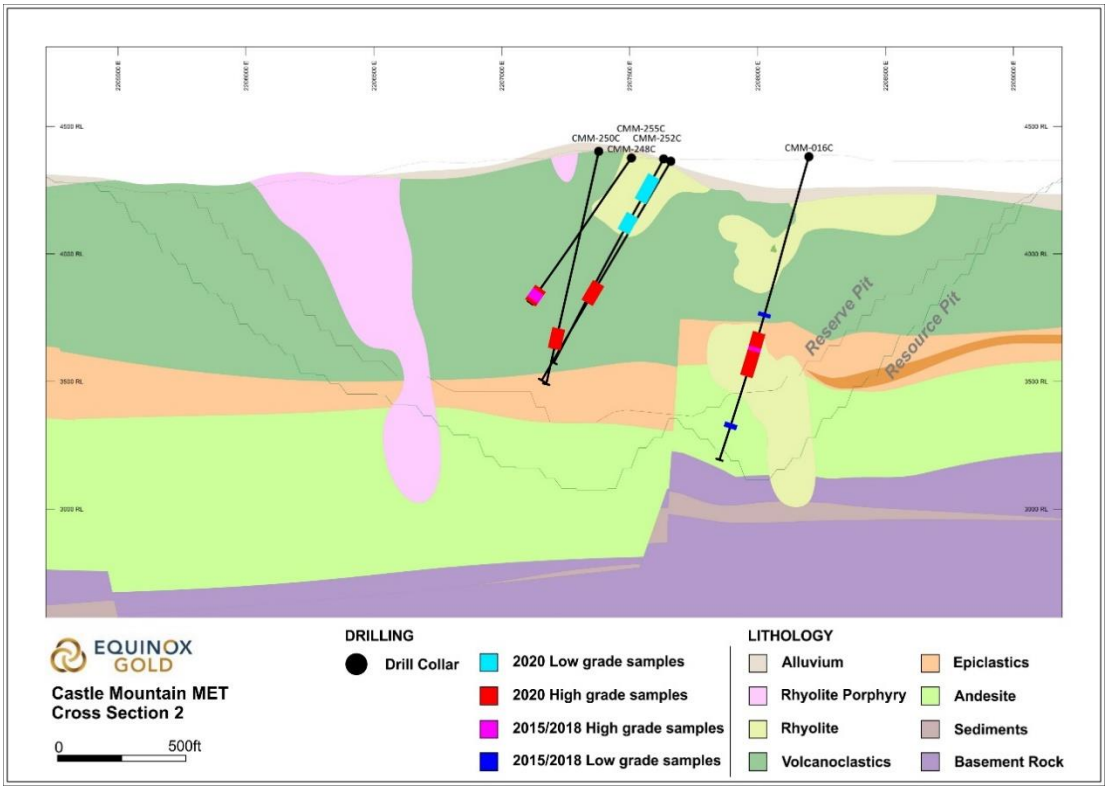


Figure 13-5: Castle Mountain Metallurgy Cross Section 2

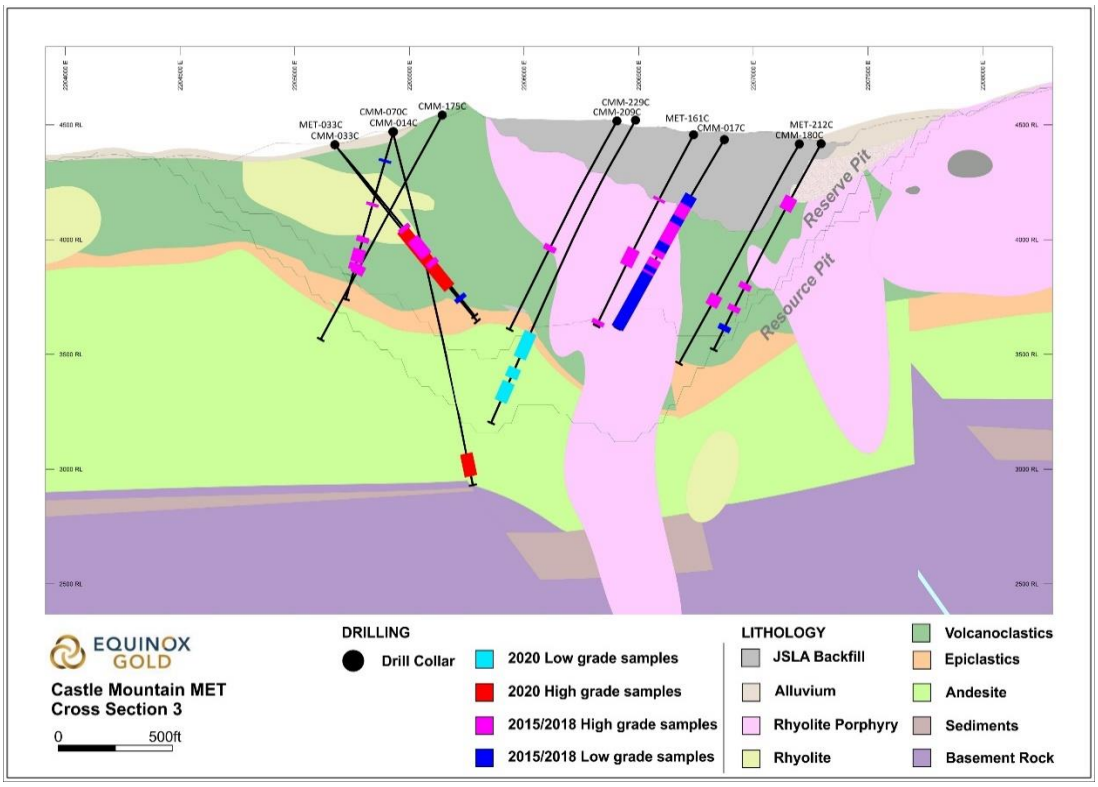


Figure 13-6: Castle Mountain Metallurgy Cross Section 3

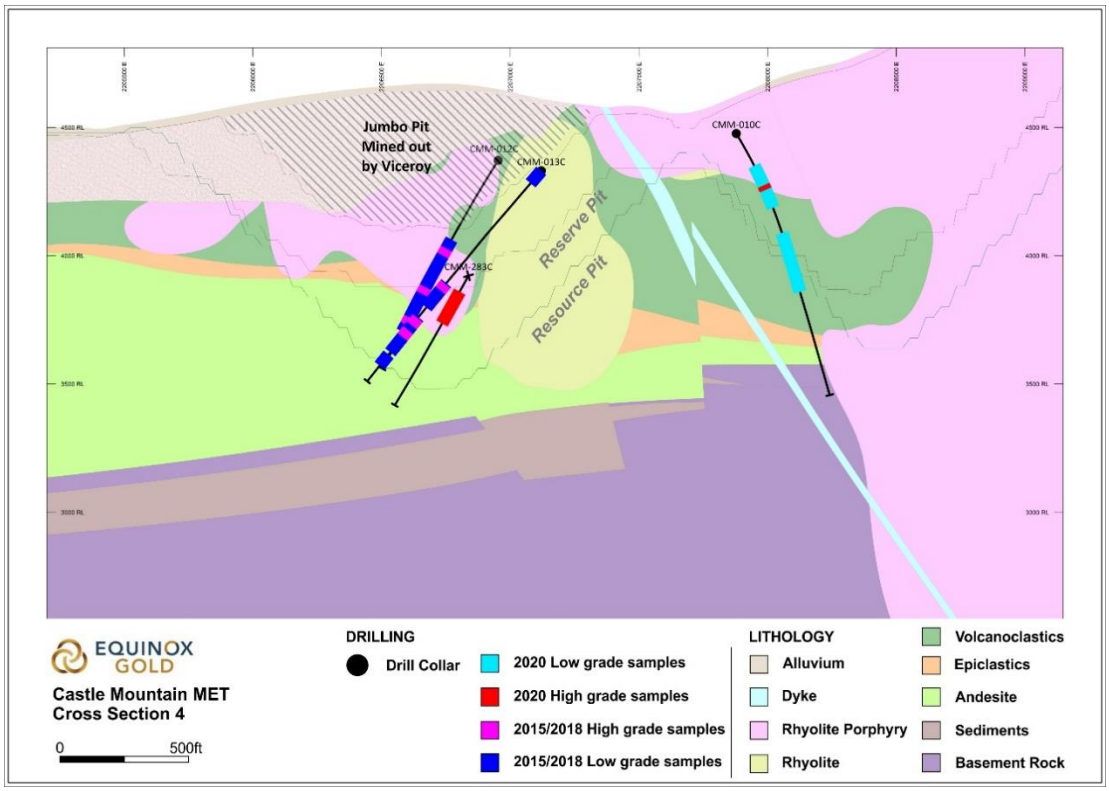


Figure 13-7: Castle Mountain Metallurgy Cross Section 4

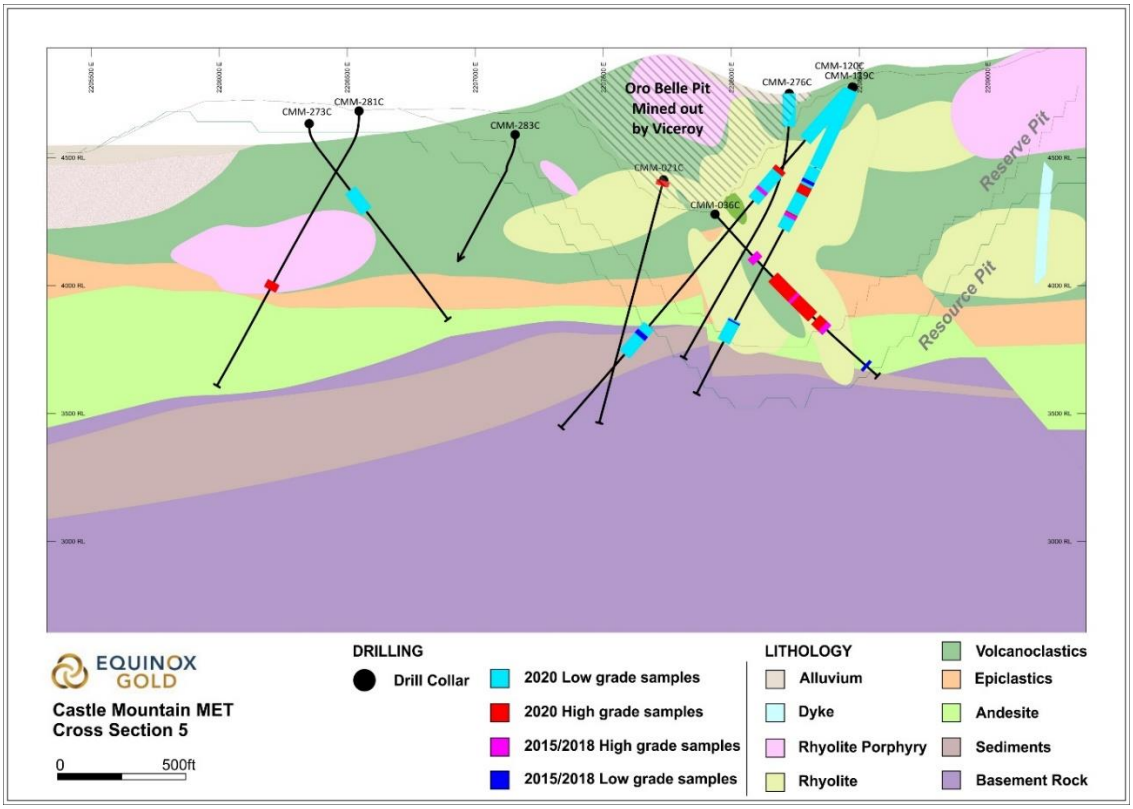


Figure 13-8: Castle Mountain Metallurgy Cross Section 5

13.4 SAMPLE ELEMENT ANALYSIS

ICP scans and mercury analyses were completed for all heap leach and mill grade ore composites.

ICP readings show some elevated concentrations for some elements (e.g. As, Cu, Ni, Pb, and Zn), that may be detrimental to carbon adsorption depending on solubility and ratio to concentration of precious metal in solution. These values are primarily associated with Andesite samples which are near the bottom of the pits and represent a small fraction of the overall orebody.

Sulfur content for the composites ranged from 0.01% to 1.64% with the average being 0.14%. Sulfur content in the heap leach composites was less than 0.75% which may impact recovery and/or reagent consumption. Sulfur content in the mill grade composites was generally low with the exception of one composite being 1.64%. ICP analysis for the heap leach and mill composites are listed in Table 13-5 and Table 13-6.

Table 13-5: Multi-Element Analysis for Heap Leach Grade Ore Composites

		4505-001-LG South Domes	4505-002-LG South Domes	4505-003-LG South Domes	4505-007-LG JSLA	4505-010-LG Jumbo	4505-015-LG East Ridge	4505-017-LG Oro Belle	4505-018-LG Oro Belle	4505-019-LG Oro Belle	4505-020-LG Oro Belle	4505-021-LG Oro Belle	4505-025-LG Oro Belle
Analysis	Unit	Vx	Rhy-Aph	Diatreme	Andesite	Vx	Rhy-Aph	Vx	Rhy-Aph	Andesite	Vx	Rhy-Aph	Epiclastic
Ag	mg/kg	0.92	3.24	0.92	1.74	0.45	0.53	1.59	1.30	1.20	1.14	0.94	1.05
Al	%	5.40	4.68	5.04	7.54	5.59	5.50	5.47	5.62	7.55	5.50	5.83	6.93
As	mg/kg	42.7	11.9	33.5	180.5	55.3	54.7	125.5	115.0	72.2	122.0	77.0	85.0
Ba	mg/kg	230	20	230	1,980	90	90	230	100	1,540	170	90	1,380
Be	mg/kg	3.96	2.93	4.21	3.01	3.33	3.27	6.23	3.47	2.48	5.07	3.86	2.83
Bi	mg/kg	0.10	0.08	0.09	0.16	0.08	0.13	0.10	0.17	0.14	0.09	0.08	0.12
Ca	%	0.23	0.22	0.17	1.20	0.10	0.10	0.16	0.16	0.79	0.13	0.14	0.68
Cd	mg/kg	0.04	0.05	0.04	0.10	0.06	0.07	0.15	0.05	0.13	0.16	0.03	0.06
Ce	mg/kg	60.3	33.7	55.0	265	56.4	53.1	65.6	50.3	198.5	58.1	50.5	166.0
Co	mg/kg	1.9	0.4	1.4	21.0	0.2	0.2	17.7	1.2	19.2	2.4	0.8	10.2
Cr	mg/kg	100	115	106	76	69	72	80	97	43	106	101	98
Cs	mg/kg	10.45	3.81	12.40	4.05	4.66	4.33	9.57	4.80	3.23	7.53	4.67	3.72
Cu	mg/kg	11.0	6.5	7.2	110.0	4.5	7.3	14.7	8.7	79.7	8.3	6.0	45.3
Fe	%	0.95	0.48	0.82	4.22	0.52	0.51	0.90	0.70	2.48	0.82	0.64	2.81
Ga	mg/kg	13.25	10.95	12.25	23.5	14.95	14.65	15.85	13.40	19.15	15.90	14.60	17.95
Ge	mg/kg	0.19	0.15	0.19	0.37	0.17	0.12	0.14	0.12	0.24	0.13	0.14	0.24
Hf	mg/kg	3.5	2.9	3.3	9.2	3.3	3.2	3.5	3.1	6.3	3.4	3.2	5.8
In	mg/kg	0.029	0.024	0.025	0.056	0.027	0.031	0.023	0.028	0.037	0.028	0.029	0.039
K	%	4.70	4.40	4.43	3.97	4.24	4.54	4.79	4.62	5.38	5.09	4.96	5.93
La	mg/kg	31.4	16.7	28.4	138.0	29.8	26.9	32.4	23.5	100.0	28.0	24.8	85.7
Li	mg/kg	58.3	122.5	81.3	56.8	97.5	90.5	81.6	61.0	25.7	89.6	53.6	45.7
Mg	%	0.14	0.03	0.13	0.83	0.22	0.21	0.21	0.16	0.35	0.13	0.10	0.78
Mn	mg/kg	111	94	335	467	162	150	559	161	481	274	142	261
Mo	mg/kg	5.53	13.25	4.70	5.70	9.84	9.59	9.00	12.75	3.35	8.60	25.0	8.23
Na	%	1.25	0.17	1.07	0.93	0.32	0.31	0.40	0.93	1.02	0.41	1.40	0.63
Nb	mg/kg	21.5	19.4	21.0	34.7	23.8	23.2	22.1	22.9	31.8	21.8	23.6	23.0
Ni	mg/kg	6.6	4.3	6.2	44.8	1.5	1.5	12.9	4.0	31.5	4.8	2.9	26.1
P	mg/kg	310	20	240	3,830	50	30	310	180	2,350	210	230	1,680
Pb	mg/kg	18.6	13.8	19.3	32.7	19.3	18.0	19.6	19.5	32.0	18.0	18.9	24.7
Rb	mg/kg	311	231	231	136.0	212	239	287	286	208	270	288	238
Re	mg/kg	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	0.008
S	%	0.01	0.01	0.01	0.41	0.01	0.01	0.08	0.02	0.01	0.05	0.02	0.71
Sb	mg/kg	13.20	29.0	9.13	8.59	12.25	12.20	19.75	14.00	8.39	23.9	21.3	12.50
Sc	mg/kg	1.9	0.9	1.5	9.3	1.1	1.0	2.2	1.5	4.6	1.8	1.5	7.2
Se	mg/kg	<1	1	1	1	1	<1	<1	<1	1	<1	1	1
Sn	mg/kg	2.5	2.8	2.1	2.1	2.6	2.5	3.8	2.9	1.6	2.4	2.8	1.7
Sr	mg/kg	179.5	77.4	131.0	802	138.5	137.0	143.5	127.0	565	155.0	140.0	488
Ta	mg/kg	1.46	1.40	1.39	1.57	1.73	1.67	1.49	1.67	1.52	1.53	1.71	1.14
Te	mg/kg	<0.05	<0.05	<0.05	0.16	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Th	mg/kg	22.3	18.60	20.9	34.2	23.3	22.8	21.9	22.1	27.0	21.5	22.8	25.4
Ti	%	0.090	0.035	0.073	0.599	0.050	0.049	0.105	0.062	0.392	0.086	0.060	0.388
Tl	mg/kg	1.42	1.61	1.38	1.49	1.31	1.28	1.56	1.50	2.26	1.77	1.57	1.99
U	mg/kg	3.4	2.6	3.0	13.1	2.9	2.7	5.1	3.5	7.2	4.3	5.0	8.5
V	mg/kg	24	47	20	120	6	6	17	10	72	16	8	84
W	mg/kg	5.7	1.9	4.5	11.8	1.1	1.1	3.5	3.0	7.6	2.9	2.5	5.3
Y	mg/kg	21.8	19.4	21.6	22.5	23.2	22.2	23.3	21.0	17.3	22.5	25.1	18.7
Zn	mg/kg	38	14	38	96	23	25	49	25	84	33	24	62
Zr	mg/kg	109.0	71.3	99.1	416	84.9	83.5	102.5	82.0	307	99.2	83.5	258

ALS USA Inc. Report No.RE20003638

Table 13-6: Multi-Element Analysis for Mill Grade Ore Composites

		4505-004-HG South Domes	4505-005-HG South Domes	4505-006-HG South Domes	4505-008-HG JSLA	4505-009-HG JSLA	4505-011-HG Jumbo	4505-012-HG Jumbo	4505-013-HG Jumbo	4505-022-HG Oro Belle	4505-023-HG Oro Belle	4505-024-HG Oro Belle	4505-026-HG Oro Belle
Analysis	Unit	Vx	Rhy-Aph	Vx	Diatreme	Rhy-Bx	Rhy-Aph	Andesite	Rhy-Porph	Rhy-Aph	Diatreme	Andesite	Vx
Ag	mg/kg	1.50	1.05	1.01	1.84	1.30	2.01	6.06	1.97	1.80	1.14	1.82	1.20
Al	%	5.39	5.17	5.89	6.98	4.86	6.13	8.28	5.47	5.75	5.71	6.92	5.77
As	mg/kg	44.0	29.3	31.6	127.0	64.1	40.6	116.5	41.7	91.0	51.2	183.5	86.9
Ba	mg/kg	260	20	150	1,330	190	20	1,880	230	60	360	1,380	120
Be	mg/kg	4.14	4.74	4.95	2.18	3.42	4.75	5.40	3.39	3.53	2.36	2.65	5.58
Bi	mg/kg	0.10	0.02	0.12	0.11	0.14	0.10	0.13	0.08	0.08	0.08	0.15	0.10
Ca	%	0.16	0.07	0.16	0.77	0.06	0.16	0.99	0.14	0.15	0.21	0.60	0.17
Cd	mg/kg	0.09	0.02	0.03	0.08	0.09	0.09	0.10	0.09	0.06	0.03	0.10	0.14
Ce	mg/kg	62.6	40.0	58.5	190.5	43.6	48.4	222	65.9	46.7	66.4	173.5	62.6
Co	mg/kg	3.5	0.4	0.8	14.1	0.7	1.3	9.2	1.2	0.7	2.8	11.6	1.0
Cr	mg/kg	100	108	74	101	136	59	23	82	103	116	95	64
Cs	mg/kg	4.06	6.18	4.38	2.25	3.36	8.45	8.51	6.56	4.50	3.55	2.79	4.86
Cu	mg/kg	9.8	3.0	5.2	63.4	6.5	3.8	110.5	9.5	6.5	12.0	51.9	5.7
Fe	%	0.89	0.50	0.89	3.11	0.74	0.55	2.97	0.66	0.64	1.08	3.07	0.76
Ga	mg/kg	12.80	11.95	15.25	15.10	10.55	17.75	21.0	14.50	14.25	12.10	19.05	14.55
Ge	mg/kg	0.14	0.13	0.14	0.24	0.11	0.12	0.25	0.13	0.12	0.14	0.23	0.14
Hf	mg/kg	3.8	3.0	3.8	6.1	3.0	3.5	9.5	3.5	3.1	3.7	5.5	3.6
In	mg/kg	0.031	0.023	0.027	0.039	0.037	0.031	0.041	0.025	0.031	0.027	0.043	0.033
K	%	4.73	5.24	4.58	4.66	5.43	4.00	5.11	4.21	5.07	5.37	5.46	4.17
La	mg/kg	29.8	17.9	27.1	94.8	19.5	21.6	107.0	33.8	21.1	32.7	88.1	30.4
Li	mg/kg	85.2	56.7	44.2	34.6	104.5	76.7	22.4	52.9	89.4	42.7	32.2	46.7
Mg	%	0.11	0.05	0.17	0.69	0.04	0.56	0.41	0.20	0.14	0.16	0.36	0.22
Mn	mg/kg	480	71	175	319	98	282	403	198	139	175	290	183
Mo	mg/kg	4.51	3.53	3.41	5.41	8.53	32.3	3.30	5.63	17.70	5.66	6.81	4.60
Na	%	1.28	1.08	1.04	0.83	0.28	0.28	1.42	0.55	0.71	0.55	1.03	1.39
Nb	mg/kg	21.5	21.8	24.5	26.3	19.8	25.7	44.7	22.4	23.5	21.9	22.4	24.6
Ni	mg/kg	6.5	2.4	4.3	34.3	3.9	1.6	9.9	4.8	3.1	9.1	36.0	5.2
P	mg/kg	260	20	120	2,380	50	30	3,120	150	170	480	1,950	200
Pb	mg/kg	18.9	14.7	17.4	25.2	15.9	26.5	41.1	15.4	19.7	17.6	25.9	18.5
Rb	mg/kg	303	258	256	122.5	237	336	133.0	206	307	254	267	239
Re	mg/kg	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	<0.002
S	%	0.01	<0.01	0.01	1.64	0.02	0.01	0.02	<0.01	0.03	0.02	0.01	0.05
Sb	mg/kg	10.60	14.30	7.98	6.97	23.5	8.56	12.50	7.70	14.15	9.20	11.35	8.73
Sc	mg/kg	1.7	1.0	1.5	6.5	1.0	1.4	3.2	1.4	1.5	2.6	8.0	1.9
Se	mg/kg	1	1	<1	2	1	<1	1	1	1	1	1	1
Sn	mg/kg	2.1	2.2	2.5	1.4	2.6	3.3	1.5	2.2	3.1	2.0	1.3	3.6
Sr	mg/kg	210	50.5	115.5	560	131.5	103.5	1,280	168.0	105.0	266	447	105.5
Ta	mg/kg	1.50	1.54	1.71	1.29	1.42	2.02	2.00	1.67	1.77	1.49	1.10	1.81
Te	mg/kg	<0.05	<0.05	<0.05	0.71	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	<0.05
Th	mg/kg	22.2	20.8	23.5	29.4	19.85	26.3	28.7	23.4	23.3	21.9	22.3	24.2
Ti	%	0.090	0.037	0.070	0.436	0.040	0.049	0.454	0.070	0.057	0.120	0.430	0.081
Tl	mg/kg	1.60	1.26	1.20	1.47	1.78	1.59	1.23	1.10	1.72	1.64	2.06	1.20
U	mg/kg	4.2	2.9	3.2	5.9	2.9	3.0	9.0	3.3	3.8	5.9	8.5	3.8
V	mg/kg	45	7	26	72	17	6	91	19	9	33	85	10
W	mg/kg	6.6	3.4	5.3	8.3	5.1	1.8	10.7	8.7	3.8	5.7	18.0	2.4
Y	mg/kg	25.6	22.3	24.2	16.9	21.2	27.2	17.0	24.3	22.5	20.4	17.6	22.6
Zn	mg/kg	33	17	37	69	17	31	114	36	23	28	62	51
Zr	mg/kg	115.0	73.8	103.0	319	75.1	81.9	470	92.8	79.6	115.5	246	97.7

ALS USA Inc. Report No. RE20003638

Low amounts of mercury have been observed in the composites sampled. On average, 2.3% of the mercury in the heap leach composites was extracted and loaded on the carbon. Mercury levels for both heap leach and mill grade ore composites are shown in Table 13-7 and Table 13-8 respectively. Mercury levels are minor and are not expected to be an issue.

Table 13-7: Mercury Analysis Results – Heap Leach Grade Ore Composites

Composite	Ore Zone	Lithology	g Hg/t ore
4505-001-LG	South Domes	Vx	0.422
4505-002-LG	South Domes	Rhy-Aph	1.04
4505-003-LG	South Domes	Diatreme	0.457
4505-007-LG	Main Pit	Andesite	1.30
4505-010-LG	Jumbo	Vx	0.055
4505-015-LG	East Ridge	Rhy-Aph	0.359
4505-017-LG	Oro Belle	Vx	0.668
4505-018-LG	Oro Belle	Rhy-Aph	0.642
4505-019-LG	Oro Belle	Andesite	1.46

Table 13-8: Mercury Analysis Results – Mill Grade Ore Composites

Composite	Ore Zone	Lithology	g Hg/t ore
4505-004-HG	South Domes	Vx	1.12
4505-005-HG	South Domes	Rhy-Aph	0.247
4505-006-HG	South Domes	Vx	0.537
4505-008-HG	JSLA	Diatreme	1.56
4505-009-HG	JSLA	Rhy-Bx	1.20
4505-011-HG	Jumbo	Rhy-Aph	0.239
4505-012-HG	Jumbo	Andesite	0.662
4505-013-HG	Jumbo	Rhy-Porph	0.488
4505-022-HG	Oro Belle	Rhy-Aph	0.841
4505-023-HG	Oro Belle	Diatreme	0.870
4505-024-HG	Oro Belle	Andesite	2.11
4505-026-HG	Oro Belle	Vx	0.312

13.5 HEAP LEACH TESTING

13.5.1 2015 ROM and Crushed Ore Column Testing

The 2015 column leach tests were performed in large columns (4 ft diameter by 20 ft tall) with ROM samples of -300 mm with 80% passing 50 mm as well as smaller columns at nominal 80% passing 9.5 mm. The samples were JSLA backfill material and in-situ ore from Oro Belle.

The ROM column leach tests had a gold recovery of 86% and 71% for Oro Belle and JSLA respectively (avg 78%) after leaching, rinsing, and draining for 174 days. The comparable column leach tests done on the same sample in parallel with the ROM tests at a crushed size of 9.5 mm had similar ultimate gold recoveries of 90% and 72%, as seen in Table 13-9. Gold extraction was progressing at a slow but significant rate from both ROM tests when leaching was terminated suggesting gold recovery would be the same given sufficiently long leach time, as shown in Figure 13-9. Notably, the higher-grade sample from JSLA was above crossover grade and is considered

material that should be mill feed. This sample had lower recoveries in both tests and the tails assays had spotty residual gold which may indicate presence of unleached coarse gold particles.

Table 13-9: Summary of Metallurgical Results, ROM and Crushed Ore Column Tests, 2015

Sample	Feed Size	Leach Time, days	Test Type	Au Rec., %	gAu/mt ore Ext'd.	gAu/mt ore Tail	gAu/mt ore Calc'd. Head	gAu/mt ore Avg. Head	Ag Rec., %	gAg/mt ore Ext'd.	gAg/mt ore Tail	gAg/mt ore Calc'd. Head	gAg/mt ore Avg. Head	Reagent Req., kg/mt ore NaCN Cons.	Reagent Req., kg/mt ore Lime Added
Oro Belle	ROM	160	CLT	85.8	1.03	0.17	1.20	1.11	11.8	0.2	1.5	1.7	1.6	0.27	0.9
Oro Belle	80%-9.5mm	157	CLT	89.6	1.20	0.14	1.34	1.11	11.1	0.2	1.6	1.8	1.6	1.51	1.1
Oro Belle	80%-1.7mm	4	BRT	84.8	1.34	0.24	1.58	1.11	17.6	0.3	1.4	1.7	1.6	<0.07	1.4
JSLA	ROM	164	CLT	71.0	1.49	0.61	2.10	2.06	22.2	0.6	2.1	2.7	2.3	0.28	0.8
JSLA	80%-9.5mm	157	CLT	72.0	1.21	0.47	1.68	2.06	20.8	0.5	1.9	2.4	2.3	1.71	1.0
JSLA	80%-1.7mm	4	BRT	69.7	2.28	0.99	3.27	2.06	34.5	1.0	1.9	2.9	2.3	<0.07	1.2

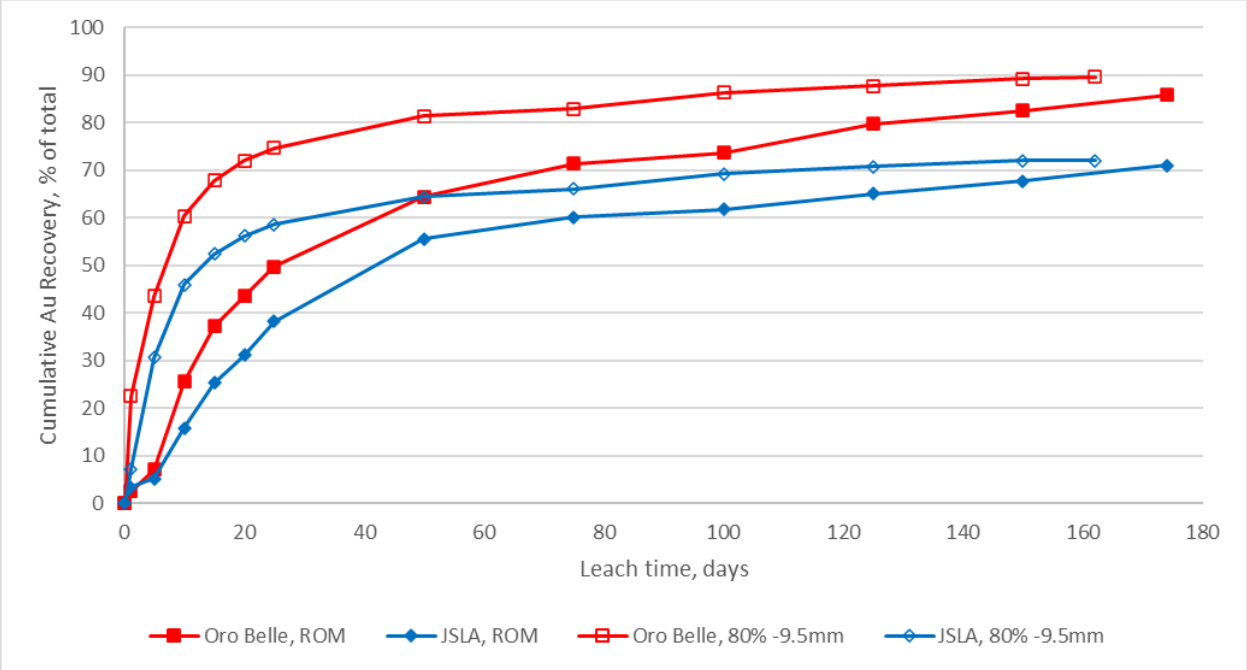


Figure 13-9: ROM and Crushed Sample Leach Curves, 2015

13.5.2 2018 ROM Column Leach and Crushed Ore Bottle Roll Testing

The 2018 ROM column leach tests were again performed in large columns with JSLA backfill ROM samples of -300 mm with 80% passing 50 mm as well as bottle roll tests at nominal 80% passing 50 mm and 9.5 mm. Column tests on crushed ore were not conducted in parallel in this campaign.

The ROM column leach test gold recovery ranged from 66% to 85% with an average gold recovery of 77% after leaching, rinsing, and draining for 173 days. The two tests with lower recovery were lower grade samples at 0.17 g/t and 0.32 g/t. See the summary metallurgical results in Table 13-10 and leach curves in Figure 13-10.

These tests are helpful to predict ROM heap leach recovery, but it is difficult to use these tests as a comparison of ROM recovery to crushed ore recovery. The four ROM column results averaged 77% recovery. The bottle roll tests did not correlate well to the ROM columns. The corresponding

bottle roll tests at -50 mm and -9.5 mm averaged 63% and 72%. The results indicate the bottle roll tests at -9.5 mm may underestimate ROM heap leach recoveries by up to 13% and on average by 5%.

It is recommended to conduct additional ROM testing on in-situ ore paired with 9.5 mm, 25 mm, and 50 mm columns to validate optimal size for heap leach.

Table 13-10: Summary Metallurgical Results, ROM, and Crushed Ore Column Tests, 2018

						gAu/mt ore				Reagent Requirements, kg/mt ore	
Sample	Test	Feed Size	Test No.	Leach Time, Days	Au Rec., %	Ext'd.	Tail	Calc'd. Head	Avg. Head	NaCN Cons.	Lime Added
RAB 17-083	Column	ROM (-460mm)	173	P-4	84.6	0.33	0.06	0.39	0.41	0.22	1.3
RAB 17-083	Bucket*	ROM (-460mm)	141	V-4	89.6	0.43	0.05	0.48	0.41	2.04	1.3
RAB 17-083	Bucket*	-150mm	141	V-8	87.5	0.63	0.09	0.72	0.41	1.67	1.3
RAB 17-083	BRT	100%-50mm	4	CY-4	72.2	0.26	0.10	0.36	0.41	0.07	1.2
RAB 17-083	BRT	80%-9.5mm	4	CY-8R	71.4	0.30	0.12	0.42	0.41	<0.07	1.5
RAB 17-098	Column	ROM (-460mm)	173	P-1	65.5	0.19	0.10	0.29	0.32	0.32	1.4
RAB 17-098	Bucket*	ROM (-460mm)	141	V-1	33.3	0.29	0.58	0.87	0.32	1.98	1.4
RAB 17-098	Bucket*	-150mm	141	V-5	60.5	0.23	0.15	0.38	0.32	1.34	1.4
RAB 17-098	BRT	100%-50mm	4	CY-1	55.0	0.11	0.09	0.20	0.32	<0.07	1.1
RAB 17-098	BRT	80%-9.5mm	4	CY-5	63.2	0.12	0.07	0.19	0.32	<0.07	1.7
RAB 17-123	Column	ROM (-460mm)	173	P-3	85.1	0.40	0.07	0.47	0.52	0.27	1.8
RAB 17-123	Bucket*	ROM (-460mm)	141	V-3	86.5	0.45	0.07	0.52	0.52	1.81	1.8
RAB 17-123	Bucket*	-150mm	141	V-7	86.5	0.64	0.10	0.74	0.52	1.78	1.8
RAB 17-123	BRT	100%-50mm	4	CY-3	63.9	0.39	0.22	0.61	0.52	0.15	1.9
RAB 17-123	BRT	80%-9.5mm	4	CY-7	75.4	0.43	0.14	0.57	0.52	<0.07	2.2
RAB 17-146	Column	ROM (-460mm)	173	P-2	71.4	0.15	0.06	0.21	0.17	0.23	1.1
RAB 17-146	Bucket*	ROM (-460mm)	141	V-2	65.4	0.17	0.09	0.26	0.17	1.47	1.1
RAB 17-146	Bucket*	-150mm	141	V-6	80.8	0.21	0.05	0.26	0.17	1.29	1.1
RAB 17-146	BRT	100%-50mm	4	CY-2	61.5	0.08	0.05	0.13	0.17	<0.07	0.8
RAB 17-146	BRT	80%-9.5mm	4	CY-6	76.9	0.10	0.03	0.13	0.17	<0.07	1.4

* Flooded static bucket/barrel leach test.
Note: Column leach cyanide consumption calculated based on balance through the end of the leach cycle (before rinsing).

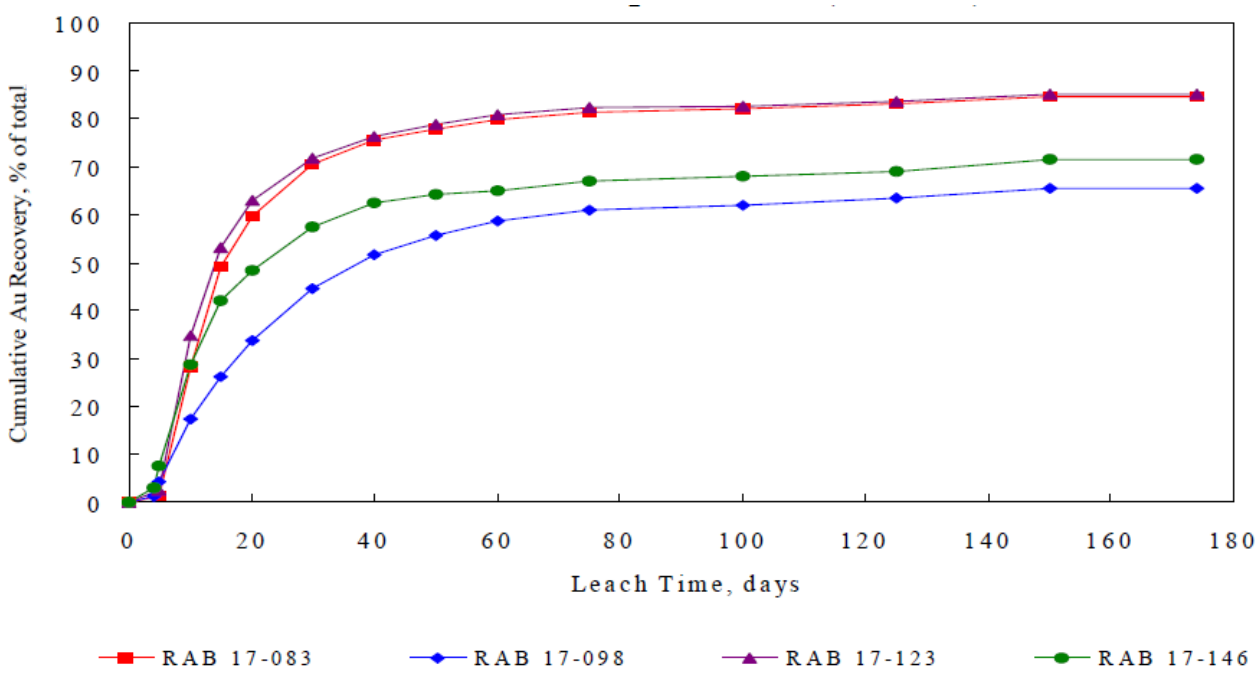


Figure 13-10: JSLA ROM Column Test Leach Curves, 2018

13.5.3 2020 Testing

The test program was performed by MLI and included bottle roll tests and column tests on 12 composites. The 96-hour bottle roll tests were completed using 80% minus 1.7 mm material to determine lime requirements for column leach tests and check direct head assay results against bottle roll test calculated head grades.

Comparative column leach tests were conducted on all composites and on one additional heap leach master composite. The blend of the heap leach master composite consisted of 24% South Domes, 19% East Ridge, and 57% Oro Belle zones.

Tests were planned on 50 mm feeds and 9.5 mm feeds. Composites were made-up from half HQ drill core that was crushed slightly finer than 100% minus 50 mm to ensure fresh, broken surfaces for leaching. Where sufficient material was available, the composites (8) were subjected to column leach testing at an approximately 80% passing 25 mm to determine sensitivity to crush size and more closely approximate ROM. Tests were also completed on material with a particle size of 80% passing 9.5 mm to provide direct comparison to previous testing and commercial production from the Castle Mountain Project. More tests were performed using 9.5 mm material as they require less material.

Table 13-11 shows the number of tests done by ore zone.

Table 13-11: Summary of 2020 Heap Leach Material Testing

Ore Zone	Bottle Roll Tests	Column Leach Tests	
	1.7 mm	9.5 mm	25 mm
JSLA	1	1	1
South Domes	3	3	2
East Ridge	1	1	1
Jumbo	1	1	-
Oro Belle	6	6	4
Heap Leach Master Composite	-	-	1
Total	**12**	**12**	**9**

13.5.3.1 Heap Leach 2020 Bottle Roll Test Results

Table 13-12 is a summary of the bottle roll test results for the heap leach grade ore composites. Detailed results can be found in MLI Report Job No. 4505, June 2020. The Epiclastic lithology had the lowest recovery and Vx had the highest recovery.

Table 13-12: Summary of Bottle Roll Tests on Low-Grade Composites

Composite	Ore Zone	Lithology	Gold Rec %	Gold Calc Head g /t Au	NaCN kg/t ore	Lime kg/t ore
4505-001-LG	South Domes	Vx	92.9	0.85	<0.07	1.6
4505-002-LG	South Domes	Rhy-Aph	90.0	0.30	<0.07	0.9
4505-003-LG	South Domes	VxDiatreme	88.2	0.34	<0.07	1.4
4505-007-LG	JSLA	Andesite	73.5	0.34	0.18	1.5
4505-010-LG	Jumbo	Vx	94.1	<0.17	0.09	1.3
4505-015-LG	East Ridge	Rhy-Aph	71.4	0.14	<0.07	1.0
4505-017-LG	Oro Belle	Vx	70.0	0.20	<0.07	1.5
4505-018-LG	Oro Belle	Rhy-Aph	80.8	0.52	<0.07	1.4
4505-019-LG	Oro Belle	Andesite	91.5	0.47	<0.07	2.4
4505-020-LG	Oro Belle	Vx	52.6	0.19	<0.07	1.2
4505-021-LG	Oro Belle	Rhy-Aph	76.7	0.30	<0.07	1.0
4505-025-LG	Oro Belle	Epiclastic	40.0	0.20	0.16	0.8

Calculated head grade versus gold recovery was plotted. There is a trend with higher head grade generally resulting in higher recovery as shown in Figure 13-11; however, it is not possible to curve fit this data. Recoveries varied for samples with different head grades and for samples with similar head grades.

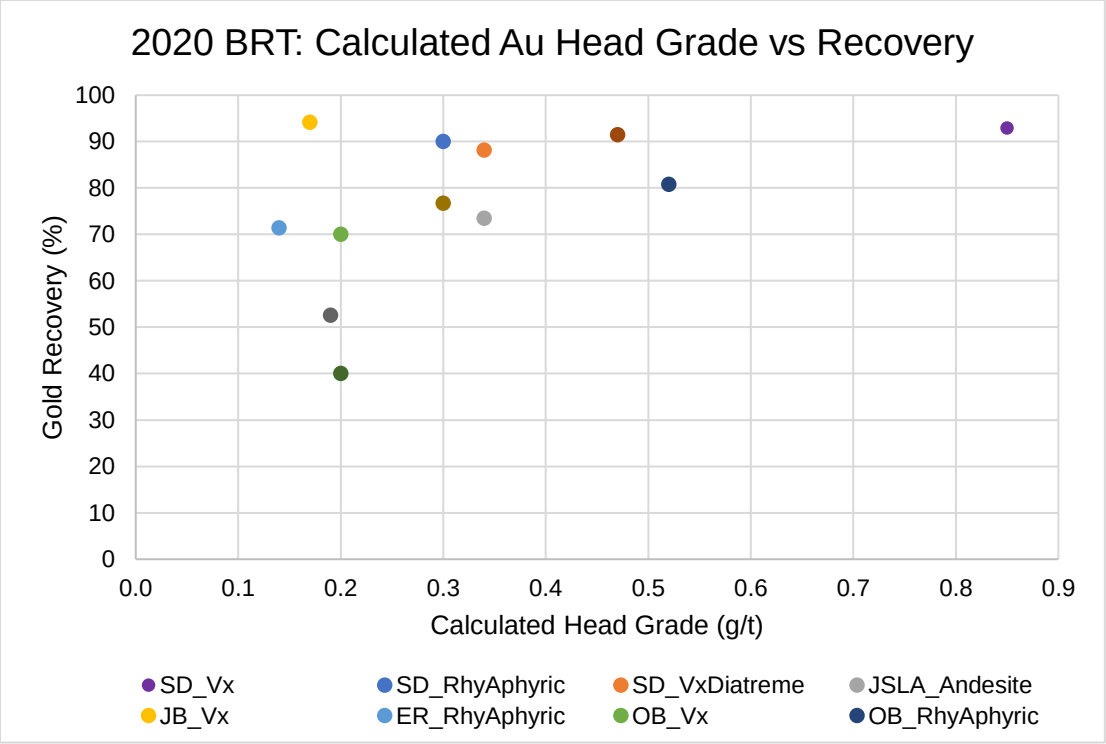


Figure 13-11: 2020 Bottle Roll Tests – Calculated Gold Head Grade vs Recovery

The average gold and silver recovery from these tests were 77% and 22% respectively. The Oro Belle deposit had the most variation compared to the other ore zones with gold recoveries ranging from 40% to 92%. Table 13-13 lists the average bottle roll test results by ore zone.

Table 13-13: Average Bottle Roll Test Results by Ore Zone

Ore Zone	Gold Recovery (%)	Silver Recovery (%)
JSLA	74	33
South Domes (SD)	90	17
East Ridge (ER)	71	20
Jumbo (JB)	94	20
Oro Belle (OB)	69	23

Figure 13-12 shows the gold recovery for each ore zone by lithology. Gold recovery for South Domes was consistent across the lithologies tested. Recovery for Oro Belle did vary based on lithology. Recovery for Vx varied for the Oro Belle but was consistent for South Domes and Jumbo. Recovery for the two tests done on Vx from the Oro Belle varied from 53% to 70%. The composites for these two tests were from different drill holes taken from similar depths. Results of the Vx tests for South Domes and Jumbo had a gold recovery of 93% and 94%, respectively. Epiclastic had the lowest recovery. Figure 13-13 shows the variation in recovery by lithology from the 2020 test. The dash line represents the arithmetic average from all 12 tests, being 77%.

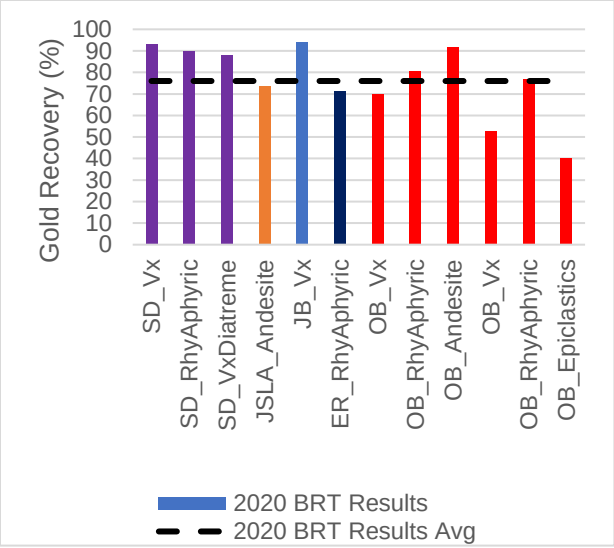


Figure 13-12: Gold Recovery for Each Ore Zone by Lithology

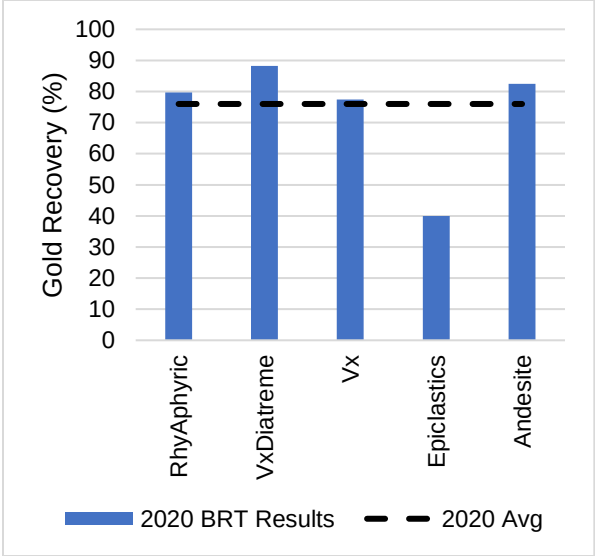


Figure 13-13: Arithmetic Average Gold Recoveries by Lithology

All bottle roll tests were done at 40% solids by weight with a targeted cyanide concentration of 0.1% NaCN (1 g NaCN/L). Lime was added to maintain the pH between 10 and 11. The average consumption for cyanide was 0.18 lb/ton ore (0.09 kg/t ore). Lime consumption was an average of 2.7 lb/ton ore (1.3 kg/t ore). There was no consistent relationship between reagent consumption and head grade or recovery.

13.5.3.2 Heap Leach 2020 Column Leach Test Results

The summary of column leach tests is shown below in Table 13-14 and includes 12 tests at a nominal 9.5 mm size and eight tests at a nominal 25 mm size.

Table 13-14: Summary of Column Tests on Heap Leach Composites

Composite	Ore Zone	Lithology	Size mm	Gold Rec %	Gold Calc Head g/t Au	Gold Extracted g/t Au	Gold in Tails g/t Au	NaCN kg/t ore	Lime kg/t ore
4505-001-LG	South Domes	Vx	24	87.0	1.46	1.27	0.19	1.51	1.3
			9.5	96.2	1.32	1.27	0.05	2.66	1.3
4505-002-LG	South Domes	Rhy-Aph	25	85.3	0.34	0.29	0.05	0.72	0.9
			9.5	88.2	0.34	0.30	0.04	0.84	0.9
4505-003-LG	South Domes	VxDiatreme	9.5	89.2	0.37	0.33	0.04	1.27	1.1
4505-007-LG	JSLA	Andesite	25	64.9	0.33	0.24	0.13	1.01	1.2
			9.5	69.7	0.33	0.23	0.10	1.14	1.2
4505-010-LG	Jumbo	Vx	9.5	87.5	0.24	0.21	0.03	0.89	1.0
4505-015-LG	East Ridge	Rhy-Aph	22	66.7	0.15	0.10	0.05	0.74	1.0
			9.5	73.3	0.15	0.11	0.04	1.13	1.0
4505-017-LG	Oro Belle	Vx	22	71.4	0.21	0.15	0.06	0.95	1.2
			9.5	66.7	0.21	0.14	0.07	1.20	1.2
4505-018-LG	Oro Belle	Rhy-Aph	24	83.7	0.47	0.36	0.07	0.76	1.1
			9.5	88.9	0.47	0.40	0.05	1.24	1.1
4505-019-LG	Oro Belle	Andesite	9.5	95.2	0.44	0.40	0.02	0.94	1.9
4505-020-LG	Oro Belle	Vx	23	37.5	0.16	0.06	0.10	0.83	1.0
			9.5	41.2	0.17	0.07	0.10	1.16	1.0
4505-021-LG	Oro Belle	Rhy-Aph	24	78.6	0.28	0.22	0.06	0.82	1.0
			9.5	82.1	0.28	0.23	0.05	1.10	1.0
4505-025-LG	Oro Belle	Epiclastic	9.5	36.8	0.19	0.07	0.12	0.96	0.8

The average gold recovery for the 9.5 mm and 25 mm column tests was 77% and 74% respectively. Recovery from the 9.5 mm columns ranged from 37% to 96% and from 38% to 87% for the 25 mm columns. Gold recovery between sizes for each of the zones tested seems to indicate that 25 mm columns had higher recovery than 9.5 mm columns, but the tail assays show that the residual gold is within 0.01 g/t for 5 of the column pairs which is within the repeatability of the assay measurement and these differences are not significant.

There were two notable samples with poor recovery, one Oro Belle Vx and one Oro Belle epiclastic, and these matched closely with the BRT results. These were two of the lowest grade samples tested, both <0.2 g/t. The remainder of the samples had recoveries of 65% or above and averaged 81% recovery. 4505-001-LG and 4505-020-LG samples were selected for further mineralogical analysis and gold deportment study to explain the difference in recovery between Vx in South Domes and Vx in Oro Belle and is discussed in Section 13.8.6.

The results have been grouped by ore zone and lithology to examine specific trends. Table 13-15 and Table 13-16 list the results by size and ore zone. The column leach test results on the heap leach master composite at 25 mm had a gold recovery of 76.5%.

Table 13-15: 2020 Column Leach Test Results by Size and Ore Zone

No. of Tests	Ore Zone	Nominal Size mm	Avg Gold Recovery %
1	JSLA	9.5	70
1	JSLA	25	65
1	Jumbo	9.5	88
6	Oro Belle	9.5	68
4	Oro Belle	25	68
1	East Ridge	9.5	73.3
1	East Ridge	25	66.7
3	South Domes	9.5	91
2	South Domes	25	86
1	Heap Leach Master Composite	25	76.5

Gold recovery by lithology ranged from 37% to 95% with an average of 75%. The lithology with the lowest recovery was Epiclastic which had a calculated head grade below the criteria specified above for evaluation. Table 13-16 lists the results by lithology.

Table 13-16: 2020 Column Leach Test Results Summary

No. of Tests	Lithology	Gold Recovery (%)
8	RhyAphyric	84
1	VxDiatreme	89
7	Vx	70
1	Epiclastic	37
3	Andesite	77

Cyanide concentration for the column leach tests was maintained at a concentration of 0.1% (1,000 ppm) and the average consumption was 2.0 lb/ton ore (1.0 kg/t ore). Lime addition to maintain the pH between 10 – 11 was an average of 2.24 lb/ton ore (1.3 kg/t ore). No correlation is apparent between sodium cyanide consumption and calculated head grade or gold recovery.

13.5.3.3 ICP Analysis on Pregnant Solution

Multi-element analyses using ICP were done on the pregnant solution for the heap leach (column tests) and mill (gravity plus tails leach) composite tests. Two heap leach composites out of 12 had higher levels of copper than the other composites. These two samples were from the JSLA and Oro Belle ore zones with copper levels of 66 ppm and 62 ppm, respectively.

One mill grade ore composite out of the 12 had a higher level of copper. Analysis shows this composite with a copper level of 31 ppm while the rest of the samples had levels below 4 ppm. Copper can be concerning because at high levels it may increase cyanide consumption, decrease gold recovery, or impact carbon loading/movement. However, these levels are low enough in all cases to cause minimal concern.

13.5.3.4 Physical Ore Characteristics

Saturation and retained moisture of the heap leach grade ore samples are shown in Table 13-17. For the 9.5 mm crushed material, saturation moisture ranged from 12% to 25% and the moisture

retained ranged from 9% to 19%. The Oro Belle andesite sample had the highest saturation (25%) out of all the samples. The respective sample at a coarser size had a saturation of 18%. As expected, the coarser material had both a lower saturation moisture and a lower retained moisture. The saturation moisture for the 25 mm material ranged from 8.7% to 13.7% averaging 11.4% while the retained moisture ranged from 6.4% to 10.8%, averaging 8.9%. The heap leach master composite saturation moisture was 15.2% while the retained moisture was 12.3%. The ROM samples tested in 2018 had an average saturation moisture of 12.5% and an average retained (drain down) moisture of 9.7%.

Table 13-17: Heap Leach Grade Ore Sample Saturation and Retained Moisture

Composite	Ore Zone	Lithology	Feed Size	Moisture, wt. %		-200 mesh content, %
			mm	To Saturate	Retained	
4505-001-LG	South Domes	Vx	25	8.8	6.8	1.9
4505-007-LG	JSLA	Andesite	25	8.7	6.4	3.2
4505-002-LG	South Domes	Rhy-Aph	25	10.0	8.2	2.4
4505-015-LG	East Ridge	Rhy-Aph	25	13.0	10.2	3.1
4505-001-LG	South Domes	Vx	9.5	14.6	11.7	5.6
4505-002-LG	South Domes	Rhy-Aph	9.5	11.9	8.9	6.2
4505-003-LG	South Domes	Diatreme	9.5	16.9	12.8	7.3
4505-007-LG	JSLA	Andesite	9.5	15.0	11.5	8.5
4505-010-LG	Jumbo	Vx	9.5	24.3	18.5	17.3
4505-015-LG	East Ridge	Rhy-Aph	9.5	17.3	13.1	6.6
4505-021-LG	Oro Belle	Rhy-Aph	25	11.3	9.0	3.1
4505-017-LG	Oro Belle	Vx	9.5	13.7	10.8	9.9
4505-018-LG	Oro Belle	Rhy-Aph	9.5	13.0	9.8	5.4
4505-020-LG	Oro Belle	Vx	9.5	12.9	10.0	6.8
4505-017-LG	Oro Belle	Vx	9.5	22.3	17.5	12
4505-018-LG	Oro Belle	Rhy-Aph	9.5	21.1	16.4	9.9
4505-019-LG	Oro Belle	Andesite	9.5	24.5	18.2	12.7
4505-020-LG	Oro Belle	Vx	9.5	20.0	15.8	10.4
4505-021-LG	Oro Belle	Rhy-Aph	9.5	18.8	14.7	9
4505-025-LG	Oro Belle	Epiclastic	9.5	16.2	12.5	7.2
4505 LG MC	Blend	Heap Leach Master Composite	25	15.2	12.3	7.9

13.5.3.5 Fines and Saturation

Tails screen analysis was done on residue from each of the column leach tests. The quantity of fines (material finer than 200 mesh) was compared to the saturation by sample tested, lithology and ore zone. As expected, the saturation moisture results correlated closely with the fines content of the samples tested. Samples from the Jumbo ore zone had the most fines and the highest average level of saturation, followed by Oro Belle. The saturation for Jumbo and Oro Belle was on average 24% and 17%, respectively. Figure 13-14 shows the average saturation and fines for each ore zone. No ponding was observed from any of the column tests.

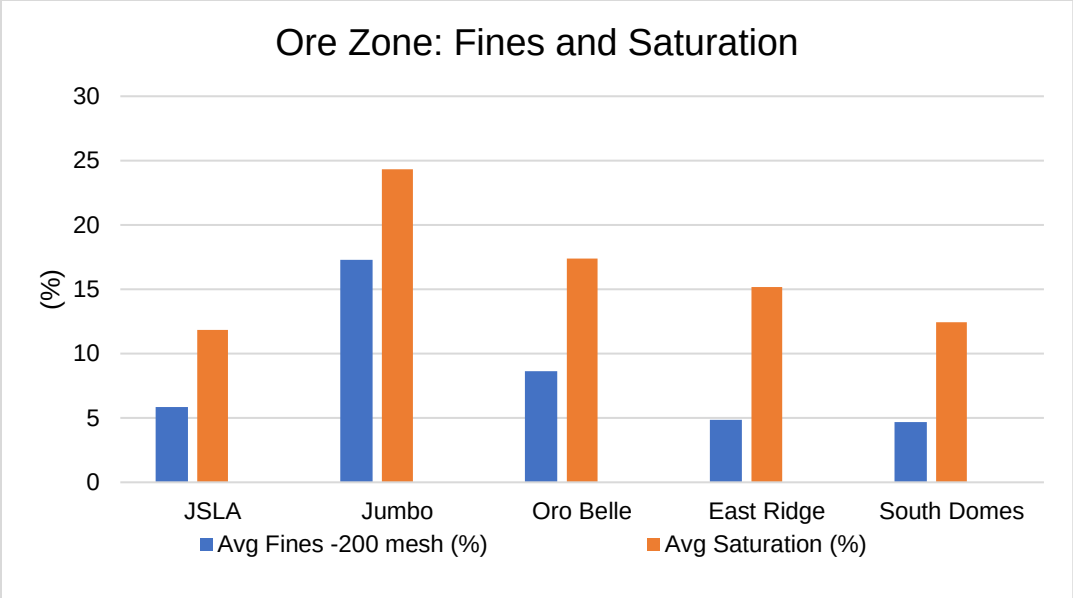


Figure 13-14: Ore Zone: Fines and Saturation

The lithology with the most fines and highest saturation was Vx followed by Andesite. Figure 13-15 lists the average saturation and fines for each lithology.

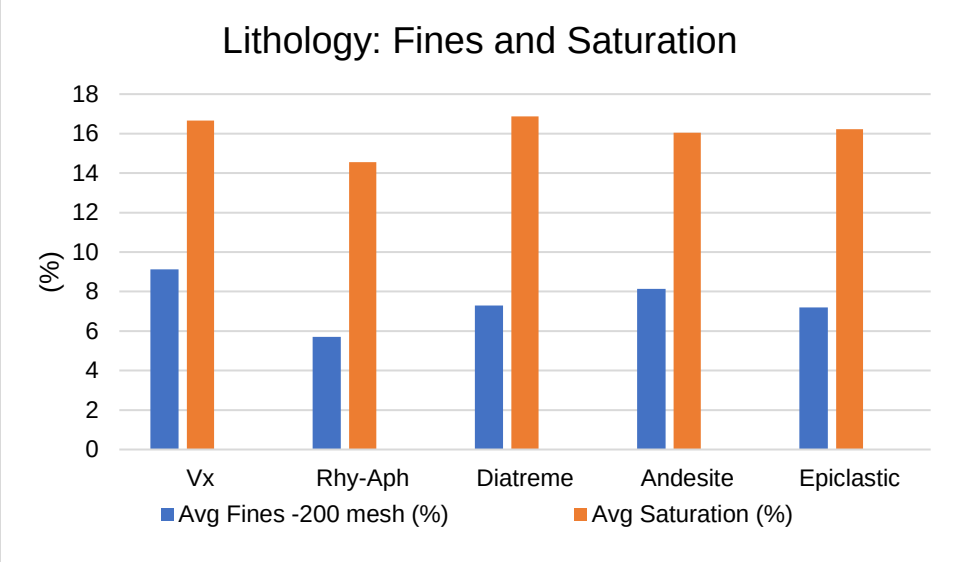


Figure 13-15: Lithology: Fines and Saturation

Based on the crushed samples tested, Jumbo ore zone with the Vx and Diatreme lithology is estimated to have a high quantity of fines and saturation requirement. The water balance may be impacted when the material with high fines and saturation is placed on the pad.

13.5.3.6 Tail Screen Assays by Size Fraction

Tail screen analysis was done on the leach residue for all column tests. The average fines in the 200 mesh (75 µm) was 7% with the respective gold distribution averaging 3%. Overall, the fraction

of gold decreased with the decreasing particle size indicating most of the gold was associated with a coarser size or that the fines fraction leached preferentially.

13.5.3.7 Cyanide Consumption

Cyanide consumption for the column tests used to estimate the gold recovery range from 0.5 to 4.8 lb/ton ore (0.25 to 2.4 kg/t ore) with the average being 2.0 lb/ton ore (1.0 kg/t ore). Samples with a head grade below 0.02 oz/ton (0.684 g/t ore) had a consumption less than 3 lb/ton (1.5 kg/t) and samples above a head grade of 0.02 oz/ton (0.684 g/t ore) had a consumption greater than 3 lb/ton ore (1.5 kg/t ore). Lithology had no effect on cyanide consumption as seen in Figure 13-16.

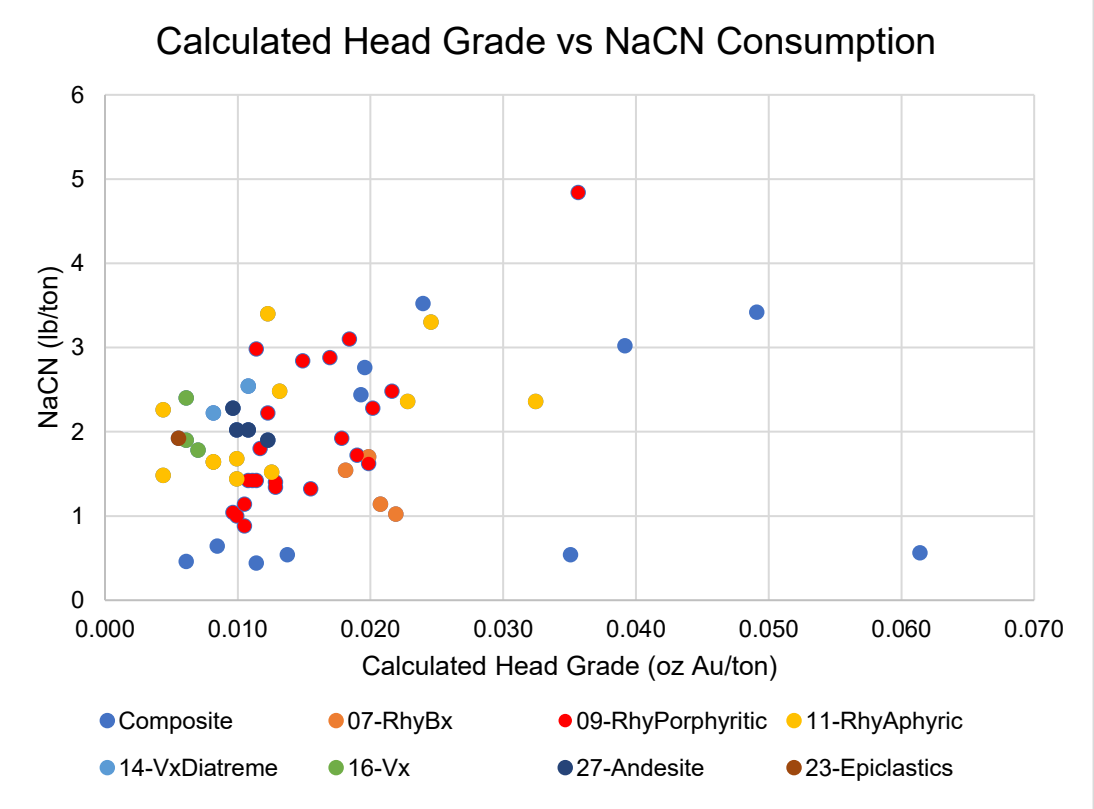


Figure 13-16: NaCN Consumption by Gold Head Grade

The average cyanide consumption weighted by the respective LOM tons in each ore zone yields a consumption of 1.9 lb/ton ore (0.95 kg/t ore). Field cyanide consumptions are expected to be lower than those measured in the lab. A typical factor used in industry of 30% was applied to obtain a cyanide consumption of 0.6 lb/ton ore (0.3 kg/t ore). This also benchmarks well against similar operations.

13.5.4 Heap Leach Ore Gold Recovery

The ROM heap leach recovery estimate for the feasibility study is based upon the testwork from 2015 through 2020. All heap leach grade column tests were evaluated by feed size, ore zone and lithology.

In order to strictly evaluate heap leach recovery, only samples with a calculated head grade between 0.006 – 0.036 oz/ton (0.2 – 1.25 g/t) were included, unless noted otherwise, and used to estimate a recovery.

After applying the above criteria, 53 tests fell within the heap leach grade criteria. Three tests with a head grade greater than 0.036 oz/ton and three tests with a head grade below 0.006 oz/ton were included, for a total of 59 tests that were used to determine gold recovery. The three tests above the cut-off grade were included since they were done concurrently with ROM column tests. The three tests below the cut-off grade were included since the they represented samples from an ore zone (East Ridge) or lithology (epiclastic) not previously tested. A total of 59 tests were evaluated and used to determine the gold recovery.

13.5.4.1 Average Recovery by Feed Size

Column leach test results were evaluated by feed size. The results indicated slight variation in gold recovery between the different feed sizes as shown in Table 13-18. The arithmetic average gold recovery of the column leach tests that met the calculated head grade was 81.5%.

Table 13-18: Average Gold Recovery Summary

Nominal Feed Size (mm)	Avg Gold Recovery (%)	No. of Tests
9.5	83	32
19	80	7
25	78	7
50	80	7
Arithmetic Avg Recovery	**81.5**	**53**

13.5.4.2 Average Recovery by Ore Zone

The test results were also reviewed by ore zone. Results for the East Ridge ore zone are included even though samples had a calculated head grade below 0.006 oz/ton.

Column leach test results indicated no significant difference between gold recovery and size. The average gold recovery by size for each ore zone is shown in Figure 13-17. The gold recovery for the Jumbo ore zone was consistent for all column tests (approximately 85%). The ROM column leach test done on Oro Belle had a gold recovery of 86%. The Oro Belle column tests performed at a finer size had a slightly lower gold recovery than the ROM test. The tests done on the JSLA backfill material is shown for comparison. The JSLA backfill material is previously mined material from the JSLA ore deposit which is not part of Phase 2.

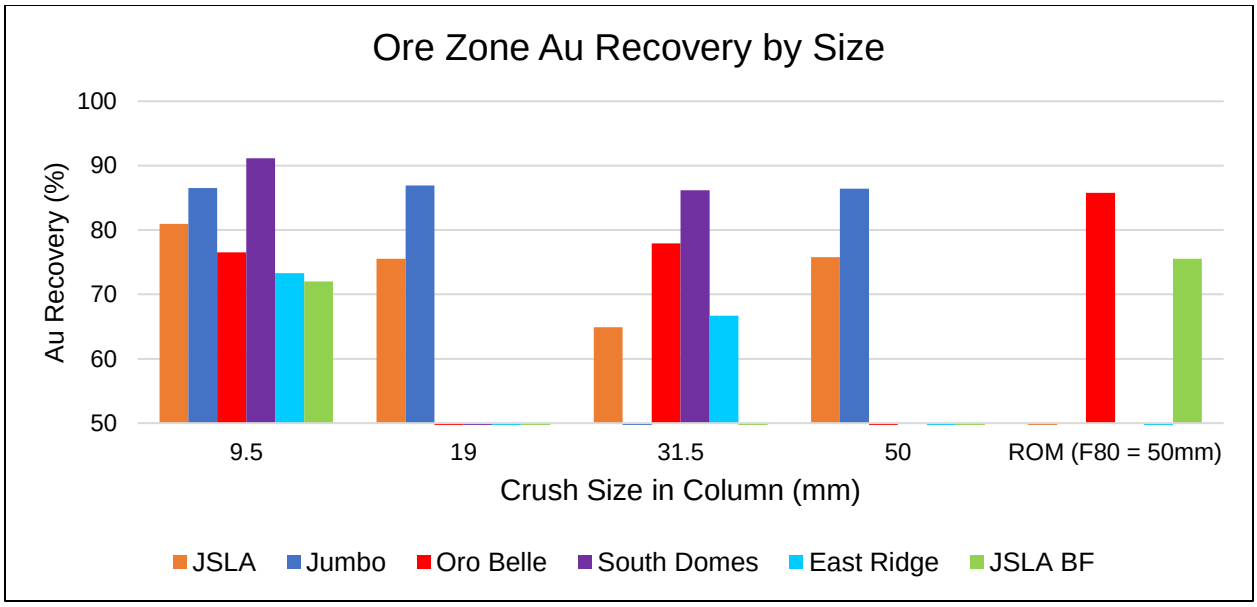


Figure 13-17: Ore Zone Gold Recovery by Size

13.5.4.3 Weighted Average Recovery by Lithology

The column leach test results by lithology are plotted in a box and whisker plot as shown in Figure 13-18. As seen, lithologies RhyAphyric and Andesite had the greatest gold recovery distribution.

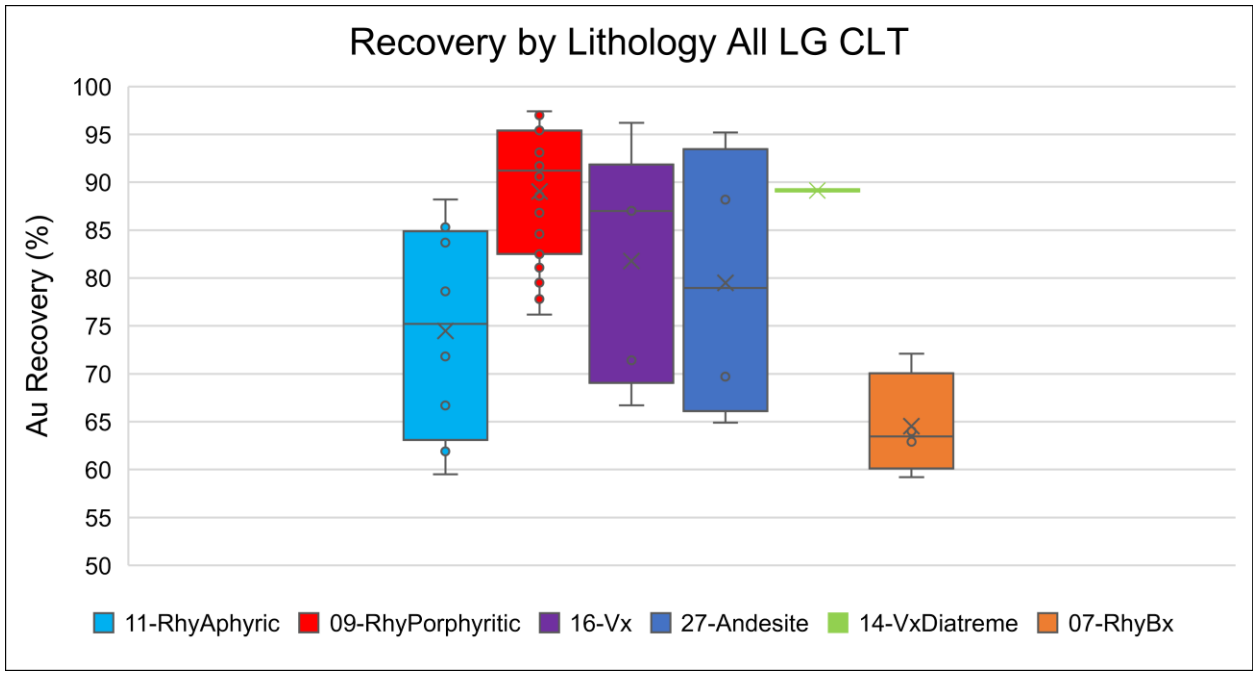


Figure 13-18: Recovery by Lithology All LG CLT

The average gold recovery for the lithologies ranged from 37% to 89%. Lithologies RhyAphyric, RhyPorphyritic and Vx which account for 86% of the ounces, had a gold recovery of 77%, 89% and 75%, respectively. Table 13-19 lists the percent of tons and ounces for each lithology and the average gold recovery from the column leach tests that met the calculated head assay criteria.

Table 13-19: Average Gold Recovery by Lithology

Lithology	Heap Leach Tons %	Heap Leach Ounces %	No. of Tests	Avg Gold Rec %
11-RhyAphyric	26.6	25.1	12	77
09-RhyPorphyritic	32.3	36.6	22	89
16-Vx	29.6	24.5	3	75
27-Andesite	2.1	1.8	4	80
14-VxDiatreme	4.8	6.9	2	89
23-Epiclastic	3.6	4.2	1	37
07-RhyBx	0.7	0.7	4	65
Total / Weighted Average	**99.7**	**99.8**	**48**	**80**

A weighted gold recovery, using the ounces associated with each lithology, was calculated to be 80%.

13.5.4.4 Calculated Head Grade by Gold Recovery

Gold recovery relationship to head grade is shown in Figure 13-19 for all 48 tests. While there was no clear relationship observed from this data, lower grade samples (<0.008 oz/ton) typically have lower than average recovery, while higher grade samples (>0.025 oz/ton) have higher than average recovery.

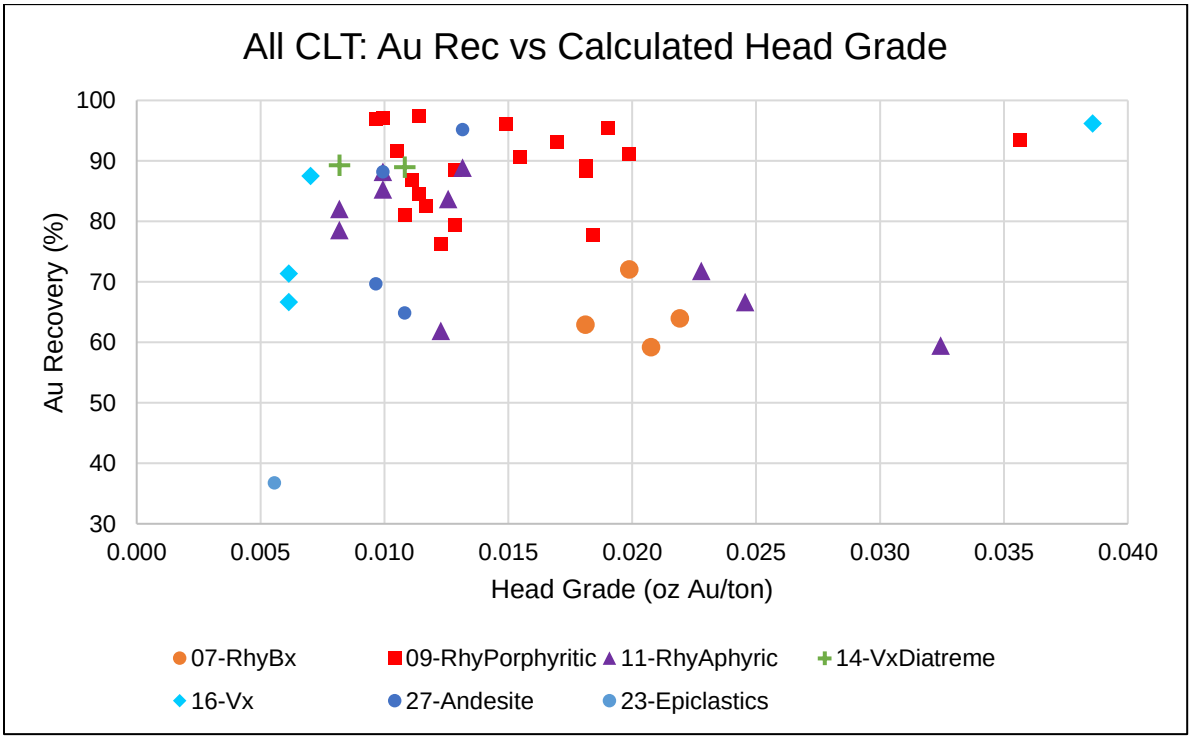


Figure 13-19: Calculated Head Grade by Gold Recovery

13.6 MILL GRADE ORE TESTING

13.6.1 2015 and 2018 Testing

In 2015, gravity plus gravity tail cyanidation testwork and whole ore leach tests were completed on six composites. All tests were done at 75 µm and showed gold recovery greater than 95%. The gravity recoverable gold varied from 18% to 87%, with a combined recovery for all samples above 95%. All whole ore leach tests had a recovery above 95%.

For the 2015 testwork, cyanide consumption for the gravity tail cyanidation tests averaged 1.4 lb/ton ore (0.70 kg/t ore). Lime consumption ranged from 2.8 to 5.4 lb/ton ore (1.40 to 2.70 kg/t) ore with the average being 4.7 lb/ton ore (2.35 kg/t ore). Cyanide consumption for the whole ore leach tests ranged from 0.30 to 0.90 lb/ton ore (0.15 to 0.45 kg/t ore) with the average being 0.45 lb/ton ore (0.22 kg/t ore). Lime consumption ranged from 3 to 5 lb/ton ore (1.50 to 2.50 kg/t ore with the average being 4 lb/ton ore (2 kg/t ore).

In 2018, gravity plus gravity tail cyanidation testwork and whole ore leach tests were completed on nine composites. All tests were done at 150 µm. The recovery to gravity varied from 16% to 46%, with a combined recovery above 95% for all samples. A tenth high grade sample was used for grind size optimization test with gravity, cyanidation, and comminution testing. The grind sizes evaluated were 80% minus 300, 212, 150 and 106 µm. Gold recoveries were all high and slightly improved with finer size. Cyanide consumption was less than 0.20 lb/ton ore (0.10 kg/t ore) for all tests. To further evaluate gravity plus tails leach versus whole ore leach additional testing was on three RC drill composites. Tests were done at 75 µm for 72 hours. The recoveries for all the tests after 72 hours were greater than 95%.

For the 2018 testwork, cyanide consumption for the gravity tail cyanidation tests ranged from 0.20 to 0.24 lb/ton ore (0.10 to 0.12 kg/t ore) with the average being 0.20 lb/ton ore (0.10 kg/t ore). Lime consumption ranged from 1.6 to 6.4 lb/ton ore (0.80 kg/t ore to 3.20 kg/t ore) with the average being 3.28 lb/ton ore (1.64 kg/t ore). Cyanide consumption for the whole ore leach tests ranged from 0.30 to 0.90 lb/ton ore (0.15 to 0.45 kg/t ore) with the average being 0.44 lb/ton ore (0.22 kg/t ore). Lime consumption ranged from 3 lb/ton ore (1.50 to 2.50 kg/t ore) with the average being 4 lb/ton ore (2.0 kg/t ore).

In 2018, CIL and gravity CIL tests were done on a single composite. All tests were done at 150 µm. Different times were evaluated to determine the retention time for CIL. For direct CIL testing, the gold recovery was 92% after 96 hours. For gravity and tail CIL testing, the combined recovery was 93% for 48 hours.

Test results from 2015 and 2018 are summarized along with 2020 results and are provided in Section 13.6.3.

13.6.1.1 Comminution

In 2015, FLS performed Bond abrasion index (Ai) and Bond crusher impact (CWi) testing on seven samples of rock types most commonly associated with mineralization at Castle Mountain. Samples were prepared to meet all testing standards and all work was conducted according to industry best practices. The results from these tests show the CWi and the Ai classify as Very Soft to Medium, as shown in Table 13-20. Results suggest relatively low required crusher energy and wear part replacements.

Table 13-20: Abrasion Index and Crusher Impact Test Results (2015 results)

Lithology	No. of Samples Tested	ID	Relative Density	Bond Abrasion Index (Ai)		Crusher Work Index (CWi)		
				grams	Classification	kW-hr/ton	kW-hr/t	Classification
Ash Tuff	20	3878-204	2.11	0.0115	Very Soft	9.70	10.7	Very Soft/Soft
Conglomerate Multi-Lithic	20	3878-203	2.13	0.2165	Medium	13.6	15.0	Soft/Medium
Rhyolite	20	3878-201	2.30	0.2978	Medium	13.90	15.30	Soft/Medium
Rhyolite-Breccia	20	3878-202	2.19	0.1602	Soft	13.9	15.40	Soft/Medium

13.6.1.2 Thickening

In October 2017, thickening testwork was conducted on leached residue from a JSLA mill grade ore sample and results were discussed in the PFS for the Castle Mountain Project (Scott et al., 2018).

13.6.2 2020 Testing

Twelve mill grade ore composites were selected and used for testing to further evaluate whole ore leach versus gravity concentration tests with agitated leaching of the gravity tails and confirm design parameters. The test program for mill grade ore includes:

- Head Assays
- Comminution Testing – Ai, RWi, BWi, SMC, JK Dropweight Test
- Grind Size/Recovery
- Gravity Recovery/Leach Tests
- Whole Ore Leach Tests
- Cyanide Detox Testing
- Solid and liquid separation
- Geotech testing

The calculated gold head grades of the composites ranged from 0.019 to 0.045 oz/ton (0.65 to 1.55 g/t ore). The expected gold grade to the mill is greater than 0.037 oz/ton (1.26 g/t ore), and the average LOM grade is 0.067 oz/ton (2.3 g/t ore).

13.6.2.1 Comminution

In 2020, FLS performed a series of comminution testwork which included seven (7) SMC tests® and one (1) JK Drop Weight test (DWT) (FLSmidth, 2020). On a full JK Drop-Weight test, ore is grouped into several different size fractions and tested at increasing energy levels. This test yields an illustration of the size-by-size rock strength for the ore being tested. Furthermore, a relationship is established between breakage and impact energy, which is described by the JK parameters A and b. The SMC Test uses a single size fraction at increasing energy levels. The size-by-size rock strength characteristics of an ore, that are determined by a full drop-weight test, are utilized to estimate the JK rock breakage parameters A and b.

FLSmidth received six (6) different samples for SMC testing in 2019. One (1) additional sample was received for one (1) additional SMC test® and one (1) JKTech Drop Weight test. The samples were prepared according to standard procedures and tested in accordance with the standard practices for these tests. Table 13-21 provides a summary of the tests which were conducted on the seven (7) samples.

In the case of the 4505-004-HG, 4505-005-HG, 4505-006-HG, 4505-009-HG, 4505-012-HG,4505-023-HG and 4505-CC-1 samples from Castle Mountain Project, the A and b estimates are based on the results of full drop-weight testing on similar ore (4505-CC-1). The full drop-weight test results were used to calibrate the DWi versus A and b correlations.

Table 13-21: SMC and Drop Weight Test Results

Description	Lithology	Zone	ID	DWi	DWi	M_{ia}	M_{ih}	M_{ic}	A	b	Axb	sg	ta	SCSE
	% tons			kWh/m³	%	kWh/t	kWh/t	kWh/t						kWh/t
Vx	49.2	South Domes	4505-004-HG	5.31	32	19.1	13.5	7.0	64.9	0.67	43.48	2.28	0.49	9.5
Rhy-Aph	24.3	South Domes	4505-005-HG	5.33	33	19.2	13.6	7.0	64.3	0.67	43.08	2.28	0.49	9.5
Vx	49.2	South Domes	4505-006-HG	4.66	25	17.5	12	6.2	67.9	0.76	51.60	2.24	0.56	9.2
Rhy-Bx	1.5	JSLA	4505-009-HG	6.15	43	20.9	15.2	7.9	68.1	0.56	38.14	2.35	0.42	9.9
Andesite	8	Jumbo	4505-012-HG	4.17	20	15.4	10.4	5.4	63.7	0.88	56.06	2.33	0.62	8.5
Diatreme	1	Oro Belle	4505-023-HG	5.47	34	19.1	13.5	7.0	**64.1**	**0.67**	**42.95**	2.34	0.48	9.4
-	-	-	4505-CC-1	4.45	23	16.0	10.9	5.6	64.1	0.84	53.84	2.37	0.59	8.6

Bolded values (80th percentile) were used in the JKSimMet software to determine power requirements for a SAG mill option.

In 2020, MLI performed crusher work index (CWi) testing on whole HQ core (4505-CC-1). Results to date are shown in Table 13-22 and indicate the interval was very soft.

Table 13-22: Crusher Work Index Test Result

Work Index, kWh/ton:	9.43
Work Index, kWh/ton:	10.40
Crusher Work Index Classification	Very Soft

In 2020, MLI also performed Bond abrasion index (Ai), Bond rod mill work index (RWi), and Bond ball mill work index (BWi) testing on six mill grade ore composites. Bond ball mill work index was performed by MLI on one JSLA master composite sample in 2015 and is shown for comparison. Results to date are shown in Table 13-23.

Table 13-23: Abrasion Index, Bond Rod & Ball Mill Work Index Test Results

Description	Lithology	Zone	ID	Abrasion Index (Ai)		Bond Ball Work Index (BWi)			Rod Mill Work Index (RWi)		
	% tons			grams	Classification	kW-hr/ton	kW-hr/t	Classification	kW-hr/ton	kW-hr/t	Classification
Vx	49.2	South Domes	4505-004-HG	0.3663	Abrasive	14.20	15.65	Medium	15.71	17.32	Hard
Rhy-Aph	24.3	South Domes	4505-005-HG	0.3651	Abrasive	14.13	15.58	Medium	11.67	12.87	Medium
Vx	49.2	South Domes	4505-006-HG	0.2192	Abrasive	13.78	15.20	Medium	12.40	13.67	Medium
Rhy-Bx	1.5	JSLA	4505-009-HG	0.7134	Very Abrasive	17.61	19.41	Hard	15.48	17.06	Hard
Andesite	8	Jumbo	4505-012-HG	0.1205	Moderately Abrasive	12.33	13.60	Medium	11.55	12.73	Medium
Diatreme	1	Oro Belle	4505-023-HG	0.4232	Very Abrasive	16.19	17.84	Hard	17.27	19.04	Hard
Vx; Rhy-Aph	49.2; 24.3	-	JSLA MC 4210-067	-	-	18.03	19.87	Hard	-	-	-

Test results based on abrasion index and crusher work index classify the rock as soft but abrasive. Based on the testwork, an abrasion index of 0.264 g was selected to be used in the design. Rod and ball mill work index results indicate the material is relatively hard. Based on the testwork, a rod mill work index of 14.0 kWh/ton and bond ball work index of 15.2 kWh/ton was selected for the design of the grinding circuit. These selected indices are a weighted average of the lithologies

tested by the estimated percentage of tons they account for. Since JSLA ore is scheduled first in the mine production, high wear and energy consumption may be observed.

13.6.2.2 Whole Ore Leach and Gravity Tails Leach Tests

The summary of whole ore leach (WOL) and gravity tails leach (Grav/CN) tests are shown in Table 13-24 and include 12 test pairs at the following conditions:

- P_{80} of 150µm (100 mesh)
- Leached at the following conditions:
  - 96 hour leach time
  - 40% solids (w/w)
  - pH 10.5-11.0 maintained with hydrated lime
  - 0.5 g NaCN/L maintained

Note for Grav/CN tests the ground ore was first processed through a Knelson concentrator in a single pass before leaching the gravity tails.

Table 13-24: Summary of WOL and Grav/CN Tests on Mill Composites

Composite	Ore Zone	Lithology	Test Type	Gold Rec %	Gold Rec	Gold Rec	Gold Calc Head g/t Au	NaCN kg/t ore	Lime kg/t ore
4505-004-HG	South Domes	Vx	WOL	N/A	N/A	98.9	0.82	0.07	1.0
			Grav./CN	16.1	81.5	97.6	0.84	0.07	0.8
4505-005-HG	South Domes	Rhy-Aph	WOL	N/A	N/A	98.7	0.79	0.07	0.8
			Grav./CN	19.8	78.7	98.5	0.75	0.07	0.8
4505-006-HG	South Domes	Vx	WOL	N/A	N/A	98.5	1.36	0.07	1.5
			Grav./CN	26.5	71.1	97.6	1.25	0.09	1.3
4505-008-HG	JSLA	Diatreme	WOL	N/A	N/A	85.1	0.94	0.19	1.4
			Grav./CN	28.1	63.3	91.4	1.17	0.27	1.3
4505-009-HG	JSLA	Rhy-Bx	WOL	N/A	N/A	94.1	0.68	0.07	0.8
			Grav./CN	8.3	86.5	94.8	0.76	0.07	0.7
4505-011-HG	Jumbo	Rhy-Aph	WOL	N/A	N/A	89.3	0.28	0.07	1.9
			Grav./CN	6.1	86.9	93.0	0.29	0.10	2.2
4505-012-HG	Jumbo	Andesite	WOL	N/A	N/A	96.0	1.00	0.09	1.8
			Grav./CN	11.7	84.9	96.6	0.88	0.15	1.4
4505-013-HG	Jumbo	Rhy-Porph	WOL	N/A	N/A	96.9	0.65	0.07	1.0
			Grav./CN	19.2	76.7	95.9	0.48	0.07	1.3
4505-022-HG	Oro Belle	Rhy-Aph	WOL	N/A	N/A	96.2	1.04	0.09	1.3
			Grav./CN	19	75.5	94.5	1.00	0.08	1.6
4505-023-HG	Oro Belle	Diatreme	WOL	N/A	N/A	92.9	1.12	0.07	1.2
			Grav./CN	17.9	74.6	92.5	1.06	0.10	1.7
4505-024-HG	Oro Belle	Andesite	WOL	N/A	N/A	94.8	1.73	0.07	2.1
			Grav./CN	18.8	76	94.8	1.55	0.14	2.7
4505-026-HG	Oro Belle	Vx	WOL	N/A	N/A	93.6	0.78	0.07	1.7
			Grav./CN	10.5	83.5	94.0	0.83	0.15	2.1

Gravity gold recovery ranged from 6% to 28%. The recovery on the gravity tail leach varied from 63% to 87% for a combined average recovery of 95% after 96 hours.

The 2020 testwork showed good amenability to gravity concentration and gravity tail leaching for all mill grade ore samples.

Cyanide and lime consumption for the gravity tail cyanidation tests were similar to the consumptions from the 2015 and 2018 testwork. Cyanide consumption ranged from 0.14 to 0.54 lb/ton ore (0.07 to 0.27 kg/t ore) with an average of 0.20 lb/ton ore (0.10 kg/t ore). Lime consumption ranged from 1.2 to 5.4 lb/ton ore (0.60 to 2.70 kg/t ore) with the average being 2.82 lb/ton ore (1.41 kg/t ore).

ICP analysis was done on pregnant solution on gravity tail leach tests. Analyses show arsenic concentration at less than 0.2 mg/L, copper concentration ranging from 0.4 mg/L to 3.6 mg/L with one sample being at 30.8 mg/L and zinc ranging from 0.2 mg/L to 1 mg/L.

Overall gold recovery ranged from 89% to 99% with the average recovery being 95%.

13.6.2.3 Grind Size vs Recovery

In 2020, a grind recovery series was run on four composites: 4505-004-HG, 4505-005-HG, South Domes Master Composite and Main Pit Master Composite. These results are presented in Figure 13-20 alongside the grind recovery series conducted in 2018. Four tests were done at both 150 µm and 300 µm with better recovery in all cases at 150 µm. Grinding to 106 µm resulted in lower recovery in two of the three tests and grinding further down to 74 µm did not improve total recovery in either of the two samples. Based on these test results, a 150 µm (100 mesh) grind size appears to be the optimum size for the mill grade ore.

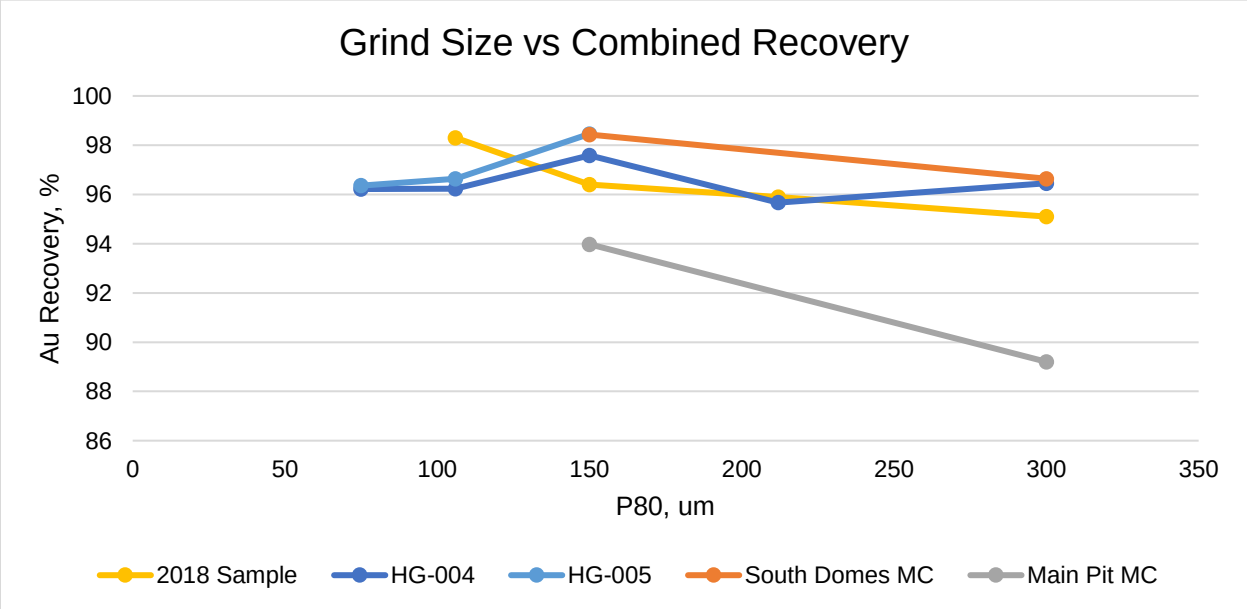


Figure 13-20: Grind Size vs Combined Recovery

13.6.3 Mill Grade Ore Gold Recovery

The results for the 2020 testwork, which is representative of the majority of lithologies within the mine and consisted of 12 samples ground to a P_{80} of 150 µm, indicated faster leach kinetics for gravity plus tails leach in comparison to whole ore leach without gravity. Gravity plus tails leach at 24 hours shows a similar recovery to that of whole ore leach after 96 hours. Results for the 2020 combined gravity and tails leach indicated an average of 94.7% recovery at 24 hours. Whole ore leach had an average recovery of 92.5% at 48 hours. Individual whole ore leach results at 48 hours range from 87% to 96% compared to the gravity plus tails leach tests at 24 hours which range from 91% to 98%. Table 13-25 shows resulting average recoveries for incremental tested leach times. Figure 13-21 below shows the resulting leach curves from 2020 testwork showing average recovery.

Table 13-25: 2020 Testwork – Average Recovery vs Time

Leach Time	Whole Ore Leach Recovery (%)	Gravity + Tails Leach Recovery (%)
2	40.5	59.6
4	57.2	76.8
8	62.6*	87.6
24	84.4	94.7
48	92.5	94.2
72	93.6	95.4
96	94.6	95.4

* Value interpolated; 8-hour reading was not taken for Whole Ore Leach (2020 Testwork)

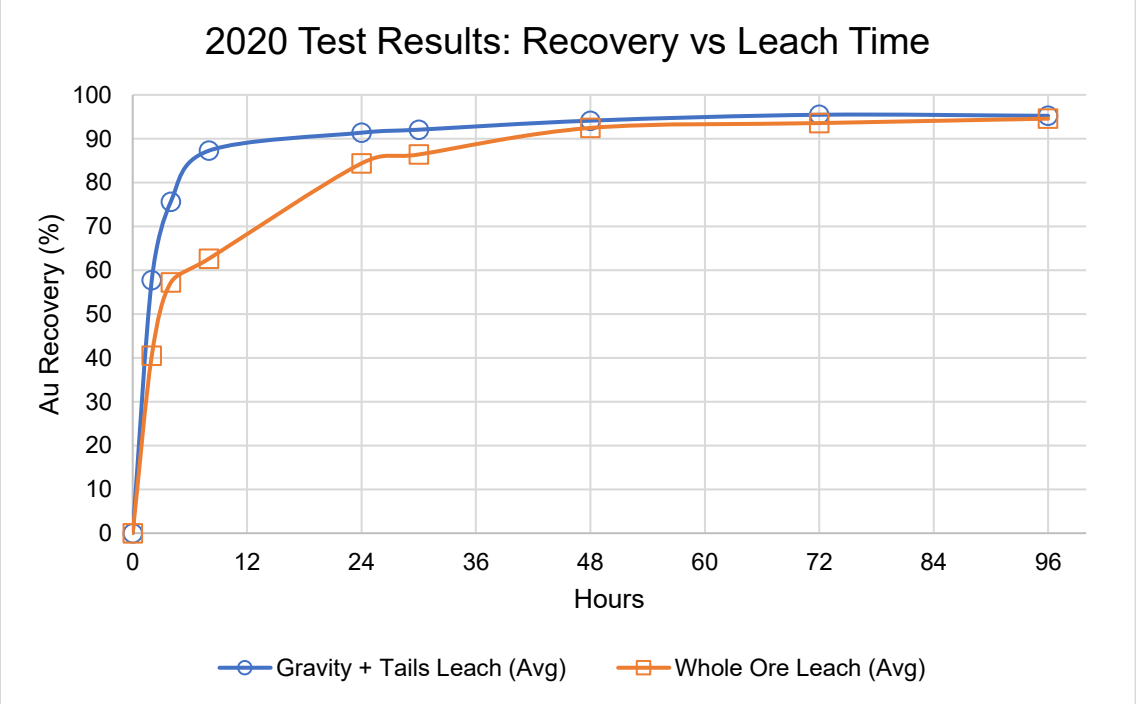


Figure 13-21: 2020 Test Results – Recovery vs Leach Time

Cyanide consumption for the whole ore leach tests ranged from 0.14 to 0.40 lb/ton ore (0.07 to 0.20 kg/t ore) with the average being 0.16 lb/ton ore (0.08 kg/t ore). Lime consumption ranged from 1.6 to 4.2 lb/ton ore (0.80 to 2.10 kg/t ore) with an average of 2.8 lb/ton ore (1.4 kg/t ore).

Gravity plus gravity tail cyanidation and whole ore leach testwork completed in 2015, 2018, and 2020 was evaluated. Test programs were executed primarily at a P_{80} of 75 and 150 µm with an overall leach time of 72 and 96 hours. Review of the resulting leach curves and recoveries from each of these test programs were then used as basis for establishing criteria with which to evaluate use of a gravity circuit within the Castle Mountain flow sheet.

Gold recovery for whole ore leach and gravity plus tail leach was universally high independent of grade, in all tests evaluated as can be seen in Figure 13-22.

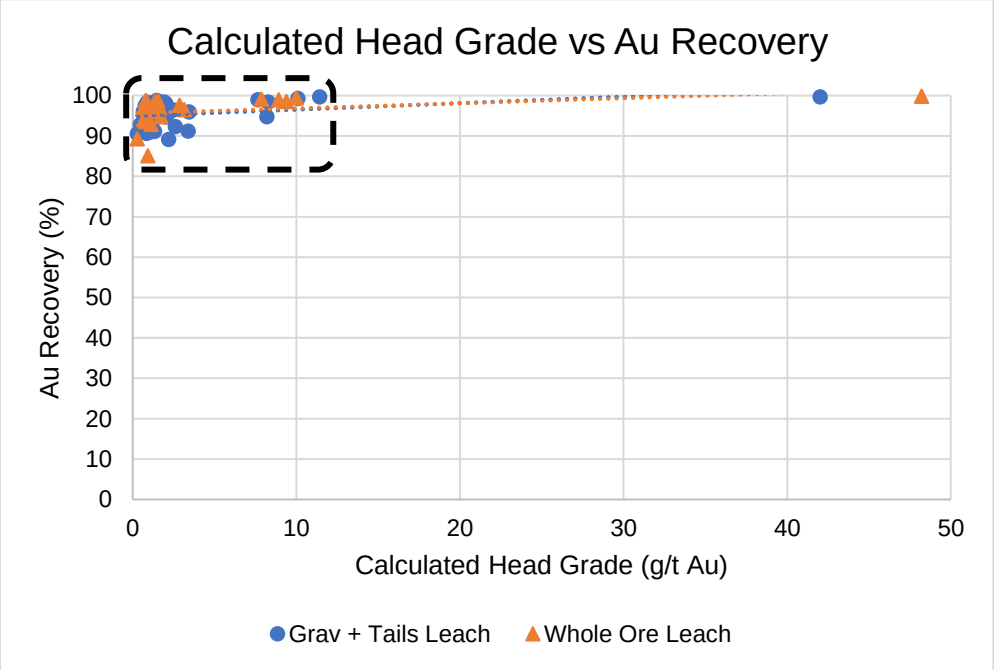


Figure 13-22: Calculated Head Grade vs Gold Recovery

Figure 13-23 is the same data plotted in Figure 13-22 with adjusted x-axis scale since almost all test results fell within this range.

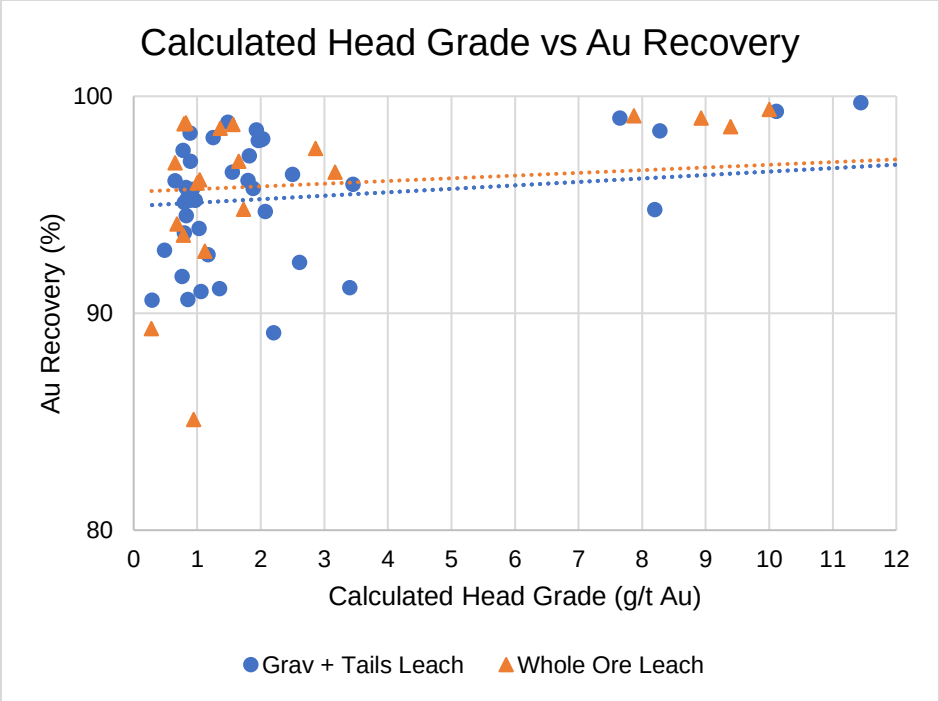


Figure 13-23: Calculated Head Grade vs Gold Recovery (Adjusted Scale)

Results of leaching testwork at 150 µm from 2015, 2018 and 2020 were plotted for whole ore leach and gravity plus tails leach to show the range in recovery by lithology. Figure 13-24 shows that resulting ranges for recovery are generally similar between whole ore leach and gravity plus tails leach.

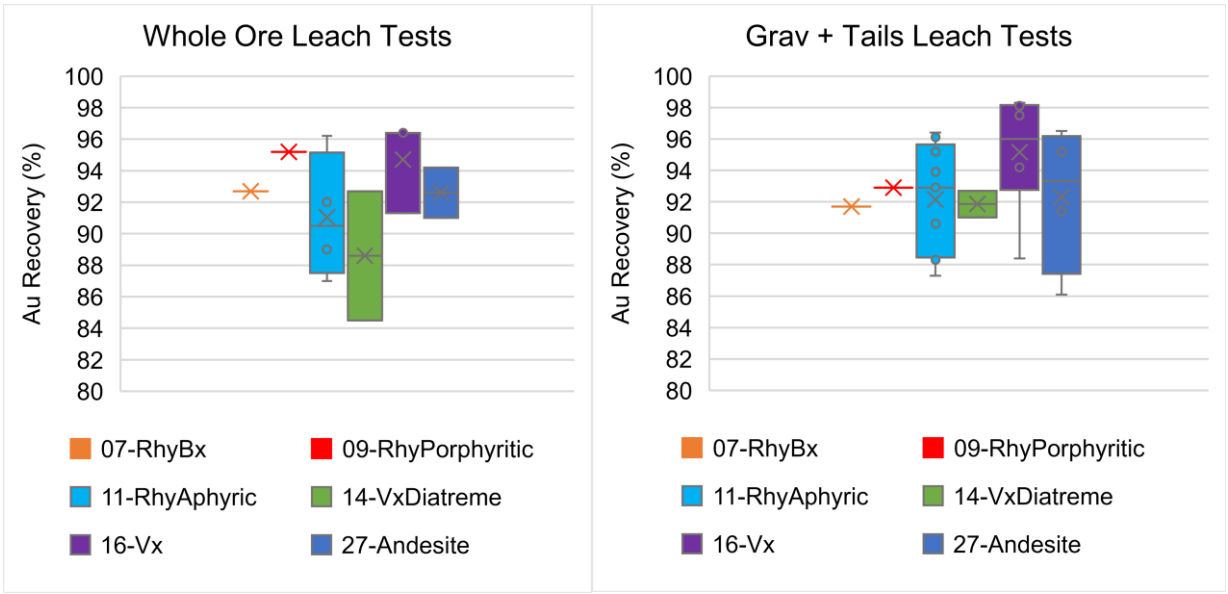


Figure 13-24: % Recovery Range by Lithology, 150 µm (2015-2020) Combined Results

An average of all the tests was taken for each lithology. These values were then weighted based on the percentage of ounces that these lithologies carry in the project mine plan. The resulting

average recoveries by lithology and weighted by percent ounces are shown below in Table 13-26.

Table 13-26: Weighted Average Recoveries by Lithology – 150 µm (2015-2020)

Lithology	Whole Ore Leach Recovery (%) – 24 Hours	Whole Ore Leach Recovery (%) – 48 Hours	Gravity + Tails Leach Recovery (%) – 24 Hours	Gravity + Tails Leach Recovery (%) – 48 Hours	% Ounces
Rhy-Bx	86.7	92.7	91.7	90.8	1.2
Rhy-Porph	89.7	95.2	92.9	91.2	17.7
Rhy-Aph	81.5	91.1	92.1	93.3	22.1
Diatreme	81.9	88.6	91.9	90.8	2.3
Vx	86.1	94.7	95.2	96.1	42.4
Andesite	86.1	92.6	92.3	92.5	8.4
Weighted Average	**85.6**	**93.6**	**93.6**	**94.0**	**94.0**

Whole ore leach recovery was incomplete after 24 hours having achieved only 86% and required 48 hours to reach recoveries of nearly 94%. Gravity plus gravity tails leach nearly reached ultimate recovery of 94% after 24 hours and was the same as whole ore leach after 48 hours and only had marginal recovery when the gravity tails leach continued to 48 hours.

All whole ore leach and gravity plus tails leach tests were evaluated by ore zone. Average gold recovery varied slightly between whole ore leach tests and gravity plus tails leach as shown in Table 13-27.

Table 13-27: Weighted Average Recoveries by Ore Zone – 2015, 2018, 2020 Testwork

Ore Zone	Whole Ore Leach Recovery (%) – 48 Hours	Gravity + Tails Leach Recovery (%) – 24 Hours	% Ounces
JSLA	93.1	94.9	33.9
Oro Belle	92.8	93.2	13.9
South Domes	94.9	94.3	26.2
Jumbo	92.1	92.9	9
Weighted Average	**93.5**	**94.2**	**83**

For this Feasibility Study, gravity followed by gravity tail leach in a hybrid leach/CIL circuit was selected for the process based on economics. An overall gold recovery of 94% is expected from mill grade ores processed through the mill after 24-hour CIL retention time.

13.6.3.1 Cyanide Consumption

Cyanide consumption is estimated from gravity tails leach testwork at 150 µm in 2018 and 2020 on ore with grades exceeding 0.036 oz/ton (1.25 g/t). This includes 13 gravity tails leach tests and 3 gravity tails CIL tests. Cyanide consumption for the tests used to estimate the gold recovery range from 0.2 to 1.6 lb/ton ore (0.1 to 0.8 kg/t ore) with the average being 0.4 lb/ton ore (0.2 kg/t ore). Based on this, cyanide consumption for mill grade ore is estimated to be 0.4 lb/ton ore (0.2 kg/t ore) over the LOM.

13.7 MILL GRADE ORE MASTER COMPOSITE 2020 TESTING

Two master composites were made representing Main Pit and South Domes, respectively. Both samples were tested through the entire milling process: crushing, grinding, gravity, pre-leach thickening, CIL, detox, tailings thickening, filtering and tailing stacking. Emphasis was placed on testing detox, thickening, filtering and tailings stacking.

13.7.1 Sample Prep and Grinding

Two master composites, Main Pit HG MC and South Domes HG MC, were produced by MLI as per the composite make-up presented in Table 13-28 and Table 13-29. These samples were crushed and ground to a P_{80} of 150 µm (100 mesh).

Table 13-28: Main Pit Mill Grade Ore Master Composite Make-up

Composite	Lithology	Hole ID	Make-up Proportion
HG-011	Rhy-Aph	CMM-021C	15%
HG-012	Andesite	CMM-283C	5%
HG-013	Rhy-Porph	CMM-281C	30%
HG-022	Rhy-Aph	CMM-119C	15%
HG-024	Andesite	CMM-036C	5%
HG-026	Vx	CMM-120C	30%

Table 13-29: South Domes Mill Grade Ore Master Composite Make-up

Composite	Lithology	Hole ID	Make-up Proportion
HG-004	Vx	CMM-248C	25%
		CMM-252C	
HG-005	Rhy-Aph	CMM-016C	50%
HG-006	Vx	CMM-250C	25%

13.7.2 Bulk CIL for Tailings Tests

The two master composites were split and four bulk CIL tests were completed to generate tailing at two different residual free cyanide concentrations for the subsequent detox tests. Parameters used for each bulk CIL test are shown below, cyanide conditions are presented in Table 13-30, and CIL recovery results are presented in Table 13-31.

- Approximately 11 kg of ore, P_{80} of 150 µm (100 mesh)
- 50% solids (w/w)
- pH 11 maintained with hydrated lime
- 48 hours leach time
- Au/Ag extraction method CIL
- Carbon concentration 10 g/L

Table 13-30: CIL Initial and Residual Cyanide Concentration

Composite	Initial Cyanide Concentration g NaCN/kg ore	Residual Cyanide Target g NaCN/kg ore (ppm CN_{WAD})[1]
Main Pit HG MC	500	250 (125)
Main Pit HG MC	300	150 (75)
South Domes HG MC	500	250 (125)
South Domes HG MC	300	150 (75)

Note 1: at 50% solids, g NaCN/kg ore is approximately 1/2 ppm CN_{WAD} in solution.

For each composite, recoveries were essentially the same (within 0.8%) at both initial NaCN concentrations. South Domes composite gold recovery averaged 98.4%. Main Pit composite gold recovery averaged 94.0%.

Bulk tests were done at higher density (50% vs 40%) than other high-grade leach tests, shorter leach time (48 hours vs 96 hours), and at lower cyanide concentrations (500 and 300 ppm vs 1,000 ppm).

The weighted average recovery from 1 kg whole ore cyanidation tests of the three constituent South Domes composites was 98.7% compared to 98 and >98.8 for the bulk tests. The weighted average whole ore recovery from the six constituent Main Pit composites was 95.1% compared to 94.2% and 93.8% for the bulk tests.

Based on this, relative to the tests on individual composites discussed in Section 13.6.2, it appears that increasing the slurry density (40% to 50%) reducing the leach time (96 to 48 hours) and decreasing the NaCN concentration (1 g/L to 0.5 or 0.3 g/L) did not impact recovery.

Silver recoveries were comparable to the individual 1 kg tests, although most of the loaded carbon silver grades were below detection limits, so these results are not definitive.

Calculated gold head grades are reasonably close to the predicted head grades.

Table 13-31: Bulk Bottle Roll Tests (CIL) Recoveries

Composite	g/t Au Calculated Head	Initial NaCN Conc., g/L	Au Recovery, %	g/t Au		Ag Recovery, %	g/t Ag		Reagent Requirements kg/t ore	
				Extracted	Tail		Extracted	Tail	NaCN Cons.	Lime Added
Main Pit HG MC	0.69	0.50	94.2	0.65	0.04	<38.9	<0.7	1.1	0.24	1.4
Main Pit HG MC	0.80	0.30	93.8	0.75	0.05	<38.9	<0.7	1.1	0.09	1.8
South Domes HG MC	1.02	0.50	98.0	1.00	0.02	<50.0	<0.7	0.7	<0.07	0.9
South Domes HG MC	<0.85	0.30	>98.8	0.84	<0.01	40.0	0.4	0.6	0.09	1.3

13.7.3 Cyanide Detox Testing

Caro's Acid and SO_2/air cyanide destruction tests were performed on two Castle Mountain slurry samples to identify detoxification operating parameters, final residual cyanide values, and estimated reagent requirements.

Each of the samples were tested using Caro's Acid and SO_2/air. Target free cyanide levels for the tests were weak acid dissociable cyanide (CN_{WAD}) levels of 25 and 1 ppm. Tests on Main Pit samples were run at 55% solids density while tests on South Domes samples were run at 60% and 62% solids density. Test procedures are detailed in the Cyanco test report (Cyanco, 2020).

Based on the results of the testwork program both methods of cyanide detox will work on the Castle Mountain Main Pit and South Domes slurry tested. Both methods tested were successful in reducing the CN_{WAD} levels to the desired targets of below 25 and 1 ppm. Test results indicated that a higher pulp density for both the Main Pit ore and the South Domes ore did not allow for proper mixing of the reagents. In addition, a two-hour retention time and sparging of pure (93%) oxygen is recommended for the SO_2/air method.

Required treatment limits should be confirmed and further testwork would be recommended to optimize conditions (reagents/air) in conjunction with optimization of the CIL circuit.

13.7.4 Thickening

Three solid-liquid separation programs were conducted at Pocock Industrial Inc. for MLI on the Castle Mountain mineralization. The first took place in October 2017. The second program was conducted in March and April 2020 on master composites from Main Pit and South Domes ore zones. This included two CIL feed samples (Main Pit and South Domes HG MCs) and two detoxed CIL residue samples (Main Pit and South Domes HG MCs). In June, ten additional tests were done on composites from JSLA, South Domes, Oro Belle and Jumbo ore zones to further investigate potential thickening, filtration, and viscosity issues.

Thickening tests (static and dynamic) and filtration tests (vacuum and pressure) were completed. The P_{80} of the samples of the Main Pit ore were 122 µm for the CIL feed sample and 134 µm for the detoxed residue sample. The P_{80} of the samples of the South Domes ore were 147 µm for the CIL feed sample and 144 µm for the detoxed residue sample. The specific gravity of the samples was back calculated using solids concentration and pulp densities and ranged from 2.65 to 2.84. Lime was used to adjust the pH of the CIL feed samples to 11.5.

The following contains a summary of the recommendations from the 2020 testing program, (Pocock, 2020).

- A single flocculant could not be used to provide acceptable results for both the CIL feed samples and the detoxed residue samples. The flocculant selected for the best performance was an anionic polyacrylamide flocculant (SNF AN910SH) for the CIL feed samples while a cationic product (SNF FO 4190 SSH) was selected for the detoxed residue samples. Flocculant (anionic) dose requirements for thickening on the CIL feed samples ranged from 21 to 39 g/t and were delivered at a solution concentration of 0.1 g/L. Flocculant (cationic) dose requirements for thickening on the detoxed residue samples ranged from 50 to 73 g/t and were delivered at a solution concentration of 0.2 g/L.
- Results of dynamic or high-rate thickening tests indicated that the Main Pit CIL feed sample was difficult to thicken and the feed solids concentration required was low at 12.3% while the South Domes CIL feed sample thickened well at a feed solids concentration of 19.2% The pH of both CIL feed samples was raised to 11.5 to reduce the amount of flocculant used and to improve the clarity of the overflow.

- Results of dynamic or high-rate thickening tests indicated that the Main Pit detoxed residue sample thickened well at a feed solids concentration of 15% while the South Domes detoxed residue sample thickened well at a feed solids concentration of 17.8%.
- The predicted operating density range for a high rate thickener on Main Pit or South Domes CIL feed with a grind size of approximately 80% passing 100 mesh was 50% to 62%. The recommended maximum operating density for Main Pit ore was 52% and for South Domes ore is 62%.
- Based on the testwork, a net loading rate range for high rate thickener sizing for Main Pit CIL feed is between 2.74 and 3.91 m^3/m^2h and the range for South Domes CIL feed is 2.21 to 3.11 m^3/m^2h.
- Recommended thickener feed solids concentrations varied between the two ore bodies tested. Main Pit material (CIL feed and detoxed CIL residue) performed acceptably at feed solids concentrations between 10 and 15 percent. South Domes material performed well at feed solids concentrations up to 15 to 20 percent.
- Since one grinding thickener will be installed in the plant to treat CIL feed, a thickener feed solids concentration of 12% and a net loading rate of 3.43 m^3/m^2h is recommended to be used for sizing. Optimum flocculation efficiency and thickener performance was achieved when flocculant solution concentration was maintained at 0.01 to 0.02%.
- A second thickener will be installed in the plant to treat CIL residue (cyanide recovery), and it is recommended that the same parameters be used to size the thickener.

13.7.5 Filtration

A brief summary of the recommendations from the 2020 testing program is as follows, (Pocock, 2020).

- Vacuum filtration tests and pressure filtration tests were performed on Main Pit and South Domes detoxed CIL residue underflow generated from the thickening tests described in Section 13.7.4. All tests were conducted on material that was at a pH of 8.5.
- Vacuum filtration tests were done using an applied vacuum level of 20” Hg. Tests were done with and without filter aid (flocculant). Filter cake moistures varied from 23 to 33 percent with a production rate range of 37.6 $kg/m^2 \cdot hr$ to 724.7 $kg/m^2 \cdot hr$. Both Main Pit tests and one South Domes test failed to produce filter cakes at moisture contents low enough for good discharge and stacking. Vacuum filtration is not recommended.
- Pressure filtration tests were done using air blow only and light membrane squeeze during air blow followed by a full pressure membrane squeeze. A driving force of 80 pounds per square inch gauge (psig) was used for all fill and air blow operations. When squeeze was applied during air blow, 100 psig squeeze was applied until the last 30 seconds of air blow when the pressure was increased to 232 psig for the remainder of the cycle.
- With filter feed solids of 50% for Main Pit ore and 59% for South Domes ore, membrane squeeze reduced the estimated moisture of the filter cake from 19.9% to 18.1% for the Main Pit sample and from 17.5% to 16.4% for the South Domes sample. At these moistures, the filter cakes produced from pressure filtration testing of the leach residue material were easily dischargeable from the testing apparatus and generated a stackable and conveyable cake. Cycle times ranged from 12 minutes for the South Domes material to 20.5 minutes for the Main Pit material.

13.8 OTHER TESTWORK AND ANALYSIS

13.8.1 Blast & Fragmentation Analysis

Blast and fragmentation analysis were done for ore and waste material by AMC Consultants (Rogers, 2020). The lithology units modeled make up 95% of the mined ore and include rhyolite (45%), volcaniclastic (32%), andesite (13%) and epiclastic (5%). A summary of the fragmentation of the ore material for each lithology is listed in Table 13-32.

Table 13-32: Ore Material Fragmentation Summary for Each Lithology

Fragmentation	Rhyolite	Volcaniclastic	Andesite	Epiclastic
Top size (in)	17	14	14	13
F_{80} (in)	8	6	6	6
F_{50} (in)	4	3	3	3

Note: Data source from AMC Consultants (Rogers, 2020)

From these results, a top size of 17 in with an F_{80} of 8 in was considered for the ROM for Phase 2. The size distribution of the four lithologies are shown in Figure 13-25. The screen analysis from the ROM tests done in 2018 were plotted for comparison. This analysis suggests the fragmentation particle size distribution may be somewhat coarser than the ROM samples from the Oro Belle and JSLA backfill that were used in the tests.

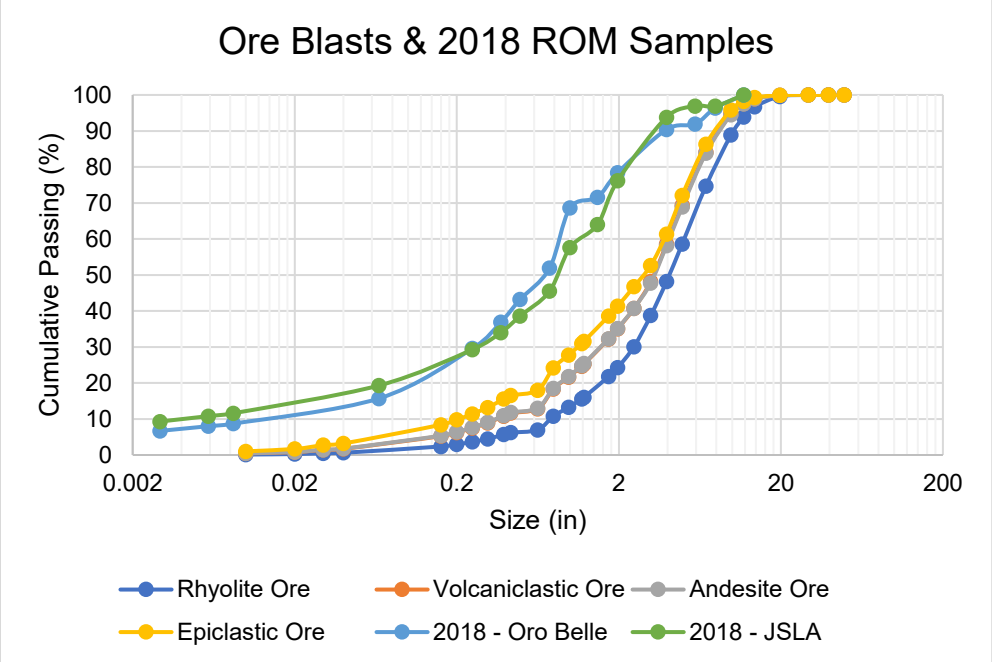


Figure 13-25: Ore Size Distribution

13.8.2 Sulfur Speciation

Sulfur speciation by pyrolysis were done to determine the sulfur content in the composites tested.

Two out of the 12 heap leach composites had higher sulfur than the other samples. Results for 4505-007-LG and 4505-025-LG had a sulfur content of 0.40% and 0.67% respectively and had a low gold recovery. The remaining composites had a lower sulfur content (below 0.8%). Head analyses of the two composites with high sulfur content also indicated higher levels of base metals (e.g. copper, nickel, and zinc). Table 13-33 is a summary of the sulfur content and gold recovery.

Table 13-33: Heap Leach Composites Sulfur Content

Ore Zone	Lithology	Composite	Hole No.	%S (Total)	%S (Sulfate)	%S (Sulfide)	Gold Rec %	NaCN kg/t ore
South Domes	Vx	4505-001-LG	CMM-122C	<0.01	<0.01	<0.01	96.2	2.66
South Domes	Rhy-Aph	4505-002-LG	CMM-255C	<0.01	<0.01	<0.01	88.2	0.84
South Domes	Diatreme	4505-003-LG	CMM-242C	<0.01	<0.01	<0.01	89.2	1.27
JSLA	Andesite	4505-007-LG	CMM-229C	0.4	0.19	0.21	69.7	1.14
Jumbo	Vx	4505-010-LG	CMM-273C	<0.01	<0.01	<0.01	87.5	0.89
East Ridge	Rhy-Aph	4505-015-LG	CMM-010C	<0.01	<0.01	<0.01	73.3	1.13
Oro Belle	Vx	4505-017-LG	CMM-119C	0.07	0.07	<0.01	66.7	1.2
Oro Belle	Rhy-Aph	4505-018-LG	CMM-119C	0.02	0.02	<0.01	88.9	1.24
Oro Belle	Andesite	4505-019-LG	CMM-119C	<0.01	<0.01	<0.01	95.2	0.94
Oro Belle	Vx	4505-020-LG	CMM-120C	0.05	0.05	<0.01	41.2	1.16
Oro Belle	Rhy-Aph	4505-021-LG	CMM-120C CMM-276C	0.02	0.02	<0.01	82.1	1.1
Oro Belle	Epiclastic	4505-025-LG	CMM-120C	0.67	0.13	0.53	36.8	0.96

One out of the 12 mill composites had a higher level of sulfur while the rest of the composites had an average sulfur content of 0.01%. The high sulfur content composite, 4505-008-HG, had the lowest gold recovery and highest cyanide consumption. Head analyses on the composite with higher sulfur also had higher levels of base metals. Table 13-34 is a summary of the sulfur content, gold recovery and reagent consumption.

Table 13-34: Mill Composites Sulfur Content

Ore Zone	Lithology	Composite	Hole No.	%S (Total)	%S (Sulfate)	%S (Sulfide)	Gold Rec %	NaCN kg/t ore
South Domes	Vx	4505-004-HG	CMM-248C CMM-252C	<0.01	<0.01	<0.01	97.6	0.07
South Domes	Rhy-Aph	4505-005-HG	CMM-016C	<0.01	<0.01	<0.01	98.5	0.07
South Domes	Vx	4505-006-HG	CMM-250C	<0.01	<0.01	<0.01	97.6	0.09
JSLA	Diatreme	4505-008-HG	CMM-070C	1.63	0.23	1.4	91.4	0.27
JSLA	Rhy-Bx	4505-009-HG	CMM-033C	0.01	0.01	<0.01	94.8	0.07
Jumbo	Rhy-Aph	4505-011-HG	CMM-021C	<0.01	<0.01	<0.01	93	0.07
Jumbo	Andesite	4505-012-HG	CMM-283C	0.01	0.01	<0.01	96.6	0.15
Jumbo	Rhy-Porph	4505-013-HG	CMM-281C	<0.01	<0.01	<0.01	95.9	0.07
Oro Belle	Rhy-Aph	4505-022-HG	CMM-119C	0.02	0.02	<0.01	94.5	0.08
Oro Belle	Diatreme	4505-023-HG	CMM-036C	0.02	0.02	<0.01	92.5	0.1
Oro Belle	Andesite	4505-024-HG	CMM-036C	<0.01	<0.01	<0.01	94.8	0.14
Oro Belle	Vx	4505-026-HG	CMM-120C	0.04	0.04	<0.01	94	0.15

The composites with higher sulfur were from the deepest part of the respective ore body as shown in Figure 13-6 and Figure 13-8. Based on the results from tests of the composites above, gold recovery and/or cyanide consumption may be impacted when material with high sulfur is processed. Higher sulfur content was only detected in more minor lithology units of the mine plan, namely andesite, epiclastic and diatreme containing 4%, 4% and 5% of total ounces, respectively. Further, high sulfur was present in only one of four andesite samples tested and only one of three diatreme samples tested (MLI, 2020b).

13.8.3 Carbon Adsorption Rate and Capacity

A batch carbon adsorption rate test (CAR) and adsorption carbon capacity (CAC) test were completed on one mill master composite made up of the following composite samples: 4505-004-HG (60%), 4505-022-HG (30%) and 4505-024-HG (10%), based upon relative lithological representation in the ore body.

A CAR test was conducted to determine the Fleming K and n values for the CIL system. These constants allow simulation of the CIL circuit and calculation of the expected carbon and solution profiles. Results from the CAC Test are shown in Table 13-35 (MLI, 2020b).

Table 13-35: Carbon Adsorption Capacity Test Results

	Carbon Dose, g/L Pulp		Solution Analysis Barren Grade, ppm		Carbon Loading g/t	
Test	Target	Actual	Au	Ag	Au	Ag
CAC-1	0.1	0.1	0.55	0.46	1737	755
CAC-2	0.5	0.5	0.17	0.24	895	481
CAC-3	1.0	1.1	0.04	0.11	520	360
CAC-4	2.0	2.1	0.00	0.03	284	180
CAC-5	5.0	5.1	0.00	0.01	113	70
CAC-6	10.0	9.8	0.00	0.00	59	44

The CAC test to measure the equilibrium gold capacity (K value) was done at carbon concentrations of 0.10, 0.50, 1, 2, 5 and 10 g/L.

The gold in solution versus the carbon loading were plotted and aligned well as in seen in Figure 13-26.

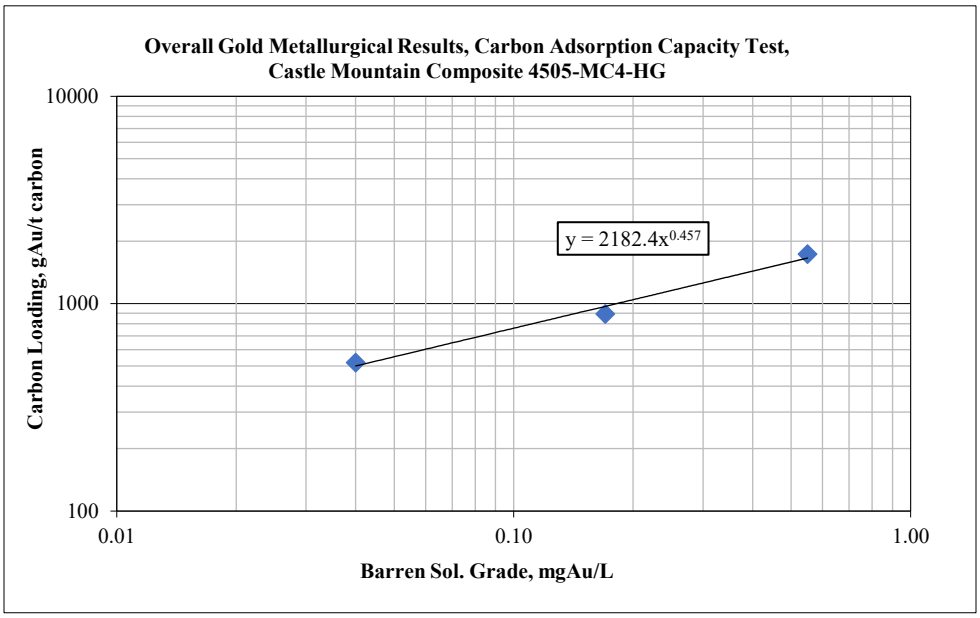


Figure 13-26: Overall Gold Metallurgical Results, Carbon Adsorption Capacity Test

Freundlich isotherm coefficients calculated from the data are shown in Table 13-36.

Table 13-36: Freundlich Isotherm Coefficients

	K	n
Au	2182	0.457
Ag	1227	0.593

The carbon loading (g Au/t C) from the capacity test is 1,737 g Au/t C (50 oz/ton) based on solution assays. Using the isotherm coefficients generated from the testwork, a loading of 1,661 g Au/t C (48 oz/ton) is expected using the following equation:

$$Au_{carbon} = K[Au]^n$$

Preliminary modelling of the adsorption circuit using 'typical' isotherm coefficients indicated a carbon loading of 1,660 g Au/t C (48 oz/ton).

Loaded carbon values typically fall in the range of 1,500 to 4,000 g/t. The results from the test completed show that the results are within industry norms.

A carbon adsorption rate test was conducted, and results are shown in Table 13-37.

Table 13-37: Carbon Adsorption Rate Test, 10 g Carbon/L Pulp

Contact Time, hrs	Solution Analysis Barren Grade, ppm		Calculated Carbon Loading g/t		Assayed Carbon Loading g/t	
	Au	Ag	Au	Ag	Au	Ag
0.33	0.28	0.27	36.4	21	-----	-----
0.75	0.14	0.14	46.4	30	-----	-----
1.50	0.03	0.06	54.2	36	-----	-----
3.00	0.00	0.02	56.2	39	-----	-----
6.00	0.00	0.00	56.2	40	-----	-----
15.00	0.00	0.00	56.2	40	-----	-----
24.00	0.00	0.00	56.2	40	57.2	<50

Kinetics for the adsorption rate tests were fast as shown in Figure 13-27. After three hours, carbon loading remained constant and soluble losses were zero indicating a carbon concentration of 10 g/l at the specified parameters above being suitable for adsorption. Higher rate of adsorption raises stage efficiency and reduces loss of soluble gold.

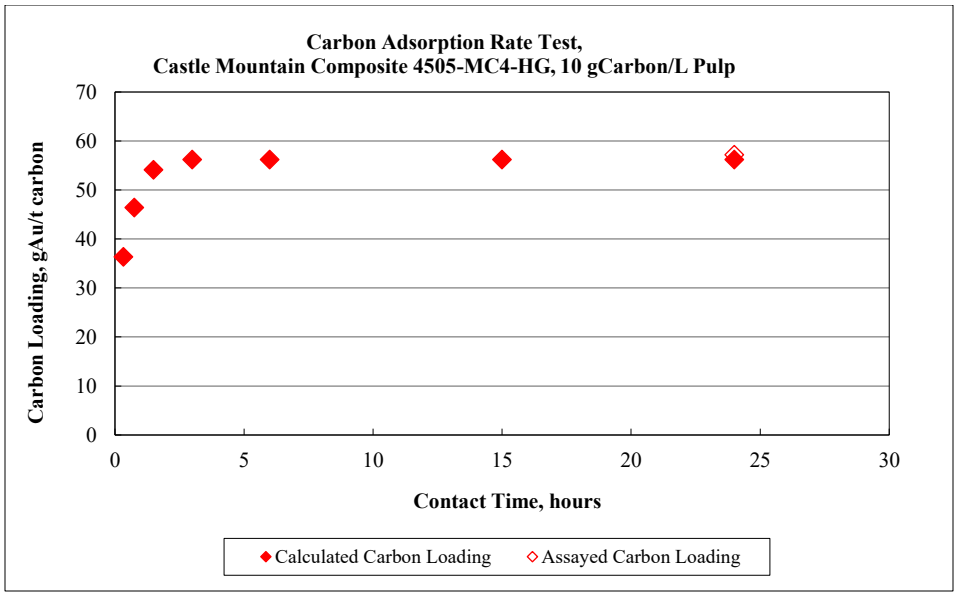


Figure 13-27: Carbon Adsorption Rate Test (4505-MC4-HG)

13.8.4 Oxygen Uptake Rate

A standard procedure was used for an oxygen uptake rate (OUR) test on one mill feed sample. The series of oxygen decay measurements was repeated at time intervals indicated in Table 13-38.

Table 13-38: Oxygen Uptake Results Summary

Time	0 Hr	1 Hr	2 Hr	3 Hr	4 Hr	5 Hr	6 Hr	24 Hr	36 Hr	48 Hr
Slope - mg/L/min	0.0363	0.38	0.33	0.33	0.07	0.65	0.65	1.31	0.45	0.37

The data indicates that the oxygen uptake demand of the Castle Mountain ore is >0.3 mg/l/min for the first three hours and after four hours increases to >0.6 mg/L/min. Higher oxygen demand later in the test is unusual and was likely caused by an error in the test procedure. Regardless, the oxygen consumption is within the range commonly supplied by air sparging so oxygen injection in the CIL circuit is not required.

An OUR test was completed on the same single master composite sample as the CAR and CAC tests, 4505-004-HG (60%), 4505-022-HG (30%) and 4505-024-HG (10%). Compared to air injection, oxygen in the leaching step may increase the rate of gold dissolution, however the same ultimate recovery is achieved. Figure 13-28 shows the result of the two tests. Note that the tests were whole ore leach and not gravity tails leach, recall in Figure 13-21 the kinetics of leaching gravity tails are much faster than whole ore leach, so the kinetics benefit of oxygen is reduced, further supporting that oxygen injection in the CIL circuit is not required (MLI, 2020b).

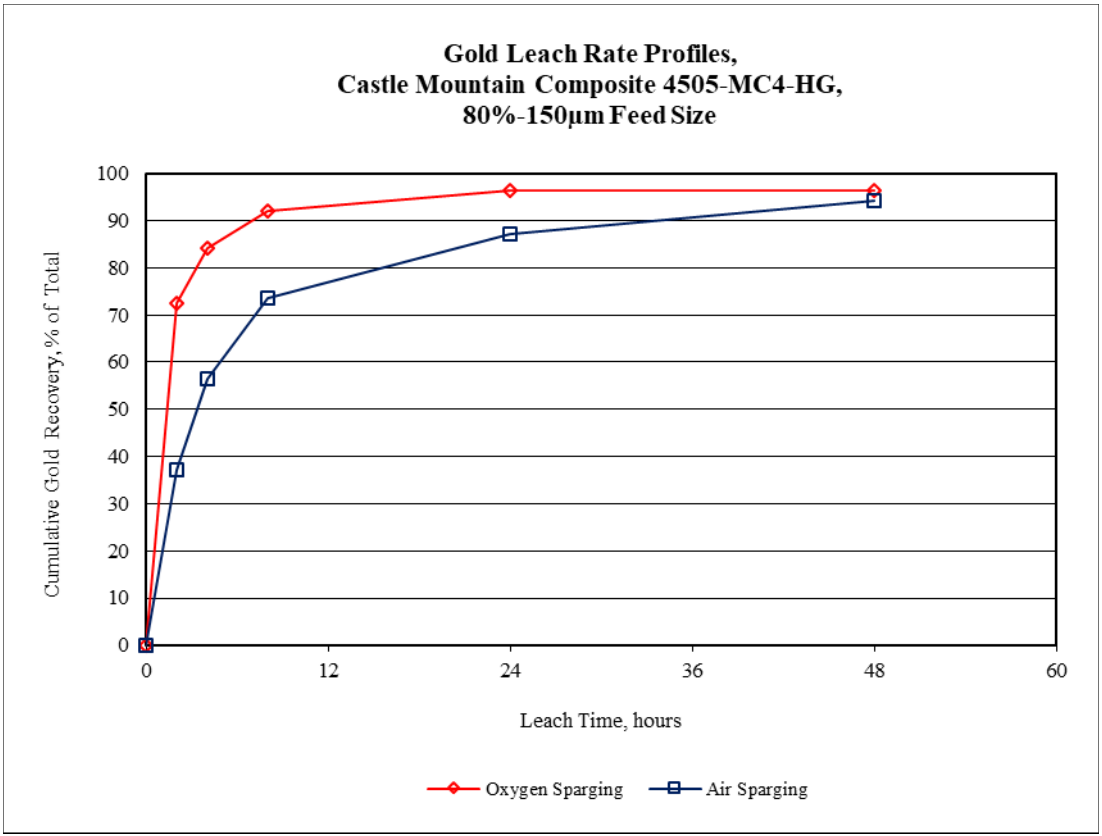


Figure 13-28: Gold Leach Rate Profiles, Oxygen Uptake Rate Test

13.8.5 Compacted Permeability Testing

In 2015, seven heap leach column residues were tested for Load vs Hydraulic Conductivity Testing up to an applied pressure of a simulated stack height of 250 ft (76 m). Four samples tested were from the Jumbo ore zone and three from JSLA. Five of the seven column residues performed well with permeabilities ranging from 10^{-1} to 10^{-3} cm/sec. One of the seven column residues showed poor permeability (10^{-4} cm/sec) from a 50 ft (15 m) simulated stack height onwards. Another residue showed poor to moderately poor permeability (10^{-5} cm/sec) from 75 ft (23m) simulated stack height onwards. Both residues with poor permeability were from the Jumbo ore zone and the respective lithology was Rhy-Porph (Gray, 2016).

In 2020, further Load vs Hydraulic Conductivity Testing was conducted up to a simulated stack height of 400 ft (122 m). Two new column residue samples from South Domes and East Ridge ore zones were tested at Call and Nicholas in Tucson. The South Domes sample showed good permeability results (10^{-2} cm/sec) like the five from 2015 and the East Ridge sample had lower permeability (10^{-3} cm/sec) but still significantly higher than two of the samples from 2015. Both samples tested had relatively consistent permeability from a simulated stack height of 250 ft to 400 ft indicating there in a very low risk in permeability issues from stacking up to 300 ft. The ore does compact under load and experiences some breakage, but the test results show that the effect on hydraulic conductivity will not meaningfully affect the heap leach (Call & Nicholas, 2020).

13.8.6 Mineralogy

In the 2020 column testing, gold recovery for Vx samples varied significantly between the South Domes and Oro Belle at 96% and 41% for LG-001 and LG-020 samples, respectively. Detailed mineralogy work was undertaken to help determine the reason for this difference. It should also be noted that the average grade of these two samples was significantly different with LG-001 averaging 0.041 oz/ton (1.39 g/t) and LG-020 averaging 0.005 oz/ton (0.17 g/t) and as such these samples are outside of the normal heap leach grade ore range 0.006 to 0.036 oz/ton (0.20 to 1.25 g/t), so the analysis of 2020 column leach samples in Section 13.5.4 excludes these two samples. The assay results from the split sample products analysed in the mineralogy work confirmed this large difference in head grade, and this partially explains the difference seen in recovery.

A Scanning Electron Microscope equipped with an Energy Dispersive Spectrometer (SEM-EDS) was used to examine several polished sections for four samples: a head a tails sample from Oro Belle, and a head and tails sample from South Domes. This work is reported by Chudy and Lane (PMC, 2020).

For the Oro Belle sample, gold-bearing grains are predominantly associated with red and red-brown breccia (97%) as well as vein-quartz. The breccias consist of variable but high amounts of quartz (47-57 wt.%) and potassic feldspar (35-47 wt.%). Minor phases include micas (muscovite/sericite, illite, biotite, chlorite, clays), pyriboles and iron and titanium oxides. The red and red-brown breccia particles were observed to have a high degree of porosity and vugs at 15-18%.

For the South Domes sample, gold-bearing grains are predominantly associated with porphyry with a very minor amount contained in polymictic breccia particles. The porphyritic rock consists of quartz (40-45 wt.%), potassic feldspar (29-36 wt.%) and sodic feldspar (14-16 wt%). Minor phases include Fe-Ti oxides, sulfides, and carbonates, with a strong decrease in abundance in the tails compared to the heads. The porphyry particles were observed to be more porous (10%) than the polymictic breccia (<5%).

Gold deportment in the head and tail samples is provided in Table 13-39. For both the Oro Belle and South Domes samples, native gold was preferentially leached and had lower frequency count in the tails sample, significantly more so for South Domes which was consistent with the relatively higher metallurgical recovery observed in the testwork. The analysis showed a higher amount of leaching of gold particles containing 80%+ gold compared to either electrum or predominantly silver particles.

Table 13-39: Frequency Count of Gold Occurrences

	Oro Belle		South Domes	
	Head (%)	**Tails (%)**	**Head (%)**	**Tails (%)**
Native Gold (>80% Au)	79	37	56	2
Electrum (50 – 80% Au)	17	57	44	83
Gold Bearing Silver (<50% Au)	4	6	0	15
Total	100	100	100	100
Total Gold Grain Count	**80**	**49**	**143**	**46**

The gold grain frequency distribution in head samples for Oro Belle and South Domes is shown in Figure 13-29. The gold grain size is largely less than 32 µm, with greater than 50% of the grains

less than 8 µm. A similar distribution is observed in the tailings samples in Figure 13-30. The total amount of gold grain observations from head sample to tails sample decreased more for the South Domes sample than the Oro Belle sample, consistent with the relatively higher metallurgical recovery observed in the testwork for the South Domes sample.

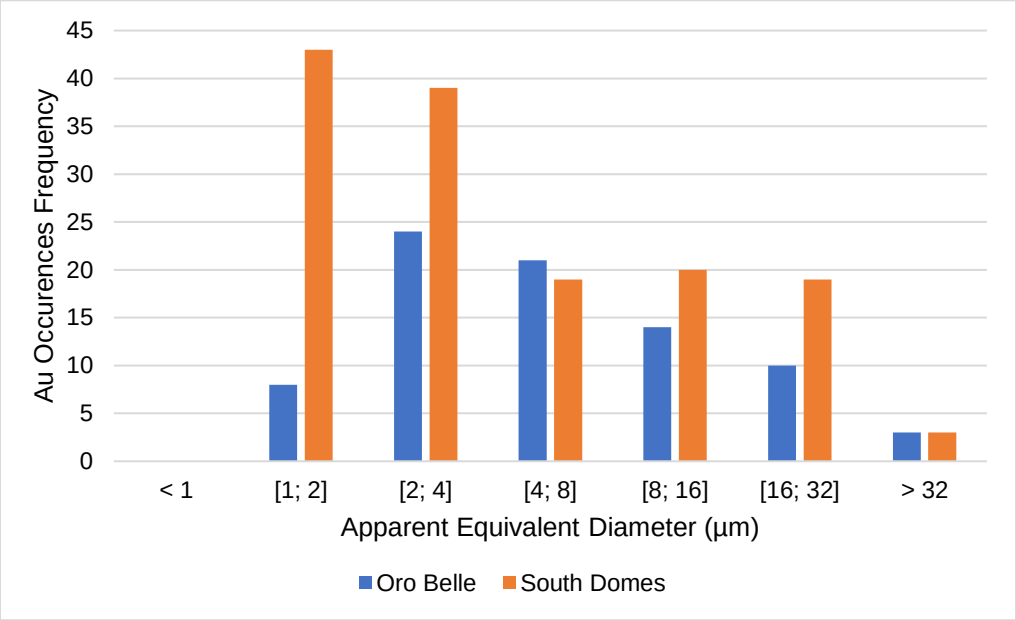


Figure 13-29: Gold Grain Size Frequency Distribution in Head Samples

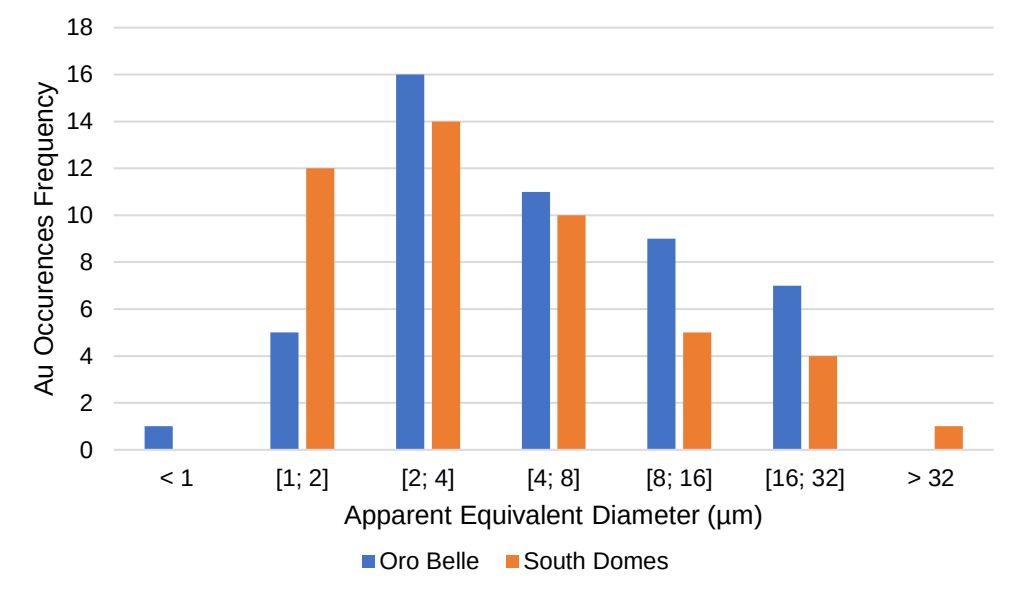


Figure 13-30: Gold Grain Size Frequency Distribution in Tails Samples

A significant difference in the amount of locked gold was found between the Oro Belle head sample and the South Domes head sample. As can be seen in Figure 13-31, approximately 76% of the gold was locked in the Oro Belle head sample. The majority of this is locked with quartz and/or Fe-oxides or feldspar, while 24% is exposed, predominantly attached to quartz in vugs.

The tailings sample as expected shows a large percentage of the gold (94%) is locked, largely in quartz and to a lesser extent in feldspar.

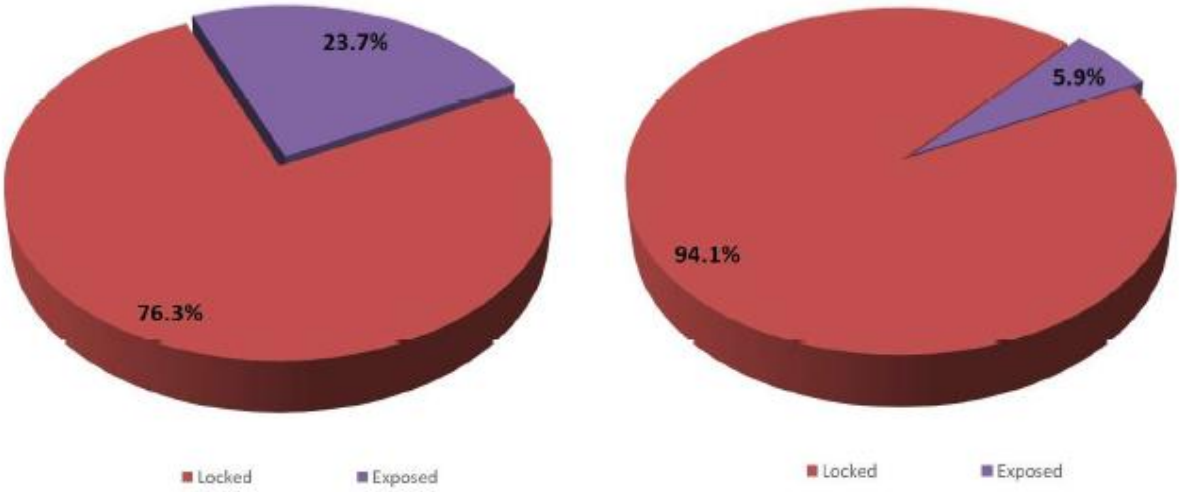


Figure 13-31: Gold Grain Exposure by Weight in Oro Belle Head and Tails Sample

In comparison, only approximately 36% of the gold in the South Domes head sample is locked, largely in feldspar and/or quartz, while 55% is found on grain boundaries and 8% is exposed. In the tails sample, a greater percentage of the gold is observed to be locked. Approximately 94% of the gold in Oro Belle Tails is locked predominantly in quartz and feldspars with only 6% exposed in vugs and pores. For South Domes, 53% of the gold is locked predominantly in quartz and 0% is exposed, but 47% of the gold is not observed.

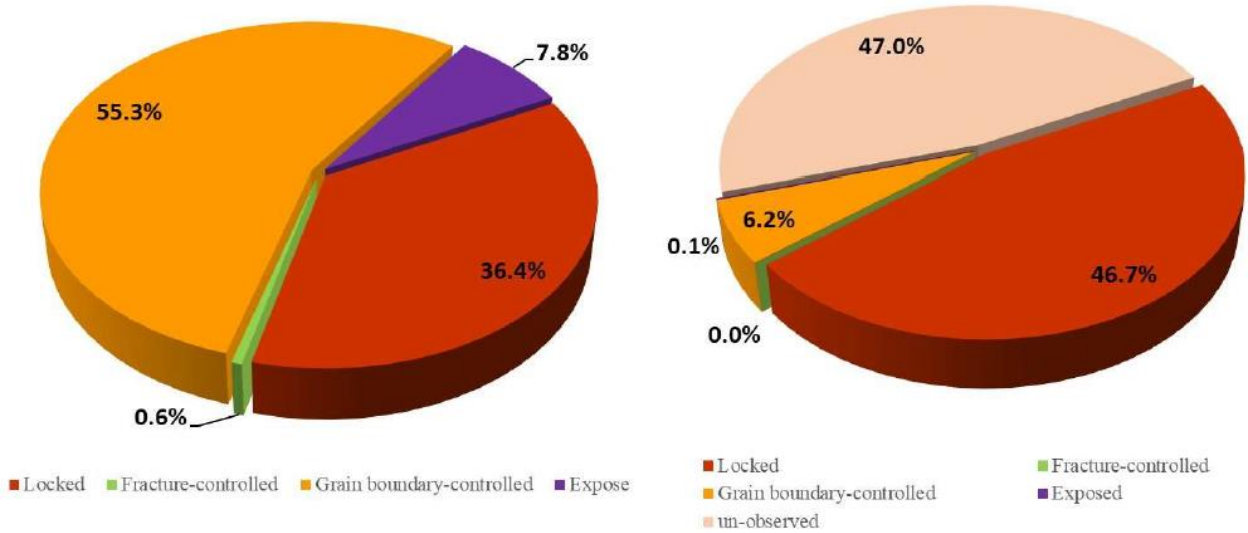


Figure 13-32: Gold Grain Exposure by Product in South Domes Head and Tails Sample

Unobserved gold is calculated based upon assays indicating the presence of gold, yet not observing the expected quantity in the polished sections. The reason for a lower number of observations is likely due to a nugget effect in the assay, or very fine locked gold particles and/or

gold grains which were simply not exposed in the 5 polished sections scanned. For the purposes here, it can be assumed that unobserved is equivalent to locked.

The reason for better metallurgical recovery of the South Domes sample could be the lower proportion of gold locked in quartz.

While the gold in the Oro Belle Vx head sample is found to be 97% hosted in one distinguished unit, red/red-brown breccia, the gold in the Oro Belle Vx tails sample is contained 78% in the red/red-brown breccia while the white breccia and vein quartz contain 9% each, indicating preferential leaching of gold from the red/red-brown breccia particles. This agrees with the observed degree of porosity, which is significantly higher than in other units and which increase the amenability to cyanide solutions.

In the South Domes head sample, nearly 100% of the gold was found to be hosted in one distinguished unit, porphyry, while in the tails the porphyry contained only 52% of the gold, with the remaining 48% hosted in polymictic breccia. This could be explained again by the observed degree of porosity, as porphyry is slightly more porous. Figure 13-33 shows a SEM-BSE image of a gold-bearing polymictic breccia. This figure provides a good example of particles that are a main contributor to an apparent nugget effect in the South Domes head sample.

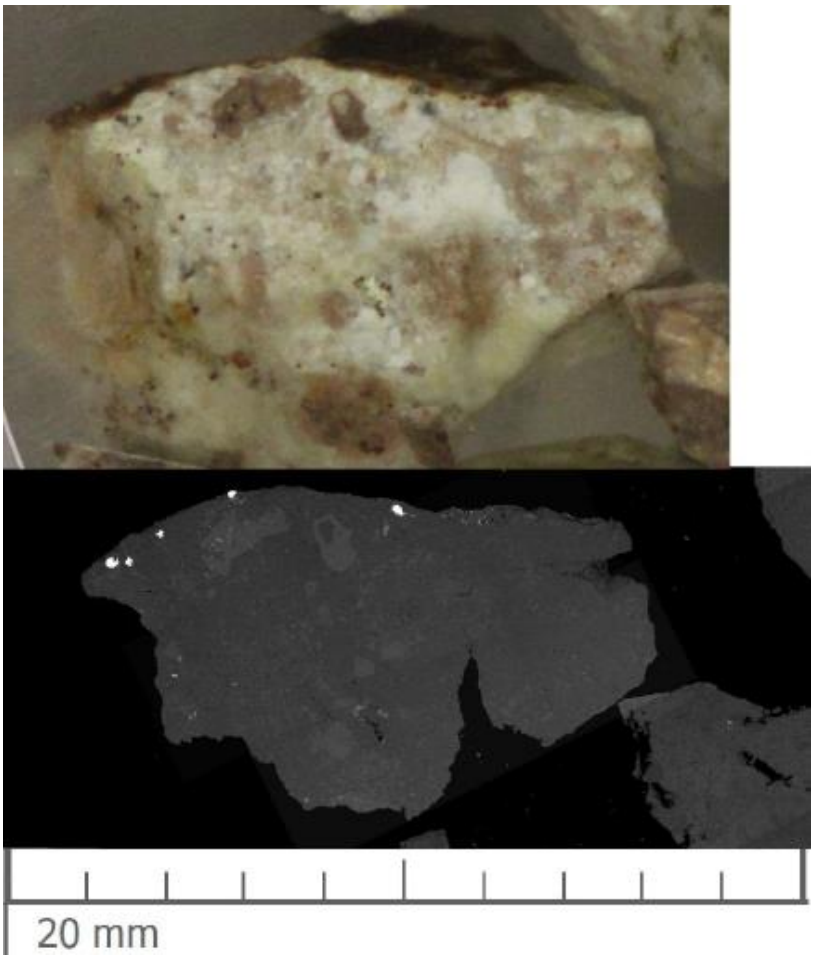


Figure 13-33: Photograph and SEM Image of Gold-Bearing 'Porphyry' Particle. South Domes Head +4.5mm Fraction

13.8.7 Viscosity

Viscosity tests were conducted at Pocock Industrial Inc. on the Main Pit and South Domes master composites in May 2020 (Pocock, 2020).

Ten additional tests were done on composites from JSLA, South Domes, Oro Belle and Jumbo ore zones to further investigate potential thickening, filtration, and viscosity issues. These tests were completed in June 2020.

Viscosity tests were performed using a Fann Model 35A instrument on samples of underflow generated from the thickening tests described in Section 13.7.4 to establish a general set of data to design thickening and underflow pumping equipment.

In general, all samples have a relatively large percentage of fine material, i.e. smaller than 25 µm, ranging from 27% to 45%. The effect of the fines is to cause the fluid parameters of the slurry to move away from the Newtonian model of viscosity. Newtonian fluids have a shear stress to shear rate ratio that is linear starting at zero. The slope of the line on a graph is the viscosity of the fluid. The slurries tested have a non-linear relationship and a definite yield stress that must be overcome before the fluid motion starts. This is described as a Bingham Plastic Fluid. The viscosity in this case is not constant until the flow reaches the relative straight part of the curve. The slope of the straight section is called the “coefficient of rigidity” by Pocock or sometimes called “plastic viscosity” by different test labs.

Underflow pulps with yield stress values in excess of 30 N/m^2 (Pascals) measured on pre-sheared pulps are normally beyond the capabilities of conventional thickening and pumping systems. Paste type thickeners and pumps would be required.

Plastic viscosity values also must be considered. In general, slurries with a coefficient of rigidity above 0.050 Pa-sec (50 centipoise) become a problem with longer pipelines because of the increase in pipe friction loss. The increased viscosity must be considered in the design of any agitators that will be handling the slurry.

The range of operation for underflow from the cyanide recovery thickener is planned to be 50% to 60% solids. Figure 13-34 indicates that only four of the fourteen samples tested can reach 60% solids before reaching a yield stress of 30 Pa and one of the samples Grinding Thickener Feed 4505-011 (Jumbo Rhy-Aph) cannot reach 50% before reaching a yield stress of 30 Pa. This ore type will be problematic if not blended to reduce the percentage of fines.

Based on the test data obtained, it appears that nearly all the material samples can be operated in the desired range of 50% to 60% solids.

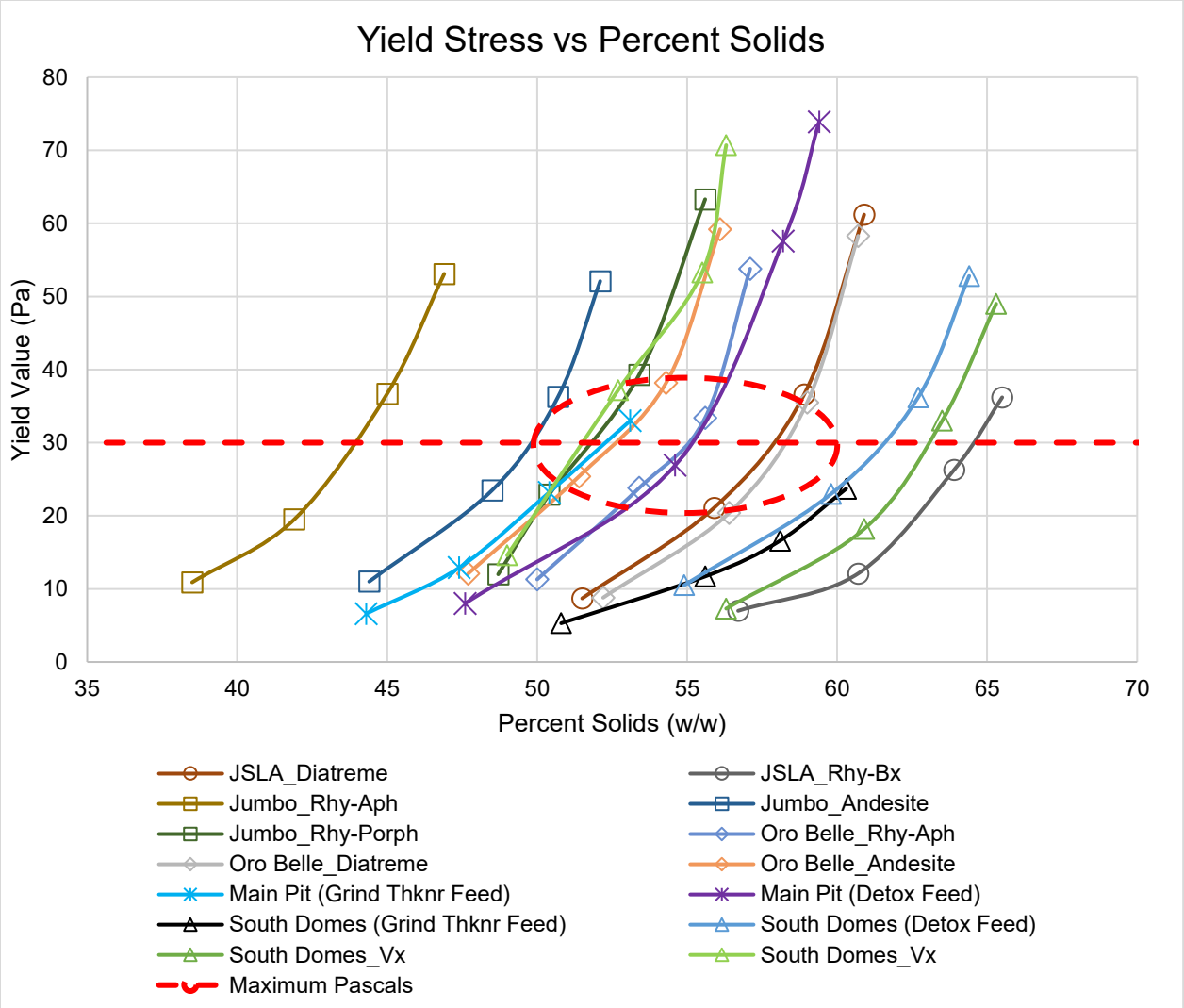


Figure 13-34: Yield Stress vs Percent Solids

13.8.8 Ore Sorting Tests

Bulk ore sorting is a pre-concentration technology currently used at many mining operations across the world. Sorting involves scanning individual rock particles on a conveyor using various types of sensor technologies. The readings for each individual rock are then analyzed by high-speed software (algorithms) to identify rocks with metal values (or other characteristics) above and below a pre-determined setpoint. At the end of the conveyor belt, focused high-pressure air jets or mechanical levers then separate the designated mill grade ore rock pieces for processing and reject heap leach grade and waste pieces. The amenability to ore sorting depends on the material characteristics of a deposit.

At Castle Mountain, the potential advantage of ore sorting is that heap leach material in the range of the mill grade ore could be upgraded, or the mid/low grade mill feed ore could be split from the mill grade ore and be sent to the heap leach pad, potentially lowering operating costs.

The objective of the testwork was to determine if Castle Mountain samples could be upgraded or if lower-grade ore could be "rejected" and be sent to a heap leach for treatment using sensor-based sorting. The ore sorting testwork was carried out by Steinert US at their test facility located in Walton, KY in January 2020.

The sorting testwork requires sample material that represents all rock types that may be mined on site. Samples for testing included approximately 400 kg of test material selected by Equinox personnel from material that was available from ongoing testwork. The samples for testing included three bulk samples and seven grab samples. The material has been sized to +12 mm to -50 mm.

A full-size Steinert Combined Sensor (KSS FLI XT) was used for the testing. This sorter includes the following sensors:

1. Dual-energy X-ray transmission sensors (XRT),
2. Color camera (F),
3. 3-D Laser (L), and
4. Induction (I).

Based on preliminary work, it was determined that XRT and color would be the sensors used to test the Castle Mountain material.

The XRT scans conducted on these samples showed marginal separation. This is most likely due to the relatively similar densities of the gold-bearing material and the barren waste rock.

Color scans conducted on the samples showed little upgrade. Metal recovery appeared tied to mass pull.

Precious metal values in the Castle Mountain mine ore (samples tested) appear to be highly disseminated and are likely not amenable to bulk ore sorting.

No additional ore sorting testing is recommended at this time (Steinert, 2020).

13.9 PRODUCTION DATA

Production data has been used to validate recent post-production testwork, although the life of mine grade during production was higher than current life of mine grades.

The Castle Mountain mine was in production from 1992 until 2004. Ore was stacked on the leach pad for nine years from 1992 to 2001. Processing and recovering gold continued for an additional three years until 2004 as part of rinsing and cleanup during closure.

The initial process plant commissioned in 1992 included heap leaching of ore that was crushed to 100% - 9.5 mm in a three-stage crushing circuit. The plant incorporated a milling circuit in 1993 that agglomerated low grade heap leach ore with partially leached mill tailings. The upgraded system followed this process:

1. Mill-grade ore was ground with cyanide to 80% passing 100 mesh (150 µm) using a ball mill.
2. Ball mill product (cyclone overflow) was directed to a thickener for solid/liquid separation.

3. Thickener overflow (pregnant solution) was sent to the carbon circuit (ADR) for gold recovery. Mill tails (thickener underflow) was agglomerated using a 1:10 ratio with the crushed heap leach ore and sent to the heap leach pad for additional leaching.

The gold extraction by leaching in the mill averaged 35% prior to being agglomerated with the crushed ore for the heap leach.

In 1995, a gravity gold recovery circuit was added to the mill, with annual gravity recoveries ranging from 13% to 22%. The gravity/cyanided tailings were then agglomerated with the crushed ore as before. After Castle Mountain added the gravity circuit, the combined recovery in the mill (gravity plus leaching) increased to approximately 45-50%.

Total gold recovery of high-grade ore from the mill from gravity concentration, milling in cyanide solution, and heap leaching of the agglomerated slurry was estimated by Castle Mountain to be 95%. See Table 13-40 for a summary of the recoveries obtained during production throughout the various stages.

Table 13-40: Recoveries as Estimated by Castle Mountain During Production for High-Grade Ore

Gold Extraction Recovery Source	Recovery
Mill	
1993 leaching in the milling circuit (prior to heap leaching on the pad)	35%
1995 gravity gold recovery circuit	13-22%
Combined mill with gravity and leaching	**45-50%**
Heap Leach	
End of 2001 heap leach ore recovery (prior to rinsing)	71%
Life of mine heap leach ore recovery (with 3 years of rinsing)	77%
Total Life of Mine	**95%**

Production records show that, over the life of the Mine, 36.9 Mton of ore with a gold grade of 0.043 oz/ton (1.47 g/t) containing approximately 1.55 Moz gold were loaded onto the heap leach pads.

The 36.9 Mton comprise approximately 34.2 Mton with a gold grade of 0.037 oz/ton (1.27 g/t) which was fed directly to the heap leach circuit and 1.967 Mton at 0.144 oz/ton (4.9 g/t) that was placed on the leach pad from agglomerated tailings from the milling circuit.

Over the life of the mine, approximately 80% of the stacked gold was recovered (total leach-grade and mill-grade combined recovery). Approximately 12% of this total production of gold was recovered in the 43 months following the end of mining. A summary of the ore production and metallurgical recoveries by year is shown in Table 13-41.

Table 13-41: Castle Mountain Mine Production Data

Item	Units	Total	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total, Leach Plus Mill															
Grade	oz/ton	0.043	0.051	0.058	0.056	0.050	0.037	0.038	0.027	0.034	0.040	0.037	-	-	-
Annual Recovery	%	-	59.3	63.0	74.0	74.3	80.6	78.5	84.8	67.8	72.0	89.9	-	-	-
Cumulative Recovery	%	80.2	59.3	61.6	66.6	68.6	70.6		71.7	72.9	72.3	72.3	75.0	78.7	79.7
Mill Ore															
Grade	oz/ton	0.144	-	0.183	0.210	0.162	0.113	0.138	0.108	0.138	0.108	0.113	-	-	-
Average Grind/Gravity Recovery	% of mill feed		-	35.9	33.5	37.9	42.3	49.7	45.0	50.5	48.7	54.9	-	-	-
Average Leach Recovery	% of mill tailings		-	92.2		91.9	91.3	90.1	90.9	89.9	90.3	88.9	-	-	-
Mill Recovery	% of mill feed	95	0.0	95	95	95	95	95	95	95	95	95	0.0	0.0	0.0
Leach Ore															
Grade	oz/ton	0.037	0.051	0.055	0.044	0.042	0.031	0.027	0.026	0.032	0.034	0.031	-	-	-
Cumulative Recovery	%	76.9		59.3	59.9	61.9	63.5	65.4	65.9	67.7	67.4	67.2	70.6	75.1	76.2

Source: Castle Mountain Mining Company Limited – Castle Mountain Project Technical Report NI 43-101, May 30, 2014, page 13-6

13.10 RECOVERY SUMMARY

13.10.1 Overall Heap Leach Recovery

After evaluating the column leach tests by feed size, ore zone, and lithology, the arithmetic average gold recovery was 81%, 80% and 80% respectively. A weighted gold recovery based on ounces per lithology was calculated as 82%. The average lab recovery for Castle Mountain low grade ore was 80%.

To estimate the Castle Mountain gold recovery for the production heap leach from the lab data, operating and environmental conditions were considered. This includes ROM particle size distribution, permeability, effective leaching of the side slopes, etc. The ROM material for the Castle Mountain Project is predicted to have an F_{80} of 152 mm to 203 mm. When considering the ore size and other data, a lab to field deduction of 6% was applied to the average lab recovery of 80% for an expected LOM heap leach gold recovery of 74% after solution application is stopped. To account for the typical time impact in recovering gold from a large leach facility at closure, the expected gold recovery during LOM operations is considered to be 67% with a final recovery of 74% attained only after extracting residual gold values and reducing cyanide levels in the heap. This is expected approximately three years after mining has ceased.

13.10.2 Overall Mill Grade Ore Recovery

For this Feasibility Study, gravity followed by gravity tail leach in a CIL circuit was selected for the process based on economics. An overall gold recovery of 94% is expected from mill grade ores processed through the mill after 24-hour hybrid leach/CIL retention time. The plant has been sized conservatively with 30 hours retention time in the leach/CIL tanks.

14 MINERAL RESOURCE ESTIMATES

14.1 INTRODUCTION

Equity Exploration Consultants Ltd. (Equity) completed a mineral resource estimate update for Equinox's Castle Mountain Project, inclusive of the JSLA pit backfill material and in-situ hard rock mineral resources. This Mineral Resource Statement supersedes the previous statement completed by Mine Technical Services Ltd. (MTS) with an effective date of March 29, 2018 that is summarized in the Preliminary Feasibility Study for the Castle Mountain Project (Scott et al., 2018).

The Mineral Resources presented conform with the most recent CIM Definition Standards (CIM, 2014), have been prepared according to CIM Best Practice Guidelines (CIM, 2019), and are reported in accordance with Canadian Securities Administrators' National Instrument 43-101 Standards of Disclosure for Mineral Projects (BCSC, 2016). The resource estimate was completed by Trevor Rabb, P.Geo., of Equity. Mr. Rabb is a qualified person independent of Equinox and its wholly owned subsidiaries in accordance with NI 43-101 guidelines, meeting requirements of education, project experience, and affiliation to a recognized professional association. The Mineral Resource Statement for the Castle Mountain Project is presented in Table 14-20 of Section 14.13.

This section summarizes the methodology, data and validation techniques used by Equity in estimating the mineral resources for the Castle Mountain Project.

14.2 METHODOLOGY

The Mineral Resource estimate detailed in this report was prepared using Leapfrog v5.0 and Micromine 2020 software, for both the JSLA backfill and hard rock resource models. Both software packages were used for modelling, geostatistical and estimation purposes. Geostatistical evaluation and estimation were completed in metric units and converted into imperial units (troy ounces per short ton and short tons). The geologic hard rock models and backfill model were both generated using Leapfrog and estimation was completed using Micromine. The main steps of the methodology used were as follows:

- Site visit for audit of exploration program practices and review of local geology.
- Review of 2018 MTS Mineral Resource estimate and updated geological models.
- Database review and audit.
- Modification of geological model.
- Sample compositing.
- Capping study on primary and composited samples.
- Spatial statistics on primary and composited samples.
- Variography of composited samples and historic production blasthole samples for each resource area.
- Gold grade estimation using composited samples.
- Validation of gold grade estimates.
- Classification of Mineral Resources in accordance with CIM definitions (CIM, 2014).
- Constraining of estimated blocks using an optimized pit.
- Comparison of Mineral Resource estimate compared to historical blasthole sample data and historical production records.
- Converting results in metric units to imperial units.

The main differences between the 2020 and 2018 resource models were:

- Classification was informed using drill hole spacing.
- Estimation of the hard rock Mineral Resources using grade shell domains, including a low, medium and high-grade domain with thresholds respectively of 0.0050 oz/ton, 0.0146 oz/ton and 0.0321 oz/ton (0.17 g/t, 0.50 g/t Au and 1.10 g/t Au).
- Unmineralized rock types were excluded from grade shell domains.
- Estimation of the JSLA backfill domains using solids generated from monthly as-built mine site survey records.
- Bench compositing completed on 20 ft (6.10 m) bench heights using the same bench intervals as the block model.
- Depletion of hard rock Mineral Resources to account for current topography and monthly Viceroy as-built surveys.
- The use of blended grades and density based on partial block partial percentages where there are overlaps between the backfill and hard rock models.
- The use of anisotropic searches based on lithological domains that exert strong controls on mineralization.

14.3 DRILL HOLE DATABASE

Equinox provided separate drill hole databases for the hard rock and backfill mining areas. A more thorough explanation of the drill hole data used is provided in Sections 10 through 12 of this report. A summary of the drill hole and surface data used for estimation is shown in Table 14-1. Due to some RC pre-collars drilled for main hole diamond drilling, the total footage may not sum.

Table 14-1: Summary of Drill Hole and Surface Data Used for Resource Estimate

Material Type	Hole Type	Hole Count	Total (ft)	Total (m)
Backfill	CORE	113	130,093	39,652
	RAB	1265	26,842	8,181
	RC	278	212,937	64,903
	RC Pre-collars	23		
Hard Rock	DDH	206	202,819.5	61,819
	RC	1391	1,064,273	324,390
	Rotary	479	258,810	78,885
	Channel	20	4,118.3	1,255

The condemnation drilling described in Section 10.2.5 and 11.2.3 was excluded in the preparation of the Mineral Resource estimate as the data was unavailable at the time of evaluation. Condemnation drill holes occur outside of the mineral resource pits (see Figure 10-4). It is therefore the opinion of the QP that the exclusion of the condemnation drilling from the preparation of the Mineral Resource are immaterial to the Mineral Resources disclosed in Table 14-20 and Table 14-21.

14.4 GEOLOGICAL MODELLING

Equinox provided Equity with four geologic models supporting the hard rock resource:

1. A lithology model,
2. An alteration model that includes clay and silicification,
3. An oxidation model that includes oxide, transition and fresh rock domains, and
4. A fault model.

Backfill and depletion models were generated for the backfilled JSLA pit and mined out portions of Castle Mountain Project, respectively. All models were generated in Leapfrog v5.0 software using a pre-mining topographic surface.

14.4.1 Topography

Three topographic surfaces were generated, representing:

1. Current topography,
2. Pre-mining topography, and
3. End of mine prior to backfilling.

The topographic surfaces were based on the Viceroy as-built pit surveys, 2017 Compass Tools LiDAR survey, 2018 Lanfair survey and 2018 PhotoSat survey.

Pre-mining topography was based on Viceroy as-built surveys that predate mining activity. Portions of the pre-mining topographic surface were informed by the 2017 and 2018 LiDAR surveys, specifically where no mining or activity had altered the topography.

The topographic surface representing the end of mine, prior to backfilling of the JSLA open pit, was generated using the 2017 and 2018 LiDAR surveys and end of mining Viceroy as-built surveys for the entire JSLA pit and northern portions of the Jumbo pit where sloughing and pit-wall failures have occurred.

14.4.2 Lithology Model

The lithology model was created from published geological mapping, drill logs from drilling completed by Equinox and interpretation of historic Viceroy drill hole logs. The lithology model interacted with a fault model (see Section 14.4.7). Rock types representing barren or weak to non-mineralized lithologies including post-mineralization units and poor host rock lithologies were grouped together and excluded from grade shell domains (see Section 14.4.6). The main lithologies are summarized in Table 14-2 and shown in Figure 14-1.

Table 14-2: Castle Mountain Lithology Codes

Lithology	Lithology Model Code	Model Code	Grouping
Alluvium	02-Alluvium	2	Barren, post mineralization
Debris Flow	03-DebrisFlow	3	Barren, post mineralization
Dacite	05-Dacite	5	Barren, post mineralization
Hart Peak Rhyolite	05-HartRhy Migos	5	Barren, post mineralization
Rhyolite Breccia	07-RhyBx	7	Mineralized
Porphyrytic Rhyolite	09-RhyPorphyritic	9	Weak to non-mineralized
Aphyric Rhyolite	11-RhyAphyric	11	Weak to non-mineralized
Volcanoclastic Diatreme	14-VxDiatreme	14	Mineralized
Volcanoclastic	16-Vx	16	Mineralized
Mudstone	22-Mudstone	22	Mineralized
Epiclastics	23-Epiclastics	23	Mineralized
Andesite	27-Andesite	27	Mineralized
Peach Springs Tuff	29-PeachSpring	29	Mineralized
Proterozoic Sediments	30-PcSediments	30	Mineralized
Proterozoic Basement	31-PcBasement	31	Mineralized

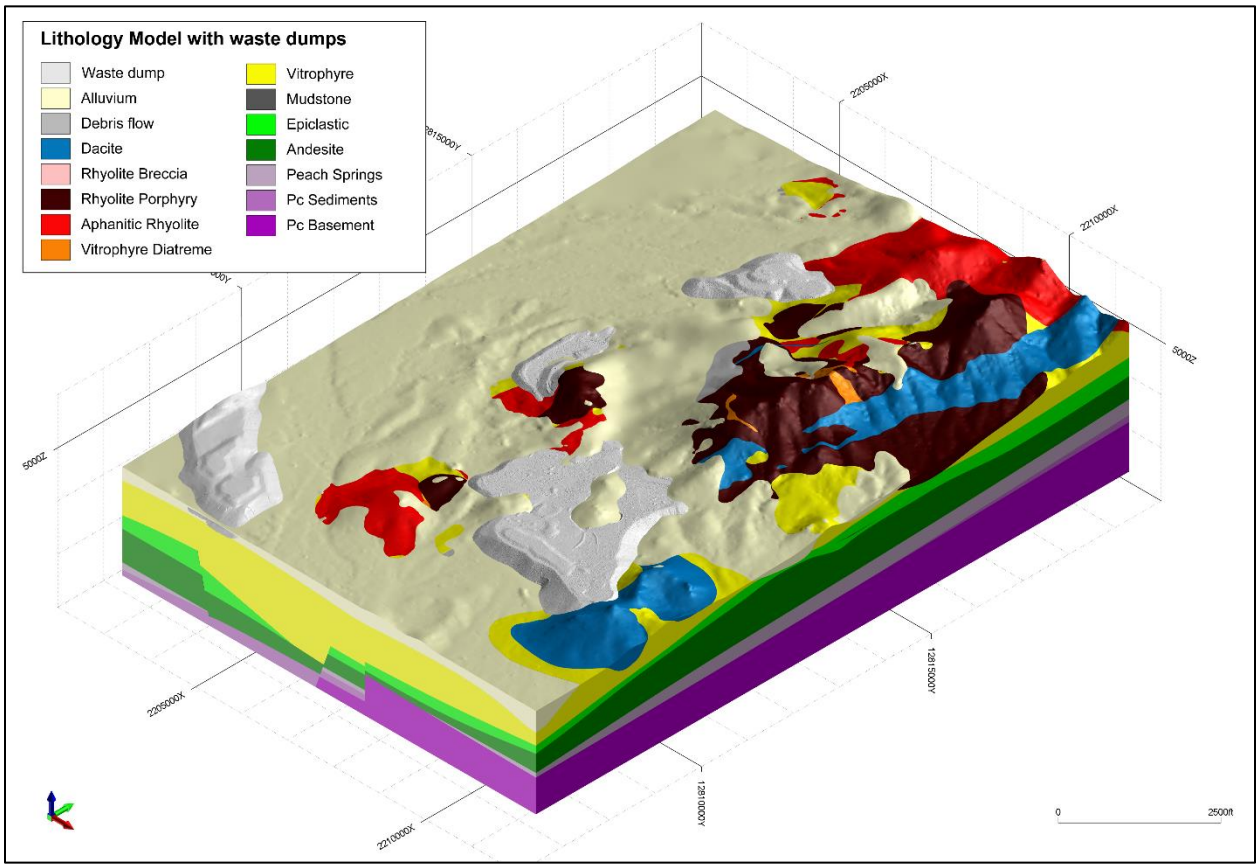


Figure 14-1: Castle Mountain Lithology Model (View Towards Northwest)

14.4.3 Alteration Model

The alteration model for the Castle Mountain Project includes alteration intensity wireframes for silicification and clay alteration. The alteration intensity models were generated by imputing numeric values to the alteration textures: on fractures = 0, patchy = 1, and pervasive = 2. For

historic holes without logged alteration texture, a value of 1 was imputed. The numerical textural rankings were added to the numerical intensity rankings, ranked 0 to 4 in order of increasing intensity, for a final alteration intensity index. Wireframes representing the final alteration index were generated using Leapfrog radial basis function (RBF) numerical modelling features to generate wireframes corresponding to alteration indexes of < 1, 1 – 2, 2 – 3 and > 3 representing trace, weak, moderate, and strong alteration. The alteration model was generated for use as an exploration vectoring tool and does not have direct application to determining geotechnical or geometallurgical parameters. Alteration intensity models for clay and silicification are shown in Figure 14-2.

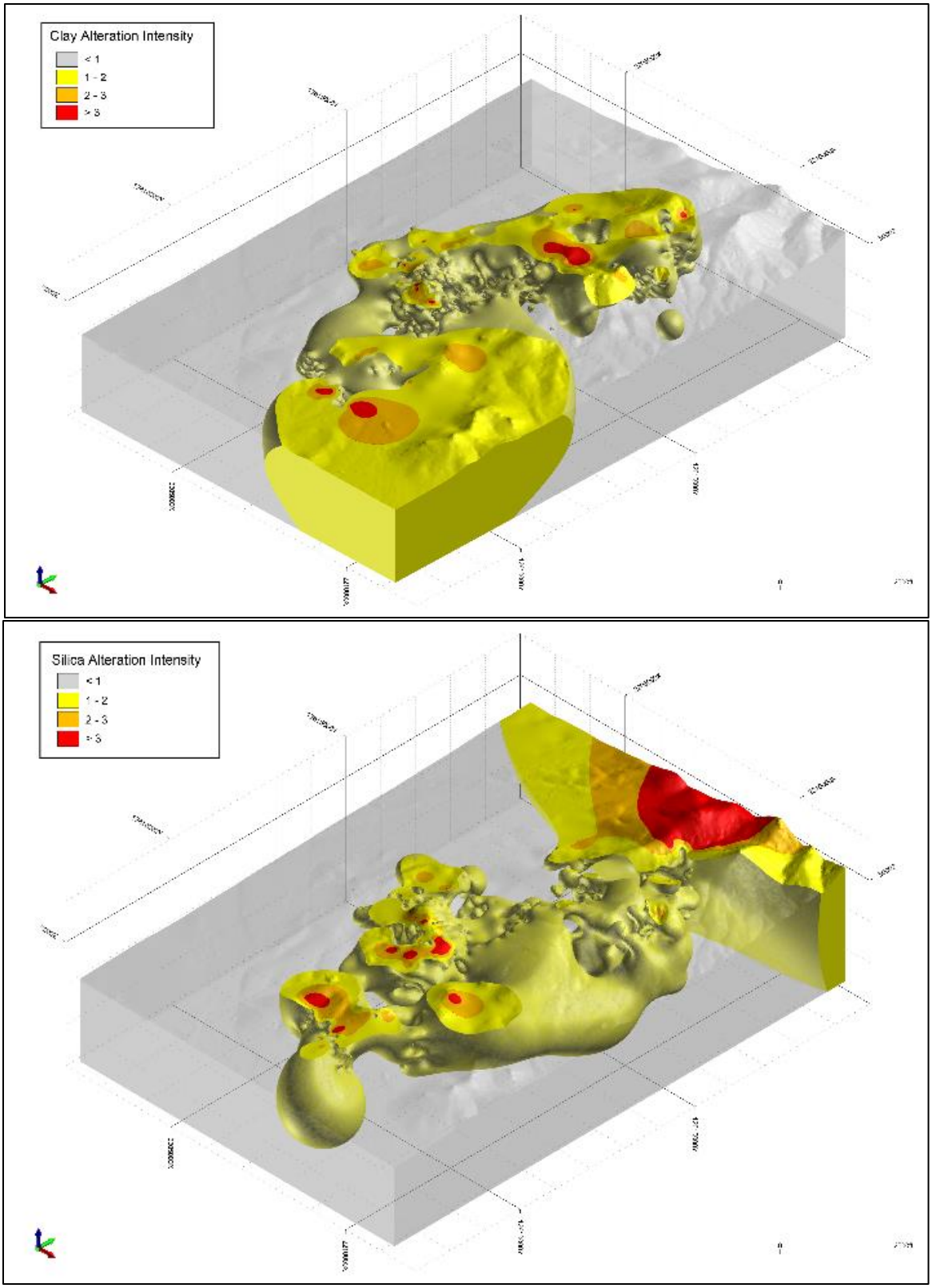


Figure 14-2: Castle Mountain Alteration Model for Clay and Silica (View to Northwest)

14.4.4 Oxidation Model

The oxidation model for Castle Mountain was generated based on numerically ranked visual abundance of iron oxide (0 to 4), and visible pyrite abundance (0 to 5) using traditional field methods applied to core and chip logging. If the ranked pyrite abundance exceeded that of iron oxide, the interval was assigned to sulfide. If the ranked abundance of pyrite and iron oxide were equal or within one, the interval would be assigned to transition. The assignment to transition also considered intervals uphole and downhole. Intervals lacking data were excluded from the model. Lithologies excluded from the oxide model include debris flow and alluvium as both units are young and post-date mineralization.

Average thickness of the modelled oxide domain is 1,000 ft (305 m), with the thickness increasing locally up to 2,000 ft (610 m) around faults. Thickness of the modelled transition domain is variable and is not well developed over the area. Average thickness of the transition zone where present is 180 ft.

The models generated using the above method were compared to sample intervals where cyanide extractable gold assay (AuCN) values and fire assay gold values both occur. Due to the limited coverage of AuCN values, only the oxidation models of the South Domes and Six 21 areas could be validated using AuCN and gold fire assay geochemistry. Within these areas, the transition and sulfide zones were found to have AuCN to gold fire assay ratios less than 0.6, whereas oxide zones typically had AuCN to gold fire assay ratios greater than 0.6, and average 0.8. Oxidation models are shown in Figure 14-3.

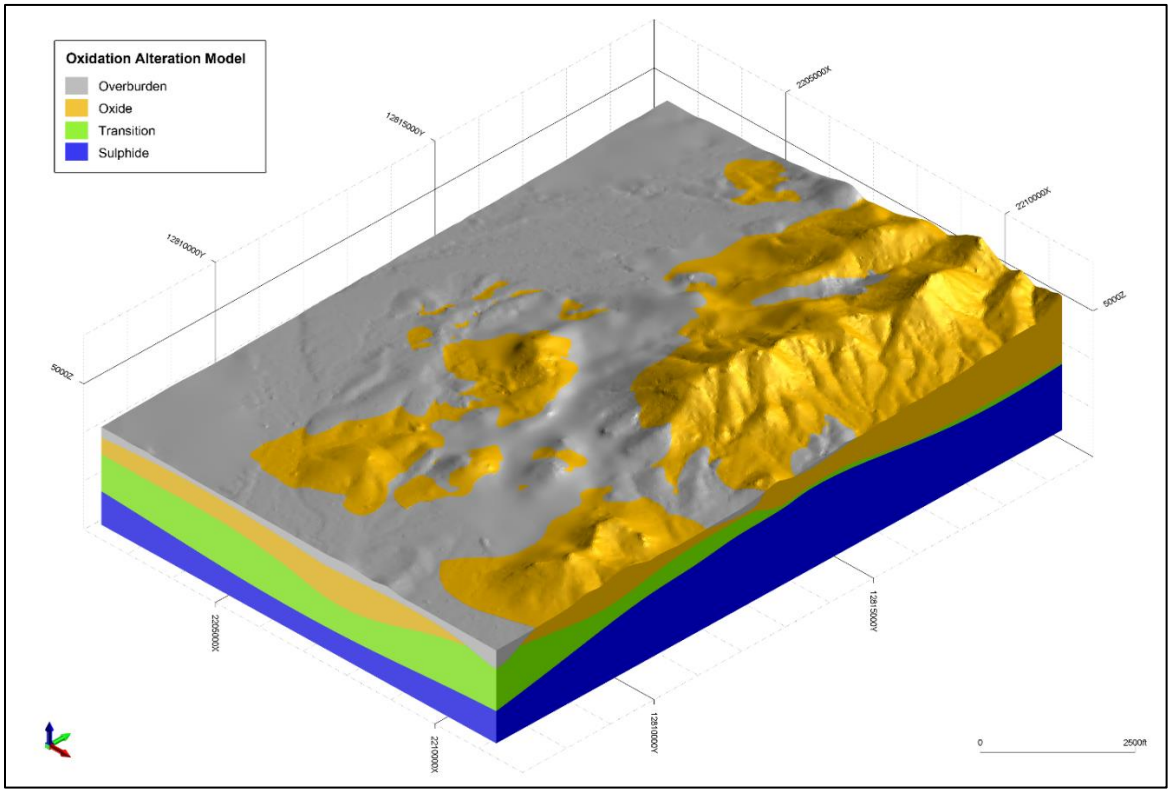


Figure 14-3: Castle Mountain Oxidation Model (View to Northwest)

14.4.5 Fault Models

Five major displacement faults and four minor displacement faults were modelled throughout the deposit. The major faults introduced up to 300 ft (91 m) of vertical offset between of lithologies and highlight mineralized structures. The faults present within the resource model are summarized in Table 14-3 and shown in Figure 14-4.

Table 14-3: Summary of Modelled Faults

Fault Name	Dip	Dip Direction	Vertical Offset (ft)	Sense	Displacement
Dillon	71	283	200 to 250	Normal Fault, East side down	Major
Maverick East	51	113	200 to 300	Normal Fault, West side down	Major
Maverick West	78	112	0 to 120	Normal Fault, West side down	Major
McLane	60	128	100 to 300	Normal Fault, West side down	Major
Predator	81	103	75 to 250	Normal Fault, East side down	Major
Ripley	81	121	-	-	Minor
Gruber	88	340	-	-	Minor
Ice Man	87	158	-	-	Minor
Connor	85	305	-	-	Minor

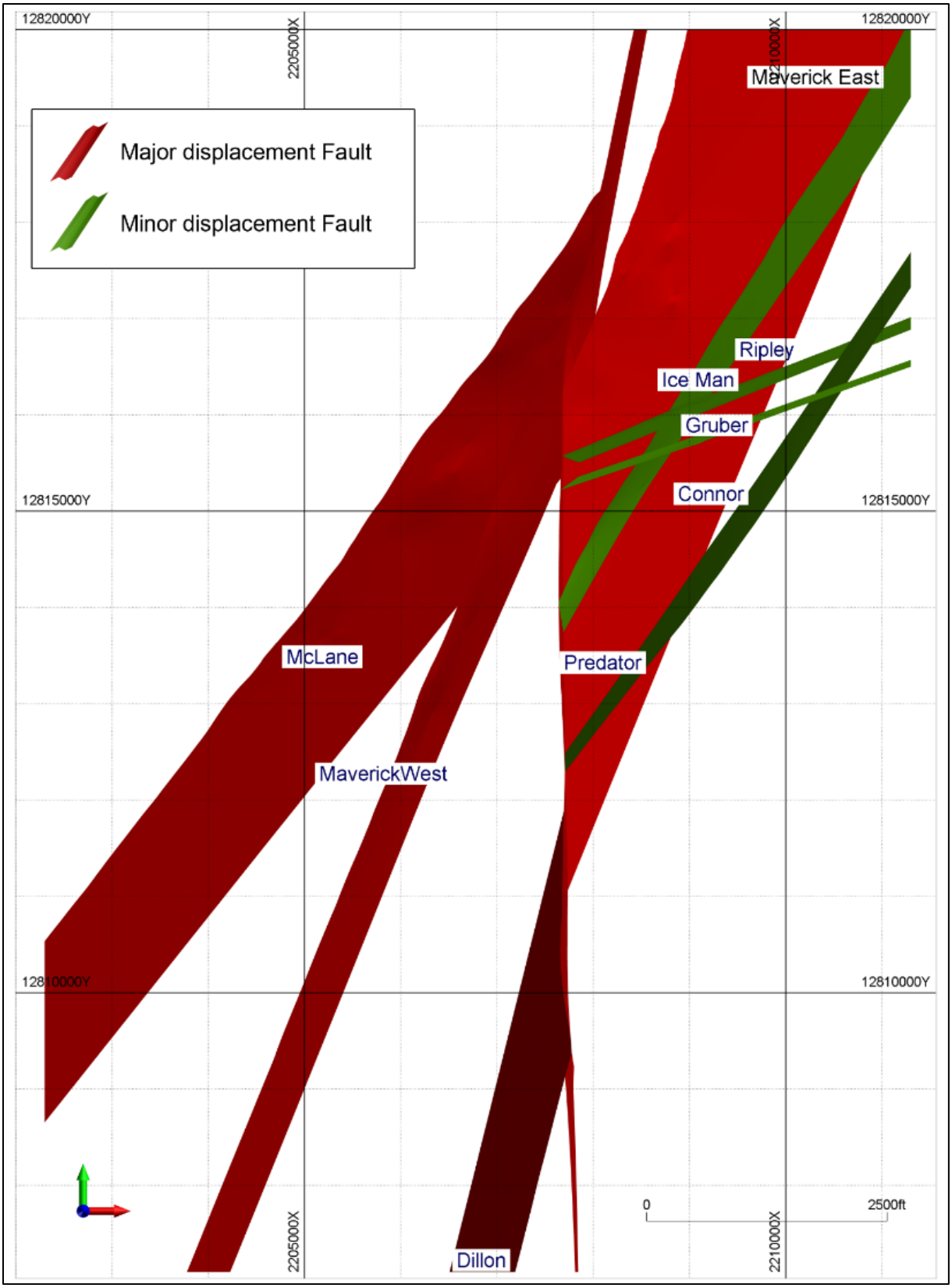


Figure 14-4: Plan View Showing Modelled Faults

14.4.6 Grade Shell Domains

Four grade shells were developed to use as estimation domains. The grade shells were generated in Leapfrog v5.0 software using bench height composite samples at three different grade thresholds 0.0050 oz/ton, 0.0146 oz/ton and 0.0321 oz/ton (0.17 g/t, 0.50 g/t, and 1.10 g/t) gold. The grade shells were generated with trends that represent the various controls on gold mineralization including the mineralizing fault network, the orientations of main lithological contacts and alteration wireframes representing elevated silicification. Final grade shells used for estimation excluded those portions of the grade shell consisting of barren or weak to non-mineralized lithologies including post-mineralization units and poor host rock lithologies. The grade shell domains are summarized in Table 14-4 and shown in Figure 14-5 to Figure 14-8.

Table 14-4: Summary of Domains

Domain	Domain Code	Grade Threshold (Au, oz/ton)	Grade Threshold (Au, g/t)	Number of Composite Samples	Average Grade (Au, oz/ton)	Average Grade (Au, g/t)
Barren or Weak to non-mineralized Lithologies	100	0.0015	0.05	3149	0.0015	0.05
Internal Waste	101	0.0015	0.05	11	0.0018	0.06
Low Grade	102	0.0050	0.17	10,891	0.0055	0.19
Medium Grade	103	0.0146	0.50	17,959	0.0134	0.46
High Grade	104	0.0321	1.10	4,638	0.0627	2.15

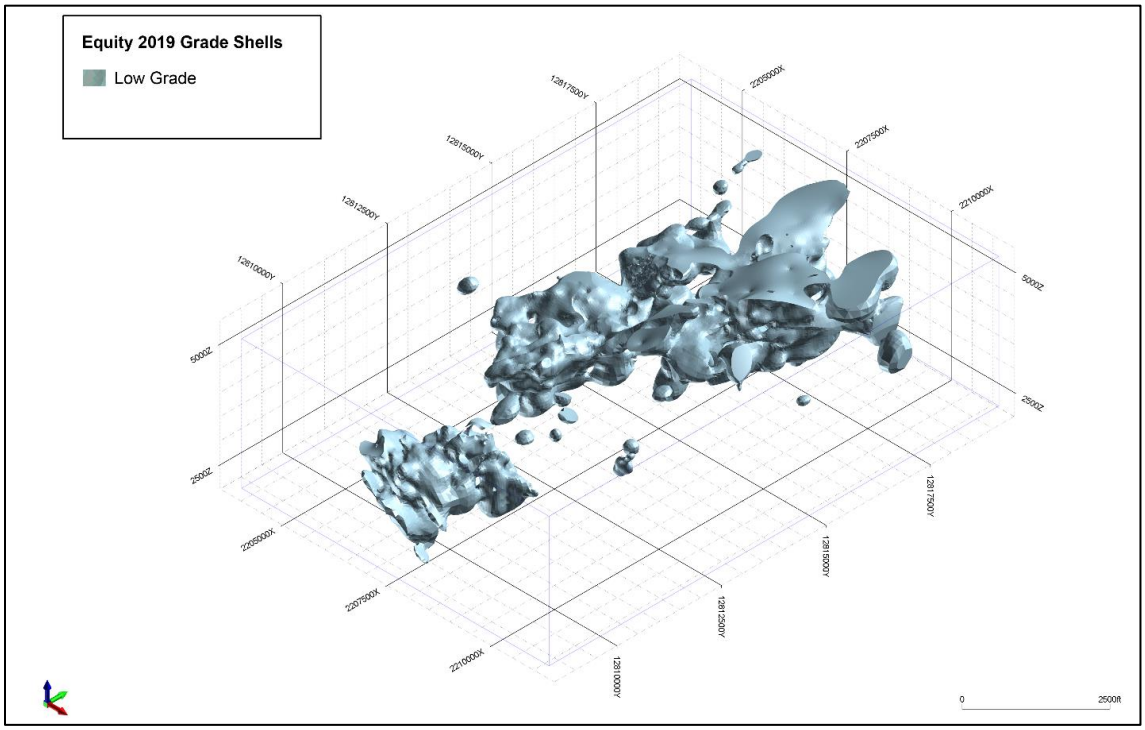


Figure 14-5: Low Grade Gold Domains (View to Northwest)

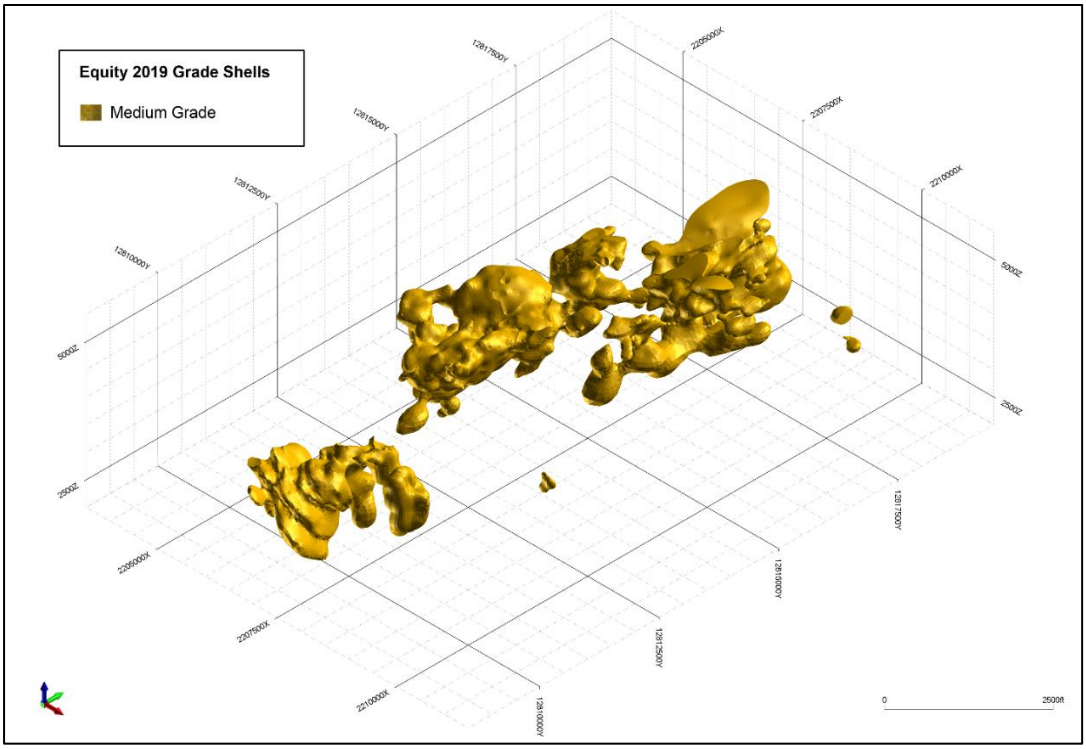


Figure 14-6: Medium Grade Gold Domains (View to Northwest)

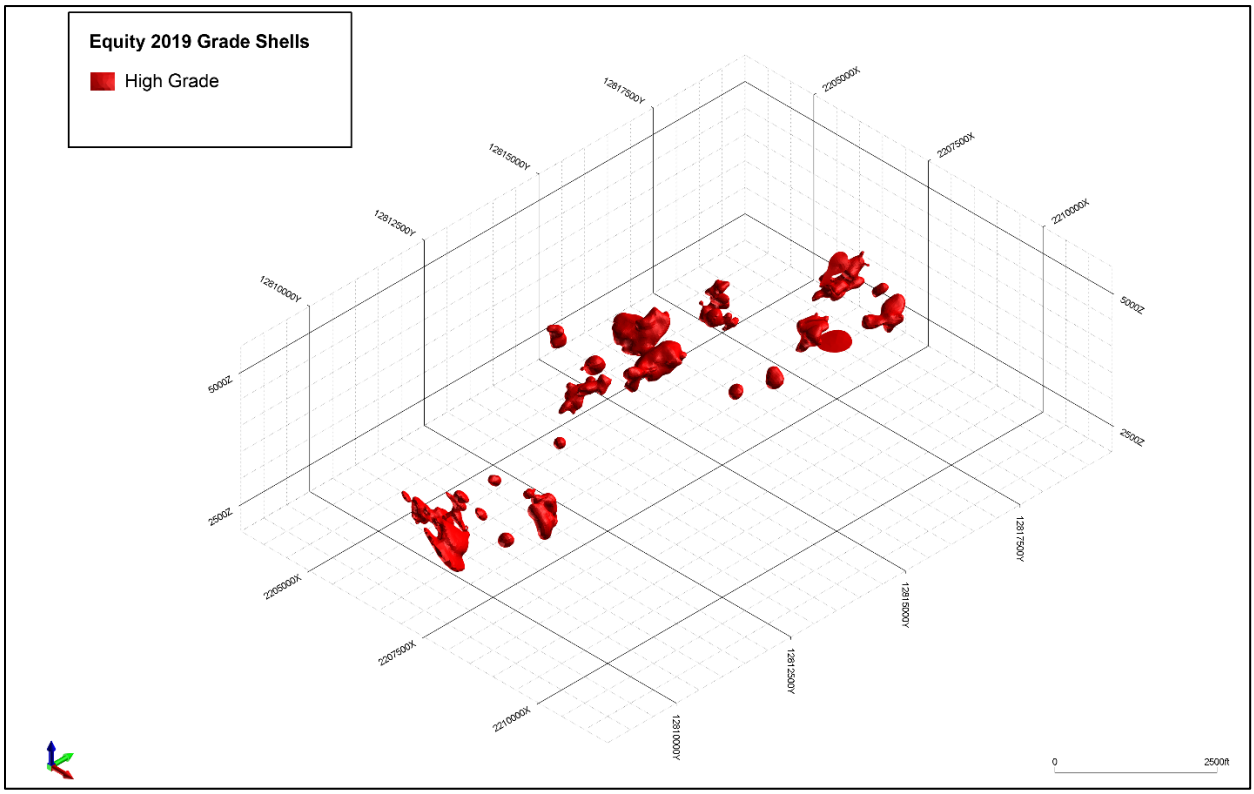


Figure 14-7: High Grade Gold Domains (View to Northwest)

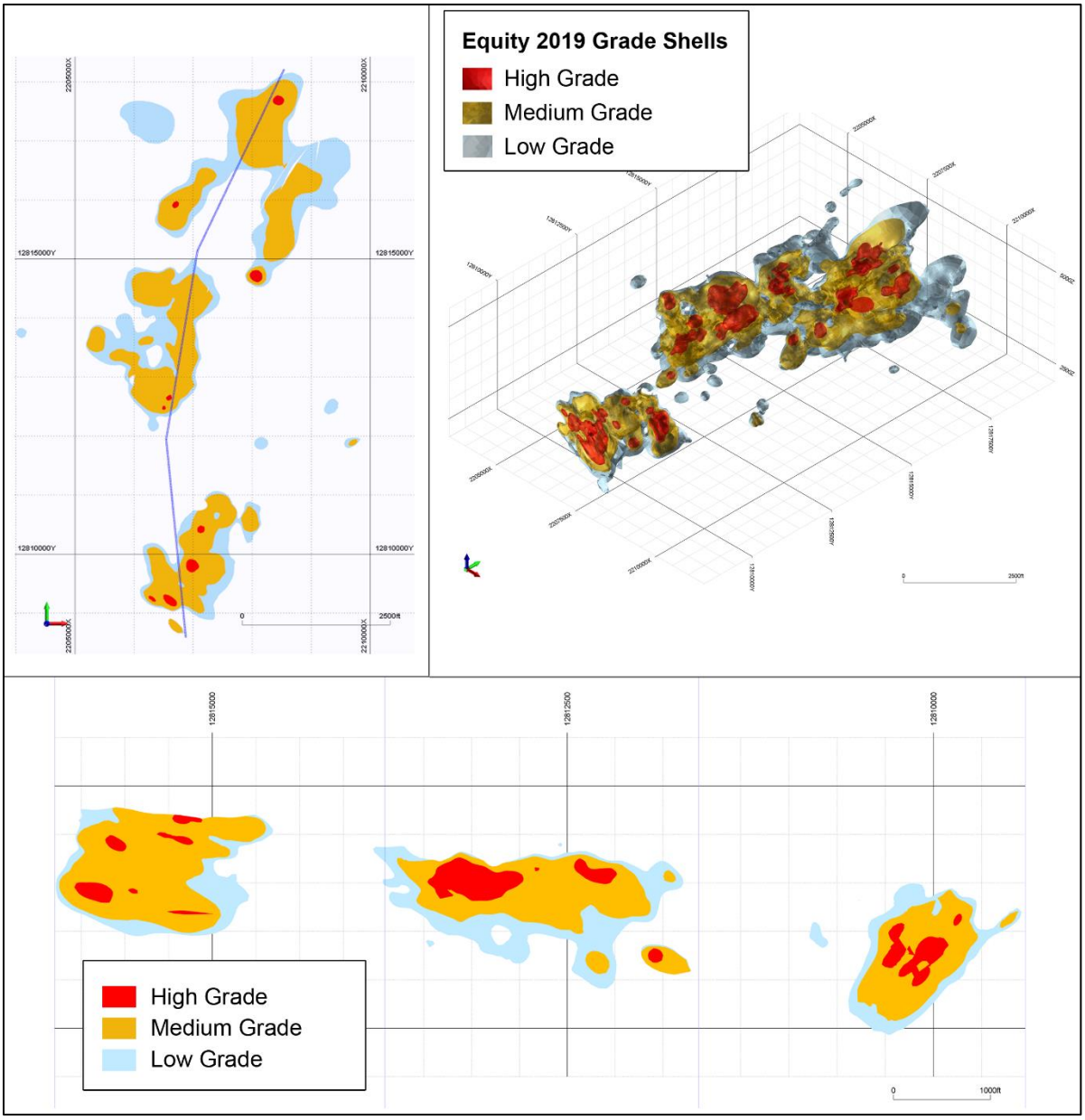


Figure 14-8: Composite Plan, Perspective & Long Section Views of Nested Grade Shell Domains

14.4.7 JSLA Backfill Model

The JSLA backfill model was developed independently of hard rock models and is based on the placement of backfill material into the JSLA pit. Temporal control for the backfill periods and final mined shape of the JSLA pit was developed using 43 monthly as-built surveys originally generated by Viceroy during active mining. The monthly as-built surveys were grouped into seven volumes based on backfill sequence and similarities between gold grades encountered in the backfill drilling. A summary of the monthly volumes and grouped backfill domains are summarized in Table 14-5 and shown in Figure 14-9.

Table 14-5: Summary of Backfill Stage Domains

Backfill Stage	Corresponding Monthly Units (year-month)	Volume (ft^3)	Volume (m^3)
1	96-10, 96-11, 96-12, 97-01, 97-02, 97-03, 97-04	140,510,000	3,978,800
2	97-05, 97-06, 97-07, 97-08, 97-09, 97-10, 97-11, 98-01, 98-02	227,930,000	6,454,300
3	98-03, 98-04, 98-05, 98-06, 98-07, 98-08, 98-09, 98-10, 98-11, 98-12, 99-01, 99-02, 99-03	246,630,000	6,983,800
4	99-04, 99-05, 99-06, 99-07, 99-08, 99-09, 99-10, 99-11, 99-12, 00-01, 00-02	232,400,000	6,580,800
5	00-03, 00-04, 00-05, 00-06, 00-08	22,753,000	644,290
6	00-07, 00-09, 00-10, 00-11, 00-12, 01-01, 01-02	31,411,000	889,460
7	01-03, 01-04	6,180,900	175,020

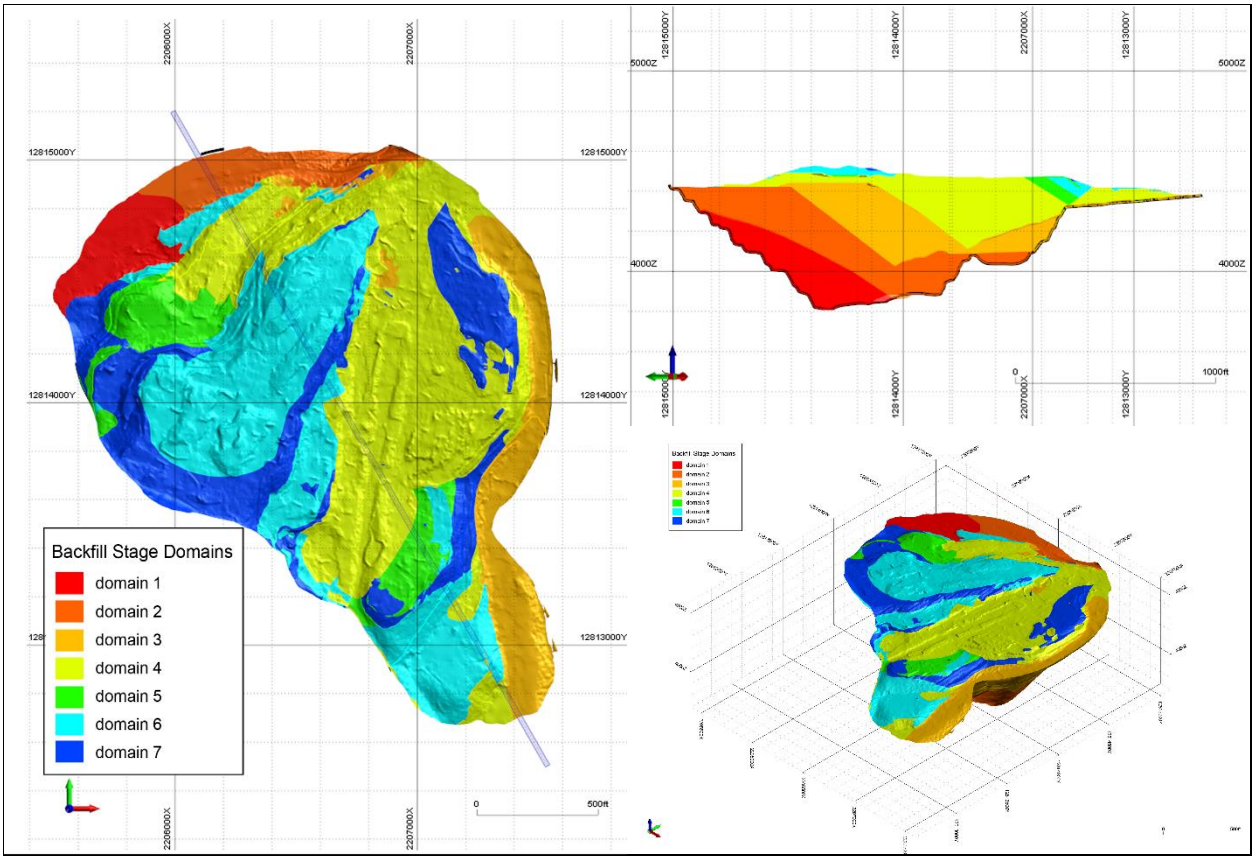


Figure 14-9: Composite Plan and Perspective View (Looking Northwest) of the JSLA Backfill Stage Domains

14.5 COMPOSITING AND CAPPING

Composites were generated for drill holes within the backfill and hard rock resource areas, and for surface channel samples within the hard rock resource areas. Compositing was completed separately for the drill holes and channel samples. The sampling of drill holes at Castle Mountain Project was predominantly done at five-foot intervals. To reduce variability and match the mining

selectivity at Castle Mountain Project, samples were composited to twenty-foot bench height intervals. Holes with missing intervals were composited to the respective bench height interval, with gold values length-weighted using the original sample lengths contained within the bench interval. This was done to avoid inserting zero grades for missing samples and unnecessarily diluting the model. Composite samples that were less than 2.5 ft (0.8 m) or samples with less than 10% coverage within the bench intervals were discarded. Channel samples were composited to 30 ft (9.14 m) lengths along the channel sample trace. Residual composite channel samples with lengths of less than 10 ft (3.05 m) were backstitched and comprise the final interval.

14.5.1 Hard Rock Model

Original samples were capped at 4.3750 oz/ton (150 g/t) gold prior to compositing to limit the influence of extreme outliers during the compositing process. In total, 18 samples were capped to 4.3750 oz/ton (150 g/t) gold. Due to the historic nature of some of the Viceroy assay data, there is significant benching of the data at the historic analytical detection limit of 0.0010 oz/ton (0.005 g/t) and increasing in 0.0010 oz/ton increments corresponding to gold values of 0.0010 oz/ton, 0.0020 oz/ton, 0.0030 oz/ton, 0.0040 oz/ton and 0.0050 oz/ton (0.034 g/t, 0.069 g/t, 0.103 g/t, 0.136 g/t and 0.170 g/t). To assist in determining if applying half the detection limit to historic Viceroy samples is appropriate for bottom cutting, statistical analysis of recent drilling was examined, which have lower detection limits of 0.00015 oz/ton (0.005 g/t) gold. Statistical analysis was completed on new drilling for values between 0.00015 oz/ton and 0.00100 oz/ton (0.005 and 0.034 g/t) gold, and then from 0.00007 oz/ton to 0.00100 oz/ton (0.0025 to 0.034 g/t) gold. In both circumstances, the distribution of these values is uniform, and exhibit mean values close to 0.0005 oz/ton (0.017 g/t) suggesting that a bottom cut value of 0.0005 oz/ton (0.017 g/t) for historic samples represents an average of expected values for samples below detection limit. Therefore, for historic Viceroy sample data, values reporting less than detection limit 0.001 oz/ton (0.034 g/t) gold were replaced with values representing half detection limit 0.0005 oz/ton (0.017 g/t) gold.

Gold grade capping of composited samples was performed globally for all domains. Final gold grade capping values were chosen based primarily on a top cut analysis utilizing probability plots, and covariance versus capping values (top cut values) for all three grade shell domains (Figure 14-10 to Figure 14-13). The treatment of domain boundaries and spatial continuity of high grade was considered for the final capping value, resulting in a final capping value of 0.8750 oz/ton (30 g/t) gold for all domains. This capping value is consistent with historical capping levels employed by Viceroy during operation of Castle Mountain Mine. A summary of the comparison between raw assays and capped composited samples is shown in Table 14-6.

The resource model is sensitive to capping methodology and values. Capping prior to compositing was investigated to assess the resource model's sensitivity to the capping and compositing strategy. Capping on raw assays was completed using top cut values appropriate to each grade shell domain. The results indicate that the estimated gold grades and metal content are comparable and are within 5% between the two methods of capping raw assays and capping composite samples.

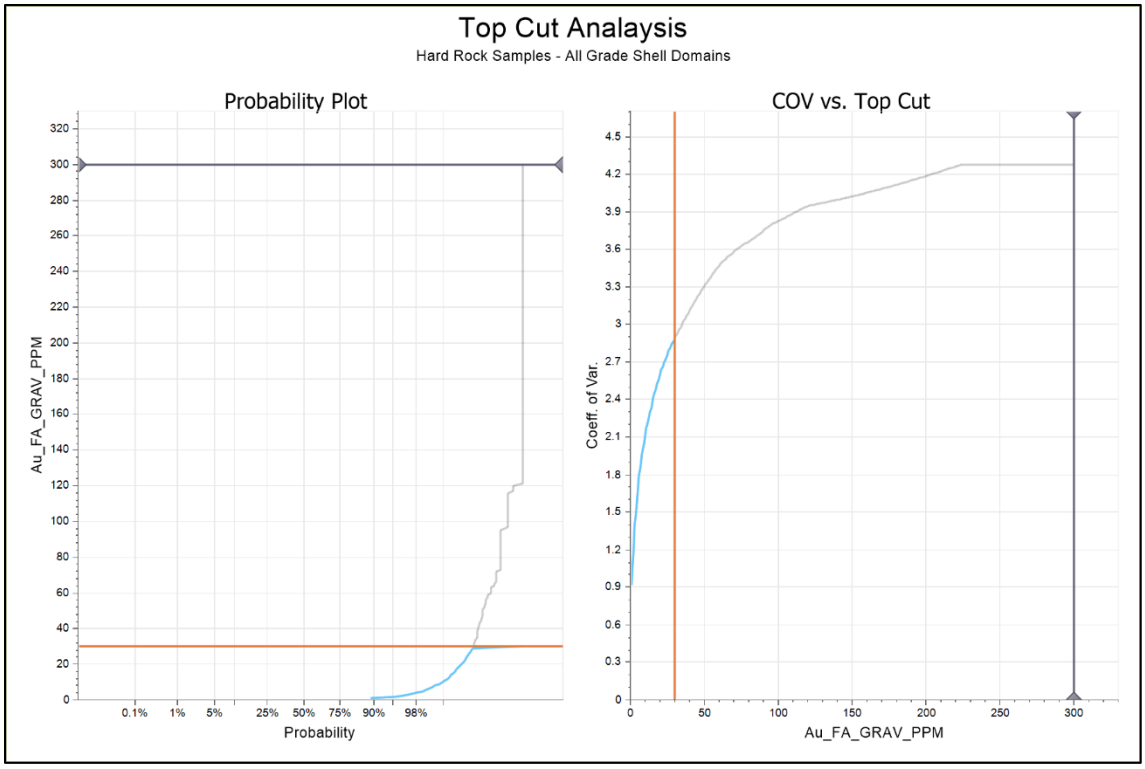


Figure 14-10: Top Cut Analysis of all Composite Samples

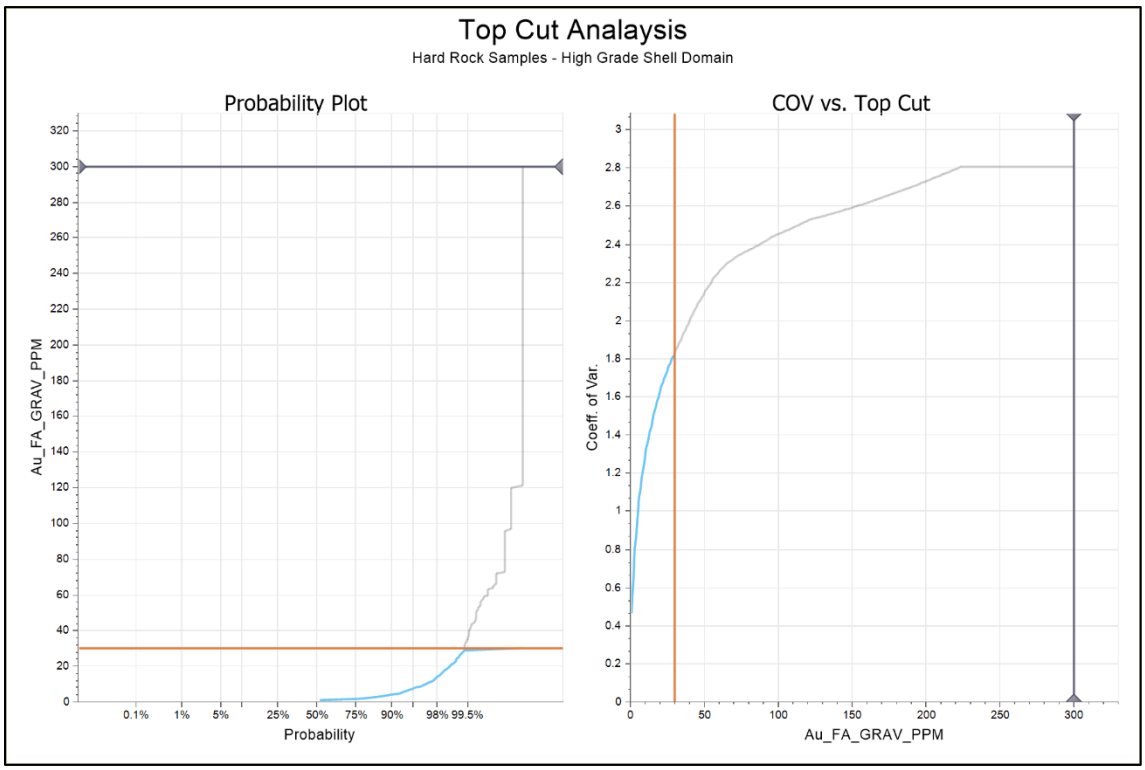


Figure 14-11: Top Cut Analysis of Composite Samples Within the High Grade Domain

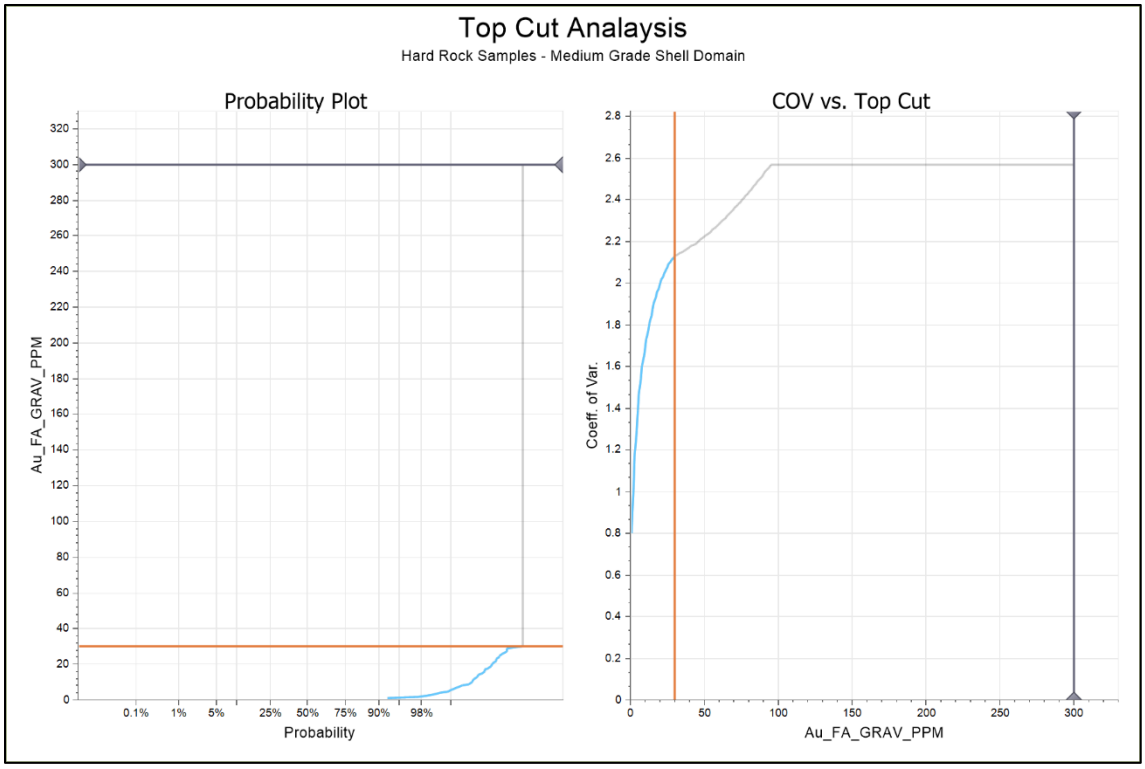


Figure 14-12: Top Cut Analysis for Composite Samples Within the Medium Grade Domain

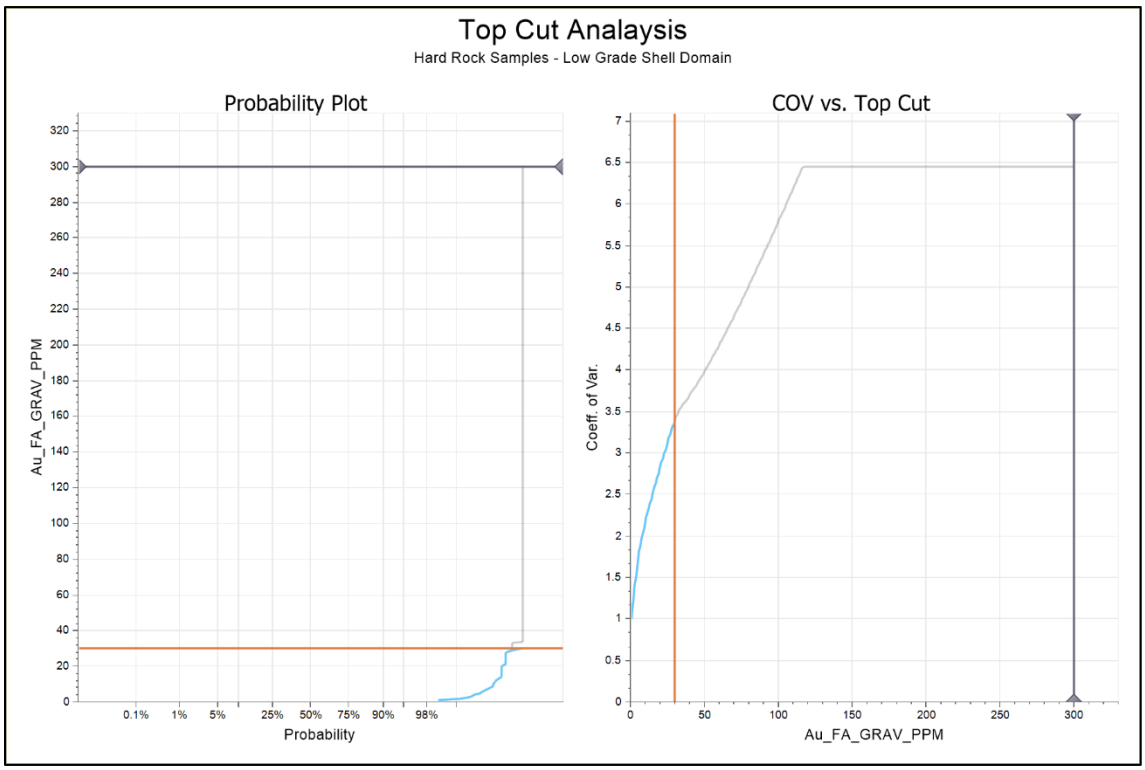


Figure 14-13: Top Cut Analysis for Composite Samples Within the Low Grade Domain

Table 14-6: Summary of Original and Composited Sample Capping Statistics

Domain	Original Samples			Composited Samples		
	Sample Count	Length Weighted Average		Sample Count	Average Grade	
		Au, oz/ton	Au, g/t		Au, oz/ton	Au, g/t
Non-Mineralized	12,511	0.0016	0.06	3,149	0.0016	0.05
Internal Waste	43	0.0016	0.06	11	0.0017	0.06
Low Grade	42,127	0.0056	0.19	10,891	0.0054	0.18
Medium Grade	74,796	0.0147	0.50	17,959	0.0133	0.46
High Grade	18,088	0.0602	2.06	4,638	0.0578	1.98
Outside	132,147	0.0016	0.06	31,440	0.0015	0.05

14.5.2 Backfill Model

Individual samples were capped at 0.2917 oz/ton (10 g/t) gold prior to compositing to limit the influence of outliers during the compositing process. One single sample was capped 0.2917 oz/ton gold prior to compositing. A summary of the sample statistics by JSLA backfill stage are provided in Table 14-7.

Table 14-7: Summary of Original and Composited Backfill Samples

JSLA Backfill Stage	Original Samples			Composited Samples		
	Sample Count	Length Weighted Average		Sample Count	Average Grade	
		Au, oz/ton	Au, g/t		Au, oz/ton	Au, g/t
1	668	0.0076	0.26	377	0.0079	0.27
2	1,188	0.0043	0.15	568	0.0043	0.15
3	1,826	0.0086	0.29	849	0.0076	0.26
4	2,864	0.0088	0.30	1,732	0.0091	0.31
5	309	0.0167	0.57	256	0.0186	0.64
6	558	0.0109	0.37	623	0.0114	0.39
7	111	0.0141	0.48	142	0.0139	0.48

14.6 CONTACT ANALYSIS

In an attempt to determine the treatment of domain boundaries during the grade estimation strategy, contact analysis was performed for each grade shell domain and oxidation domain. Contact plots representing grade profiles within and away from the grade shell domains for low, medium and high-grade domains are shown in Figure 14-14, whereas oxidation domains are shown in Figure 14-15. Contact plots show histograms of the number of samples in blue, and average grades in red. The final treatment of the domain boundaries is summarized in Table 14-8. High-, medium- and low-grade shell domains show slight increase in grade towards the contact of the high-grade shells. Gold grades also decline into the transition zones and decrease further into the sulfide domains.

Within the model there are some areas where transitional domains are absent and oxide domains overly sulfide zones. Most of these occurrences correspond with a lack of deeper drilling that may have encountered transition or sulfide mineralization. It is anticipated that additional drilling and assaying will generate a more robust oxidation model.

Table 14-8: Summary of Treatment of Domain Contacts

Contact	Treatment in Resource Model
Non Mineralized Rock Types	Hard Boundary
High and Medium grade	Soft Boundary
Medium and Low Grade	Soft Boundary
High and Low Grade	Hard Boundary
Low Grade and Internal Waste	Hard Boundary
Oxide - Transition	Soft Boundary
Transition - Sulfide	Soft Boundary

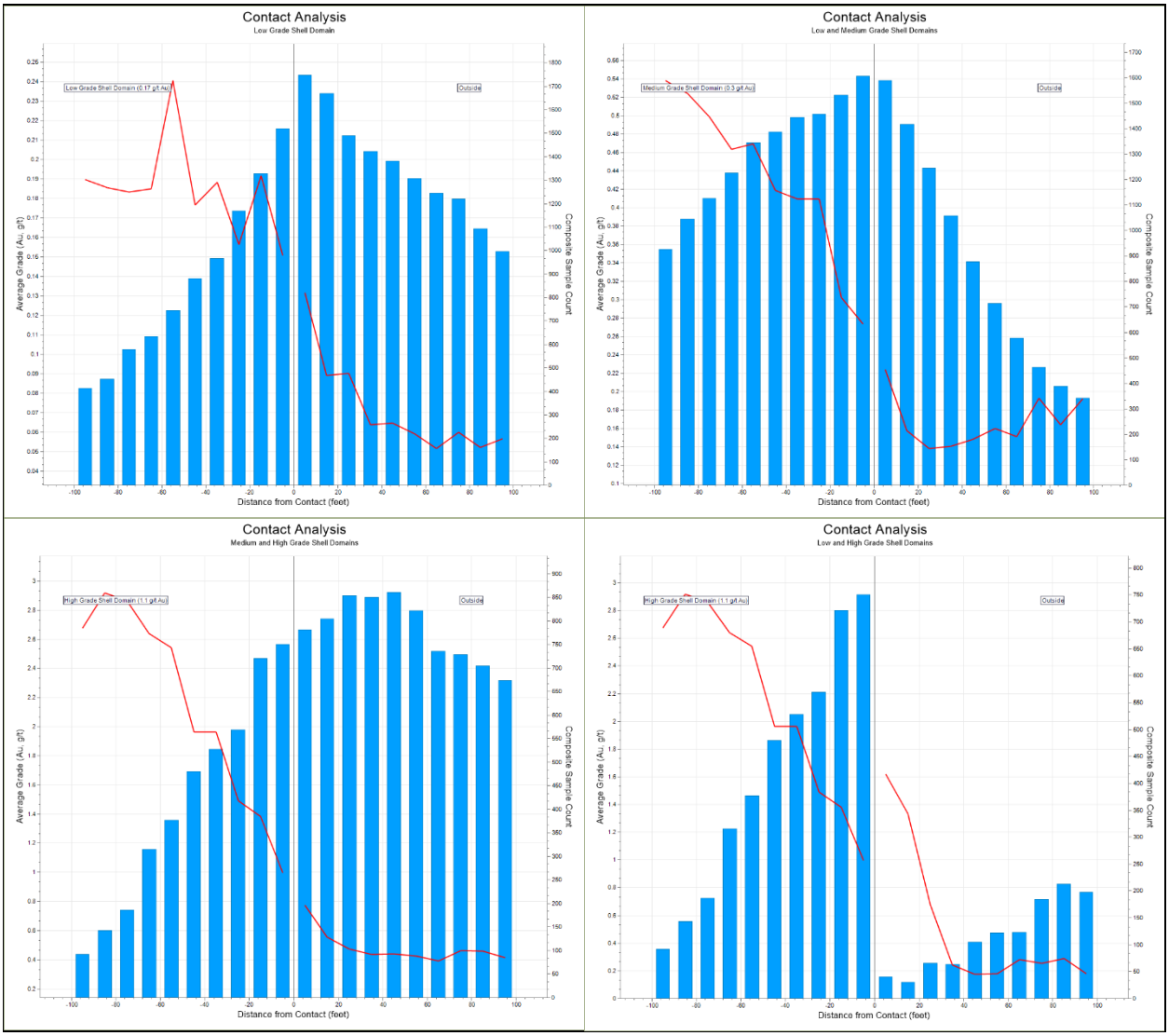


Figure 14-14: Grade Domain Boundary Analysis

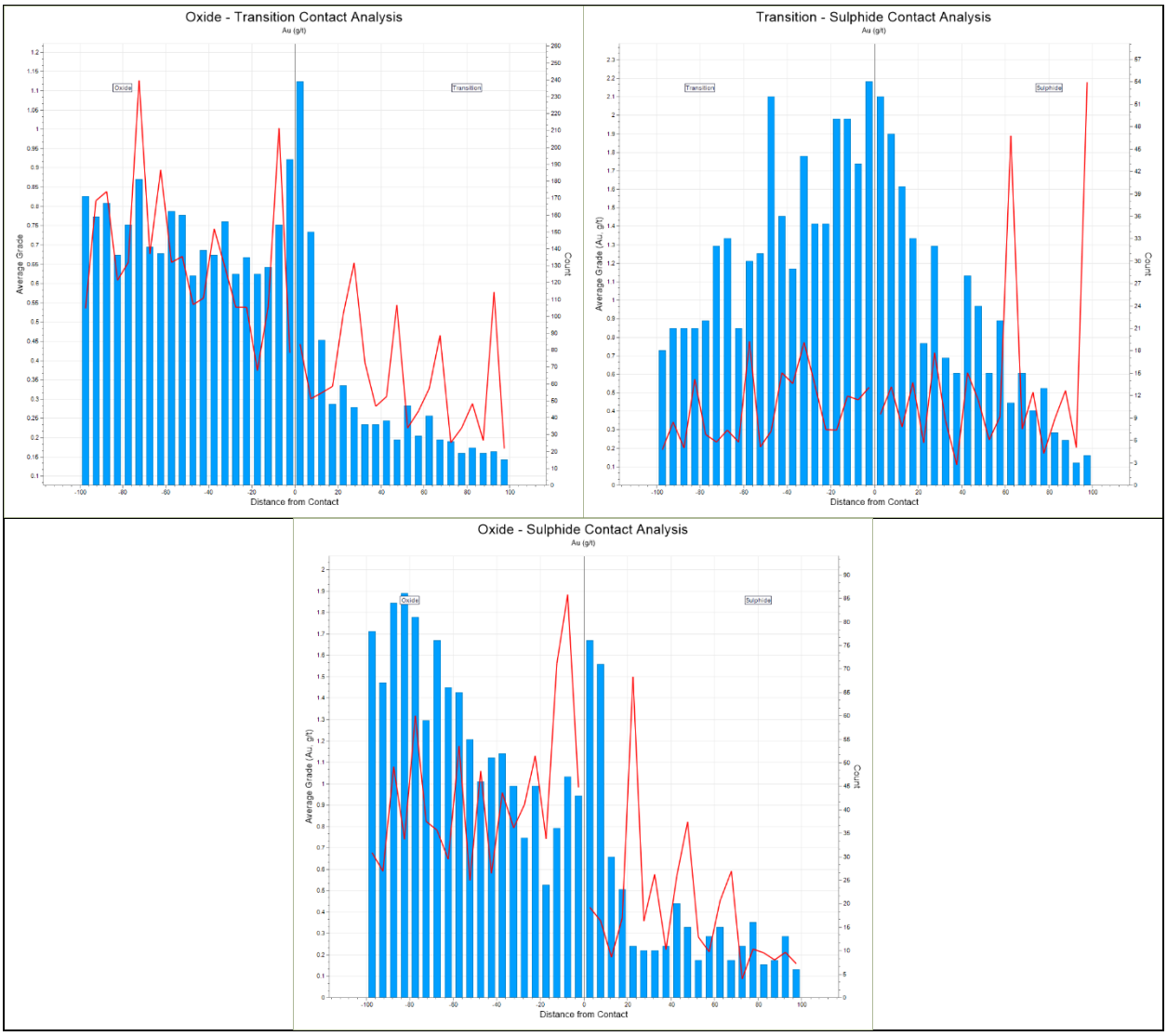
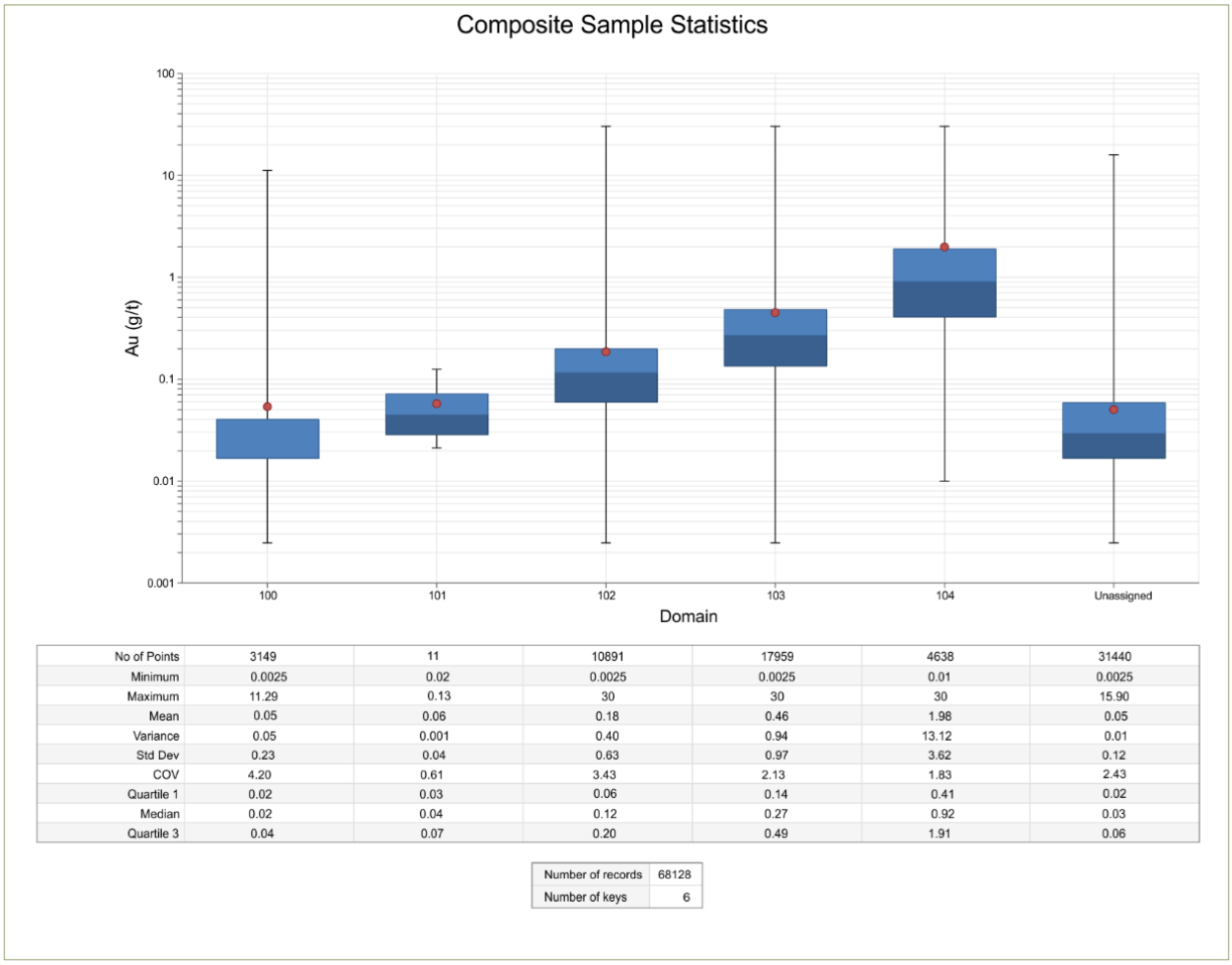


Figure 14-15: Geochemical Weathering Boundary Analysis

For the backfill portion of the resource, all backfill stage domains were treated as hard boundaries as these domains represent depositional continuity during backfilling of the JSLA pit.

14.7 STATISTICAL ANALYSIS

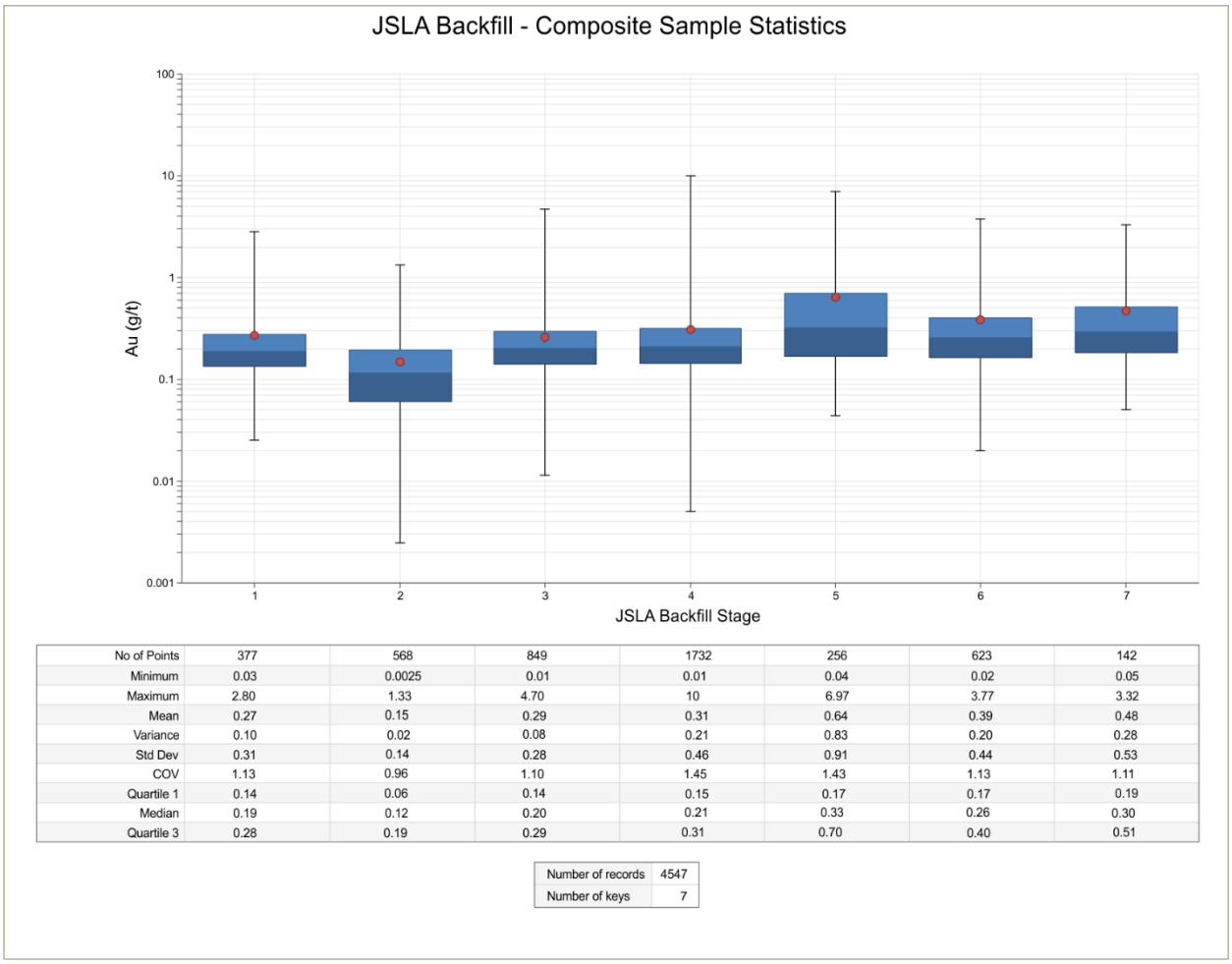
A summary of the composite sample statistics is presented in Figure 14-16 by corresponding grade domain codes for all domains used in the hard rock, JSLA backfill and waste dump resources are summarized in Figure 14-17.



No of Points	3149	11	10891	17959	4638	31440
Minimum	0.0025	0.02	0.0025	0.0025	0.01	0.0025
Maximum	11.29	0.13	30	30	30	15.90
Mean	0.05	0.06	0.18	0.46	1.98	0.05
Variance	0.05	0.001	0.40	0.94	13.12	0.01
Std Dev	0.23	0.04	0.63	0.97	3.62	0.12
COV	4.20	0.61	3.43	2.13	1.83	2.43
Quartile 1	0.02	0.03	0.06	0.14	0.41	0.02
Median	0.02	0.04	0.12	0.27	0.92	0.03
Quartile 3	0.04	0.07	0.20	0.49	1.91	0.06

Number of records	68128
Number of keys	6

Figure 14-16: Box and Whisker Plot of Composite Samples by Grade Domains



No of Points	377	568	849	1732	256	623	142
Minimum	0.03	0.0025	0.01	0.01	0.04	0.02	0.05
Maximum	2.80	1.33	4.70	10	6.97	3.77	3.32
Mean	0.27	0.15	0.29	0.31	0.64	0.39	0.48
Variance	0.10	0.02	0.08	0.21	0.83	0.20	0.28
Std Dev	0.31	0.14	0.28	0.46	0.91	0.44	0.53
COV	1.13	0.96	1.10	1.45	1.43	1.13	1.11
Quartile 1	0.14	0.06	0.14	0.15	0.17	0.17	0.19
Median	0.19	0.12	0.20	0.21	0.33	0.26	0.30
Quartile 3	0.28	0.19	0.29	0.31	0.70	0.40	0.51

Number of records	4547
Number of keys	7

Figure 14-17: Box and Whisker Plot of JSLA Backfill Composite Samples by Stage Backfill Domains

14.8 VARIOGRAPHY

Variogram modelling was completed for four resource areas to optimize interpolation parameters and to assess the viability of Ordinary Kriging for use as an interpolator. Directional variograms were calculated and modelled using exploration drilling data for four main resource areas: Oro Belle, Jumbo, JSLA – Big Chief, and South Domes – Six 21 (see Figure 14-22). With the exception of South Domes – Six 21, variograms were also calculated and modelled using production blasthole to assist in validating the variogram models generated using drill hole data. A summary of the modelled variogram ranges and directions for drill hole data and production blasthole data are included in Table 14-9 and Table 14-10, respectively. Modelled variograms for production blasthole data from the mined out areas are shown in Figure 14-18 to Figure 14-20, and for exploration data from South Domes – Six 21 shown in Figure 14-21.

Table 14-9: Summary of Variogram Parameters for Area Based Variogram Modelling

Area	Rotation Angles (°)			Variogram Model Parameters					
	Z	X	Y	Nugget	Structure	CC	Major (ft)	Semi-Major (ft)	Minor (ft)
Oro Belle	24	0	6	0	1	0.75	30	20	30
					2	0.25	100	110	150
Jumbo	210	25	0	0	1	1	40	60	30
JSLA - Big Chief	310	0	0	0	1	1	30	45	45
South Domes - Six 21	245	0	10	0	1	1	60	120	40

Table 14-10: Summary of Variogram Parameters Based On Blasthole Sampling for Mined Deposits

Area	Rotation Angles (°)			Variogram Model Parameters					
	Z	X	Y	Nugget	Structure	CC	Major (ft)	Semi-Major (ft)	Minor (ft)
Oro Belle	24	0	6	0	1	0.1	20	15	20
					2	0.75	60	60	60
					3	0.15	110	110	80
Jumbo	210	25	0	0	1	0.85	40	40	30
					2	0.15	60	60	90
JSLA	310	0	0	0	1	0.83	20	20	60
					2	0.17	160	120	60

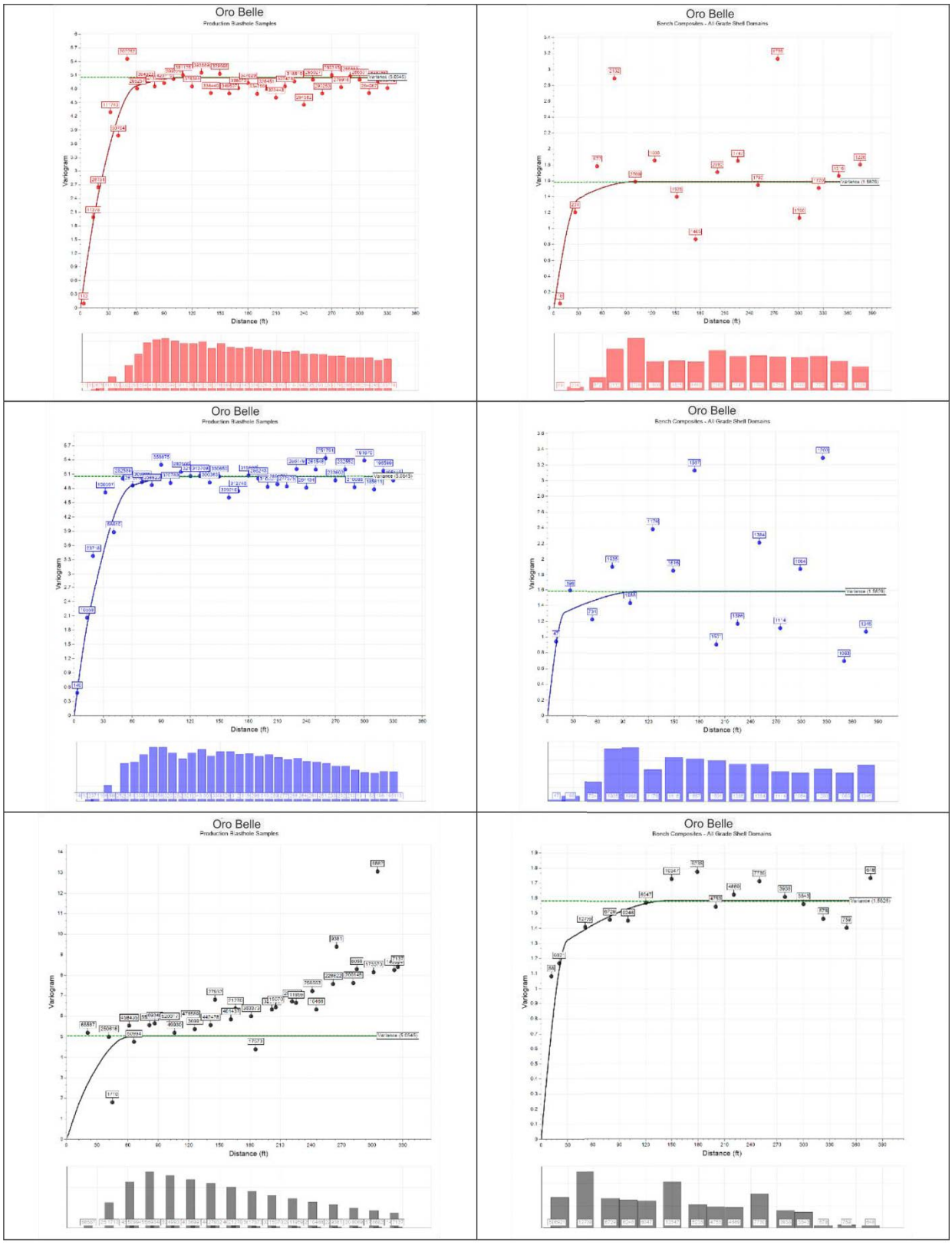


Figure 14-18: Oro Belle Variogram Modelling for Production Blasthole Samples (left) and Bench Composite Samples (right)

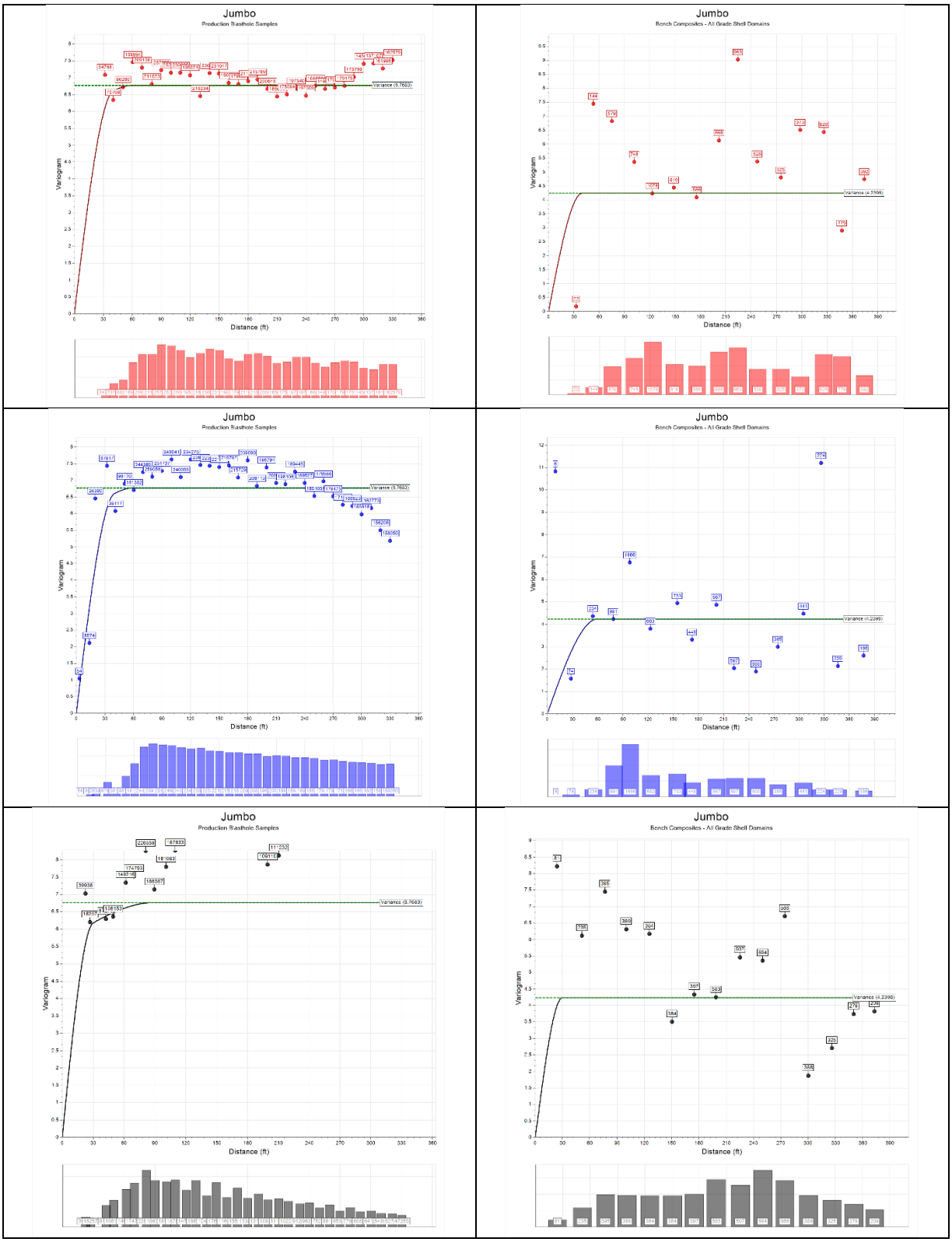


Figure 14-19: Jumbo Variogram Modelling for Production Blasthole Samples (left) and Bench Composite Samples (right)

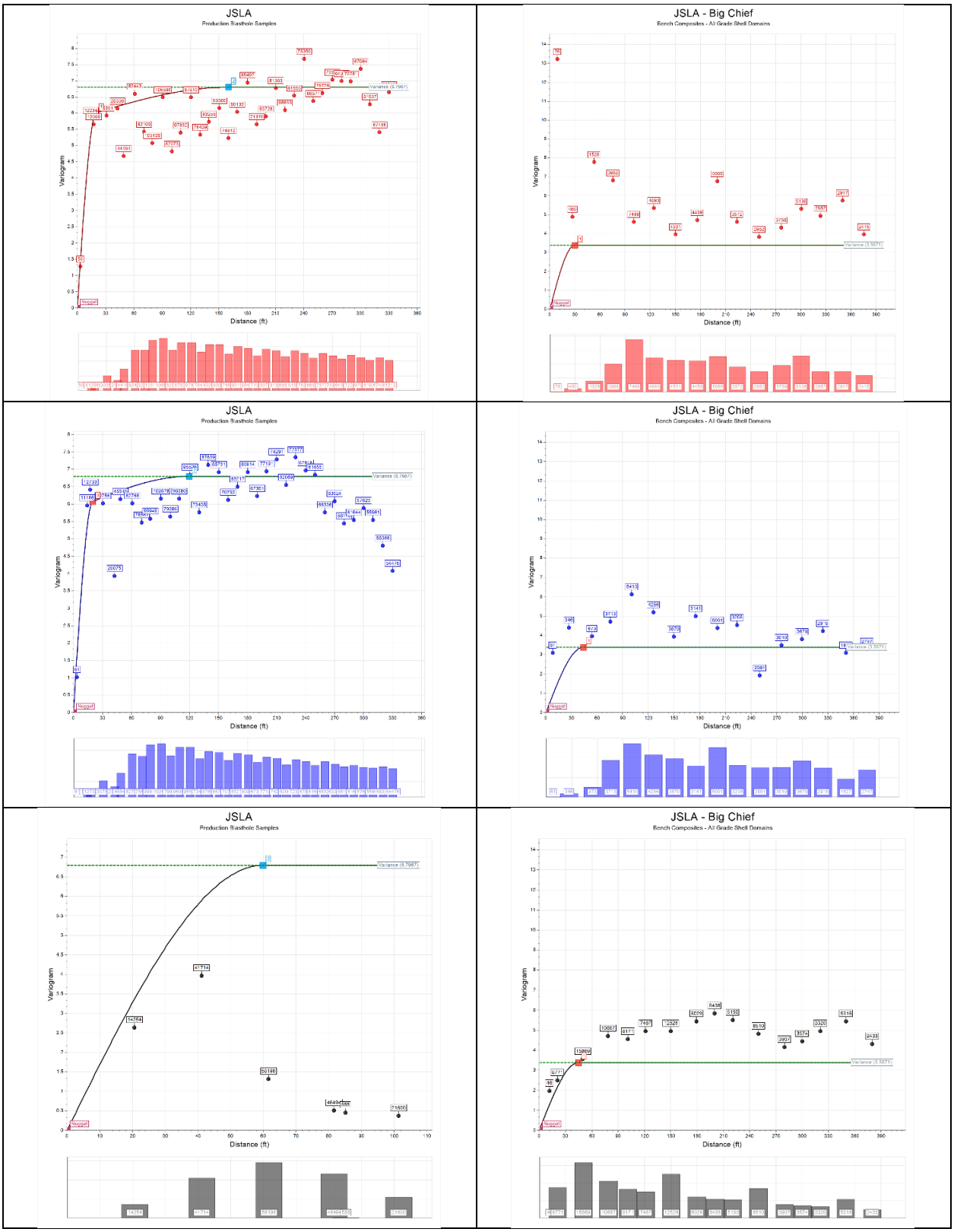


Figure 14-20: JSLA Variogram Modelling for Production Blasthole Samples (left) and Bench Composite Samples (right)

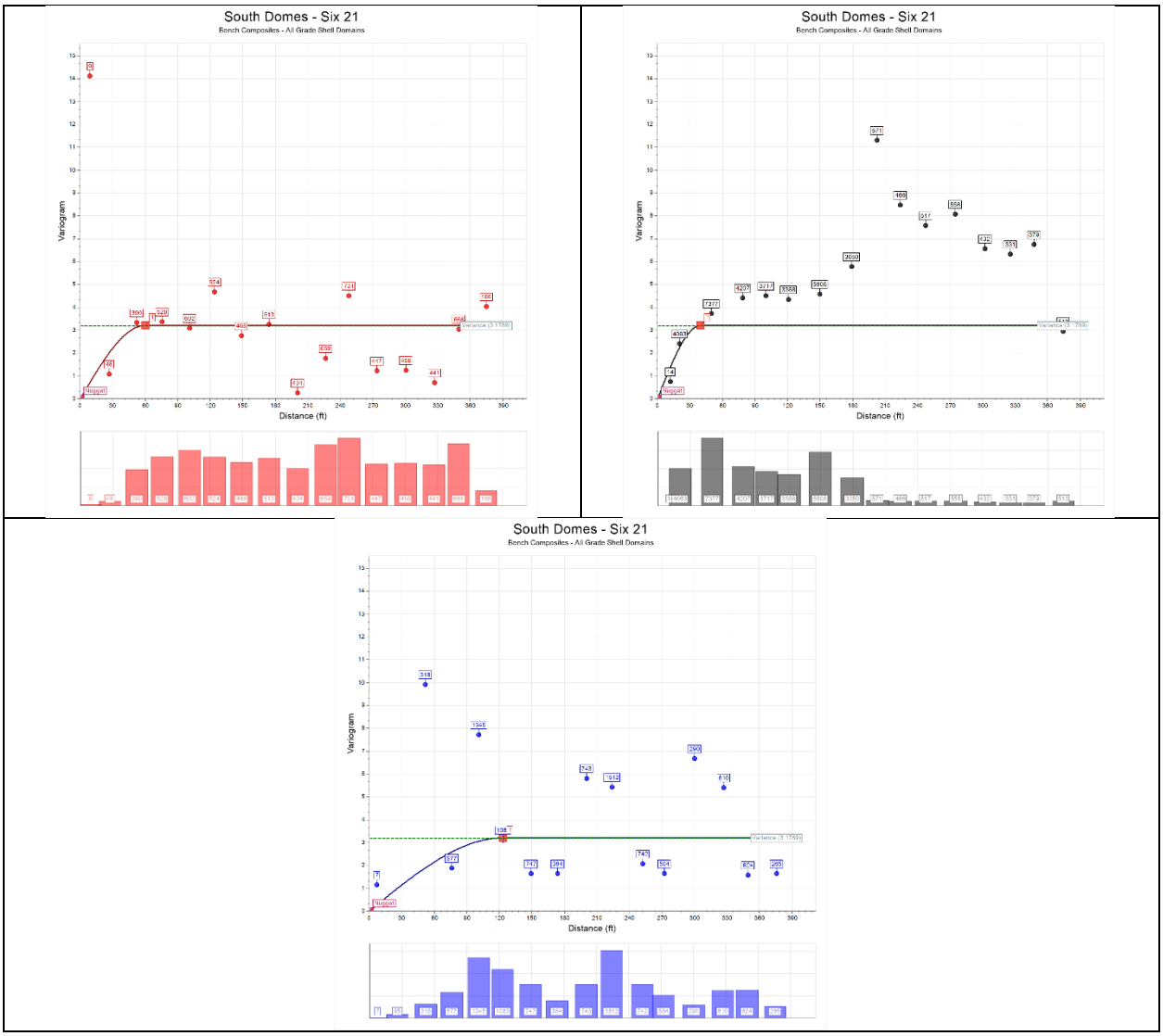


Figure 14-21: South Domes Variogram Modelling

Variogram ranges generated from production blasthole data indicate good spatial continuity up to 60 ft (18 m) on average, and generally decay towards the maximum ranges that vary from 90 to 160 ft (27 to 49 m) depending on the resource area. In general, variograms produced using composited drill hole samples produce less stable variograms and do not reproduce the production data. Both datasets support that good spatial continuity is achieved from 40 to 60 ft (12 to 18 m) for most resource areas. The area within and around Jumbo exhibits shorter ranges up to a maximum range of 60 ft (18 m) for drill hole data and 90 ft (27 m) for blasthole data.

14.9 BULK DENSITY

Bulk density was collected using the paraffin wax immersion method on 647 core samples. The bulk density measurements were converted to tonnage factors as discussed in Section 12.5. Average bulk density values were assigned to the block model according to the lithological model domain. For lithologies with inadequate sample coverage, average bulk density values of alike

rock types were assigned. The bulk density values for each lithology type are summarized in Table 14-11.

Table 14-11: Summary of Bulk Density and Tonnage Factor Values by Lithology

Model Code	Lithology	Sample Count	Average Tonnage Factor (ft^3 per short ton)	Average SG (g/cm^3)
	Backfill and Waste Dumps	0	18.8	1.7
2	Alluvium	0	16.8	1.90
3	Debris Flow	2	17.3	1.85
5	Dacite	0	14.3	2.24
5	Hart Peak Rhyolite	0	14.2	2.25
7	Rhyolite Breccia	9	14.4	2.24
9	Porphyrytic Rhyolite	158	14.3	2.25
11	Aphyric Rhyolite	112	14.7	2.20
14	Volcanoclastic Diatreme	79	14.5	2.22
16	Volcanoclastic	146	15.3	2.11
22	Mudstone	1	16.1	1.99
23	Epiclastics	33	14.9	2.16
27	Andesite	82	14.4	2.23
29	Peach Springs Tuff	9	14.5	2.23
30	Proterozoic (Pc) Sediments	7	13.6	2.36
31	Proterozoic (Pc) Basement	9	12.4	2.59

14.10 BLOCK MODEL AND GRADE ESTIMATION METHODOLOGY

The block model definitions for the Castle Mountain resource model are defined in Figure 14-12.

Table 14-12: Castle Mountain Block Model Definitions

Block Model Information			
	X	Y	Z
Block Size (ft)	30	30	20
Number of Blocks	300	430	140
Minimum Centre	2202315	12807115	2610
Maximum Centre	2211285	12819985	5390
Origin	2202300	12807100	2600
Rotation	0	0	0

Block sizes were determined from the historical mining methods, and preliminary mine design used in the Preliminary Feasibility Study for the Castle Mountain Project (Scott et al., 2018).

The methodology for resource estimation for the Castle Mountain hard rock resource model was based on the following:

- For drill holes without missing intervals, samples were composited to 20 ft (6.1 m) bench intervals using the methodology presented herein. For drill holes with missing or unsampled intervals, length weighted average grades composited to the bench interval were used. Samples with less than 10% bench coverage or samples less than 2.5 ft (0.8 m) were discarded.
- Global capping of composite samples to 0.8750 oz/ton (30 g/t) gold.
- Grade shell development based on bench composite data.
- Anisotropic search parameters were informed by surfaces generated from the lithology model where there was visual gold grade continuity corresponding to lithological contacts.
- Blocks were estimated within three grade shell domains representing high-, medium- and low-grade, with hard boundaries between the high- and low-grade shell domains.
- Only blocks estimated within an area representing drill hole spacing less than 300 ft (91 m) were considered as a Resource.
- ID2 was used to estimate block grades within the non-mineralized and waste rock domains.
- ID3 was used to estimate block grades within the low-, medium- and high-grade shell domains.
- ID3 was used to estimate the backfill and waste dump domains.
- Average bulk density ("SG") values for each lithology were assigned to the block model.

Search distances were based on variogram modelling of drill hole and production composite samples. The search distances used for the resource estimate considered drill hole spacing and grade shell dimensions. Interpolation parameters are summarized in Table 14-13.

Table 14-13: Summary of Interpolation Parameters for Hard Rock, JSLA Backfill and Waste Dumps

Hard Rock						
Pass	**Search Radius (ft)**			**Number of Samples**		
	Major	**Semi Major**	**Minor**	**Minimum**	**Maximum**	**Max per hole**
1	100	75	50	4	12	3
2	200	130	100	3	12	2
3	500	300	250	2	12	-

JSLA Backfill						
Pass	**Search Radius (ft)**			**Number of Samples**		
	Major	**Semi Major**	**Minor**	**Minimum**	**Maximum Per Octant**	**Max per hole**
1	125	125	125	1	2	3

Waste Dumps						
Pass	**Search Radius (ft)**			**Number of Samples**		
	Major	**Semi Major**	**Minor**	**Minimum**	**Maximum Per Octant**	**Max per hole**
1	75	75	50	2	10	1
2	125	125	50	2	10	1

Search orientations were based on the lithology model where localized grade continuity corresponds to lithology contacts. Where there were no observable trends in grade continuity, an isotropic search orientation was used. Mean search directions by lithology are summarized in Table 14-14. The lithology model was given specific names based on target area and an identifier to aid in modelling, which was assigned a unique numeric domain code based on the lithology model code.

Table 14-14: Mean Search Directions by Lithology

Domain Code	Lithology	Mean Dip (˚)	Mean Dip Direction (˚)
	Waste Rock and Non-Mineralized Rock Types		
502	05-HartRhy Migos	6	4
201	02-Alluvium	4.5	207
301	03-DebrisFlow	7	232
501	05-Dacite	88	92
912	09-RhyPorph Six21-NWA	88	92
1102	11-RhyAph BigChief-EastFlow	6	66
1103	11-RhyAph BigChief-West	30	42
1104	11-RhyAph BigChief-WestFlow	7	259
1118	11-RhyAph SD-FlashFlow	8	90
1117	11-RhyAph Six21-DMXFlow	1	315
1119	11-RhyAph Six21-NoName	25	40
1120	11-RhyAph WestFlow	7	259
	Mineralized Rock Types		
701	07-RhyBx-Auto LuckyJohn	29	92
901	09-RhyPorph BigChief	80	94
902	09-RhyPorph ER-Dre	84	220
904	09-RhyPorph JSLA-Kendrick	82	108
906	09-RhyPorph Jumbo	90	332
907	09-RhyPorph JumboFlow	9	328
909	09-RhyPorph OroBelleFlow	20	100
910	09-RhyPorph SD-Snoop	70	89
911	09-RhyPorph SD-Tupac	86	80
1101	11-RhyAph BigChief-East	43	315
1105	11-RhyAph ER-JayZ	83	56
1107	11-RhyAph LuckyJohn	27	125
1109	11-RhyAph OB-50centFlow	3	46
1112	11-RhyAph SD-Flash	48	27
1114	11-RhyAph SD-Mathers	60	92
1115	11-RhyAph SD-Quest	80	85
1116	11-RhyAph Six21-Biggie	60	60

Domain Code	Lithology	Mean Dip (˚)	Mean Dip Direction (˚)
1117	11-RhyAph Six21-DMX	50	244
1120	11-RhyAph West Flow	3	141
1404	14-VxDiatreme LuckyJohn	89	220
1601	16-Vx	5	183
2201	23-Epiclastics	5	196
2701	27-Andesite	5	188
2901	29-Peach Spring	4	218
3001	30-Pc. Sediments	4	220
3101	31-Pc. Basement	5	232
	Rock Types Not Included in Anisotropy Model		
1110	11-RhyAph OB-Outkast	0	0
1111	11-RhyAph OB-OutkastFlows	0	0
1402	14-VxDiatreme EastRidge	0	0
1405	14-VxDiatreme OroBelle	0	0
1406	14-VxDiatreme SouthDomes	0	0
1110	Waste Dumps and Backfill	0	0

14.11 MODEL VALIDATION

The resource models were validated by completing a series of swath and cross validation plots. Depleted resource areas were compared to estimates generated with blasthole samples and historic production records. A comparison of estimators was also completed.

14.11.1 Swath Plots

Swath plots were generated for six main resource areas (Figure 14-22). Swath plots were generated on 60 ft (18 m) swath indexes for east-west and north-south swath directions. Vertical swath plots were generated using a 40 ft (12.2 m) interval. Swath plots are shown in Figure 14-23 to Figure 14-27. Blue lines correspond to the block estimate, red lines are the nearest neighbor estimate, black lines represent composite samples, and blue histograms represent the number of composite samples. Block estimates show good correlation with composite samples and nearest neighbor with grade trends honored. As most historical holes drilled by Viceroy are subvertical, there is some bias due to drilling orientation in easting and northing swath plots.

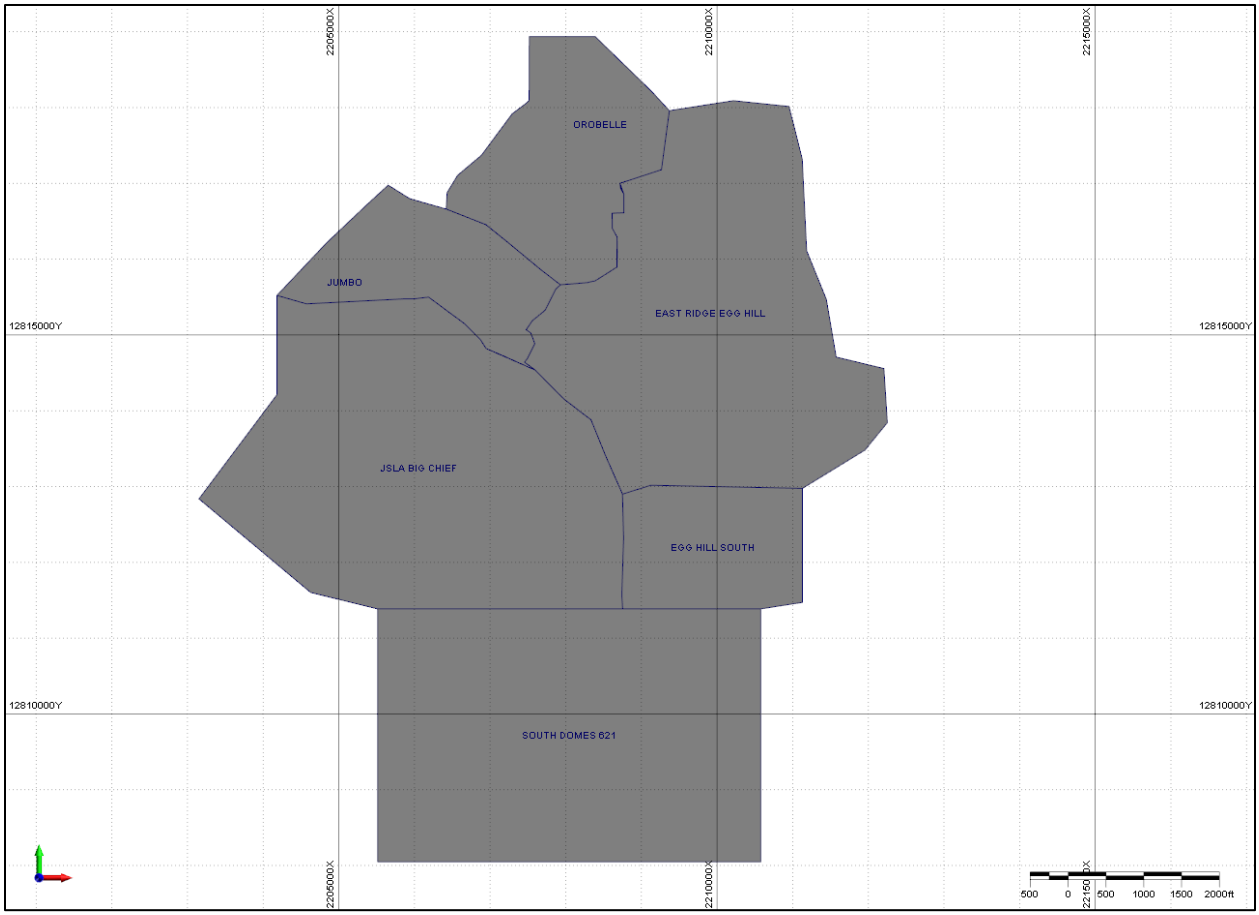


Figure 14-22: Resource Areas Used for Validation

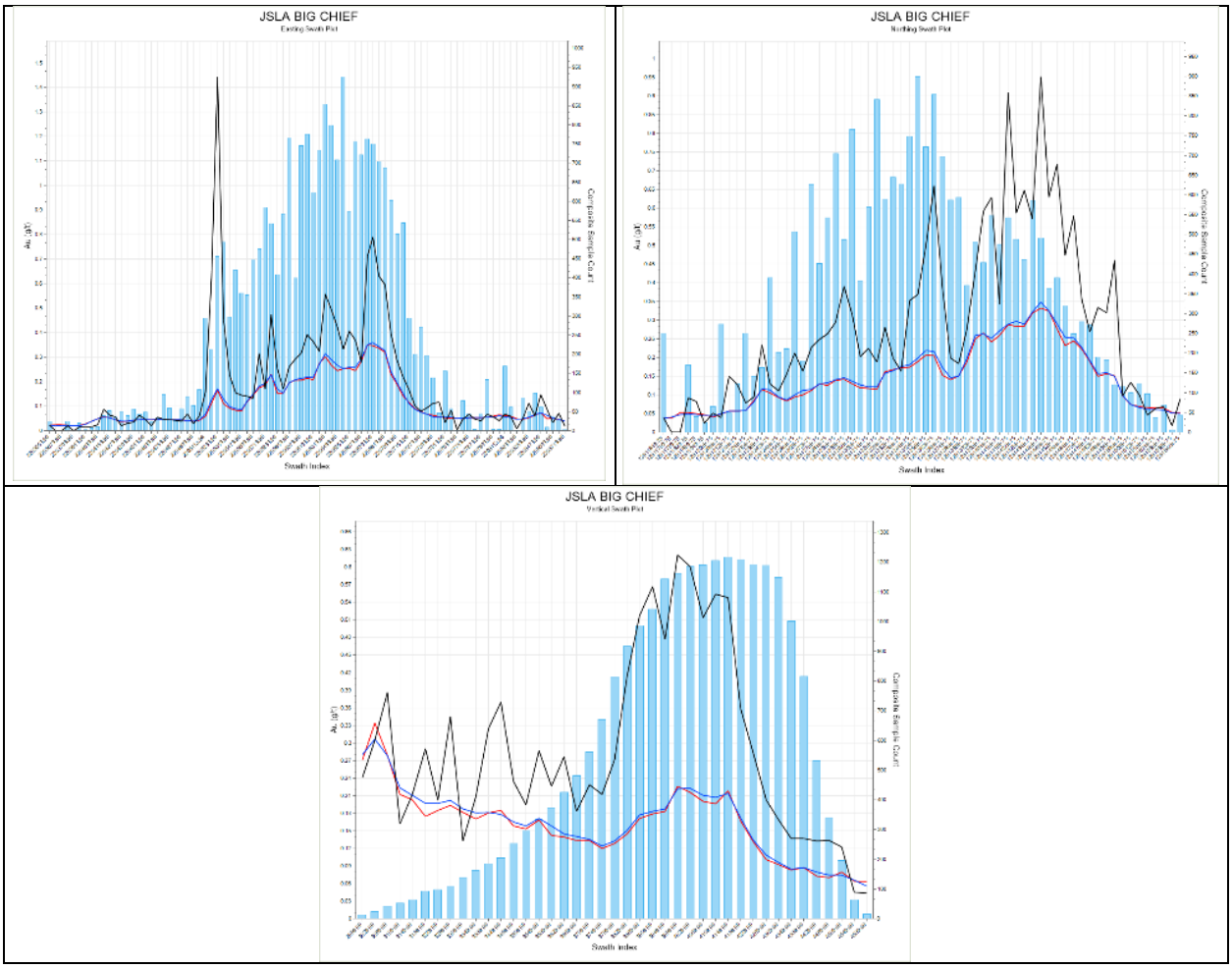


Figure 14-23: Swath Plots for JSLA-Big Chief Resource Areas

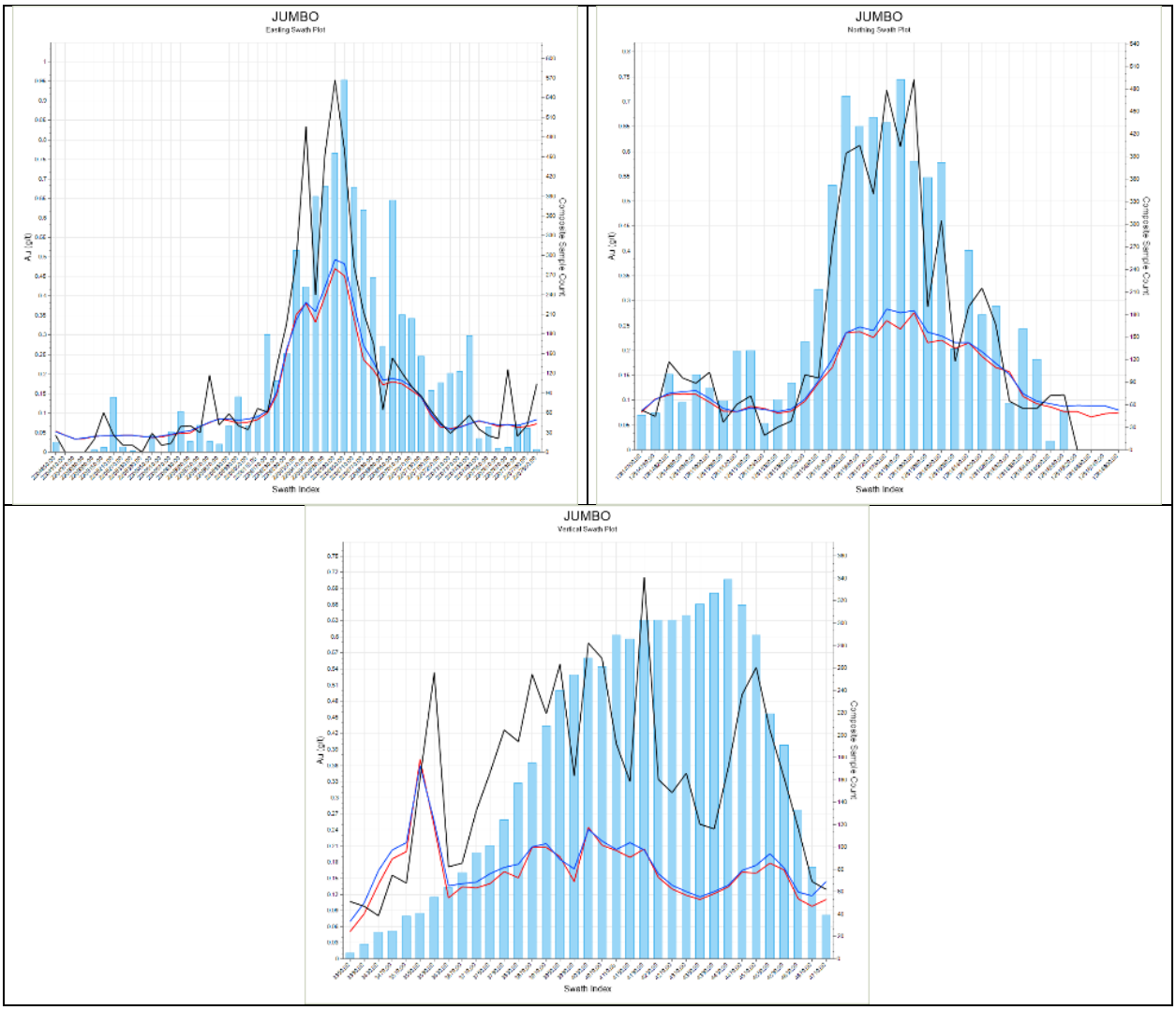


Figure 14-24: Swath Plots for Jumbo Resource Area

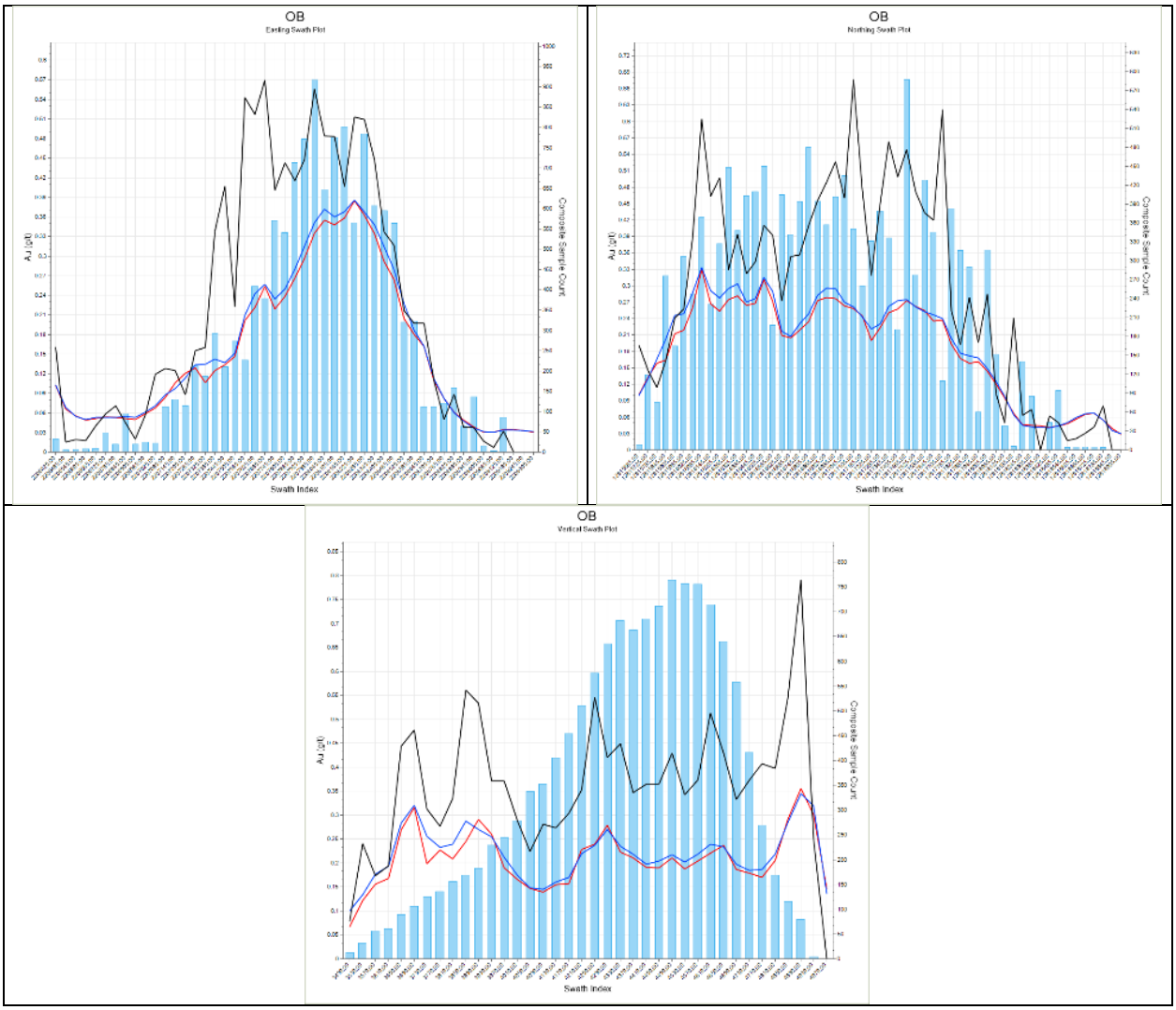


Figure 14-25: Swath Plots for Oro Belle Resource Area



Figure 14-26: Swath Plots for East Ridge – Egg Hill Resource Areas

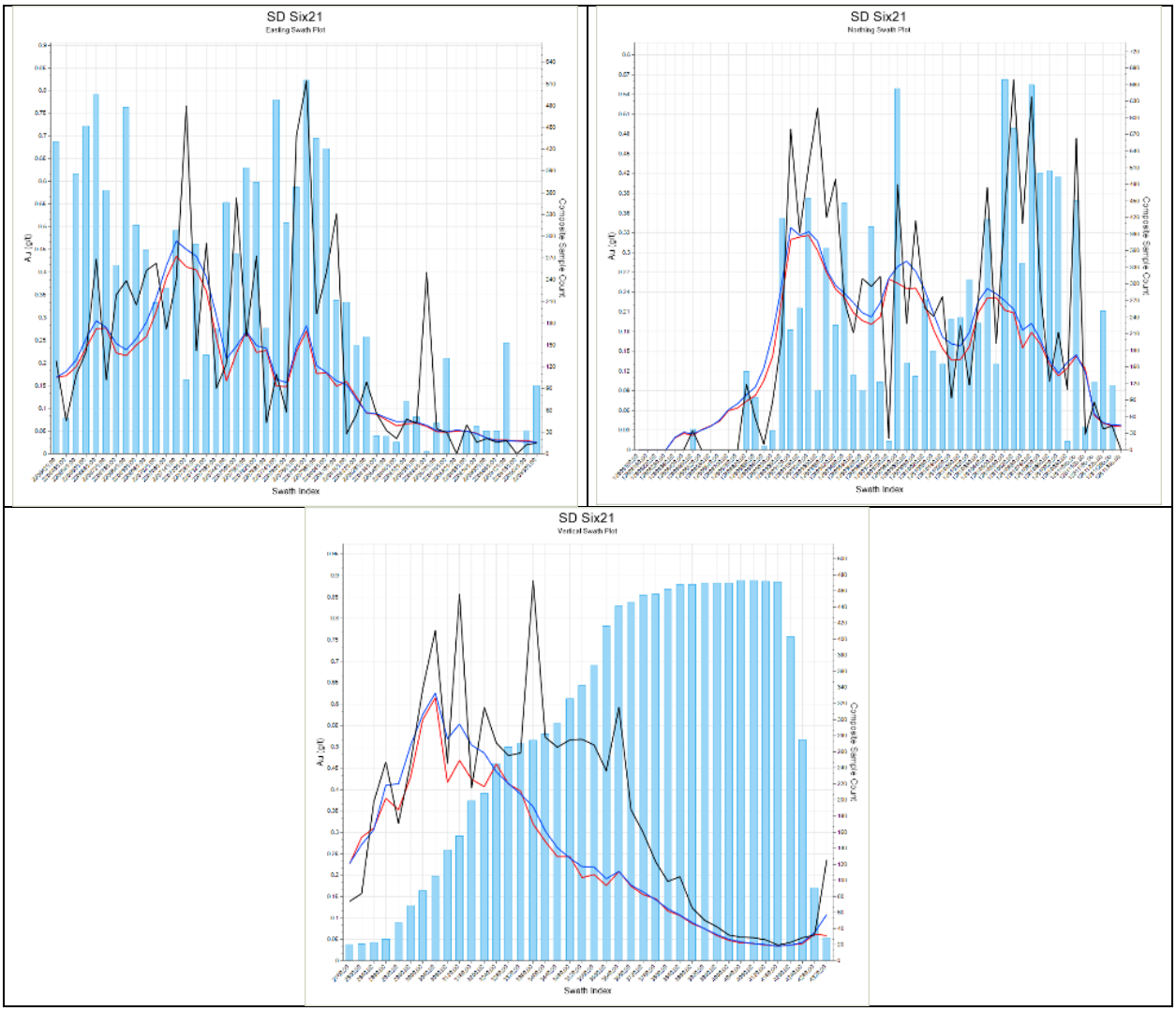


Figure 14-27: Swath Plots for South Domes – Six 21 Resource Areas

14.11.2 Cross Validation

Cross validation plots were generated for block estimates versus composite sample grades. Overall, the block estimates and composite samples show good correlation. Measured classification shows a tendency to have lower correlation to block estimates due to clustering of high-grade composite samples that have nugget effect. Cross validation plots are shown in Figure 14-28 to Figure 14-31.

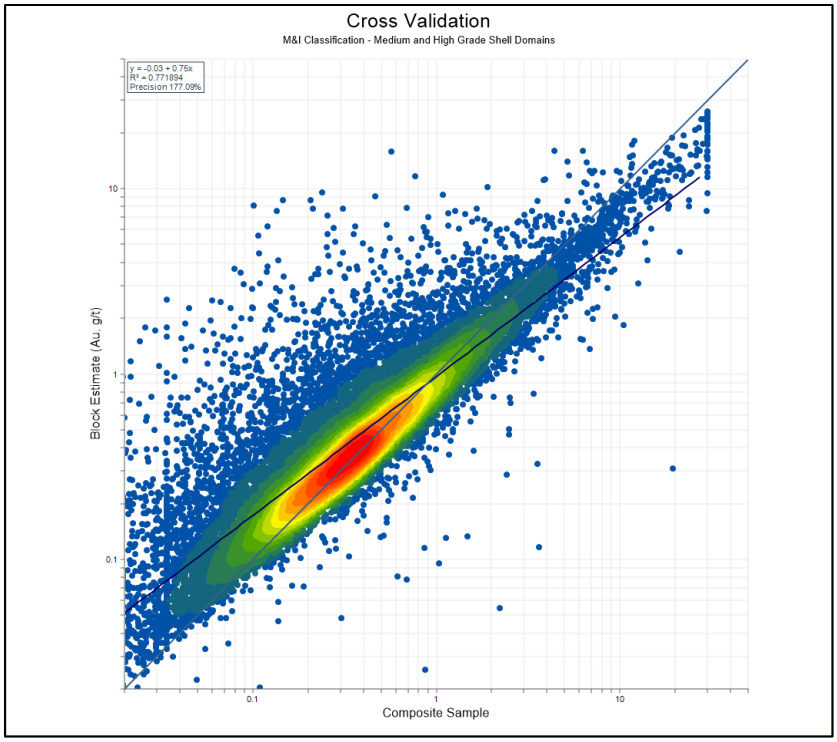


Figure 14-28: Cross Validation of Composite Samples Against Block Estimates for Medium- and High-Grade Domains Within Measured and Indicated Classified Blocks

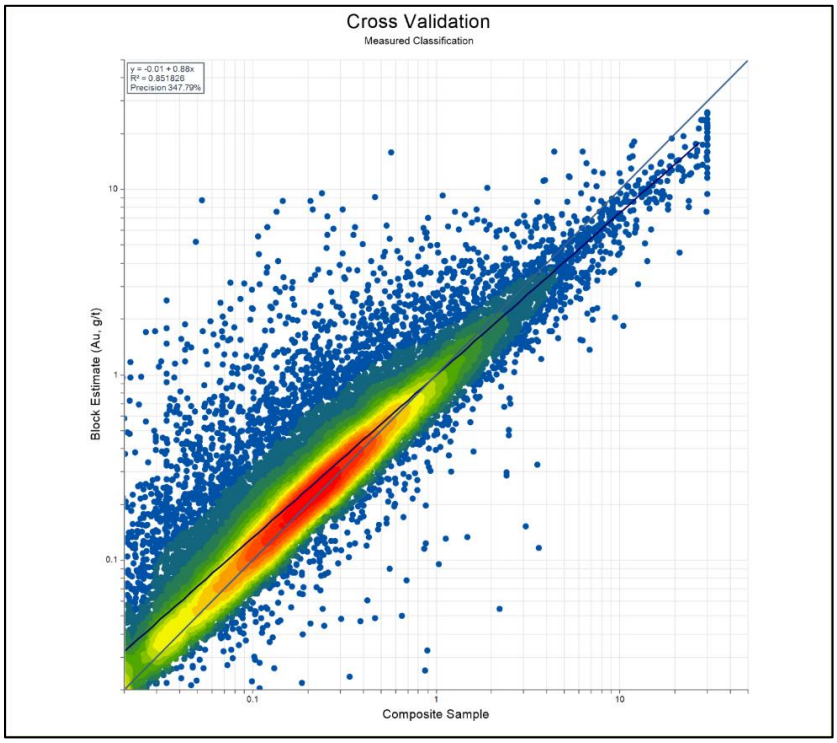


Figure 14-29: Cross Validation of Composite Samples Against Block Estimates for Medium- and High-Grade Domains within Measured Classified Blocks

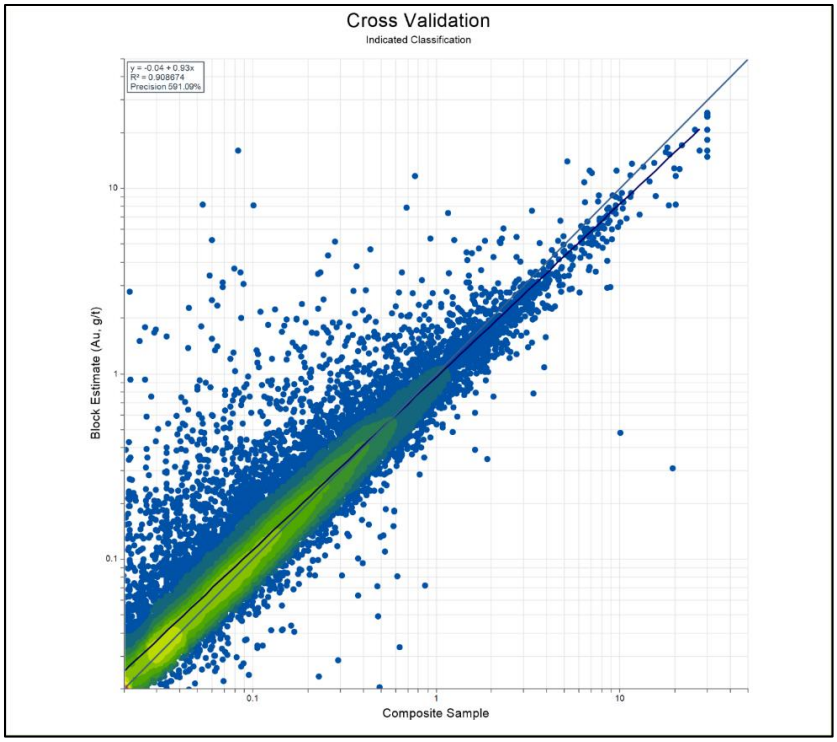


Figure 14-30: Cross Validation of Composite Samples Against Block Estimates for Medium- and High-Grade Domains Within Indicated Classified Blocks

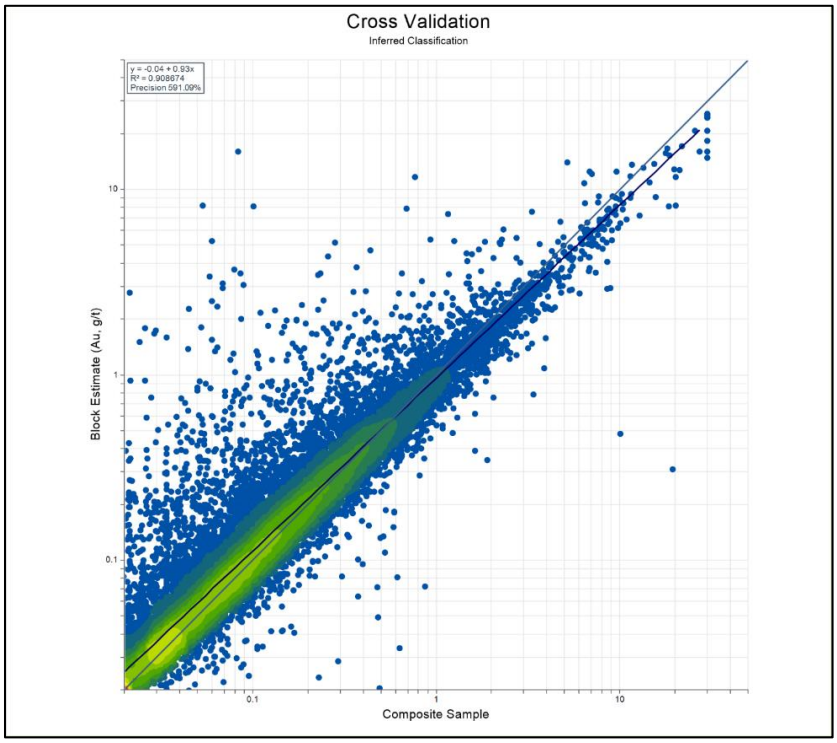


Figure 14-31: Cross Validation of Composite Samples Against Block Estimates for Medium- and High-Grade Domains Within Inferred Classified Blocks

14.11.3 Comparisons to Historical Production and Production Drilling

The resource estimate was compared to historical production and blasthole production drilling (Table 14-15).

Table 14-15: Comparison of Current Resource Model to Historical Production and Production Blasthole Model Estimates

	Tonnes	Tons	Grade (Au, g/t)	Grade (Au, oz/ton)	Contained Gold (oz)
Grade Control Model - 30 g/t Au cap, no cut-off	97,108,383	107,053,669	0.51	0.015	1,581,175
Current Resource Model, no cut-off	97,107,305	107,052,481	0.48	0.014	1,509,551
Percent Difference	**0.0%**		**-5%**	**-5%**	**-5%**
	Tonnes	**Tons**	**Grade (Au, g/t)**	**Grade (Au, oz/ton)**	**Contained Gold (oz)**
Grade Control Model - 30 g/t Au cap, 0.5 g/t Au cut-off	26,371,617	29,072,447	1.30	0.038	1,103,623
Current Resource Model, 0.5 g/t Au cut-off	23,767,545	26,201,681	1.41	0.041	1,079,165
Percent Difference	**-10%**		**8%**	**8%**	**-2%**
	Tonnes	**Tons**	**Grade (Au, g/t)**	**Grade (Au, oz/ton)**	**Contained Gold (oz)**
Historic Production (Ore Milled from 1991 to 2004)	32,831,000	36,193,000	1.47	0.043	1,550,000
Historic Production (Ore Mined from 1991 to 2004)	34,182,000	37,683,000	1.37	0.040	1,520,000
Current Depleted Resource Model (0.5 g/t Au cut-off)	34,357,586	37,876,293	1.56	0.046	1,727,845
Percent Difference to Historic Ore Milled	**5%**	**5%**	**6%**	**6%**	**11%**
Percent Difference to Historic Ore Mined	**1%**	**1%**	**14%**	**14%**	**14%**
	Tonnes	**Tons**			
Total Mined	126,954,190	139,956,113			
Total Depleted within Resource Model	119,300,607	131,518,694			
Percent Difference	**-6%**	**-6%**			

In general, the current resource model reports fewer tons at slightly higher gold grades compared to the historic grade control model. Total contained gold between the current resource model compared to the grade control model and historical milled production is within 5%. Disparities between the total historical tonnage mined and the depleted resource may be attributed in part to the accuracy of the pre-mining topography, as-built surveys of the mined-out areas that were subsequently backfilled, and density values used for the current resource model.

14.11.4 Comparisons to Other Estimation Techniques

The hard rock model was estimated using several different estimation techniques including Inverse Distance Squared (ID2), Inverse Distance Cubed (ID3), Ordinary Kriging (OK) and Nearest Neighbor (NN). All estimation methods, except for NN, were found to generate comparable results. Estimates generated using OK reported greater tonnes at a slightly lower grade when compared to the estimates generated using inverse distance methods. A comparison of the estimation techniques is shown in Table 14-16.

Table 14-16: Summary of Estimation Technique Comparison

Interpolant	Blocks Estimated >0.005 oz/ton (>0.17 g/t) Au	Average grade (Au, oz/ton)	Average grade (Au, g/t)
ID^3	273,554	0.0163	0.56
ID^2	274,230	0.0163	0.56
OK	280,653	0.016	0.55
NN	218,897	0.0195	0.67

14.12 MINERAL RESOURCE CLASSIFICATION

Block model quantities and grade estimates were classified in accordance with the CIM Definition Standards for Mineral Resources and Mineral Reserves (CIM, 2014). Mineral resource classification is subjective in nature and guided by the data used in preparing the estimate. Classification of Castle Mountain Project resources has considered geological continuity, data spacing, data type, data source, data quality, and geostatistical evaluation of these data.

The statistical criteria used for measured and indicated mineral resources is that the annual ore production should be known to at least ±15% with 90% confidence. To determine adequate hole spacing to fulfill the statistical criteria used for resource classification, blasthole data was decimated using 10 ft (3 m) spacings ranging from 10 ft up to 300 ft (91 m) within volumes representing monthly production volumes, that cumulatively represent an annual production volume. The results of the decimation showed that estimates can be reproduced reliably and within 10% of undecimated data using drill hole spacings of up to 90 ft (27 m) (Figure 14-32). Between 90 ft and 190 ft (58 m), estimates can be reproduced to within 10% to 12% but with lower confidence. With drill hole spacings exceeding 190 ft, the resulting estimates using decimated data could not be reconciled to within 15%. Therefore 190 ft was chosen as the drill hole spacing threshold for Indicated. When drill hole spacing exceeds 300 ft, potential mineralized zones are no longer detectable; therefore, 300 ft was chosen as an upper threshold for Inferred classification.

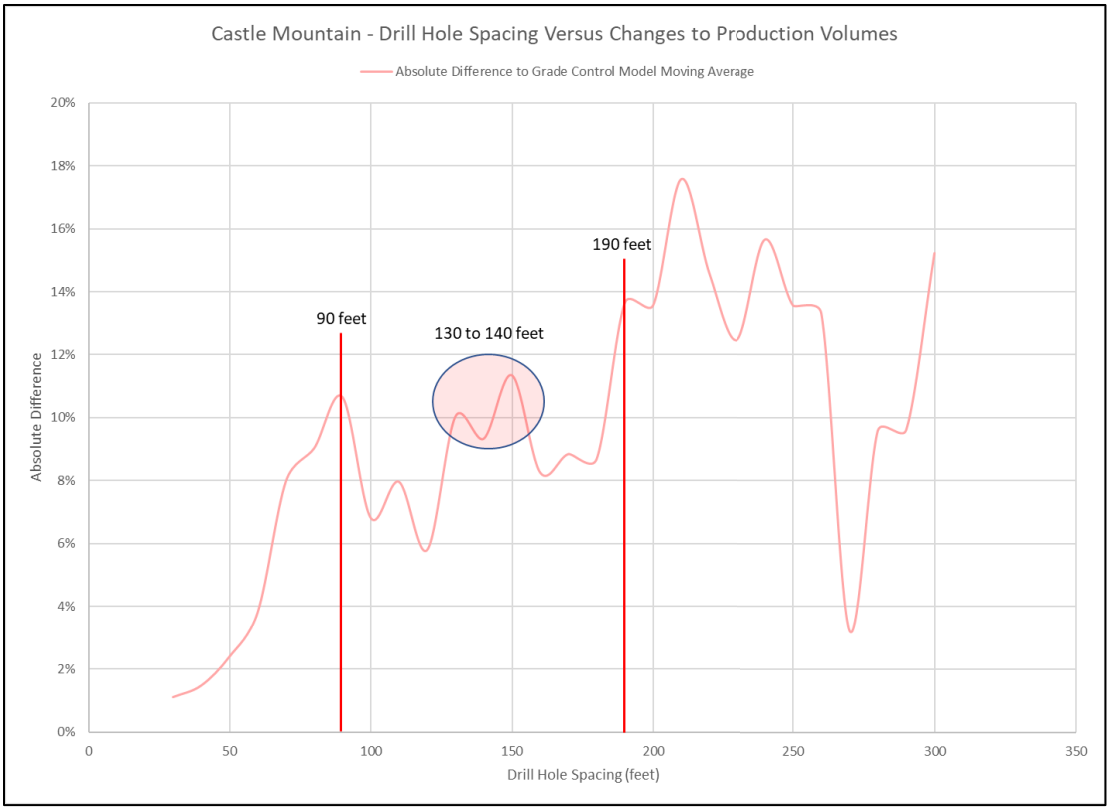


Figure 14-32: Absolute Difference to Production Volumes as a Function of Drill Hole Spacing

A summary of the hard rock resource classification is provided in Table 14-17. The JSLA backfill resource model was classified using the criteria summarized in Table 14-18.

Table 14-17: Summary of Hard Rock Resource Classification

Hard Rock Resource Model Classification						
Classification	Drill Hole Spacing (ft)			Depth Below Surface (ft)	Estimation Pass	Grade Domain
	Average	Minimum	Maximum			
Measured	85	60	100	< 900	1 or 2	Within Low Grade Domain
Indicated	145	100	190	-	-	-
Inferred	245	190	300	-	-	-

Table 14-18: Summary of JSLA Backfill Resource Classification

JSLA Backfill Resource Model Classification				
Classification	Drill Hole Spacing (ft)			Depth Below Surface (ft)
	Average	Minimum	Maximum	
Measured	50	10	80	< 30
Indicated	125	80	160	-
Inferred	180	160	250	-

14.13 MINERAL RESOURCE STATEMENT

The CIM Definition Standards on Mineral Resources and Reserves (CIM, 2014) state that:

"A Mineral Resource is a concentration or occurrence of solid material of economic interest in or on the Earth's crust in such form, grade or quality and quantity that there are reasonable prospects for eventual economic extraction."

In order to sufficiently test the reasonable prospects for eventual economic extraction by an open pit, pit shells were generated using the variable slope Lerchs Grossmann algorithm in Hexagon's MinePlan® software. The results of the pit optimization partially form the basis of the mineral resource statement and are used to constrain the mineral resource with respect to the CIM Definition Standards. Pit optimization does not constitute an attempt to estimate reserves. The open pit optimization parameters are summarized in Table 14-19.

Table 14-19: Summary of Pit Optimization Parameters

Parameter	Unit	Amount	Additional Comments
Gold Price	$/oz	1,500	
Marketing Cost	$/oz	1.51	
Royalty – Jumbo, JSLA, Oro Belle	%	2.65	
Royalty – South Domes	%	7.65	Cumulative royalty
Mining Cost: ROM	$/ton	1.52	Incremental cost of $0.02/ton per bench from the pit entrance at the 4500 ft bench elevation
Mining Waste: Rock	$/ton	1.27	
Mining Waste: Backfill & Overburden	$/ton	2.30	
Process Cost: ROM	$/ton	2.70	
Process Cost Milling	$/ton	13.74	Cross over cut-off grade (COG) for all rock types have been applied using lithology - process recovery matrix
Process Recovery: ROM	%	72.4	Variable for each rock type, from 65 to 80%
Process Recovery: Mill	%	94.0	Variable for each rock type, from 92 to 96%
General & Administrative	$/ton	0.72	
Mining Dilution	%	3.0	Dilution calculated using adjacent block contact points below COG
Pit Slope	º	48	

A summary of the Measured, Indicated and Inferred Resources exclusive of Reserves are summarized in Table 14-20 and Table 14-21. Mineral resources and depicted in cross section in Figure 14-33 and plan view in Figure 14-34.

Table 14-20: Castle Mountain Open Pit Resources Exclusive of Reserves (imperial units)

Classification	Au Cut-off	Tons	Au	Contained Au
	(oz/ton)	(kton)	(oz/ton)	(koz)
Measured	0.005	861	0.020	17
Indicated	0.005	80,967	0.018	1,453
Measured and Indicated	0.005	81,828	0.018	1,470
Inferred	0.005	77,040	0.018	1,422

Notes:

1. Mineral Resources are reported exclusive of reserves.
2. Mineral Resources are reported using gold price of $1,500/oz gold.
3. Open pit Mineral Resources are reported using a cut-off grade of 0.005 oz/ton (0.17 g/t) gold and are constrained using an optimized pit generated using Lerchs Grossmann pit optimization algorithm with parameters summarized in Table 14-19.
4. The Mineral Resource statement has been prepared by Trevor Rabb, P.Geo. (Equity) who is a Qualified Person as defined by NI 43-101.
5. Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability.
6. Any discrepancies in the totals are due to rounding.
7. Mineral resources from Castle Mountain Project presented herein have an effective date of June 30, 2020.

Table 14-21: Castle Mountain Open Pit Resources Exclusive of Reserves (metric units)

Classification	Au Cut-off	Tonnes	Au	Contained Au
	(g/t)	(kt)	(g/t)	(koz)
Measured	0.17	781	0.68	17
Indicated	0.17	73,452	0.62	1,453
Measured and Indicated	0.17	74,233	0.62	1,470
Inferred	0.17	69,890	0.63	1,422

Notes:

1. Mineral Resources are reported exclusive of reserves.
2. Mineral Resources are reported using gold price of $1,500/oz gold.
3. Open pit Mineral Resources are reported using a cut-off grade of 0.005 oz/ton (0.17 g/t) gold and are constrained using an optimized pit generated using Lerchs Grossmann pit optimization algorithm with parameters summarized in Table 14-19.
4. The Mineral Resource statement has been prepared by Trevor Rabb, P.Geo. (Equity) who is a Qualified Person as defined by NI 43-101.
5. Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability.
6. Any discrepancies in the totals are due to rounding.
7. Mineral resources from Castle Mountain Project presented herein have an effective date of June 30, 2020.

Table 14-22: Castle Mountain Open Pit Resources Inclusive of Reserves (imperial units)

Type	Au COG	Measured			Indicated			Measured and Indicated			Inferred		
		Tons	Au	Contained	Tons	Au	Contained	Tons	Au	Contained	Tons	Au	Contained
	(oz/ton)	(kton)	(oz/ton)	koz Au	(kton)	(oz/ton)	koz Au	(kton)	(oz/ton)	koz Au	(kton)	(oz/ton)	koz Au
Oxide	0.005	90,864	0.017	1,515	233,467	0.016	3,696	324,330	0.016	5,211	66,935	0.017	1,127
Trans, Sul.	0.005	1,690	0.021	35	18,501	0.021	380	20,191	0.021	415	21,494	0.020	425
JSLA Backfill	0.004	4,478	0.012	54	30,305	0.008	239	34,784	0.008	293	3,524	0.008	28
Waste Dumps	0.004	-	-	-	-	-	-	-	-	-	3,145	0.009	29
Combined	-	**97,032**	**0.017**	**1,604**	**282,273**	**0.015**	**4,315**	**379,305**	**0.016**	**5,919**	**95,097**	**0.017**	**1,608**

Notes:

1. Mineral Resources are reported inclusive of reserves.
2. Mineral Resources are reported using gold price of $1,500/oz gold.
3. Hard rock open pit Mineral Resources are reported using a cut-off grade of 0.005 oz/ton (0.17 g/t) gold whereas JSLA Backfill and Waste Dump Mineral Resources are reported using a cut-off grade of 0.0040 oz/ton (0.14 g/t) gold. Resources are constrained using an optimized pit generated using Lerchs Grossmann pit optimization algorithm with parameters summarized in Table 14-19.
4. The Mineral Resource statement has been prepared by Trevor Rabb, P.Geo. (Equity) who is a Qualified Person as defined by NI 43-101.
5. Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability.
6. Any discrepancies in the totals are due to rounding.
7. Mineral resources from Castle Mountain Project presented herein have an effective date of June 30, 2020.

Table 14-23 Castle Mountain Open Pit Resources Inclusive of Reserves (metric units)

Type	Au COG	Measured			Indicated			Measured and Indicated			Inferred		
		Tonnes	Au	Contained	Tonnes	Au	Contained	Tonnes	Au	Contained	Tonnes	Au	Contained
	(g/t)	(kt)	(g/t)	koz Au	(kt)	(g/t)	koz Au	(kt)	(g/t)	oz Au	(kt)	(g/t)	koz Au
Oxide	0.17	82,430	0.57	1,515	211,797	0.54	3,696	294,228	0.55	5,211	60,722	0.58	1,127
Trans, Sul.	0.17	1,533	0.72	35	16,784	0.70	380	18,317	0.70	415	19,499	0.68	425
JSLA Backfill	0.14	4,063	0.41	54	27,493	0.27	239	31,555	0.29	293	3,197	0.27	28
Waste Dumps	0.14	-	-	-	-	-	-	-	-	-	2,853	0.32	29
Combined	-	**88,026**	**0.57**	**1,604**	**256,074**	**0.52**	**4,315**	**344,099**	**0.54**	**5,919**	**86,271**	**0.58**	**1,608**

Notes:

1. Mineral Resources are reported inclusive of reserves.
2. Mineral Resources are reported using gold price of $1,500 /oz gold.
3. Hard rock open pit Mineral Resources are reported using a cut-off grade of 0.005 oz/ton (0.17 g/t) gold whereas JSLA Backfill and Waste Dump Mineral Resources are reported using a cut-off grade of 0.0040 oz/ton (0.14 g/t) gold. Resources are constrained using an optimized pit generated using Lerchs Grossmann pit optimization algorithm with parameters summarized in Table 14-19.
   The Mineral Resource statement has been prepared by Trevor Rabb, P.Geo. (Equity) who is a Qualified Person as defined by NI 43-101.
4. Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability.
5. Any discrepancies in the totals are due to rounding.
6. Mineral resources from Castle Mountain Project presented herein have an effective date of June 30, 2020.

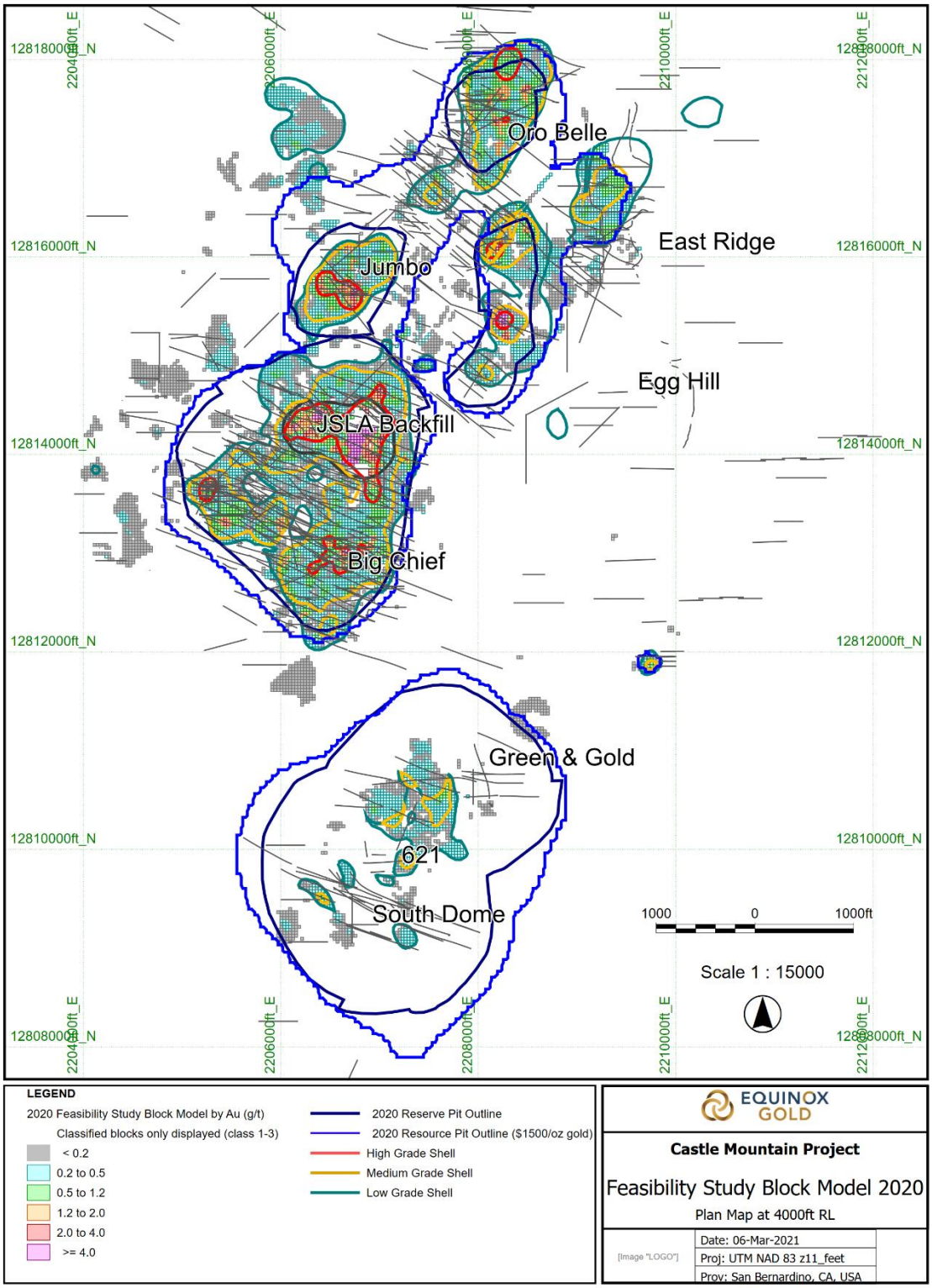


Figure 14-33: Plan Map at 4,000 ft RL Showing Block Model Colored by Estimated Gold Grade (g/t) and Showing Resource and Reserve Pits

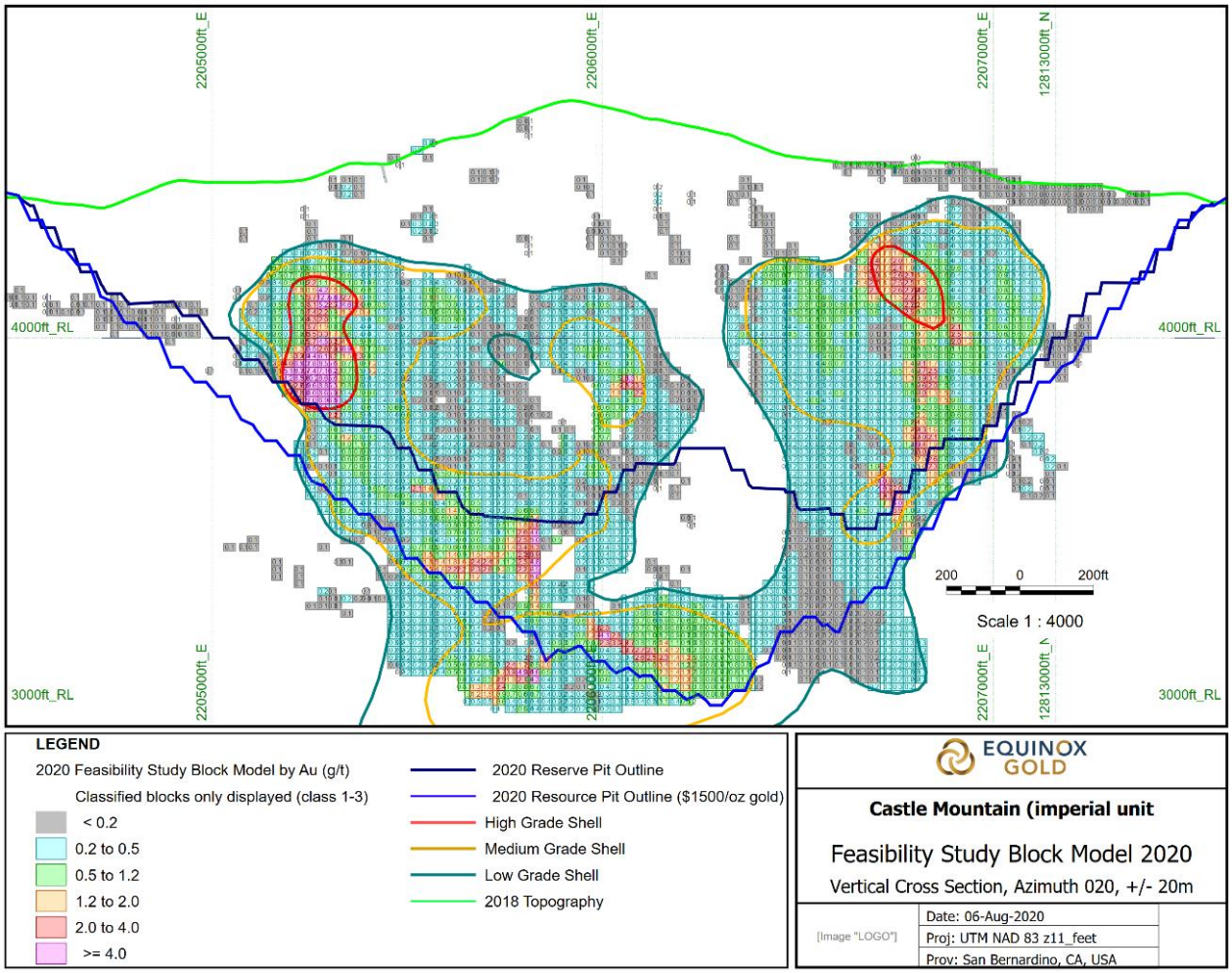


Figure 14-34: Cross Section Oriented at 020˚ Looking Northeast at Big Chief Area Showing Block Model Colored by Estimated Gold Grade (g/t) and Showing Resource and Reserve Pits

14.14 COMPARISON WITH 2018 RESOURCE ESTIMATE

There are several key differences between the two resource models. The differences can be summarized as follows:

- The 2020 Mineral Resource Estimate was generated using Micromine 2020.
- Geological model and estimation domains were generated using Leapfrog v5.0.
- Bench composites that contained missing sample intervals were assigned grades using a down the hole, length weighted average. Intervals less than 2.5 ft (0.8 m) or with less than 10% bench coverage were discarded.
- Classification informed by drill hole spacing.
- Locally varying anisotropy was incorporated from the lithology model where mineralization exhibits lithological controls.
- Non mineralized and post mineral rock types represented in the lithology model are excluded from the grade shell domains.
- Grade shell domain shapes honor anisotropies that control mineralization.

A summary comparing the resource pit constrained hard rock mineral estimates inclusive of reserves from March 29, 2018 and October 24, 2019 is presented in Table 14-24 and Table 14-25 for imperial and metric units, respectively. The data presented in Table 14-24 and Table 14-25 is provided for comparison purposes. JSLA backfill is excluded. The reader is referred to Section 14.13 for the Project's current Mineral Resource statement. Contributions to the changes to the mineral resources are predominantly due to the differences between criterion used for Mineral Resource classification.

Table 14-24: Comparison of Hard Rock Mineral Resources to March 29, 2018 Mineral Resource Estimate Inclusive of Reserves (imperial units)

Resource	Pre-Feasibility (March 29, 2018)			Feasibility (October 24, 2019)			Tonnage	Grade	Contained Au
Zones	2018 Resource Pit (PFS)			March 2020 Resource Pit (FS)					
Au (g/t) Cut-off	> 0.005 oz/ton OP Hardrock			> 0.005 oz/ton OP Hardrock					
Classification	Tons	Au	Contained Au	Tons	Au	Contained Au			
	(Mton)	(oz/ton)	(Moz)	(Mton)	(oz/ton)	(Moz)	% Diff.	Diff.	% Diff
Measured	177.1	0.0169	2.99	92.6	0.017	1.55	-48%	0.00	-48%
Indicated	71.7	0.0161	1.15	252.0	0.016	4.08	251%	0.00	254%
M&I	248.8	0.0167	4.15	344.5	0.016	5.63	39%	0.00	36%
Inferred	167.2	0.0121	2.02	88.4	0.018	1.55	-47%	0.01	-23%

Table 14-25: Comparison of Hard Rock Mineral Resources to March 29, 2018 Mineral Resource Estimate Inclusive of Reserves (Metric units)

Resource	Pre-Feasibility (March 29, 2018)			Feasibility (October 24, 2019)			Tonnage	Grade	Contained Au
Zones	2018 Resource Pit (PFS)			March 2020 Resource Pit (FS)					
Au (g/t) Cut-off	> 0.17 g/t OP			> 0.17 g/t OP					
Classification	Tonnes	Au	Contained Au	Tonnes	Au	Contained Au			
	(Mt)	(g/t)	(Moz)	(Mt)	(g/t)	(Moz)	% Diff.	Diff.	% Diff
Measured	160.6	0.57	2.99	84.0	0.57	1.55	-48%	0	-48%
Indicated	65.1	0.55	1.15	228.6	0.55	4.08	251%	0	254%
M&I	225.7	0.57	4.15	312.5	0.56	5.63	39%	0	36%
Inferred	151.7	0.41	2.02	80.2	0.60	1.55	-47%	0.01	-23%

14.15 FACTORS THAT MAY AFFECT THE MINERAL RESOURCE

Areas of uncertainty that may materially impact the mineral resource estimate include:

- Commodity price assumptions,
- Metal recovery assumptions,
- Mining and process cost assumptions,
- Pit slope angles, and
- Applied top cut values.

In the opinion of the QP, there are no known environmental, permitting, legal, title, taxation, socio-economic, marketing, political, or other relevant factors which would materially affect the Mineral Resource estimate.

15 MINERAL RESERVE ESTIMATES

15.1 INTRODUCTION

The Mineral Reserves for the Castle Mountain Project are based on the conversion of the Measured and Indicated Resources within the ultimate reserve open pit design. Measured Resources are converted to Proven Reserves and Indicated Resources are converted to Probable Reserves.

This section describes the open pit optimization process including key assumptions and economic considerations that lead to pit limit selection and the reporting of Mineral Reserves used for mine planning and scheduling in Section 16.

15.2 OPEN PIT OPTIMIZATION

15.2.1 General

The Project pit optimization and design has been carried out using Hexagon Mining's MinePlan 3D V15.60-1 software for large scale open pit mining. A series of unsmoothed pit shells were created using a Lerchs Grossmann algorithm with revenue factors declining from unity. Optimization input parameters are summarized in Table 15-1. The pit shells were used as a basis for selecting an ultimate reserve pit and to develop detailed pit phase designs to be used in production scheduling. Pit designs were updated for open pits at JSLA, Jumbo, Oro Belle, East Ridge and South Domes.

Table 15-1: Castle Mountain Open Pit Optimization Parameters

Parameter	Unit	Amount	Additional Comments
Gold Price	$/oz	1,350	
Payable	%	99.95	
Marketing Cost	$/oz	1.51	
Royalty – Franco Nevada	%	2.65	Covers entire project including Jumbo, JSLA, Oro Belle
Royalty – American Standard	%	4.65	Cumulative royalty west of JSLA
Royalty – Huntington Tile	%	7.65	Cumulative royalty over South Domes
Royalty – Conservation	%	7.65	Cumulative royalty west of Oro Belle
Mining Cost: ROM	$/ton	1.47	Incremental cost of $0.02/ton per bench from the pit entrance at the 4,500 ft bench elevation
Mining Waste: Backfill & Overburden	$/ton	1.22	
Process Cost: ROM	$/ton	1.33	
Process Cost Milling	$/ton	12.62	Cross over cut-off grade for all rock types have been applied using lithology - process recovery matrix
Process Recovery: ROM	%	73.9	Variable for each rock type, from 65 to 80%
Process Recovery: Mill	%	94.5	Variable for each rock type, from 92 to 96%
General & Administrative	$/ton	0.72	
Mining Dilution	%	3	Grade reduction
Pit Slope	°	48-52	Structural area 40-46°
Haulage	$/ton/bench	0.02	Added for each 20 ft (6.1 m) bench below an entrance bench at 4500 ft elevation.
Sustaining Capital	$/ton	0.05	

15.2.2 Economic Parameters Applied to Mine Design

15.2.2.1 Metal Prices

The Mineral Resource estimate is based on a commodity price of $1,500/oz for gold. The Mineral Reserves estimate is based on a commodity price of $1,350/oz for gold. The metal prices used for pit optimizations were set by Equinox.

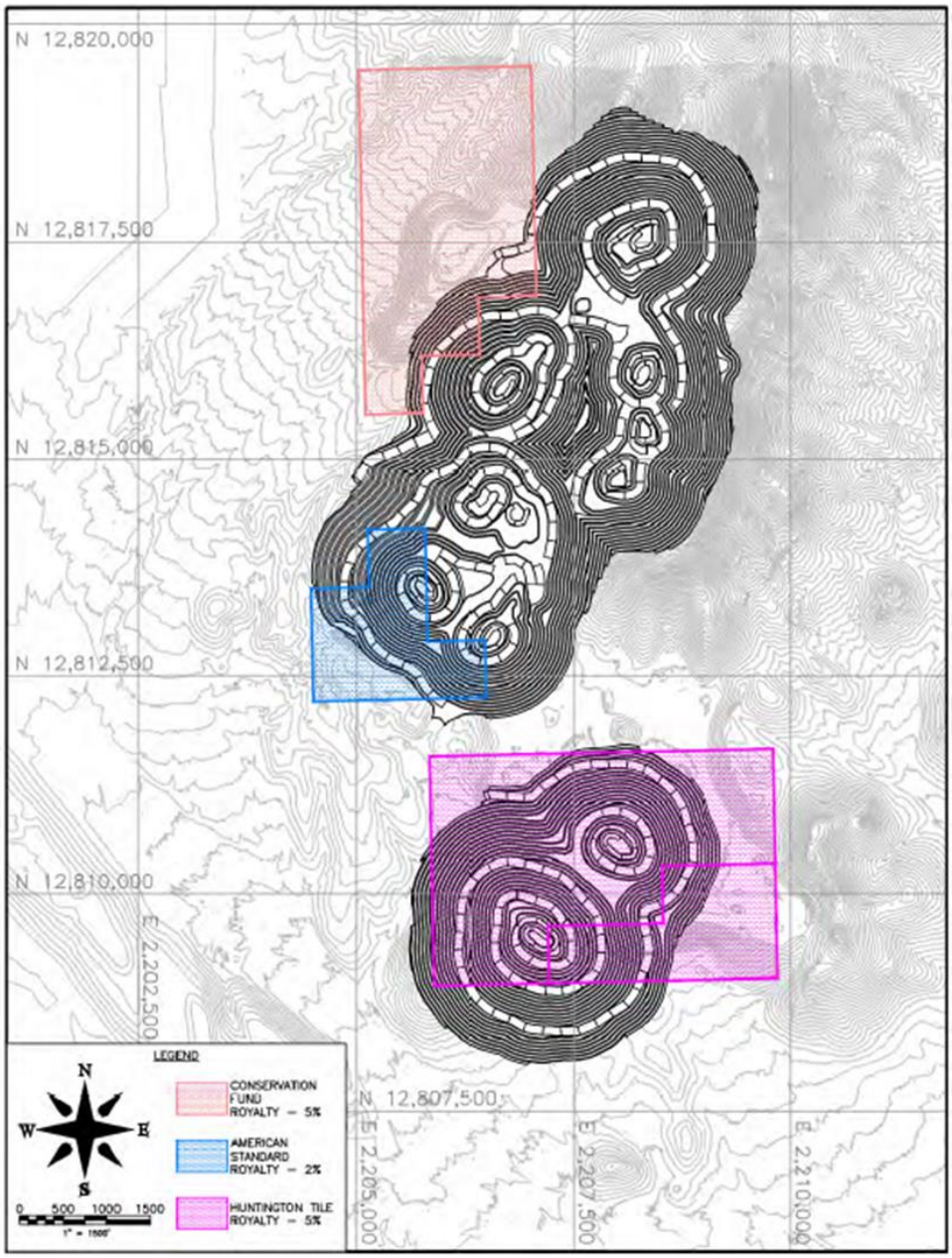
15.2.2.2 Gold Sales, Costs and Royalties

Gold will be shipped offsite as doré. The basis for pit optimization was the potential net revenue per ton calculated for each block in the resource estimate. Metal price and offsite costs for transportation and refining were used in the resource value determination. Gold payable was set at 99.95% and gold sales cost was estimated to be $1.51/oz.

The Project is subject to royalties payable to different parties:

- 2.65% Franco Nevada royalty applied to all ounces,
- 5.00% Conservation royalty,
- 2.00% American Standard royalty, and
- 5.00% Huntington Tile royalty.

The location of the various royalties applied are shown in Figure 15-1.



Source: NMS, 2020

Figure 15-1: Royalty Locations

15.2.2.3 Onsite Operating Costs and Increments

The onsite operating costs used for pit limit analysis were based upon the Preliminary Feasibility Study for the Castle Mountain Project (Scott et al., 2018) and include general and administration (G&A), processing and mining (Table 15-1). The G&A costs were estimated to be $0.72/ton. The processing cost for Run of Mine (ROM) heap leach was estimated to be $1.33/ton. The cost for milling processing was estimated to be $12.62/ton. Preliminary operating costs for mining were estimated to be $1.47/ton mined for mineral resources and $1.22/ton for waste. An incremental

haulage cost of $0.02/ton/bench was added for each 20 ft (6.1 m) bench below an entrance bench at 4500 ft (1372 m) elevation.

15.2.2.4 Sustaining Capital Consideration

Sustaining capital consideration has been made for leach pad, tailings storage and mining equipment. These are ongoing costs related directly to heap leaching and tailings placement. Mining equipment is consumed in direct relationship to mined quantities. Based upon estimates from the Preliminary Feasibility Study for the Castle Mountain Project (Scott et al., 2018), an allowance of $0.05/ton was made for equipment sustaining capital and $0.40/ton for leach pad and tailings storage sustaining capital.

15.2.3 Metallurgical Parameters

15.2.3.1 Process Selection

Run of Mine (ROM) heap leaching was selected as the processing option for the majority of the material at the Project. ROM material will be placed on the heap leach pad at an average rate of 50,000 ton/d. Higher grade material will be processed via mill processing at proposed throughput of 3,500 ton/d.

15.2.3.2 Process Recovery

Metallurgical recovery estimates have been provided based upon the Preliminary Feasibility Study for the Castle Mountain Project (Scott et al., 2018) and ongoing test-work. Recoveries for heap leach and mill processing, by lithology type are shown in Table 15-2.

Table 15-2: Metallurgical Recovery Assumptions

Model Code	Lithology Description	Heap Leach (%)	Mill (%)	Proportion of PFS Reserve Blocks (%)
2	Alluvium	72.4	94.0	0.4
3	Debris Flow	72.4	94.0	0.4
5	Dacite	72.4	94.0	0.4
7	Rhyolite Breccia	65.0	94.0	0.6
9	Porphyrytic Rhyolite	80.0	94.0	24.9
11	Aphyric Rhyolite	70.0	93.0	25.9
14	Volcaniclastic Diatreme	85.0	95.0	4.4
16	Volcaniclastic (Vx)	65.0	96.0	23.3
22	Mudstone	72.4	94.0	0.1
23	Epiclastics	72.4	94.0	4.3
27	Andesite	72.4	92.0	12.2
29	Peach Springs Tuff	72.4	94.0	0.7
30	Proterozoic Sediments	72.4	94.0	1.8
31	Proterozoic Basement	72.4	94.0	0.7

15.2.3.3 Process Destination

Metallurgical recoveries for each process option are variable by lithology, as described above. This variability results in different marginal and cross-over cut-off grades for each lithology. Results for the Aphyric Rhyolite lithology unit (model code 11) are shown in Figure 15-2. Calculated waste cut-off grades and process crossover points are shown in Figure 15-3 and Figure 15-4. These figures demonstrate the variability of possible cut-off grades by lithology.

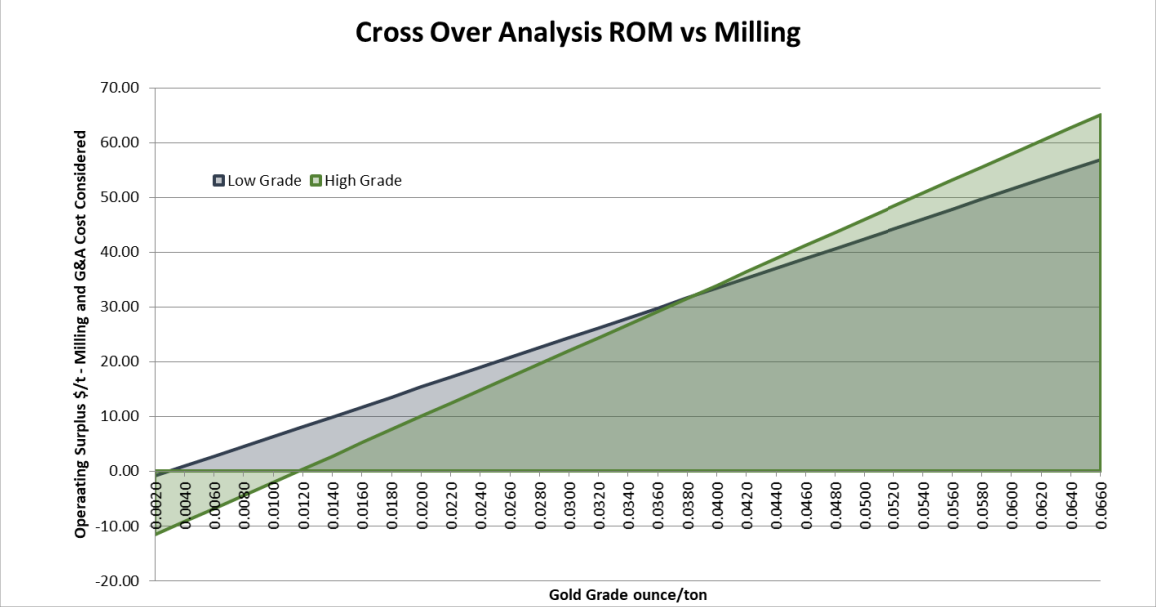


Figure 15-2: Aphyric Rhyolite Cross-over Analysis Heap Leach vs Milling

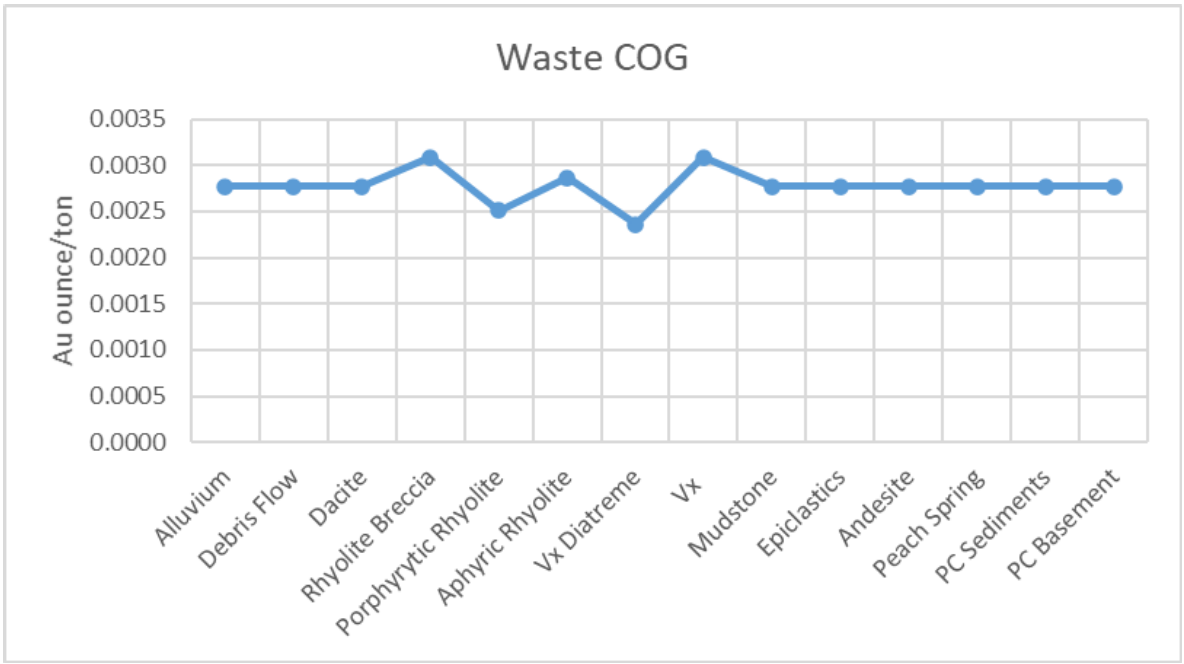


Figure 15-3: Waste Cut-off Grade

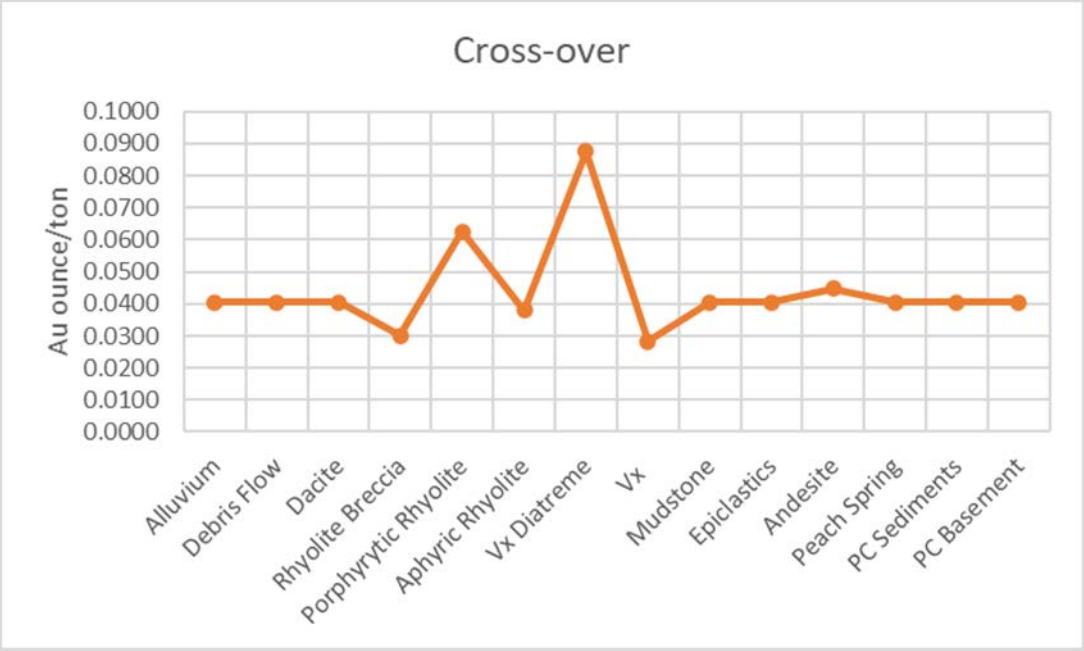


Figure 15-4: Cross-over from Heap Leach to Mill Cut-off

For the purposes of pit optimization, reporting of Mineral Reserves and scheduling, a higher than calculated heap cut-off grade of 0.005 oz/ton (0.17 g/t) has been applied in all mine planning work. Mill feed cut-off grade was based upon the crossover value estimated using the operating surplus net of processing and general and administration cost for the block net smelter return (NSR) values.

15.2.4 Block Model

15.2.4.1 General

A combined resource block model for the JSLA pit backfill material and in-situ hard rock mineral resources was developed by Equity and is described in Section 14. The resource block model is an ore percent model where the grade, tonnage factors and resource classification are pro-rated by the material type. The block model, topography surfaces and lithology wireframes were imported into MinePlan 3D mine planning software. The block model limits and block dimensions are shown in Table 15-3. Pro-rated values for grade, tonnage factors and resource classification were used for mine planning.

Table 15-3: Block Model Limits

Model Limits Fresh Rock and Backfill Combined				
	Units	**Minimum**	**Maximum**	**Length**
Limits X	ft	2,202,300	2,211,300	9,000
Limits Y	ft	12,807,100	12,820,000	12,900
Limits Z	ft	2,600	5,400	2,800
Block X	ft	30.0		
Block Y	ft	30.0		
Block Z	ft	20.0		
Blocks X	blocks	300		
Blocks Y	blocks	430	Blocks	
Blocks Z	blocks	140	18,060,000	

15.2.4.2 Resource Classification

Resource Class

In accordance with the CIM Definition Standards for Mineral Resources and Mineral Reserves (CIM, 2014), the Measured and Indicated resources have been used to define the pit limits and for reporting of Mineral Reserves for scheduling.

Mining Dilution and Recovery

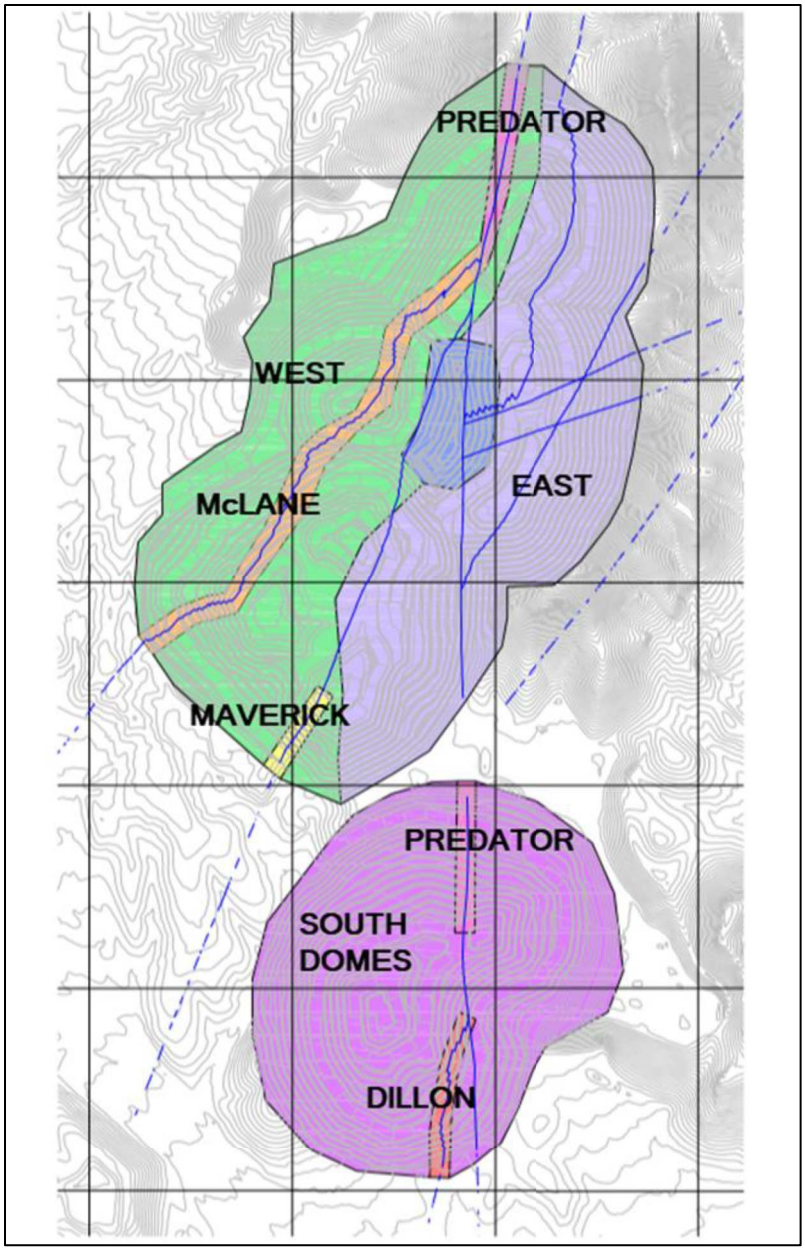
Internal dilution is incorporated in the resource model by virtue of the compositing and interpolation method used to obtain the block grades. Initial resource evaluation resulted in the selection of 0.005 oz/ton (0.17 g/t) cut-off grade for long range planning. A waste contact block analysis was undertaken to evaluate potential external dilution. Mining dilution is expected to result in 3% grade reduction from the resource estimate.

15.2.4.3 Wall Slope Geotechnical

Geotechnical wall slope recommendations have been provided by Call and Nicholas, Inc. (CNI) (Call and Nicholas, 2020). This report provided updated slope recommendations including inter-ramp slope angles and bench design parameters based on laboratory testing, geotechnical drilling information and an updated geotechnical model.

Overall analytical stability analyses were conducted on key areas of preliminary pit designs with updated rock-mass strengths derived from the laboratory testing applied to zones of similar geology. CNI developed a rock quality block model using the rock quality designation parameter (RQD).

Slope recommendations implemented in the mine plan include slope angle classified by “Geology Specific” and “Over-riding Structural Controls” domains (Figure 15-5). Geology Specific domains were identified in the South Domes, West and East domains. Structural domains were coded for the Predator, McLane, Maverick and Dillon fault zones to specified widths based on alteration. Additional domains were added for Alluvium, Backfill and Waste Dumps.



Source: Call and Nicholas, 2020.

Figure 15-5: Slope Design Domains CNI

Inter-ramp slope angle (ISA) recommendations are shown for geology specific and overriding structural control domains in Table 15-4 and Table 15-5, respectively. The geology specific domains are defined in Section 7.

Table 15-4: Geology Specific Inter-Ramp Slope Angles

Domain	Inter-Ramp Slope Angles (º)			
	Rhyolite	Volcaniclastic	Epiclastic	Andesite
South Domes	51	50	50	48
West	51	50	50	48
East	52	52	52	52

Table 15-5: Overriding Structural Controls

Structural Domain	Inter-Ramp Slope Angles (º)
Dillon Fault	40º ISA ±100 ft perpendicular to the fault
McLane Fault	40º ISA ±200 ft perpendicular to the fault
Maverick West Fault	46º ISA ±200 ft perpendicular to the fault
Predator Fault	46º ISA ±100 ft perpendicular to the fault
Island	Removal or operational remediation

Bench design parameters by domain are presented in Table 15-6, including bench-face angle (BFA). A total of 13 slope sectors were defined using a combination geotechnical domains and lithology type, which have been applied in the pit optimization and final designs (Table 15-7 and Figure 15-6).

Table 15-6: Bench Design Parameters by Domain

Domain	ISA (º)	Geology	Design BFA (º)	Design Bench Height (ft)	Design Bench Width (ft)
East	52	All	79	60	35
West South Domes	51	Rhyolite	72	60	29
	50	Volcaniclastic Epiclastic	72	60	31
	48	Andesite	70	60	32
Dillon Fault McLane Fault	40	All	60	60	37
Maverick West Fault Predator Fault	46	All	65	60	30

Table 15-7: Slope Code Summary

Code	Slope Sector Description	OSA (º) MSEP	ISA (º)	Design BFA (º)	Design Bench Height (ft)	Design Bench Width (ft)	Model Code	Fault Zone SLOP1	CNI Sector SLOP2
1	East All	50	52	79	60	35	All		1
2	West and South Domes Default	48	50	72	60	31			
3	West Rhyolite	49	51	72	60	29	7,9,11		2
4	West Volcanics & Epiclastic	48	50	72	60	31	14,16,23		2
5	West Andesite	46	48	70	60	32	27		2

Code	Slope Sector Description	OSA (°) MSEP	ISA (°)	Design BFA (°)	Design Bench Height (ft)	Design Bench Width (ft)	Model Code	Fault Zone SLOP1	CNI Sector SLOP2
6	South Domes Rhyolite	49	51	72	60	29	7,9,11		3
7	South Domes Volcanics & Epiclastics	48	50	72	60	31	14,16,23		3
8	South Domes Andesite	46	48	70	60	32	27		3
9	Dillon and McLane Faults	40	40	60	60	37		1, 2	
10	Maverick West and Predator Faults	46	46	65	60	30		3,4	
11	Alluvium	28	28	36	20	10	2		
12	Backfill	28	28	36	20	10			
13	Waste Dumps	28	28	36	20	10			

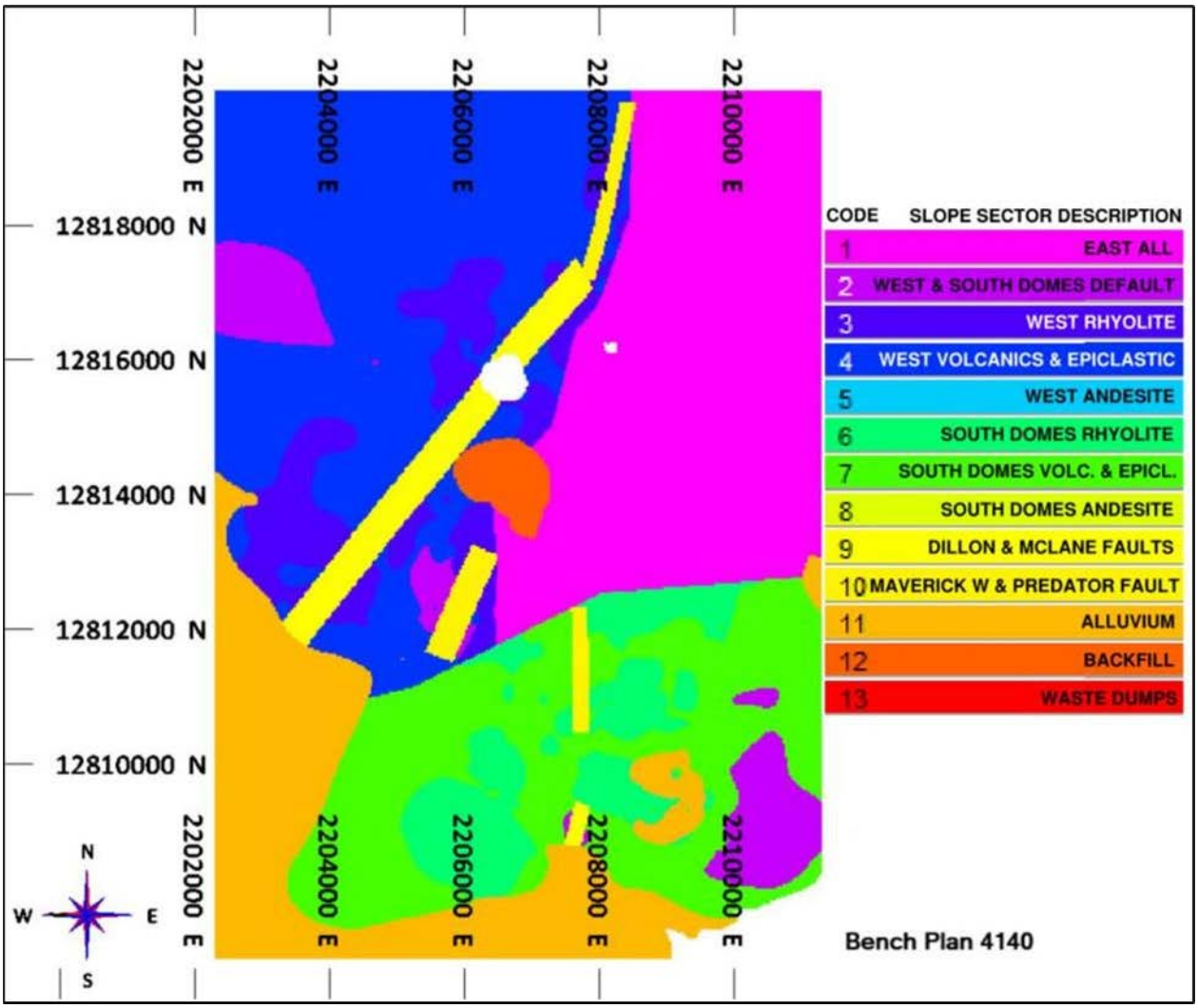


Figure 15-6: Slope Sector Bench Plan

A typical cross section of the lithology is shown in Figure 15-7.

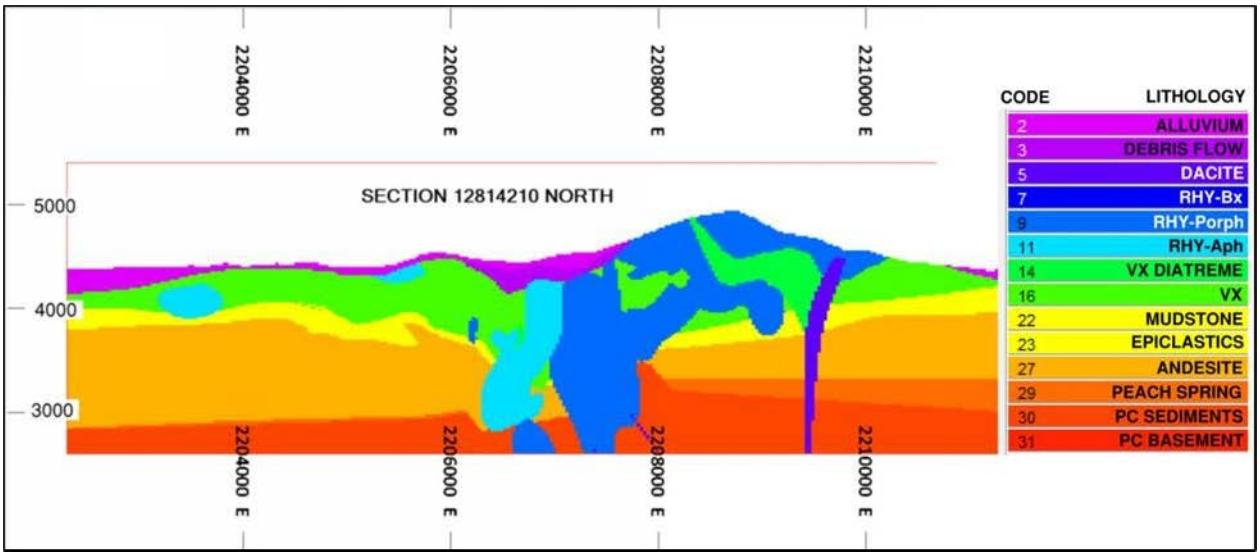


Figure 15-7: Lithology Section

15.2.5 Pit Limit Analysis

15.2.5.1 Pit Limits

Unsmoothed pit limits were developed using a MinePlan® variable slope Lerchs Grossmann algorithm. The preliminary net mine gate revenue and operating costs were used to estimate the value of each regular block in the model. A series of 30 nested pit limits were defined using revenue factors between 0.10 and 1.00.

Table 15-8 summarizes ROM, mill feed and waste for the 30 nested pit shells.

Table 15-8: Lerchs Grossmann Pit Shell Summary

			HEAP LEACH ROCK – IN-SITU			HEAP LEACH BACKFILL			HEAP LEACH TOTAL			MILL				
SHELL	Revenue Factor	Gold Value $/oz	RUN OF MINE kton	Diluted grade oz/ton	ROM NSR $/ton	RUN OF MINE kton	Diluted grade oz/ton	ROM NSR $/ton	RUN OF MINE kton	Diluted grade oz/ton	ROM NSR $/ton	RUN OF MINE kton	Diluted grade oz/ton	MILL NSR $/ton	WASTE TOTAL kton	TOTAL kton
1	0.100	$135	21,493	0.0121	12.05	8,332	0.0109	10.38	29,825	0.0118	11.58	1,280	0.0834	103.20	10,575	41,680
2	0.131	$177	27,552	0.0121	11.97	12,252	0.0100	9.54	39,804	0.0115	11.22	1,931	0.0895	111.06	19,357	61,092
3	0.162	$219	31,988	0.0119	11.81	14,834	0.0097	9.21	46,822	0.0112	10.99	2,250	0.0879	109.03	25,193	74,265
4	0.193	$261	44,322	0.0122	11.92	17,314	0.0094	8.93	61,636	0.0114	11.08	3,171	0.0804	99.49	44,056	108,863
5	0.224	$303	77,987	0.0123	12.01	20,873	0.0091	8.65	98,860	0.0116	11.30	5,234	0.0846	104.37	106,899	210,993
6	0.255	$344	90,017	0.0123	11.96	22,099	0.0090	8.58	112,116	0.0116	11.29	5,866	0.0814	100.45	125,616	243,598
7	0.286	$386	110,113	0.0120	11.75	23,031	0.0090	8.55	133,144	0.0115	11.20	6,866	0.0827	102.28	168,712	308,722
8	0.317	$428	120,246	0.0120	11.69	24,792	0.0089	8.43	145,038	0.0115	11.13	7,446	0.0808	99.93	188,077	340,561
9	0.348	$470	150,602	0.0119	11.54	30,580	0.0086	8.17	181,182	0.0113	10.97	8,920	0.0809	100.19	252,603	442,705
10	0.379	$512	219,419	0.0121	11.50	30,590	0.0086	8.17	250,009	0.0117	11.09	15,208	0.0733	89.48	425,940	691,157
11	0.410	$554	230,658	0.0121	11.48	30,603	0.0086	8.17	261,261	0.0117	11.09	15,700	0.0737	89.94	452,567	729,528
12	0.441	$596	239,170	0.0121	11.44	30,603	0.0086	8.17	269,773	0.0117	11.07	16,430	0.0734	89.50	477,363	763,566
13	0.472	$638	242,514	0.0121	11.44	30,603	0.0086	8.17	273,117	0.0117	11.08	16,657	0.0735	89.56	488,561	778,335
14	0.503	$680	246,941	0.0121	11.45	30,603	0.0086	8.17	277,544	0.0117	11.09	17,257	0.0736	89.52	509,737	804,538
15	0.534	$722	258,842	0.0120	11.40	30,603	0.0086	8.17	289,445	0.0116	11.05	18,437	0.0737	89.54	555,079	862,961
16	0.566	$763	262,297	0.0120	11.38	30,603	0.0086	8.17	292,900	0.0116	11.04	18,676	0.0736	89.41	565,165	876,741
17	0.597	$805	272,402	0.0121	11.45	30,603	0.0086	8.17	303,005	0.0117	11.12	20,756	0.0745	90.04	645,223	968,984
18	0.628	$847	273,929	0.0121	11.45	30,603	0.0086	8.17	304,532	0.0117	11.12	20,812	0.0745	89.98	650,159	975,503
19	0.659	$889	275,101	0.0121	11.46	30,603	0.0086	8.17	305,704	0.0117	11.13	20,926	0.0745	89.98	655,896	982,526
20	0.690	$931	276,896	0.0121	11.45	30,603	0.0086	8.17	307,499	0.0118	11.13	21,024	0.0745	90.01	663,836	992,359
21	0.721	$973	280,271	0.0121	11.46	30,603	0.0086	8.17	310,874	0.0118	11.13	21,290	0.0746	90.01	679,013	1,011,177
22	0.752	$1,015	281,588	0.0121	11.46	30,603	0.0086	8.17	312,191	0.0118	11.13	21,314	0.0745	89.97	682,688	1,016,193
23	0.783	$1,057	283,293	0.0121	11.45	30,603	0.0086	8.17	313,896	0.0118	11.13	21,426	0.0744	89.87	689,967	1,025,289
24	0.814	$1,099	285,231	0.0121	11.44	30,603	0.0086	8.17	315,834	0.0118	11.12	21,480	0.0744	89.79	695,982	1,033,296
25	0.845	$1,141	287,130	0.0121	11.44	30,603	0.0086	8.17	317,733	0.0118	11.12	21,572	0.0743	89.72	704,427	1,043,732
26	0.876	$1,182	287,639	0.0121	11.43	30,603	0.0086	8.17	318,242	0.0118	11.12	21,593	0.0743	89.70	706,175	1,046,010
27	0.907	$1,224	289,083	0.0121	11.43	30,603	0.0086	8.17	319,686	0.0118	11.12	21,641	0.0743	89.65	712,628	1,053,955
28	0.938	$1,266	290,772	0.0121	11.43	30,603	0.0086	8.17	321,375	0.0118	11.12	21,688	0.0742	89.62	720,353	1,063,416
29	0.969	$1,308	291,568	0.0121	11.42	30,603	0.0086	8.17	322,171	0.0118	11.11	21,693	0.0742	89.61	722,712	1,066,576
30	1.000	$1,350	292,278	0.0121	11.42	30,603	0.0086	8.17	322,881	0.0118	11.11	21,716	0.0742	89.59	725,539	1,070,136

The net operating surplus based upon pit optimization input and before capital expenditures is shown graphically in Figure 15-8. Also shown are net surplus at 5% and 10% discount rates.

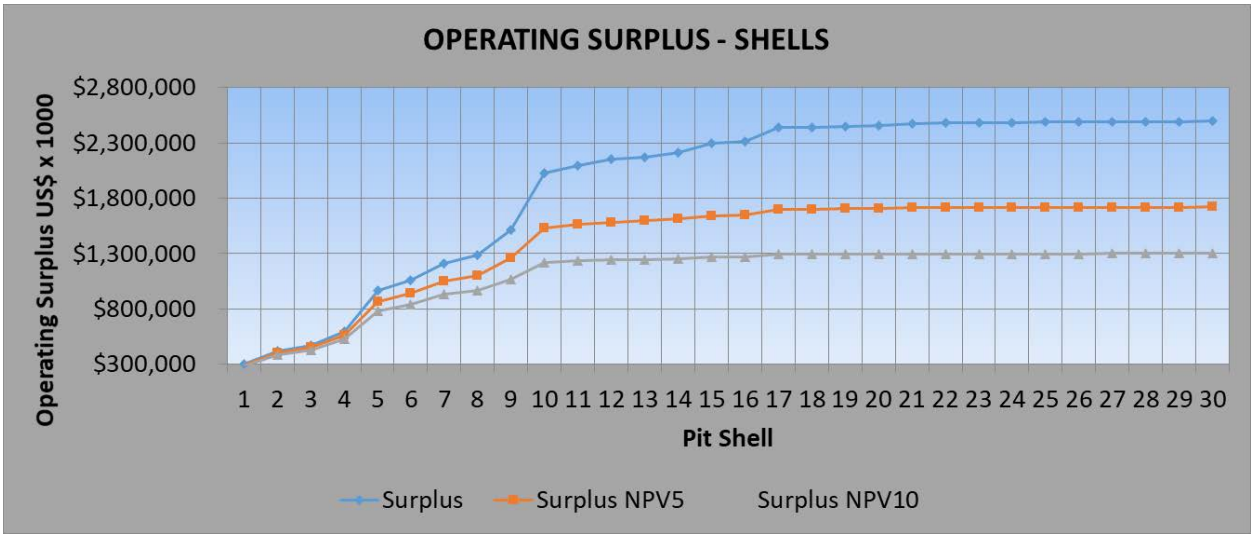


Figure 15-8: Operating Surplus – Pit Shells

The cumulative material for each pit shell is shown in Figure 15-9.

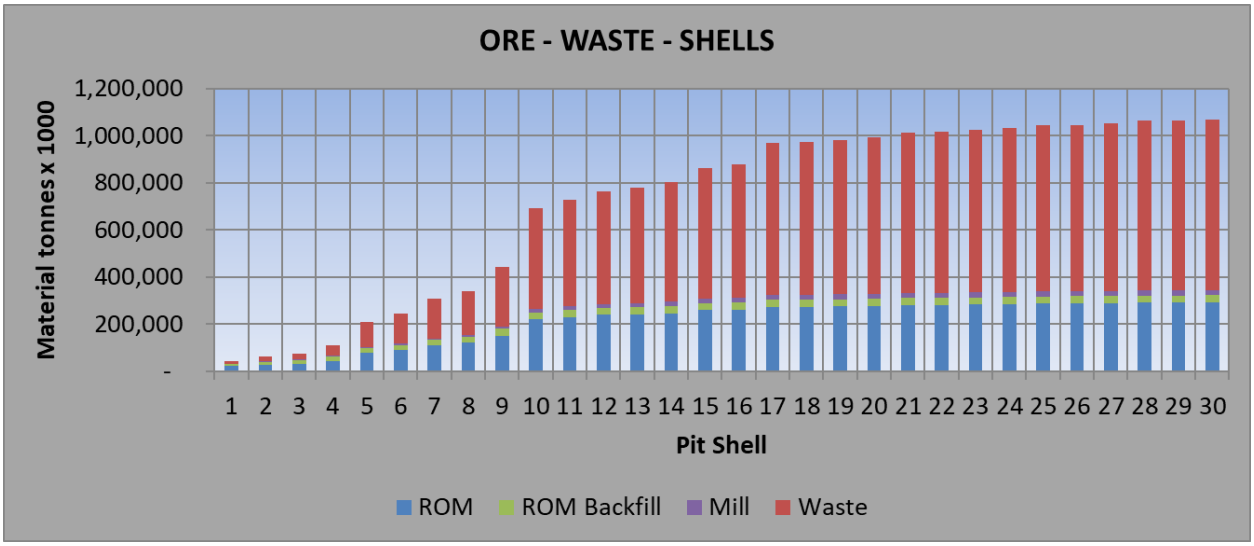


Figure 15-9: Ore and Waste – Pit Shells

The contained gold for each pit shell is shown in Figure 15-10.

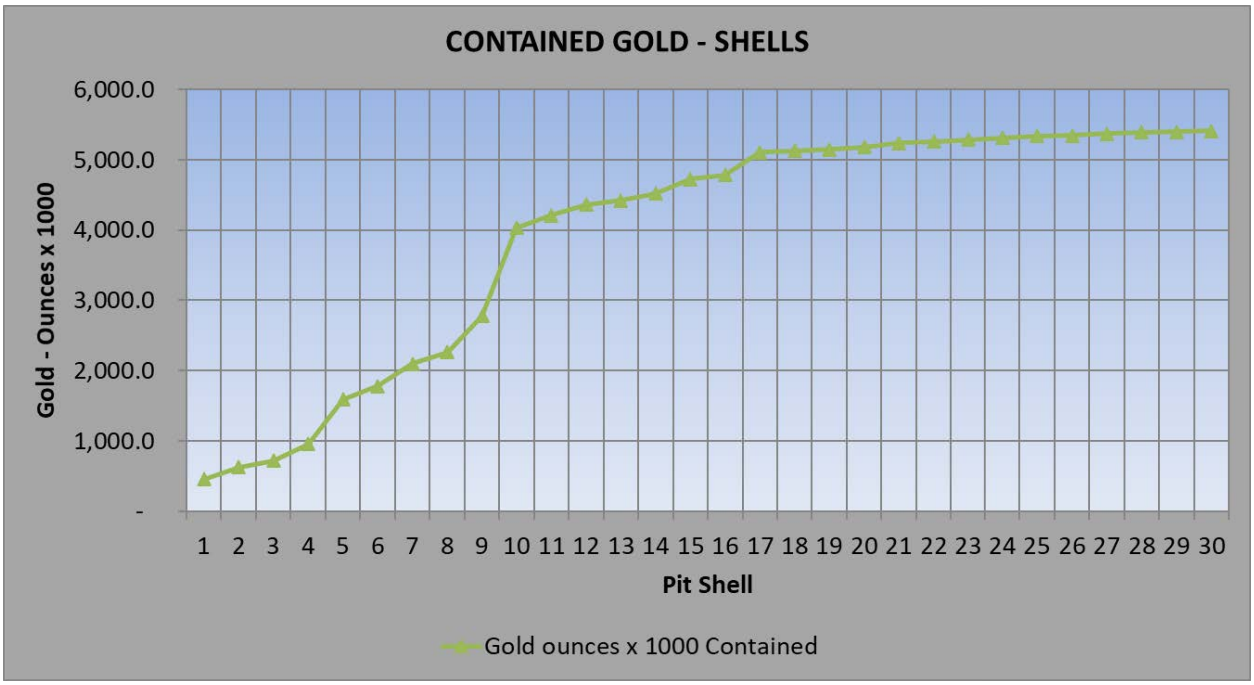


Figure 15-10: Contained Gold – Pit Shells

The cumulative proportion of discounted value and potential ore tonnage is shown together in Figure 15-11.

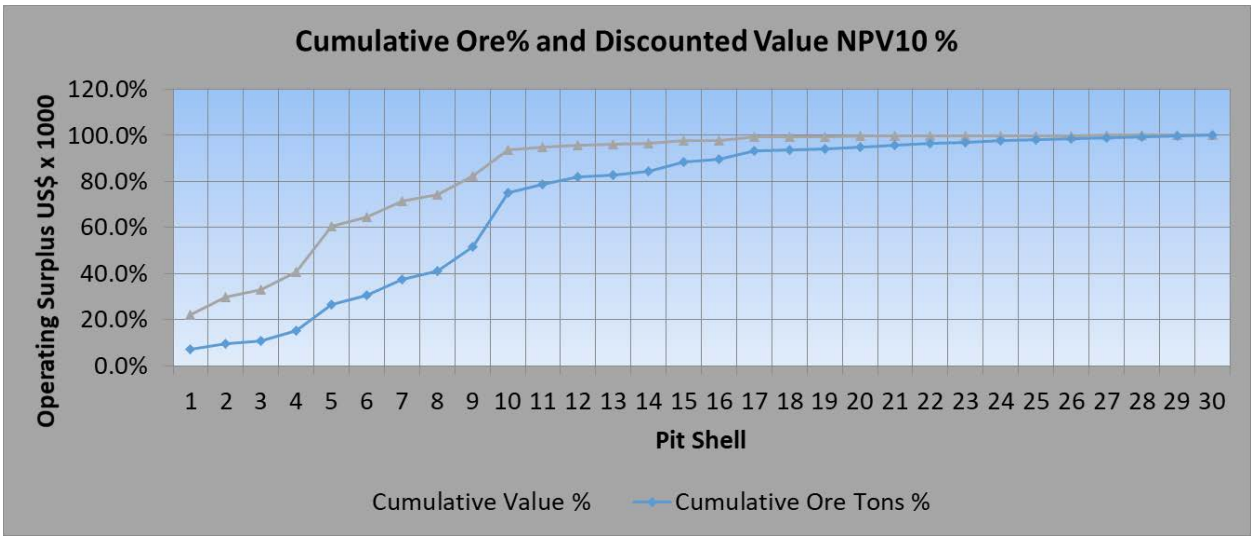
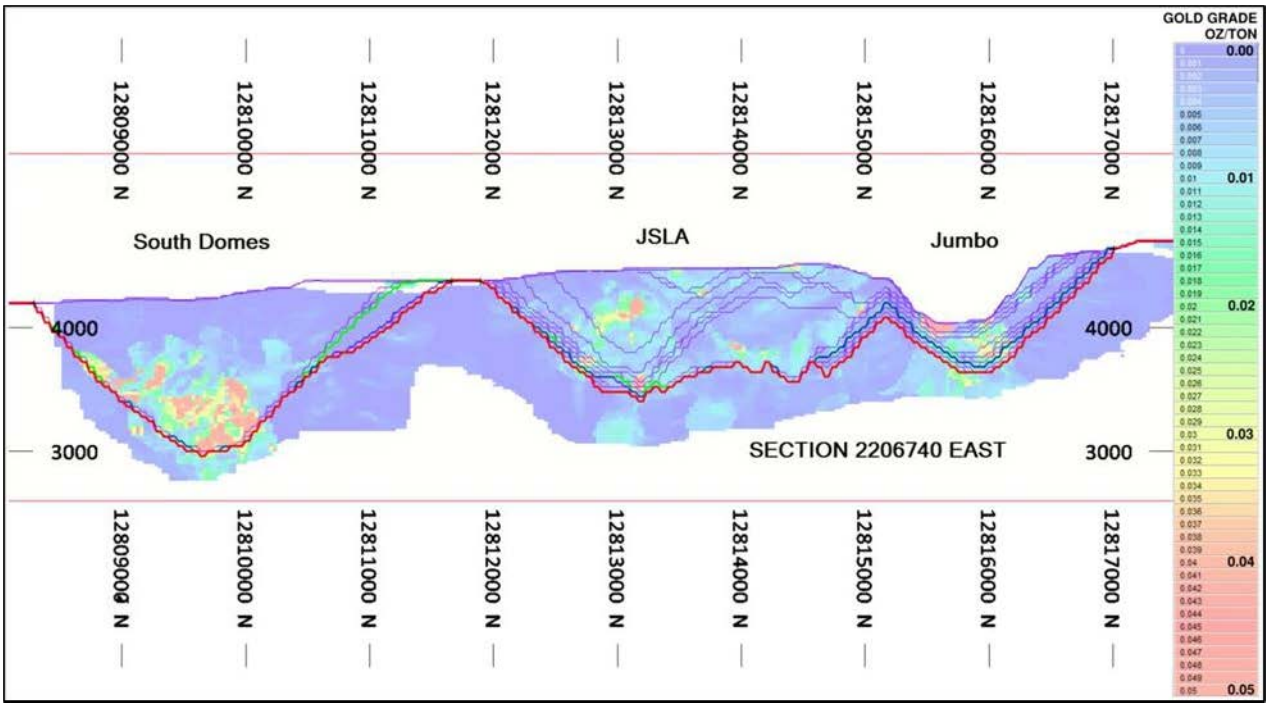


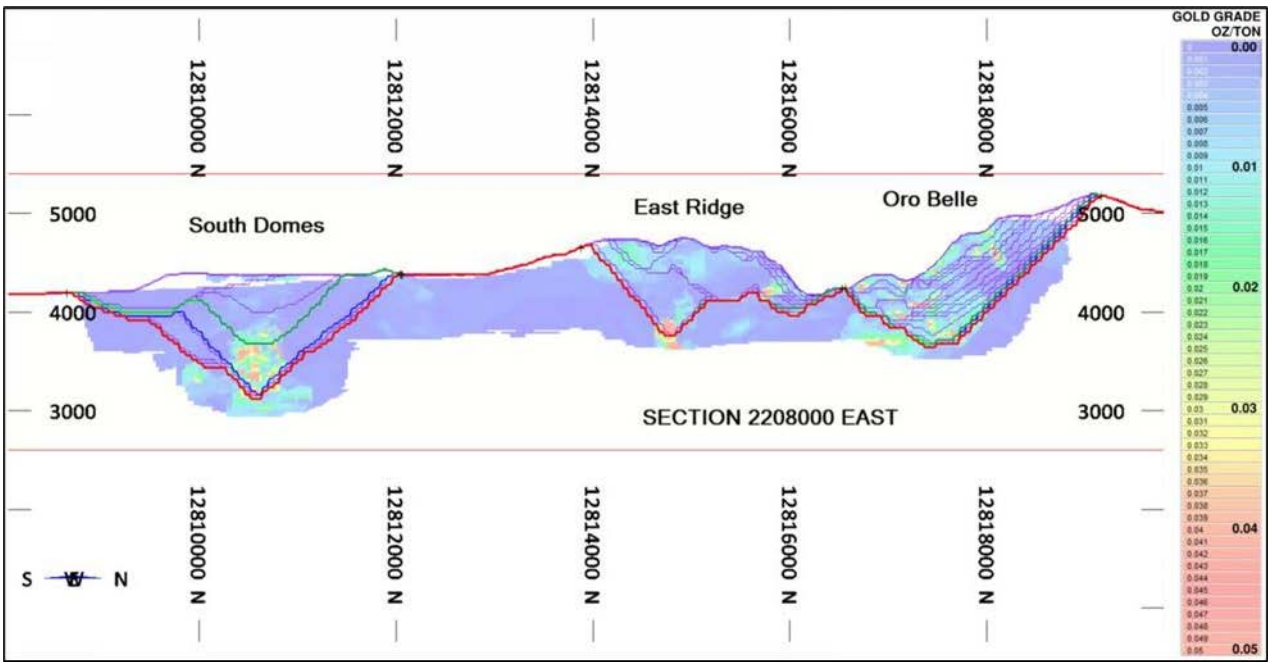
Figure 15-11: Cumulative Resource and Discounted Value – Pit Shells

The nested pit limits were used to guide pit design and are shown on the sections and plan below (Figure 15-12 to Figure 15-14).



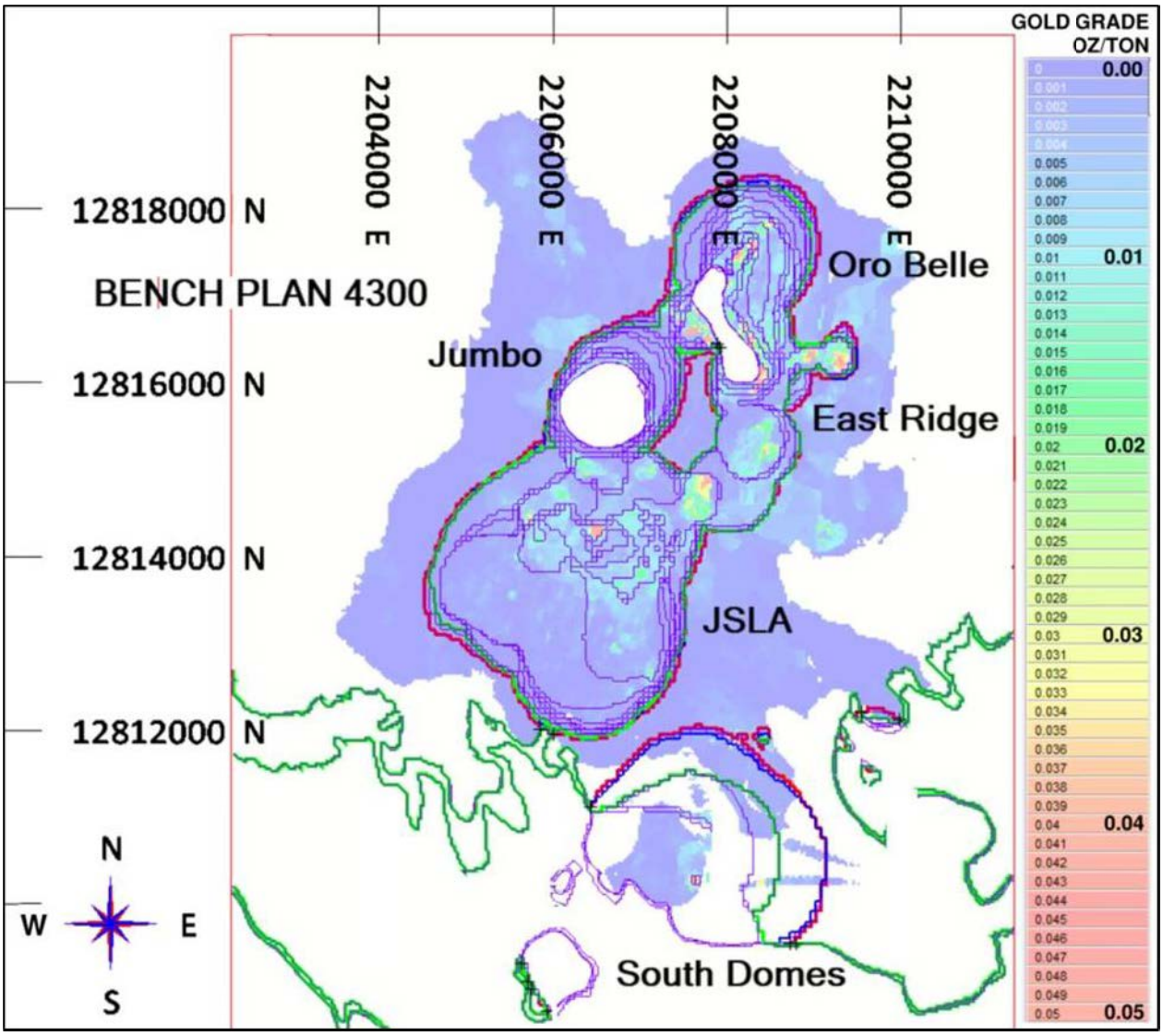
Source: NMS, 2020

Figure 15-12: Section 2206740 East Lerchs Grossmann Pit Limits



Source: NMS, 2020

Figure 15-13: Section East Lerchs Grossmann Pit Limits

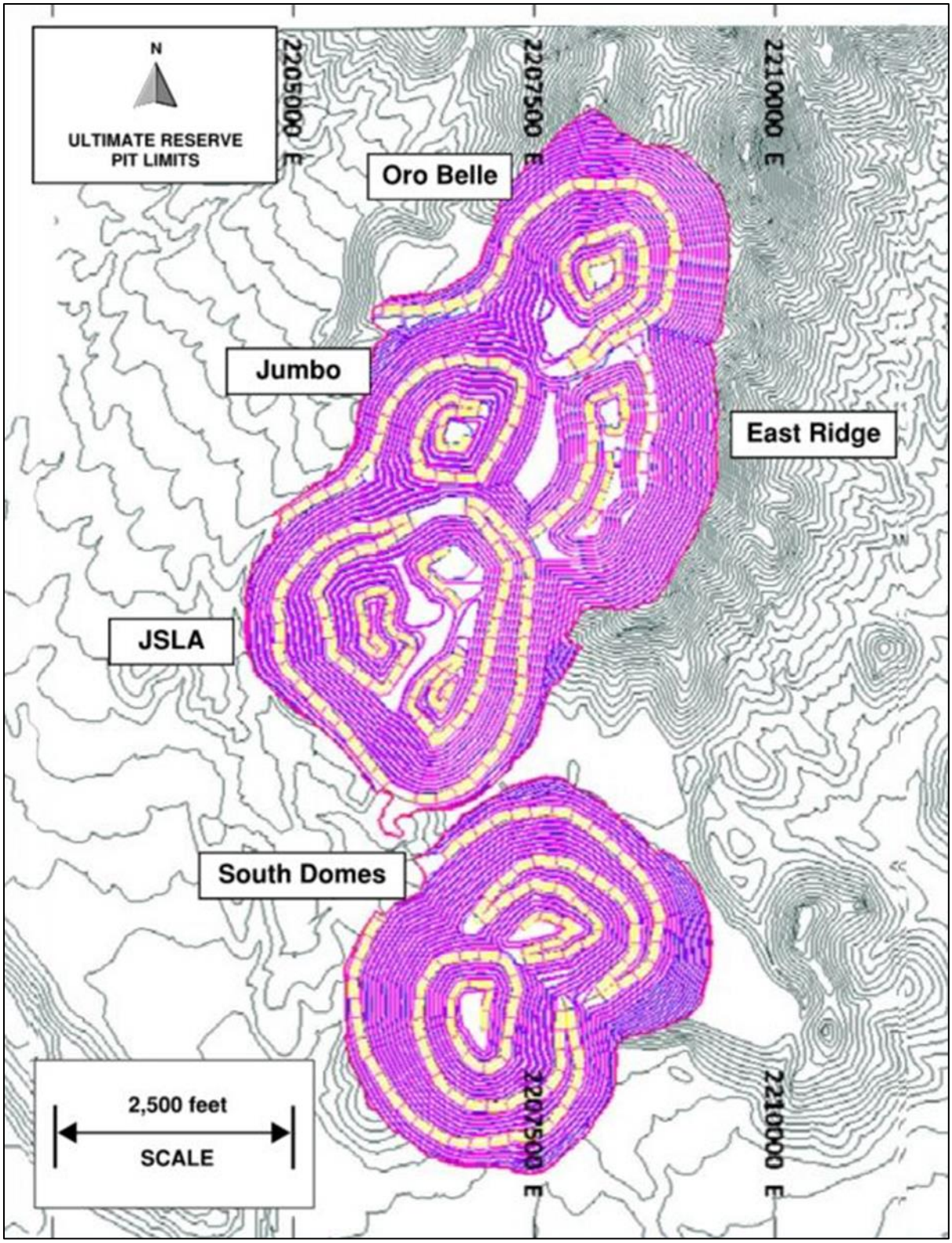


Source: NMS, 2020

Figure 15-14: Bench Plan 3385 Lerchs Grossmann Pit Limits

The design basis for the initial pit designs was 50,000 ton/d ROM to the leach pad and 3,500 ton/d to the mill. Preliminary schedules for this throughput indicated that the 99.3% of the net present value could be attained over 17.7 years with the 17th pit shell developed with a revenue factor of 0.60. This pit was selected as a guide for a detailed design.

A detailed description of the pit design is provided in Section 16. The open pit has been designed to be developed in nine phases. The ultimate reserve pit configuration is shown in Figure 15-15.



Source: NMS, 2020

Figure 15-15: Ultimate Reserve Pit Limits

15.3 MINERAL RESERVE SUMMARY

The Castle Mountain Mineral Reserves are summarized in Table 15-9. The Mineral Reserves have been reported using a cut-off grade of 0.005 oz/ton (0.17 g/t) gold.

Table 15-9: Mineral Reserve Summary

Imperial	Tons (kton)	Gold Grade (oz/ton)	Gold (koz)
Proven	93,600	0.016	1,498
Probable	190,690	0.014	2,670
Subtotal	**284,290**	**0.015**	**4,168**
Metric	**Tonnes (kt)**	**Gold Grade (g/t)**	**Gold (koz)**
Proven	84,910	0.55	1,498
Probable	172,990	0.48	2,670
Subtotal	**257,900**	**0.51**	**4,168**

Notes:
1. The Mineral Reserve estimate with an effective date of June 30, 2020 is based upon the Mineral Resource estimate prepared for Equinox by Trevor Rabb P.Geo, and described in Section 14, with an effective date of June 30, 2020.
2. The Mineral Reserve was estimated by Nilsson Mine Services Ltd. with supervision by John Nilsson P.Eng. who is a Qualified Person as defined under NI 43‑101.
3. Mineral Reserves are reported within the ultimate reserve pit design with overall economics developed for $1350/oz gold with appropriate royalties applied.
4. Mineral Reserves are reported using a cut-off grade of 0.005 oz/ton (0.17 g/t) gold.
5. The mining costs average $1.78/ton ($1.96/t) mined, processing costs are $1.33/ton ($1.47/t) for ROM and $12.62/ton ($13.91/t) for milling. G&A was $0.72/ton ($0.79/t) ore processed.
6. The average process recovery was 73.9% for ROM and 94.5% for milling.
7. Ore tons are reported in thousands of short tons (kton) and ounces.
8. Mineral Resource is exclusive of Mineral Reserves.

The Mineral Reserve estimate has been based upon economic parameters, geotechnical design criteria and metallurgical recovery assumptions detailed within this section. Changes in these assumptions will impact the Mineral Reserve estimate. In general, increases in operating costs, reductions in revenue assumptions or reductions in metallurgical recovery may result in increased cut-off grades, reductions in in-pit resources and increasing strip ratios. Reductions in operating costs, increases in revenue assumptions, or increases in metallurgical recovery may result in reduced cut-off grades and increases in in-pit resources. Environmental permits are required for the Phase 2 mine plan to proceed. These permits have a material influence on the reserve statement.

16 MINING METHODS

16.1 INTRODUCTION

Mine planning, equipment selection and cost estimation for the Castle Mountain Project was undertaken by Nilsson Mine Services Ltd. (NMS). This section of the report summarizes the design process, the mine schedule, the mine operations plan, operating and capital cost estimates for the open pit.

16.2 SUMMARY

16.2.1 Project Description

The current Phase 1 project configuration consists of a 14,000 ton/d (12,700 t/d) run of mine (ROM) heap leach operation with a planned expansion in Phase 2 to 50,000 ton/d (45,400 t/d) ROM and 3,500 ton/d (3,200 t/d) milling. The mine will be a conventional diesel powered truck and shovel operation. The Mineral Reserve is estimated to be 284.3 Mton (257.9 Mt) with an average grade of 0.015 oz/ton (0.514 g/t) gold reported at a 0.005 oz/ton (0.17 g/t) gold cut-off grade. The Mineral Reserves will be mined by open pit methods in nine phases of open pit development and expansion. The overall strip ratio is 2.47:1. The total in-pit waste is 701.9 Mton (636.8 Mt). The overall mine life including Phase 1 and Phase 2 is 19 years. Phase 2 mining depends on several things including permits and is expected to commence two years prior to full production. The expanded heap leach and mill are anticipated to reach full production by the start of Year 6, designated as Year 1 for Phase 2.

Phase 1 mining will be focused on mining backfilled material in the JSLA pit. In Phase 2, the ROM, mill feed and waste will be drilled by diesel powered drills and blasted using ammonium nitrate and fuel oil or with emulsion as required in wet conditions. ROM, mill feed and waste will be loaded into 250 ton mine trucks by 44.5 yd^3 diesel hydraulic shovels and 32.0 yd^3 wheel loaders. Waste will be placed in designated disposal sites adjacent to the pit in the early years and backfilled to mined out pits later in the mine life. Heap leach ROM ore will initially be hauled to the existing Phase 1 leach pad. In Phase 2 of the Life of Mine (LOM) plan, ROM will be hauled to a new Phase 2 leach pad that will be developed southwest of the mine progressing from south to north. Mill feed will be placed in a stockpile adjacent to the primary crusher and re-handled by wheel loaders.

16.2.2 Resources and Mineable Reserves

The resource block model for the Project was developed using conventional block modelling techniques. A combined ore percent resource block model for the JSLA pit backfill material and in-situ hard rock mineral resources is described in Section 14. Measured and Indicated Resources have been used to report Mineral Reserves and respectively develop the mine plan.

Mineral Reserves are summarized by phase in Table 16-1. These Mineral Reserves have been summarized within the ultimate reserve pit design used in this study.

Table 16-1: Mineral Reserves by Phase (Imperial Units)

	ROM ROCK		ROM BACKFILL		ROM TOTAL		MILL		TOTAL			
Pit Design Phase	Ore Tons (kton)	Diluted Gold Grade (oz/ton)	Ore Tons (kton)	Diluted Gold Grade (oz/ton)	Ore Tons (kton)	Diluted Gold Grade (oz/ton)	Ore Tons (kton)	Diluted Gold Grade (oz/ton)	Ore Tons (kton)	Diluted Gold Grade (oz/ton)	Waste Tons (kton)	Total Tons (kton)
Phase 1 - JSLA Backfill	-	-	26,524	0.0088	26,524	0.0088	193	0.0567	26,717	0.0091	14,166	40,883
Phase 2 - JSLA East	50,088	0.012	3,130	0.0085	53,218	0.0114	3,334	0.0481	56,552	0.0136	95,817	152,369
Phase 3 - JSLA West	28,401	0.011	-	-	28,401	0.0107	2,973	0.0735	31,374	0.0167	78,638	110,012
Phase 4 - Jumbo	13,837	0.013	-	-	13,837	0.0127	1,112	0.0886	14,949	0.0183	43,206	58,155
Phase 5 - Oro Belle	39,323	0.012	-	-	39,323	0.0121	2,783	0.0559	42,106	0.0150	104,402	146,508
Phase 6 - East Ridge	12,667	0.010	-	-	12,667	0.0097	365	0.0394	13,032	0.0105	31,128	44,160
Phase 7 - East Ridge	24,818	0.011	-	-	24,818	0.0107	2,072	0.0852	26,890	0.0165	66,150	93,040
Phase 8 - South Domes	57,313	0.014	-	-	57,313	0.0136	2,313	0.0767	59,626	0.0160	167,800	227,426
Phase 9 - South Domes	11,636	0.015	-	-	11,636	0.0147	1,415	0.0835	13,051	0.0222	100,618	113,669
Total	**238,086**	**0.012**	**29,654**	**0.0087**	**267,740**	**0.0117**	**16,560**	**0.0683**	**284,300**	**0.0150**	**701,925**	**986,225**

16.2.3 Open Pit Mine Plan

The mine production forecast is summarized in Table 16-2. The overall mine production has been scheduled by bench and development phase on an annual basis. A cut-off of 0.005 oz/ton (0.17 g/t) was applied for determining waste. In general, mill feed cut-off was based upon maximum net of process value for each metallurgical ore type. In some years when mill feed quantities are low, redirection of ROM material was implemented to reach mill capacity. Redirected ore totals 1.14 Mton (1.03 Mt) over the life of mine. The mine plan will depend on several activities including permitting and incorporates the following assumptions:

- Phase 1 – initiated in month 1 with contractor mining of backfilled ROM ore from the JSLA open pit to Phase 1 leach pad.
- Phase 2 – initiated in month 36 with JSLA pioneering and access road construction to commence using contractors in month 37. Contractor to develop JSLA East pit to 4,540 ft elevation.
- Staggered mining equipment deliveries month 42 to month 48. Mining rate begins to ramp up as equipment is delivered.
- Ramp up overall mining rate to 73 Mton/y (66 Mt/y) through to Year 9 then expand gradually to 80 Mton/y (73 Mt/y) through to Year 16 after which production begins to drop through Year 19.
- Overall sequence of development in the JSLA, Jumbo, Oro Belle and East Ridge area is clockwise development to final to pit limits in each area to allow for an orderly sequence of backfilling waste as pits are completed.
- Sequence at South Domes is an initial southwest pit with an expansion to the northeast.
- The resource block model was developed on 20 ft (6 m) benches. The mine design was developed using the 20 ft bench height with triple benching to 60 ft (18 m) between design catch benches or berms. Operations are planned for a 30 ft bench height. Sinking rates in the schedule were limited to 300 ft/y or the equivalent of 10 benches/year. Drills, loading units and support equipment appropriate for mining a 30 ft (9 m) bench height have been selected for the mine plan and associated cost estimates.

Table 16-2: Annual Mine Production Schedule

MINING SCHEDULE

	Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Total
ROM Ore	kton	5,110.0	5,110.0	5,110.0	5,110.0	10,950.4	18,249.6	18,250.0	18,250.0	18,250.0	18,250.0	18,250.0	18,250.0	18,250.0	18,249.7	18,250.0	18,250.0	18,250.0	14,774.6	2,576.0	**267,740.3**
Gold Grade	oz/ton	0.011	0.009	0.009	0.008	0.009	0.011	0.011	0.011	0.011	0.010	0.010	0.013	0.011	0.012	0.012	0.014	0.013	0.019	0.018	**0.012**
Gold Recoverable	oz/ton	0.008	0.007	0.006	0.006	0.006	0.008	0.008	0.008	0.008	0.007	0.008	0.009	0.008	0.009	0.009	0.011	0.010	0.014	0.013	**0.009**
Mill Ore	kton	93.0	50.0	17.5	29.4	201.5	1,057.9	1,259.4	1,479.9	1,217.0	723.0	1,255.7	1,661.6	1,021.7	915.8	1,364.3	1,273.2	492.5	1,922.4	524.0	**16,560.0**
Gold Grade	oz/ton	0.060	0.055	0.044	0.058	0.056	0.064	0.047	0.052	0.070	0.046	0.072	0.065	0.062	0.056	0.085	0.093	0.093	0.082	0.064	**0.068**
Gold Recoverable	oz/ton	0.056	0.052	0.041	0.055	0.054	0.061	0.045	0.049	0.067	0.044	0.068	0.061	0.058	0.053	0.081	0.088	0.088	0.077	0.060	**0.064**
Waste Rock	kton	-	-	-	10,569.0	33,797.0	32,532.3	39,789.6	42,238.0	52,325.5	47,627.4	50,560.7	50,604.4	57,660.1	59,449.1	48,776.5	52,783.0	42,515.5	11,988.7	2,178.0	**635,395.0**
Waste Alluvium	kton	-	-	-	354.0	1,101.0	2,196.0	75.0	271.5	291.5	426.0	893.0	2,137.6	1,518.4	-	2,807.2	3,821.8	-	-	-	**15,893.0**
Waste Backfill	kton	1,260.3	1,730.2	1,960.4	2,083.3	7,406.5	6,645.0	3,811.7	1,384.6	669.0	25.0	-	-	-	-	-	-	-	-	-	**26,976.0**
Waste Dump	kton	-	-	-	91.0	327.0	2,457.0	-	344.0	408.3	6,729.7	1,853.0	542.0	-	-	7,160.1	3,748.9	-	-	-	**23,661.0**
Total Waste	kton	1,260.3	1,730.2	1,960.4	13,097.3	42,631.6	43,830.3	43,676.4	44,238.1	53,694.3	54,808.1	53,306.7	53,284.0	59,178.6	59,449.1	58,743.8	60,353.7	42,515.5	11,988.7	2,178.0	**701,925.0**
Total Material	kton	6,463.3	6,890.2	7,088.0	18,236.7	53,783.4	63,137.8	63,185.7	63,968.0	73,161.4	73,781.2	72,812.4	73,195.5	78,450.3	78,614.6	78,358.1	79,876.9	61,258.1	28,685.7	5,278.0	**986,225.3**

PROCESSING SCHEDULE

	Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Total
ROM Ore	kton	5,110.0	5,110.0	5,110.0	5,110.0	10,950.4	18,249.6	18,250.0	18,250.0	18,250.0	18,065.6	18,228.2	18,250.0	18,250.0	18,016.3	18,250.0	18,250.0	17,547.5	14,774.6	2,576.0	**266,598.3**
Gold Grade	oz/ton	0.011	0.009	0.009	0.008	0.009	0.011	0.011	0.011	0.011	0.010	0.010	0.013	0.011	0.012	0.012	0.014	0.012	0.019	0.018	**0.012**
Gold Recoverable	oz/ton	0.008	0.007	0.006	0.006	0.006	0.008	0.008	0.008	0.008	0.007	0.008	0.009	0.008	0.009	0.009	0.011	0.010	0.014	0.013	**0.009**
Recovery	%	72.2%	72.1%	72.2%	73.6%	70.5%	71.5%	69.0%	69.7%	71.1%	72.7%	72.1%	70.5%	74.2%	78.3%	75.2%	78.1%	85.8%	76.9%	73.3%	74.1%
Recoverable Gold	oz	38,885	34,735	31,407	30,786	66,487	140,300	141,195	142,345	137,122	131,165	136,798	163,484	150,091	164,350	164,096	193,583	174,878	212,649	33,305	**2,287,660**

	Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Total
MILLING																					
Mill Ore	kton	-	-	-	-	-	1,203.0	1,277.5	1,277.5	1,277.5	1,277.5	1,277.5	1,277.5	1,277.5	1,277.5	1,277.5	1,277.5	1,277.5	1,277.5	1,169.0	**17,702.0**
Gold Grade	oz/ton	-	-	-	-	-	0.063	0.047	0.052	0.070	0.047	0.071	0.065	0.062	0.054	0.085	0.093	0.065	0.082	0.074	**0.067**
Gold Recoverable	oz/ton	-	-	-	-	-	0.060	0.045	0.049	0.066	0.044	0.067	0.061	0.059	0.051	0.081	0.088	0.061	0.077	0.070	**0.063**
Recovery	%	0.0%	0.0%	0.0%	0.0%	0.0%	94.9%	94.5%	95.1%	95.6%	94.6%	93.9%	94.0%	94.3%	94.3%	95.0%	94.6%	94.4%	93.8%	93.6%	94.5%
Recoverable Gold	oz	-	-	-	-	-	72,455	57,214	62,614	84,890	56,345	85,655	77,921	74,980	65,536	103,625	112,194	78,398	98,808	81,340	**1,111,977**

16.2.4 Waste Rock Storage and Stockpile Plan

The total waste to be mined from the open pit is 701.9 Mton (636.8 Mt). Waste has been reported as waste rock that will be drilled and blasted and as alluvium, backfill and waste dump material that will be free-digging. Over the life of mine, waste will be placed in the East Dump, the Northwest Dump and backfilled to the JSLA, Jumbo, Oro Belle and East Ridge open pits.

16.3 OPEN PIT DESIGN

16.3.1 General

This section of the report describes the basis for the reserve open pit design including the design parameters, design summary, Mineral Reserves and waste material storage method.

The reserve open pit design has been based upon the following key considerations:

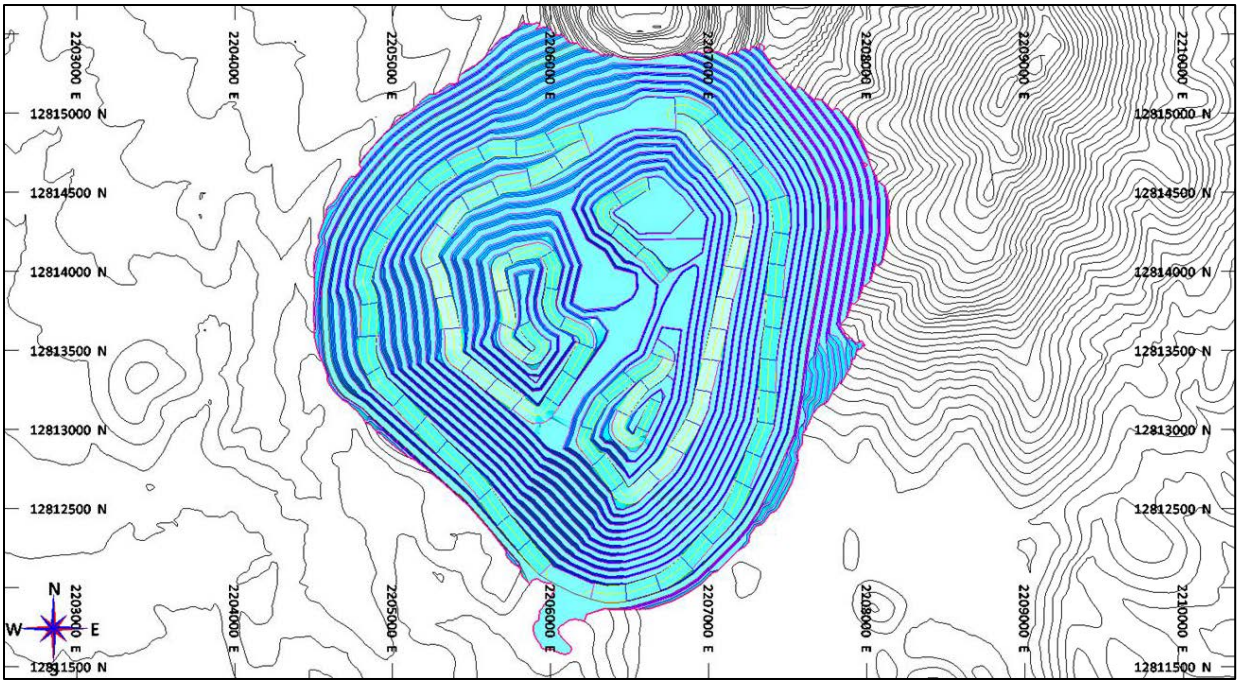
- Overall and inter-ramp slope recommendations provided by Call & Nicholas, Inc (Call & Nicholas, 2020), as discussed in 15.2.4.3.
- Waste dump final slopes of 2H:1V or 26.5°.
- Operating constraints of the equipment selected for mining:
  - Minimum mining width defined by double side loading of trucks with allowance for an access ramp.
  - Bench height achievable and within the safe operating reach of the primary loading units.
  - Minimum haulage road operating width and maximum effective grade within the operating limitations of the primary haulage units.
- Logical and efficient scheduling of material movement from multiple phases of pit expansion to the ROM pad, stockpiles and to final waste material placement sites.
- Minimum footprint for disturbance of the surrounding area.

16.3.2 Design Summary

The mining equipment will operate on a 30 ft (9m) high bench. Berms will be left on alternate benches in hard rock. CNI wall slope design recommendations have been implemented for inter-ramp slopes with variable berm widths and bench face angles applied as described in Section 15.2.4.3 (Call & Nicholas, 2020).

16.3.2.1 JSLA

The JSLA Phase 1 pit is based upon the Pre-feasibility Study plan to mine backfill at a rate of 14,000 ton/d (Scott et al., 2018). The design reflects use of the existing final ramp in hard rock from the backfilled pit. The Phase 2 design, shown in Figure 16-1, developed in this study has a double access ramp system that allows the pit to be split for scheduling of two phases. These ramps will exit the pit on the south side at 4,300 ft elevation. The pit bottoms will be at 3,480 ft elevation on the east and west sides. The pit will be 3,700 ft across in the east-west direction and 3,750 ft in the north-south direction. The overall wall height will be 1,200 ft on the east side.

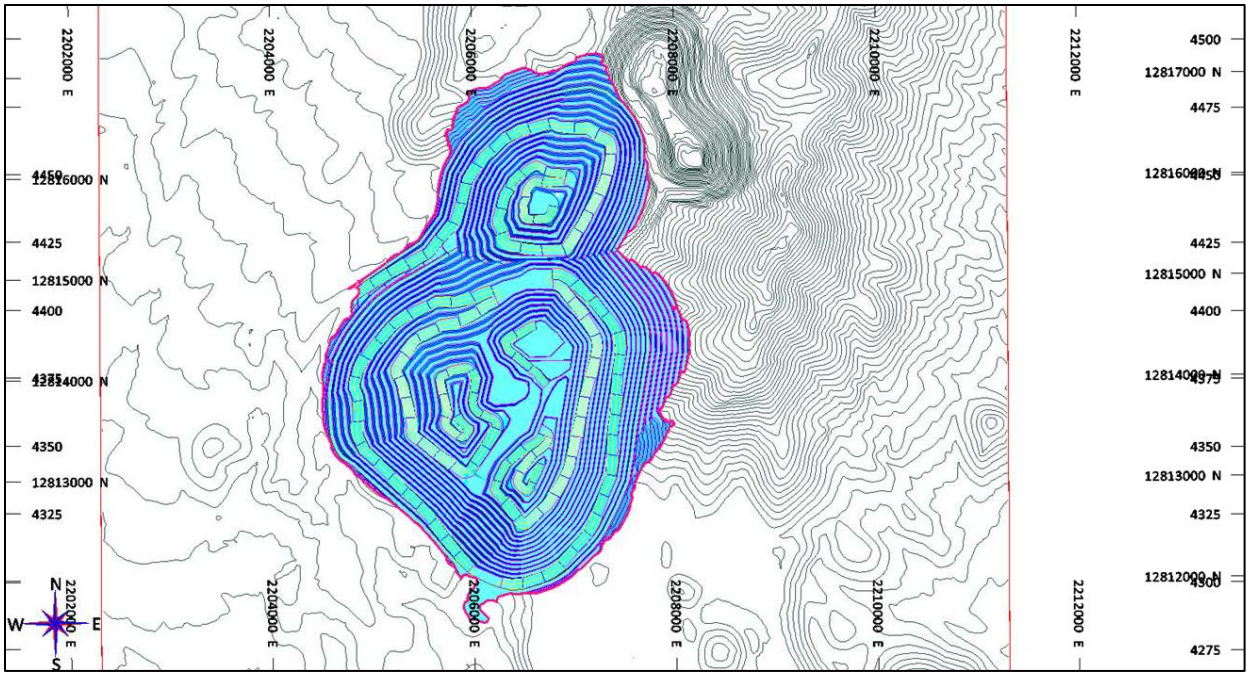


Source: NMS, 2020

Figure 16-1: JSLA Pit Design

16.3.2.2 Jumbo

The Jumbo pit design is shown in Figure 16-2. It will be located immediately north of the JSLA pit and intersect the JSLA design and the existing Oro Belle design to the north. The access ramp to the Jumbo pit will be along the north wall of the JSLA pit and the exit will be at 4,400 ft elevation. The bottom of the pit will be 3,760 bench. Overall wall height will be 940 ft. The pit will measure 2,000 ft in the east-west direction and 1,900 ft in the north-south direction.

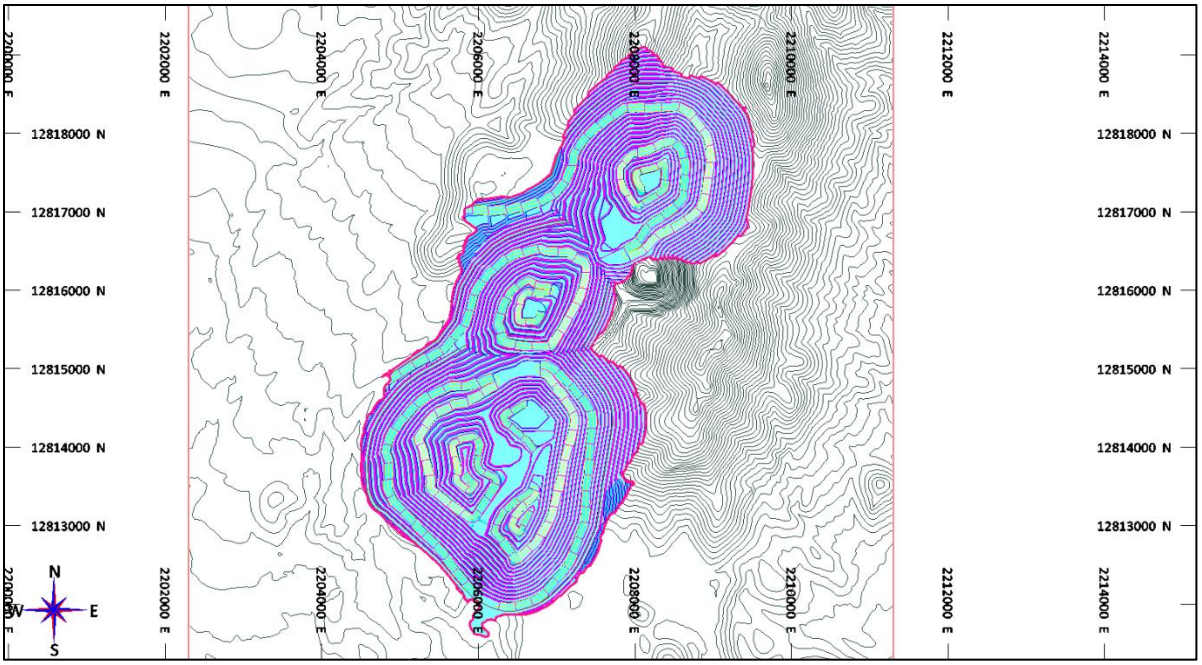


Source: NMS, 2020

Figure 16-2: Jumbo Pit Design

16.3.2.3 Oro Belle

The Oro Belle design, shown in Figure 16-3, is immediately north of Jumbo. The access ramp will break out 4,660 ft elevation on an existing dump. The north wall will break through the ridge crest at 5,180 ft elevation and the east wall will break through at 5,020 ft. The maximum wall height will be 1,420 ft on the north side. The pit will measure 2,580 ft in the east-west direction and 3,050 ft in the north-south direction. The narrow conical pit bottom resulted in some ore losses at depth due to ramp access issues. There may be an opportunity to regain some of those losses in future design iterations.



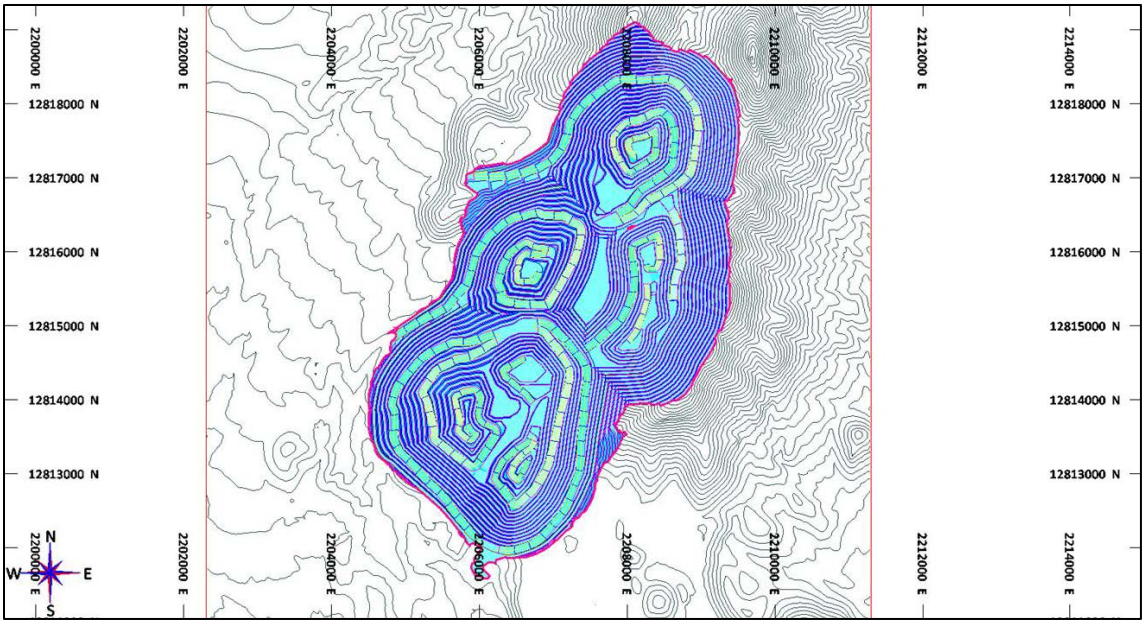
Source: NMS, 2020

Figure 16-3: Oro Belle Design

16.3.2.4 East Ridge

The East Ridge pit was designed to be developed as two phases. Access to the first internal phase will be from the east side of the ridge on an external road up from the surface of the East Dump. This road will provide access to the crest of ridge and the upper benches of East Ridge and Oro Belle. A road will be left in the east wall of the first phase to allow access to the upper benches of the second phase. Extraction of material from the lower benches of the East Ridge pit will be via the Oro Belle ramp and then finally out through the JSLA ramp connected by backfill.

The crest of the East pit will be at 4,920 ft elevation. The overall wall height when complete will be 1,100 ft. The pit will be 1,600 ft wide in the east-west direction and 2,900 ft in the north-south direction. The final configuration of East Ridge is shown in Figure 16-4.

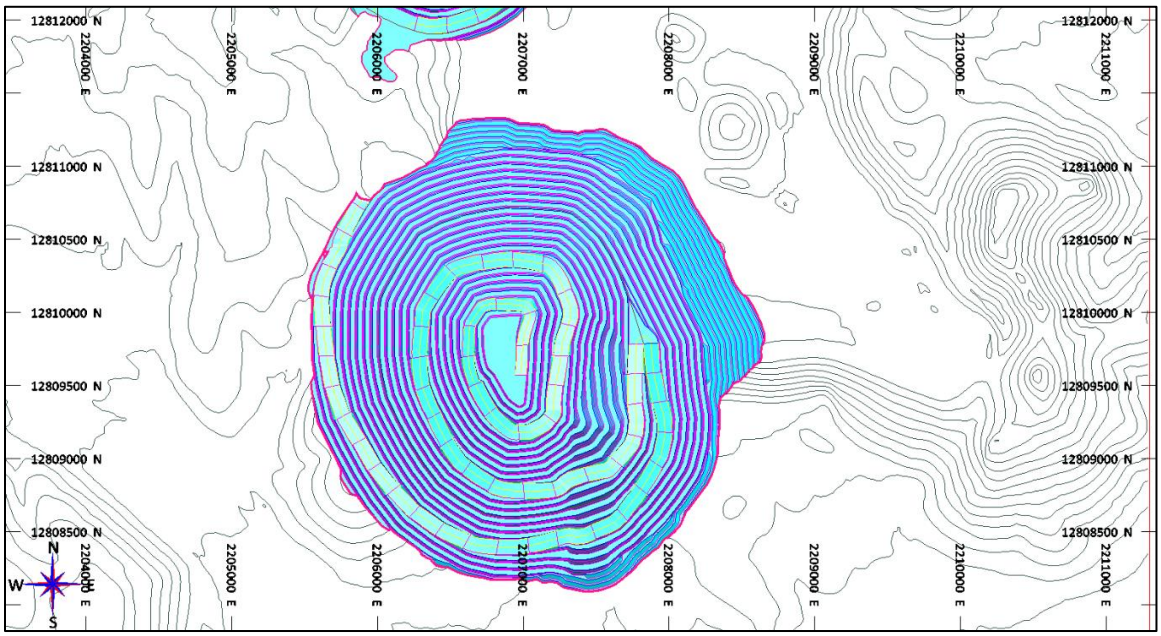


Source: NMS, 2020

Figure 16-4: East Ridge Pit

16.3.2.5 South Domes

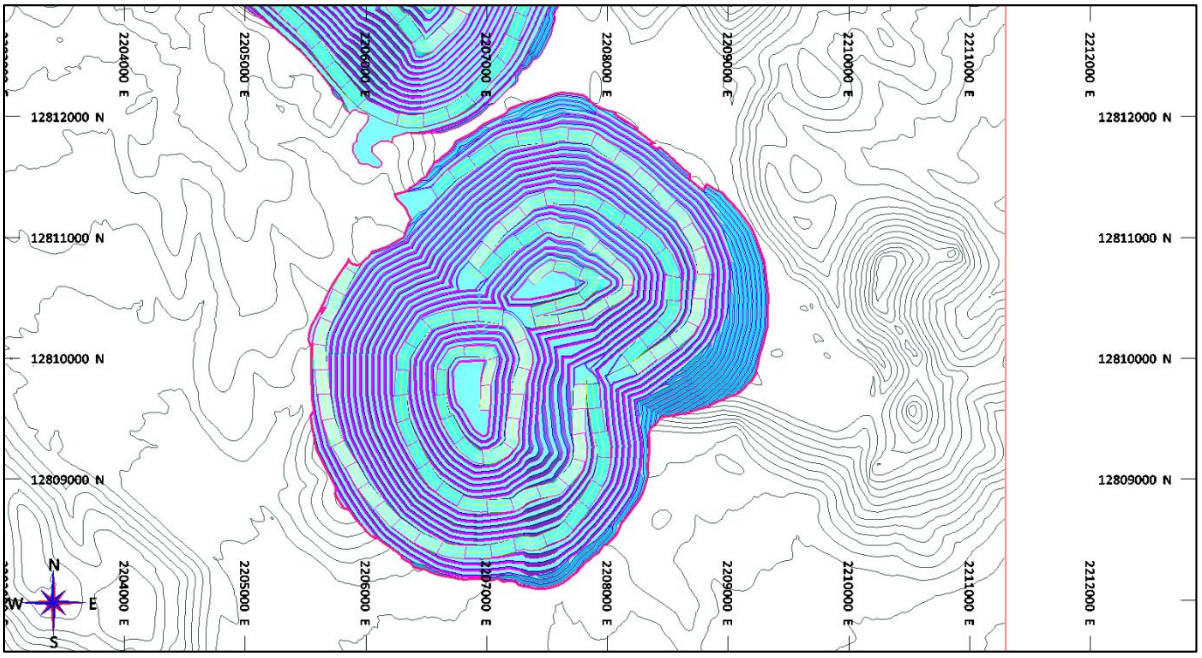
The South Domes Phase 1 pit is shown in Figure 16-5. The pit will be 1,260 ft deep and measure 3,100 ft across in the east-west direction and 3,150 ft in the north-south direction. The north and northeast walls will be developed through up to 220 ft of dump material placed during previous mining. The main ramp will be developed in a counter-clockwise direction with a switchback on the east wall at the intersection with the Phase 2 Pit.



Source: NMS, 2020

Figure 16-5: South Domes Phase 1

South Domes Phase 2 is an expansion of the Phase 1 pit to the northeast. It will be developed with a counter-clockwise ramp that switches back three times on the way to the bottom. The east wall will be developed in 180 ft of waste dump at the surface. Final wall height will be 1,080 ft. The Phase 2 South Domes pit expansion is shown in Figure 16-6.

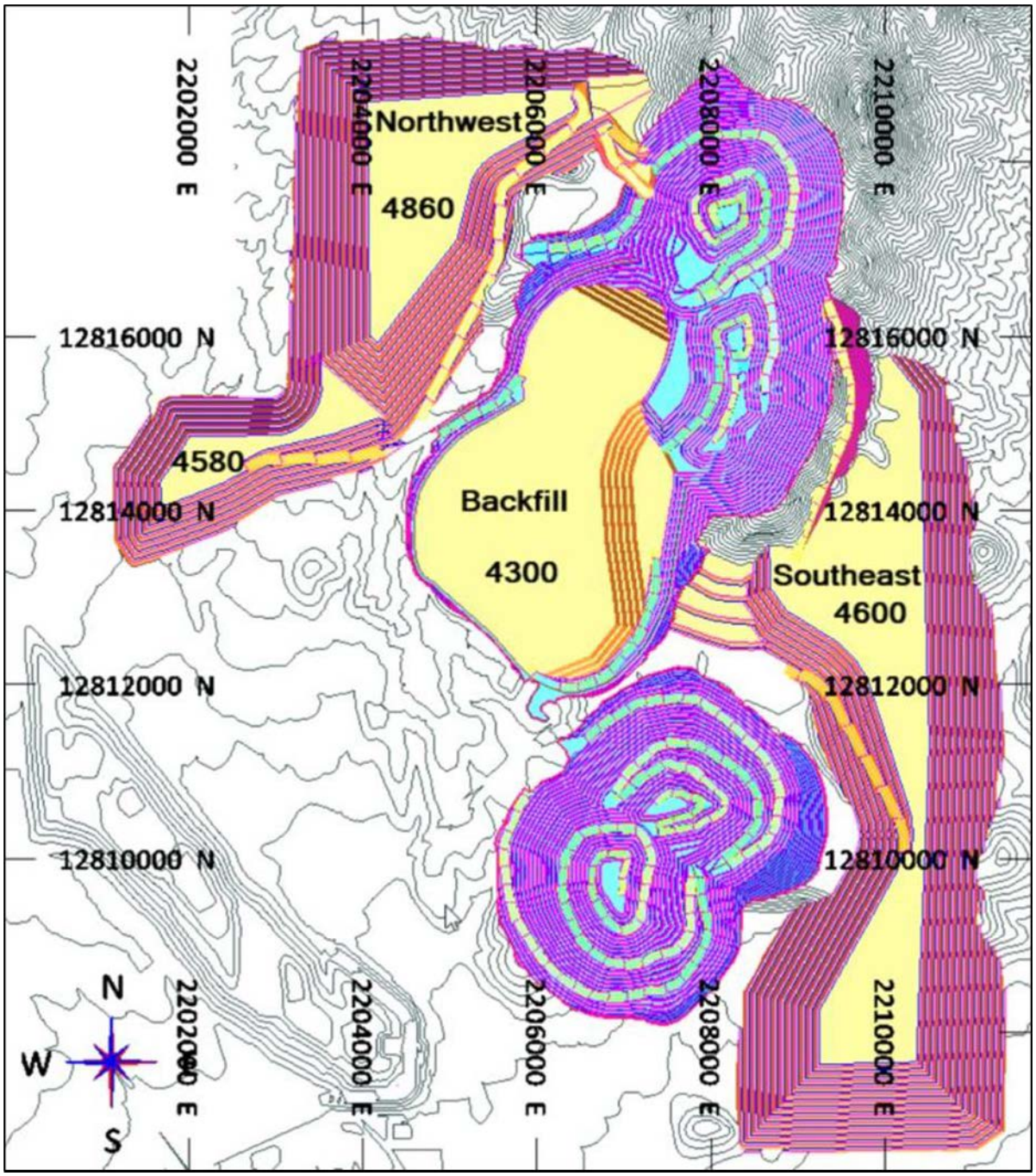


Source: NMS, 2020

Figure 16-6: South Domes Phase 2

16.3.3 Waste and Low-Grade Storage

Conceptual designs for waste dumps and waste backfill plans have been developed to accommodate volumes scheduled over the life of mine. These designs and possible final elevations are shown in Figure 16-7 below. The lift height between berms will be variable over time. The face slope during construction of the dumps was assumed to be 38° and overall final reclamation slopes will be 26.5°. The waste dump configuration with backfill completed to the JSLA and Jumbo pits is shown in Figure 16-7.



Source: NMS, 2020

Figure 16-7: Waste Dump Configuration

The general sequence for dump development and destination quantities used for haulage productivity estimation are shown in Figure 16-8.

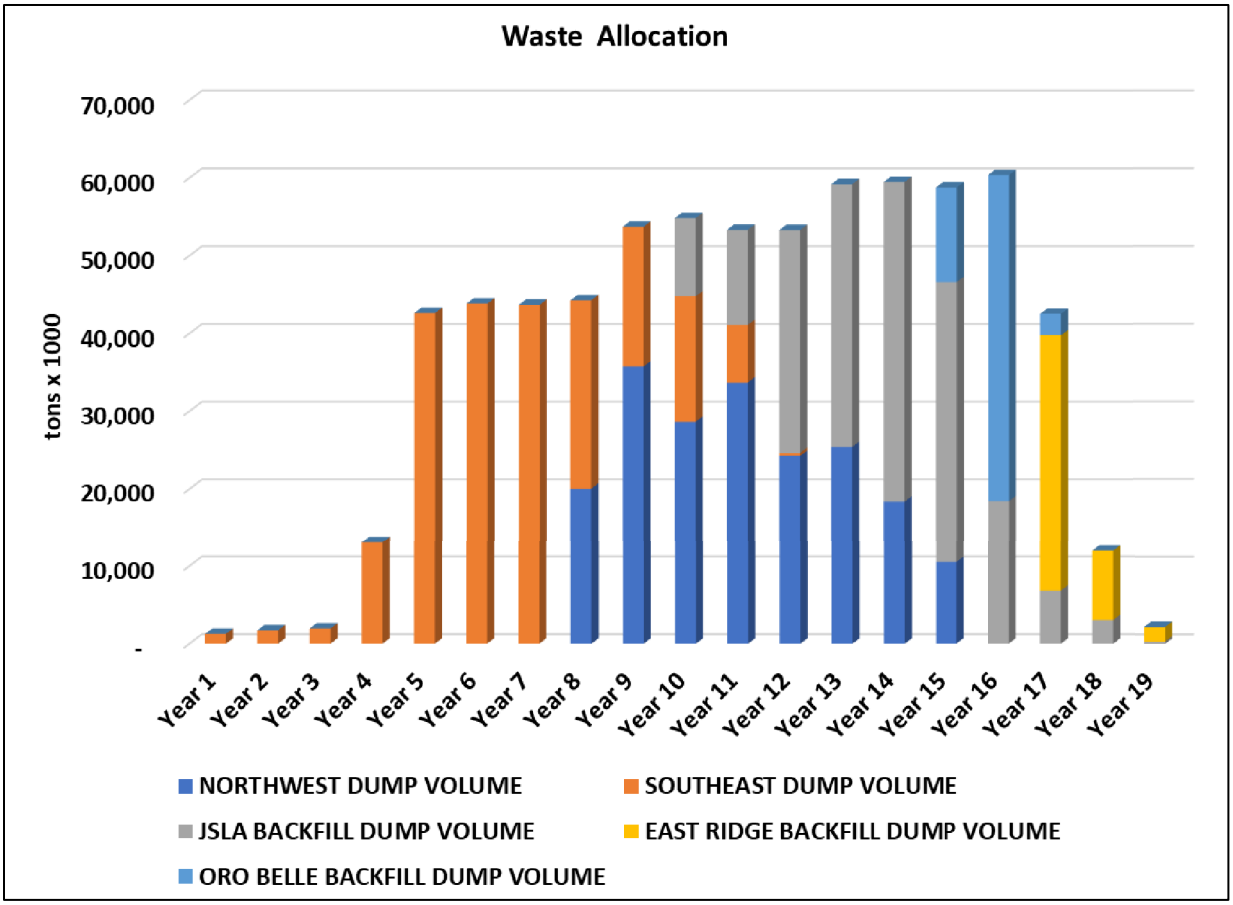


Figure 16-8: Waste Dump Material Allocation

16.3.4 Haulage Roads

Surface haulage roads will connect the pit ramps to the ROM leach pads, high grade stockpile and waste dumps. When possible, these roads will be constructed using waste rock. As in the pit, surface haulage roads will have a running surface three times the width of the largest haulage truck with allowance for ditches and berms. Roads will have a maximum grade of 10% but may be constructed to 8% to improve haulage cycle times and reduce truck component wear.

A typical haulage road cross section is shown in Figure 16-9. The trucks proposed in this mine plan are 250 ton class units with an overall width of 24 ft and 4 in (24'4"). The road allowance in the pits is 100 ft to accommodate two-way traffic, ditches and berm. This allowance has been increased on the surface to 120 ft.

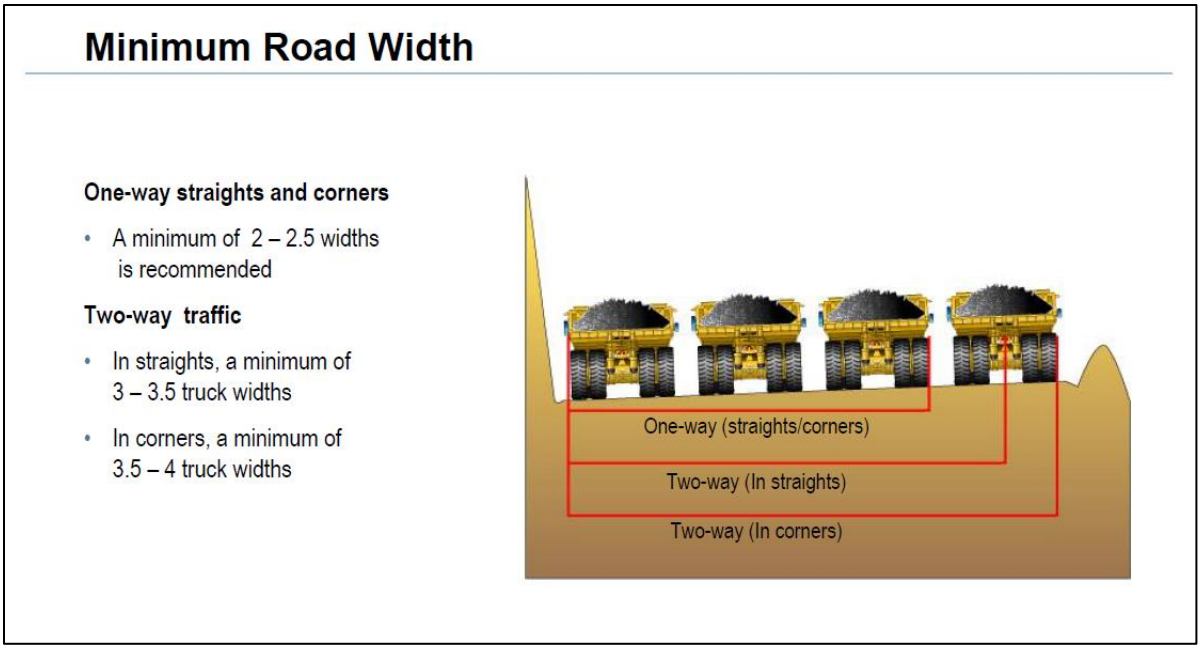


Figure 16-9: Haulage Road Width Guideline

Roads will be dressed with 12 in of coarse crush, 4 in, followed by 10 in of fine crush,1 in, road dressing. External roads on surface will be built with an 18 in layer of clean sand sub-base.

16.4 MINE PRODUCTION SCHEDULE

16.4.1 Summary

The open pit mine development plan consists of nine pit development phases expanding to two large open pits. A waste dump will be located along the east property boundary and a second dump will be expanded to the northwest property boundary. A high-grade mill feed stockpile will be located adjacent to the mill primary crusher.

The mine will operate as a conventional diesel-powered truck shovel operation. The typical production cycle will be drilling, blasting, grade control, loading and hauling. Primary loading units will be hydraulic shovels and wheel loaders with support equipment providing development access, road maintenance and equipment servicing capability.

The mine will operate for 19 years delivering 266.5 Mton (241.8 Mt) of ROM ore with an average grade of 0.012 oz/ton (0.41 g/t) gold to the leaching operation. The mill will commence operation after Year 5 and will process 17.8 Mton (16.1 Mt) of ore with an average grade of 0.066 oz/ton (2.26 g/t) gold. The total effective waste mined will be 701.9 Mton (636.8 Mt). The effective overall strip ratio will be 2.47:1.

16.4.2 Cut-off Grade Selection

As described in Section 15, pit limit analyses have been carried out using a Lerchs Grossmann algorithm to define a series of nested pit shells that can indicate maximum mining limits and potential high value starter pit areas. These limits are based upon maximizing gross operating surplus for a given set of input parameters. Application of cut-off grades for determination of waste

and ore for ROM processing is complicated by the variability of recovery for the various lithology/metallurgical ore types. Calculated cut-off grades for recovery of processing and general & administration costs vary from 0.0025 to 0.0040 oz/ton (0.086 to 0.137 g/t) gold. Typical accuracy of mine lab assaying and low ore value led Equinox management to take a decision to apply a higher cut-off grade of 0.005 oz/ton (0.17 g/t) gold and this has been used for all reporting and scheduling of ore in the mine plan.

The cut-off grades for milling have been established using a two-step process. Net of processing ore values for ROM and milling were estimated for each block in the resource model using recoverable grades, revenue assumptions and onsite costs exclusive of mining. The highest value was used to assign a processing destination. A preliminary production schedule was then developed for ROM at 50,000 ton/d (45,400 t/d) with a 3,500 ton/d (3,200 t/d) target for milling. In some years there was a surplus of mill feed and this was stockpiled. When there was a shortage of mill feed in a given year, stockpiled material was recovered and processed. If there was a shortage after stockpile recovery then higher value ROM material was re-directed to mill feed until the design capacity was achieved.

16.4.3 Pit Sequencing

The pit development phases are shown as three-dimensional solids in the perspective view Figure 16-10. The pit solids have been intersected with a precedence order reflecting the clockwise sequence of phase development and expansion. A typical bench plan with the development phase limits and the block model NSR values are shown in Figure 16-11.

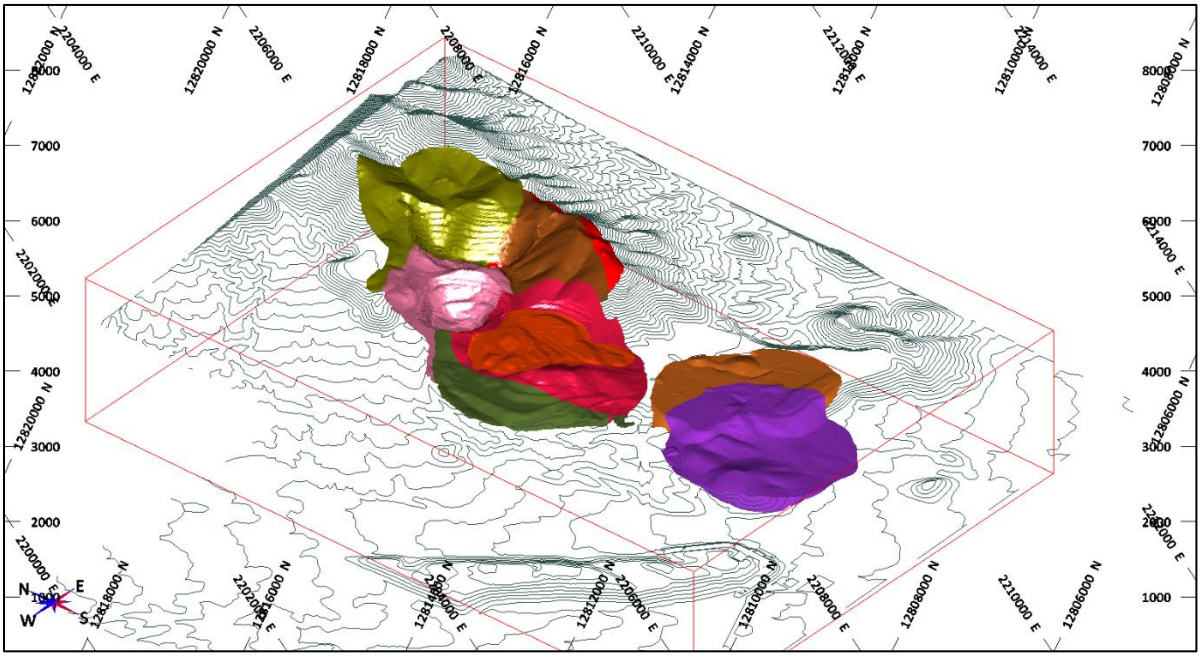


Figure 16-10: Pit Phase Solids Perspective View

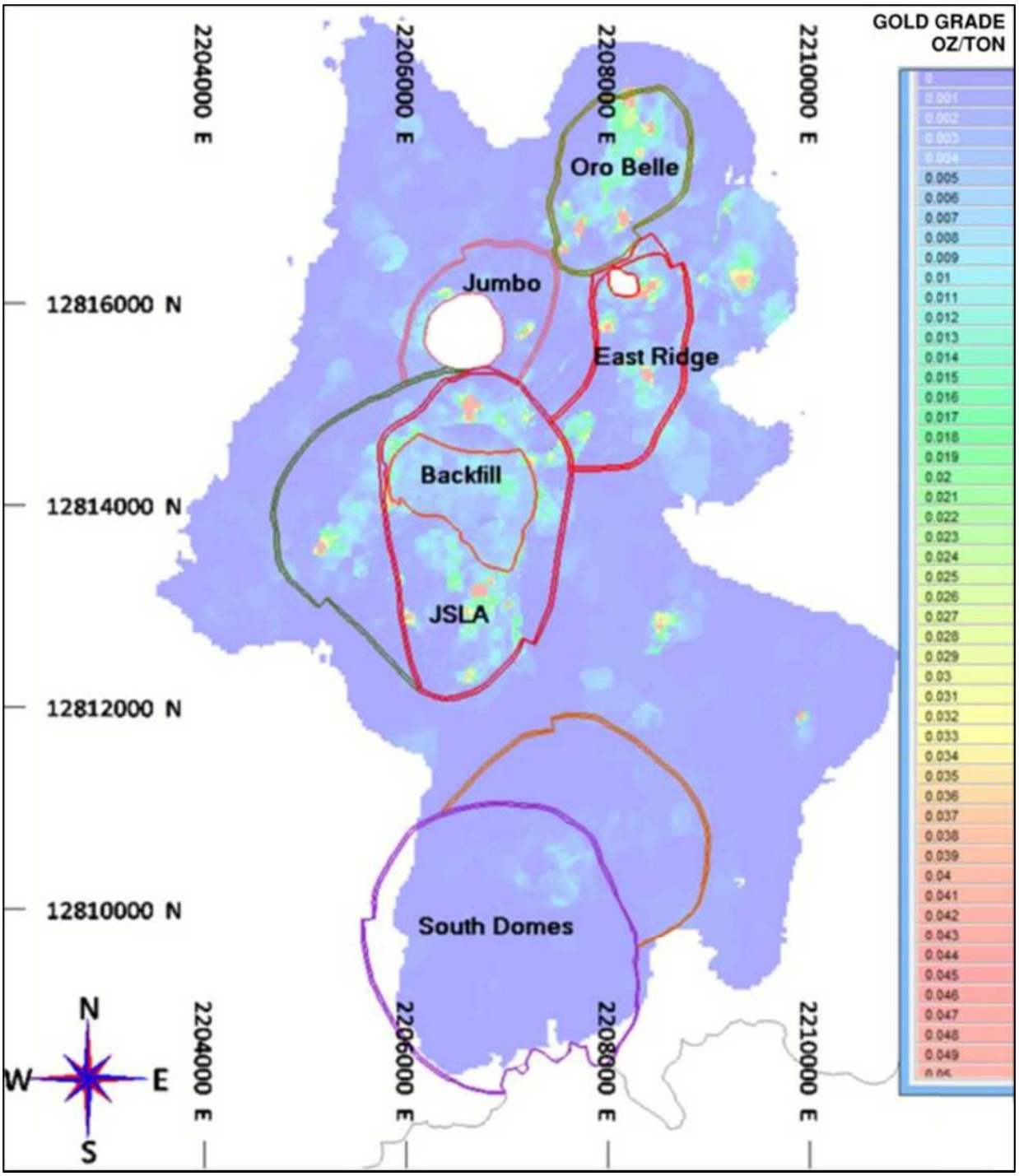


Figure 16-11: Bench Plan 4180 Phases and Gold Grade

16.4.4 Production Schedule Summary

The mine production schedule is summarized in Table 16-2. Figure 16-12 to Figure 16-16 present additional detail of material sources and destinations over time in the production schedule.

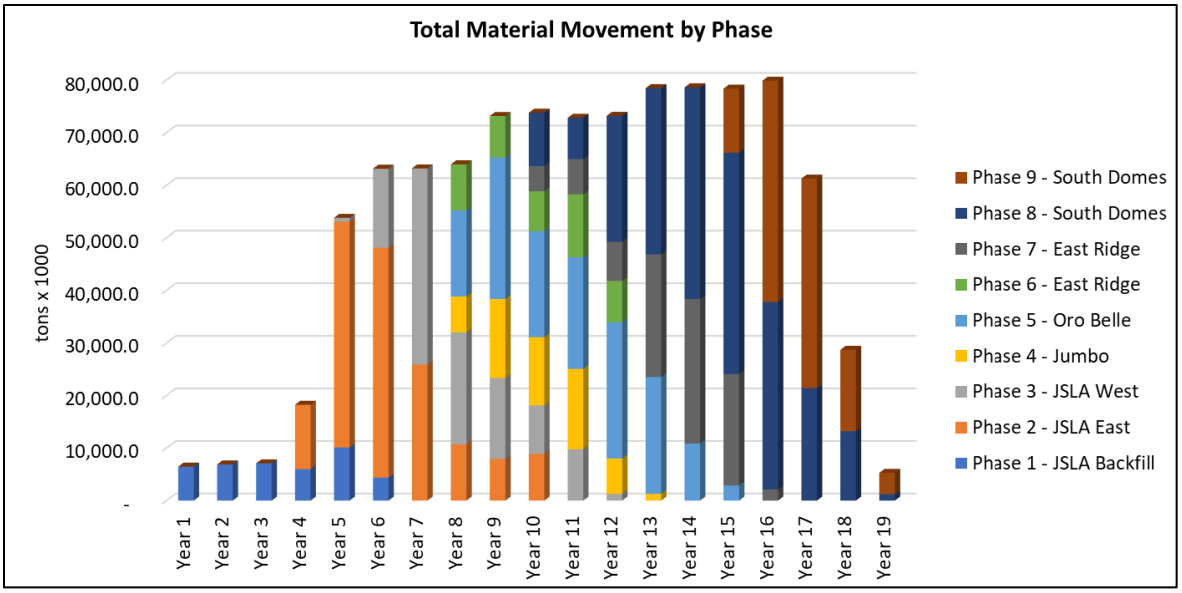


Figure 16-12: Material Movement by Phase

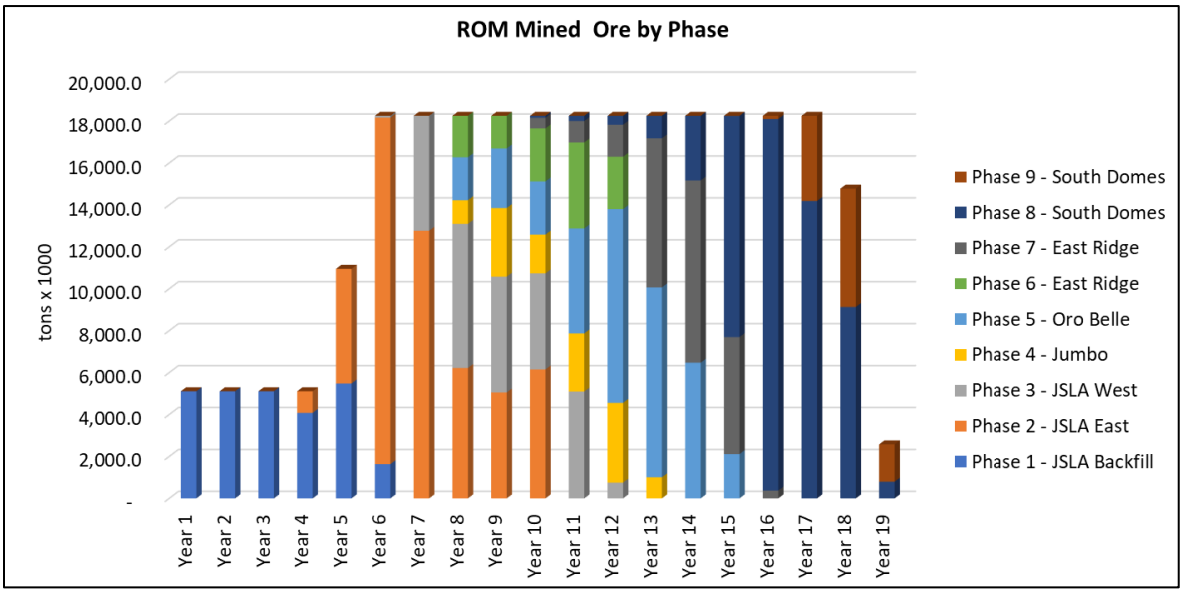


Figure 16-13: ROM Ore by Phase

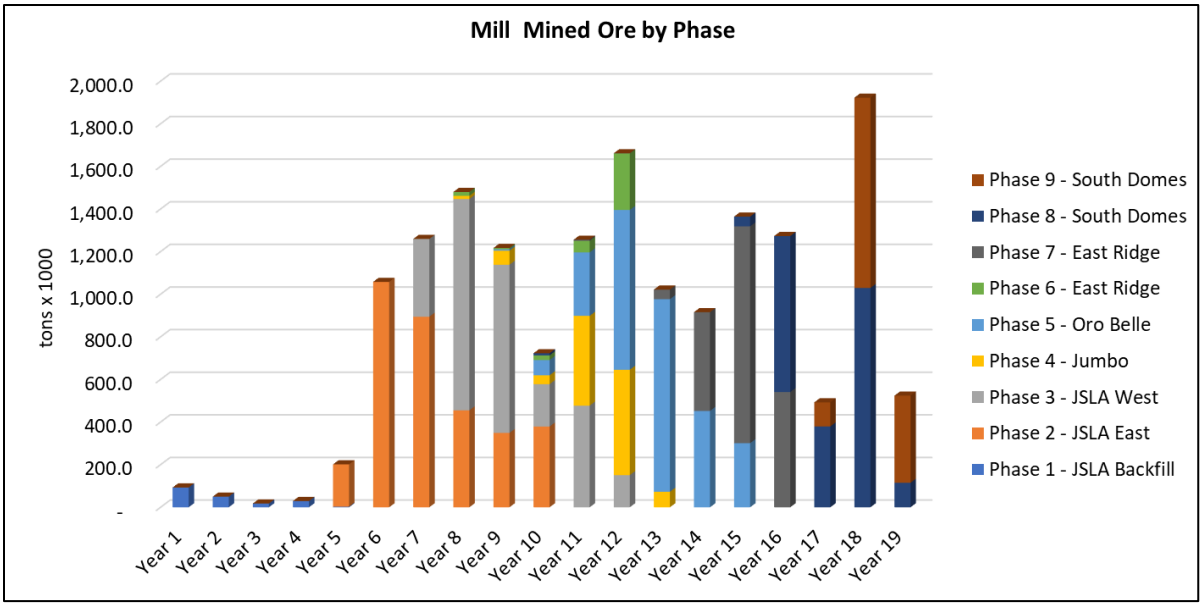


Figure 16-14: Mill Ore by Phase

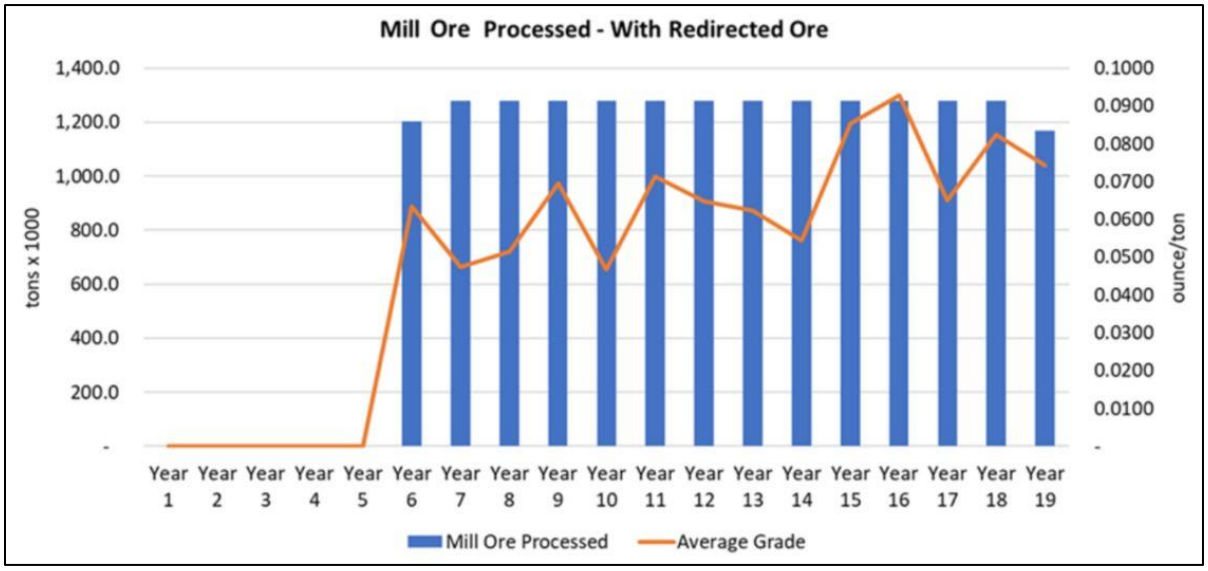


Figure 16-15: Mill Ore Processed

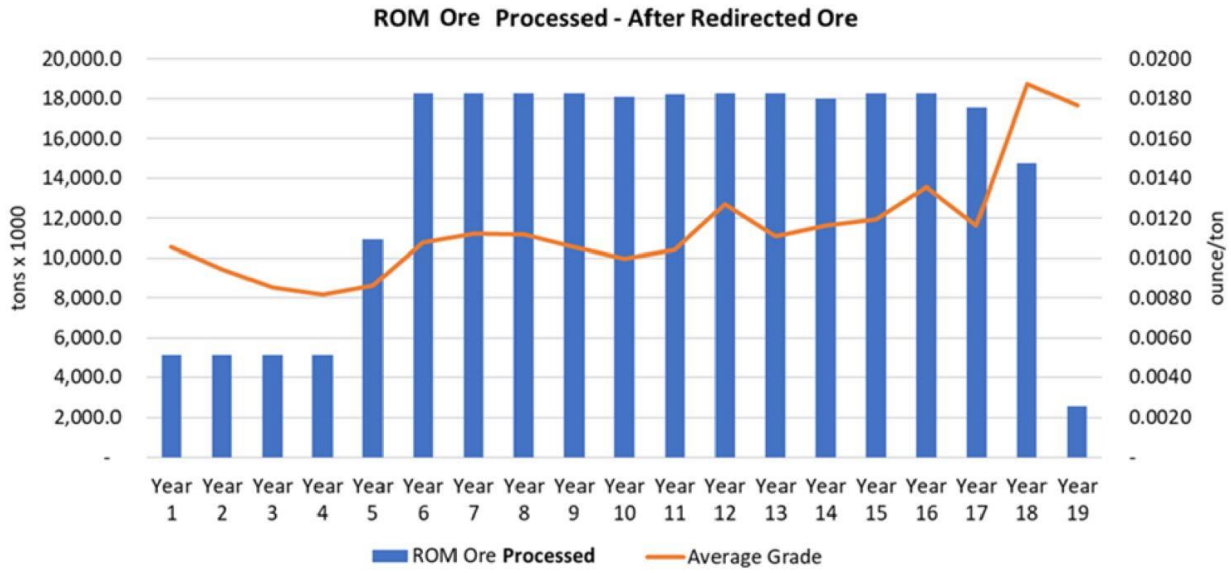


Figure 16-16: ROM Ore Processed

16.4.5 Mine Development Pre-Production and Year 4

The Phase 1 mine plan continues with contractor mining of JSLA open pit backfill material that is economic to process by ROM leaching. It is proposed to initiate hard rock mining of the JSLA East Pit with contractors in month 37 of the plan. Open pit development to mid Year 4 is shown in Figure 16-17.

Mining in the JSLA Backfill pit will take place to 4260 bench. Active benches in the JSLA East pit include 4760 to 4540 mined by contractors and 4520 bench through 4440 bench with the owners fleet. Total material moved in Year 4 totals 18.3 Mton, including 5.1 Mton ROM ore. Open pit development to the end of Year 4 is shown in Figure 16-18.

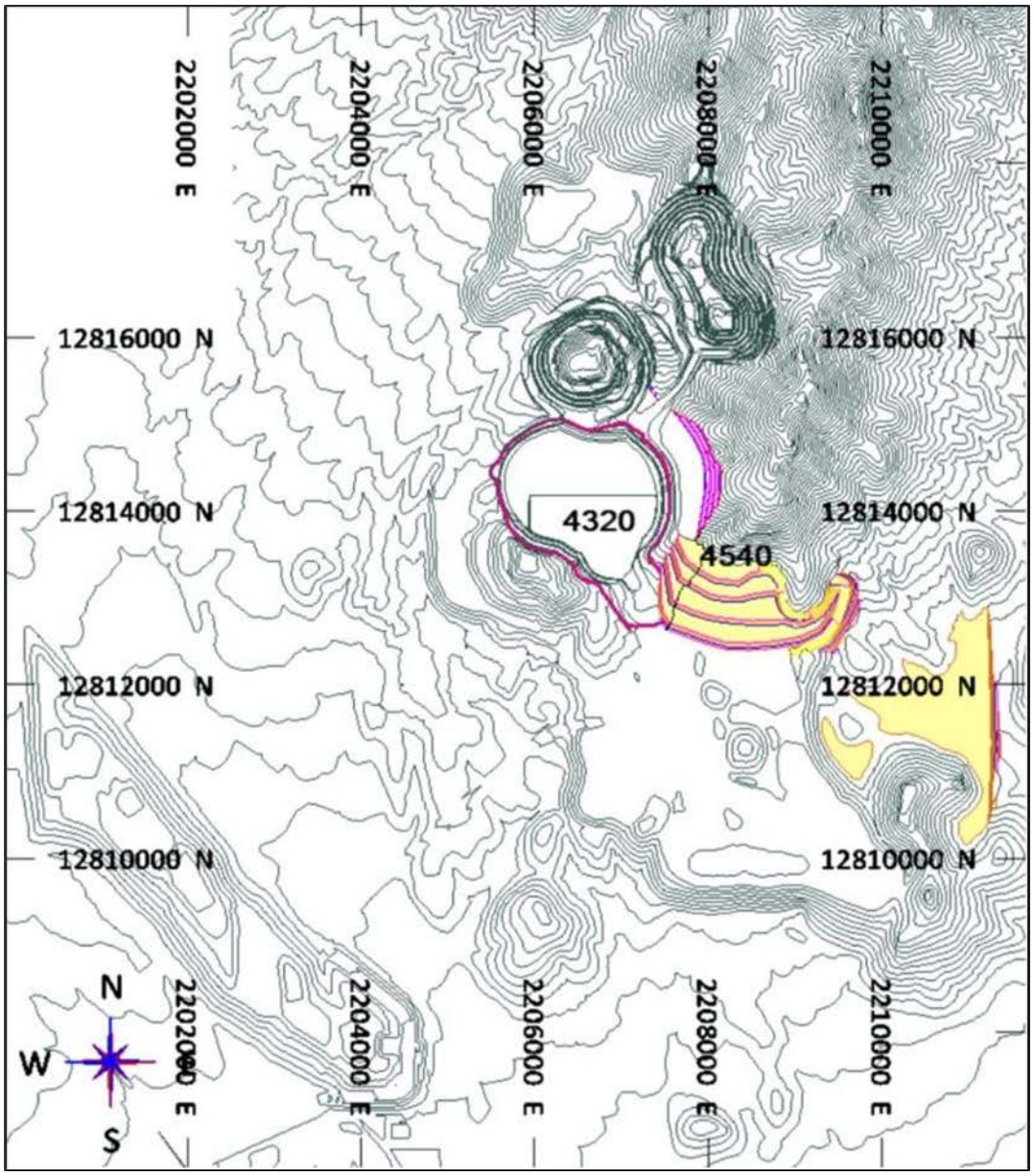


Figure 16-17: Mine Development Mid-Year 4 - Contractor

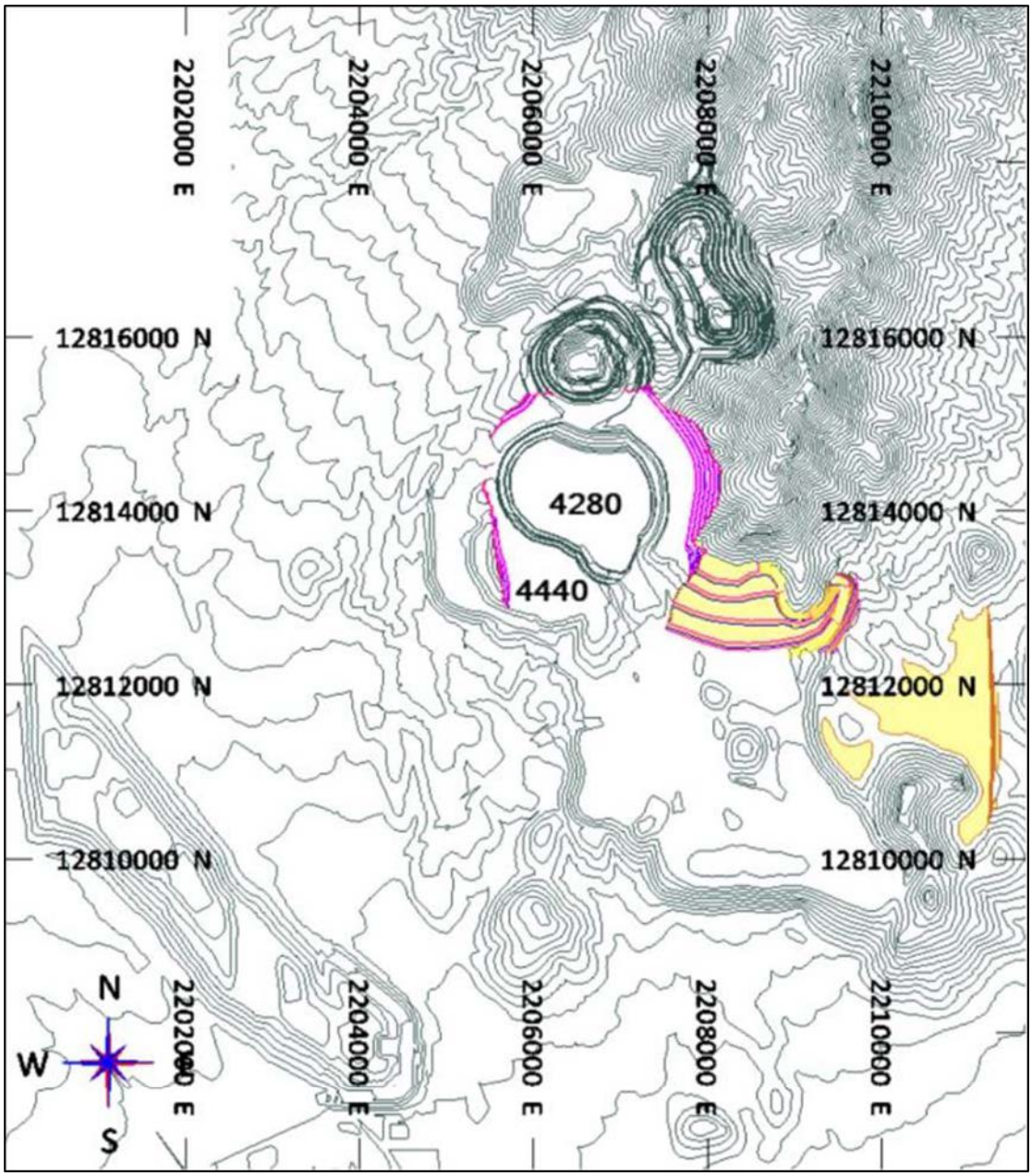


Figure 16-18: Mine Development – End of Period Year 4

16.4.6 Mine Development Year 5

Mining continues in the JSLA Backfill Pit which is completed to bench 4140 during Year 5 (Figure 16-19). Overall production for Year 5 is 53.8 Mton. A total of 10.95 Mton ROM leach ore is placed on the leach pad.

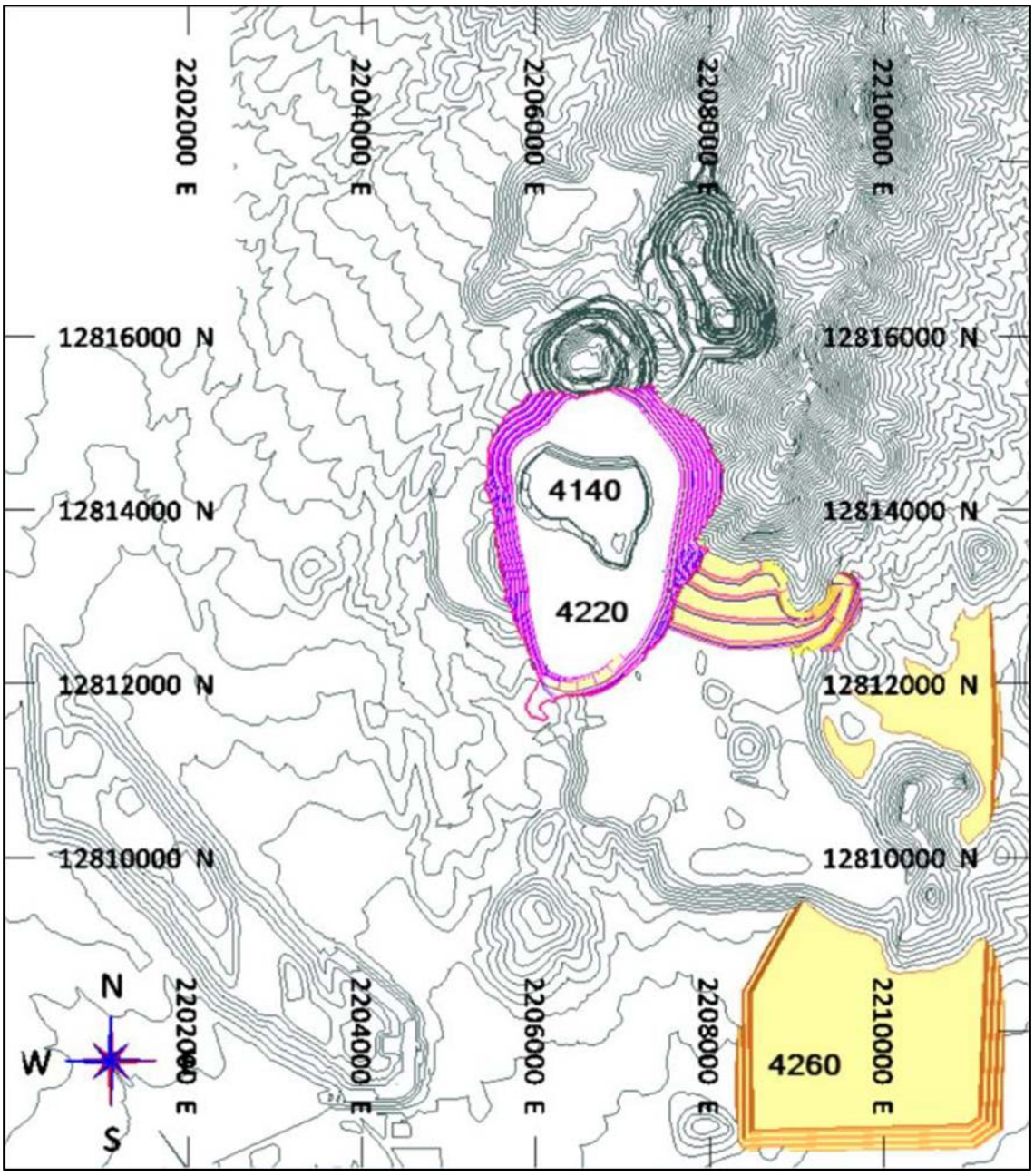


Figure 16-19: Mine Development Year 5

16.4.7 Mine Development Year 6 to Year 8

During Years 6 to 8, JSLA East Pit is mined to 3860 bench (Figure 16-20). In Year, 6 full production is reached for ROM ore production at 50,000 ton/d. JSLA West Pit developed to 3980 bench. Jumbo Pit pioneering commences in Year 8 and by Year 8 has reached 4520 bench. Oro Belle and East Ridge Pits are pioneered as well in Year 8 to the 4800 Bench. Total annual mine production averages 63.4 Mton during these years.

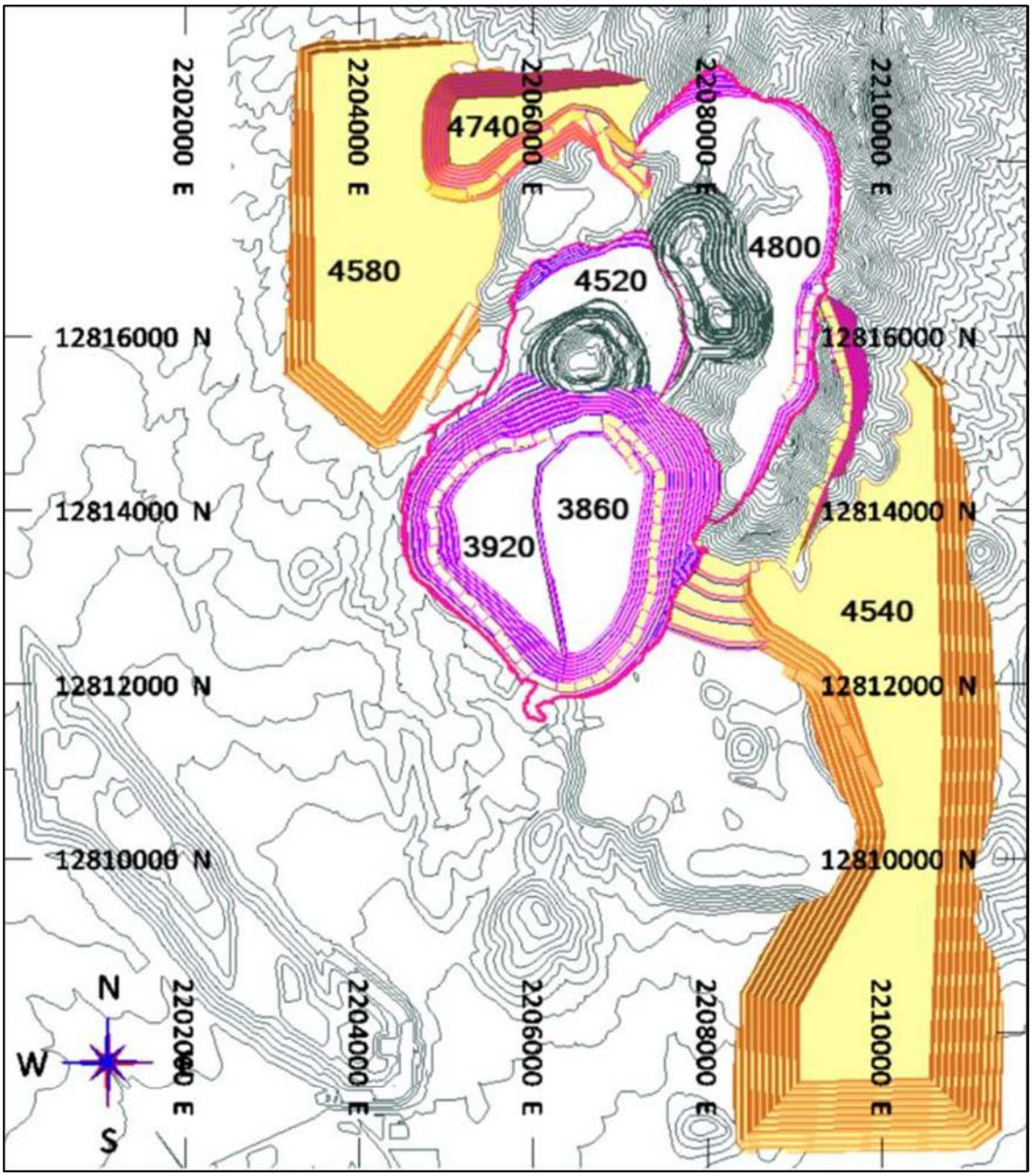


Figure 16-20: Mine Development – Year 8

16.4.8 Mine Development Year 9 to Year 12

The JSLA Pit is completed in Year 12 (Figure 16-21). Oro Belle Pit reaches 4260 bench in Year 12. East Ridge Phase 6 Pit is completed in Year 12 and East Ridge Phase 7 Pit is down to 4360. The South Domes Phase 1 Pit is pioneered in Year 10 and 11 and by Year 12 is down to 4180 bench. The average annual mining rate during this time is 73.2 Mton. The Northwest and Southeast dumps are filled to capacity during this time interval and backfilling commences in JSLA Pit.

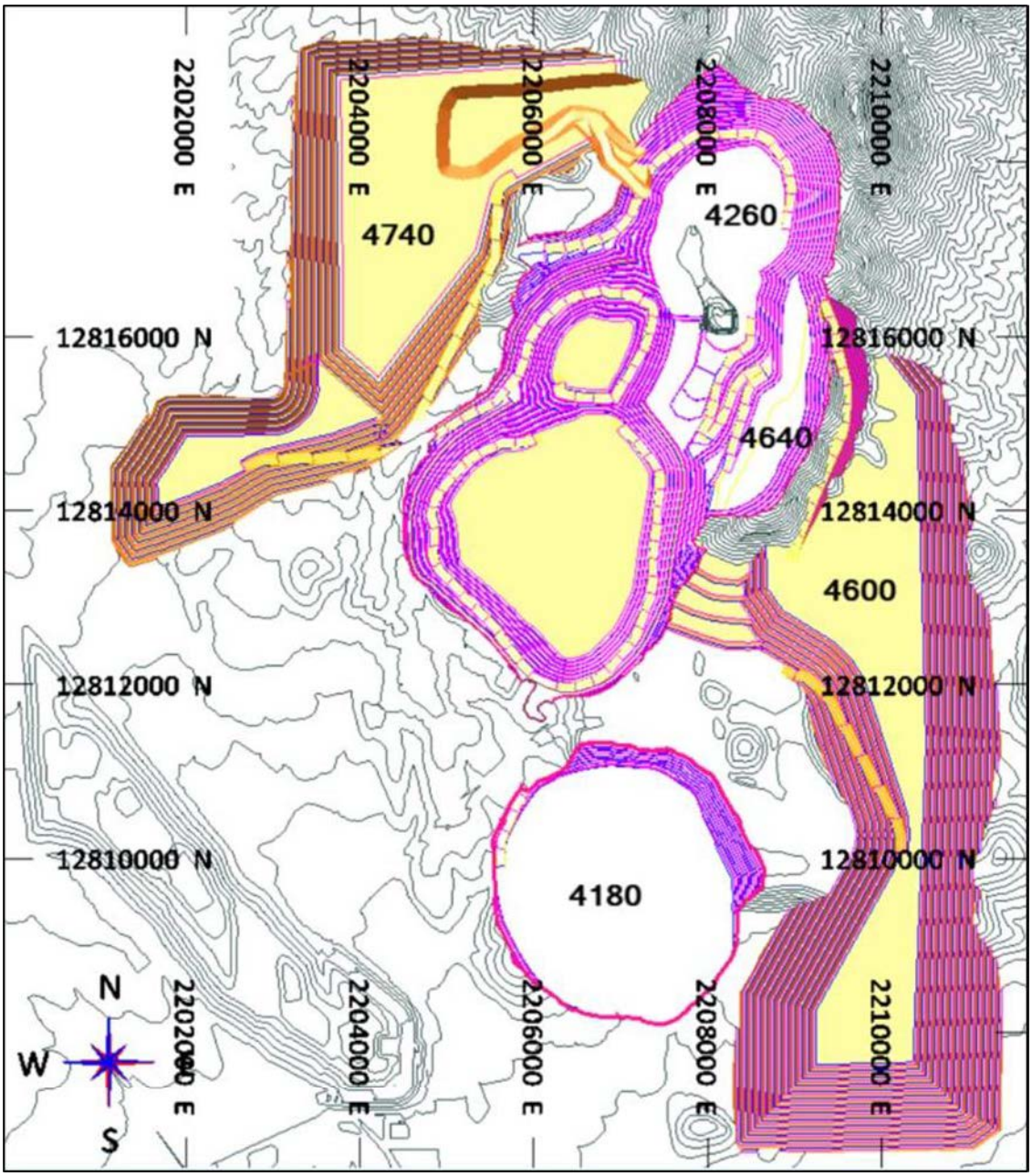


Figure 16-21: Mine Development Year 12

16.4.9 Mine Development Year 13 to Year 16

The Oro Belle Pit is completed in Year 15 and East Ridge Phase 7 Pit is completed in Year 16 (Figure 16-22). Pioneering of South Domes Phase 2 commences in Year 15 and by the end of the year Phase 1 is down to 4060 and Phase 2 is down to 3620. Waste backfilling continues in the JSLA and Jumbo Pits.

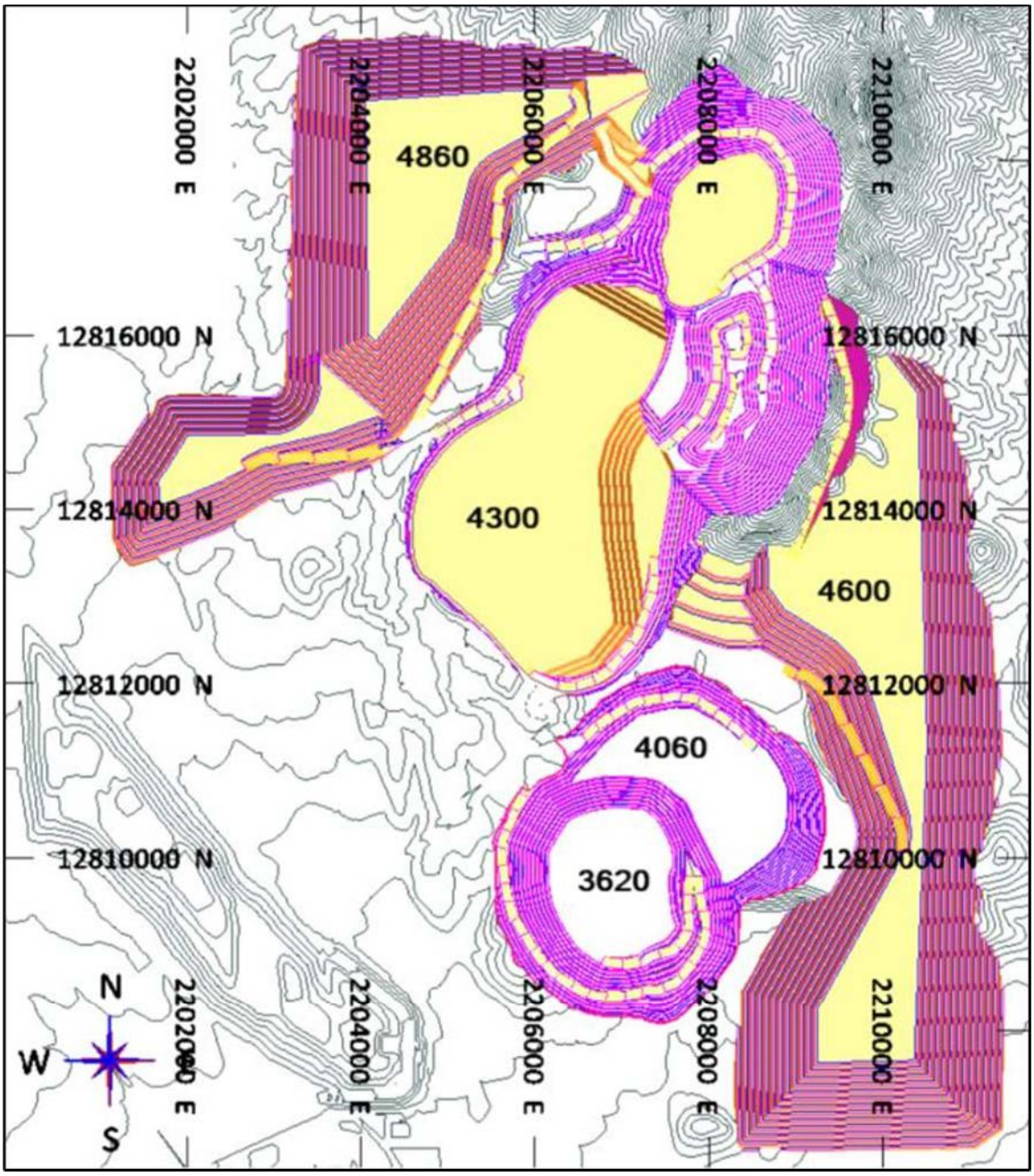


Figure 16-22: Mine Development Year 16

16.4.10 Mine Development Year 17 to Year 19

South Domes Phase 1 is completed during the first half of Year 19 and South Domes Phase 2 is completed later in the year. Overall mining rates may become limited by sinking rate limits of 300 ft/y in Year 18 and Year 19 (Figure 16-23).

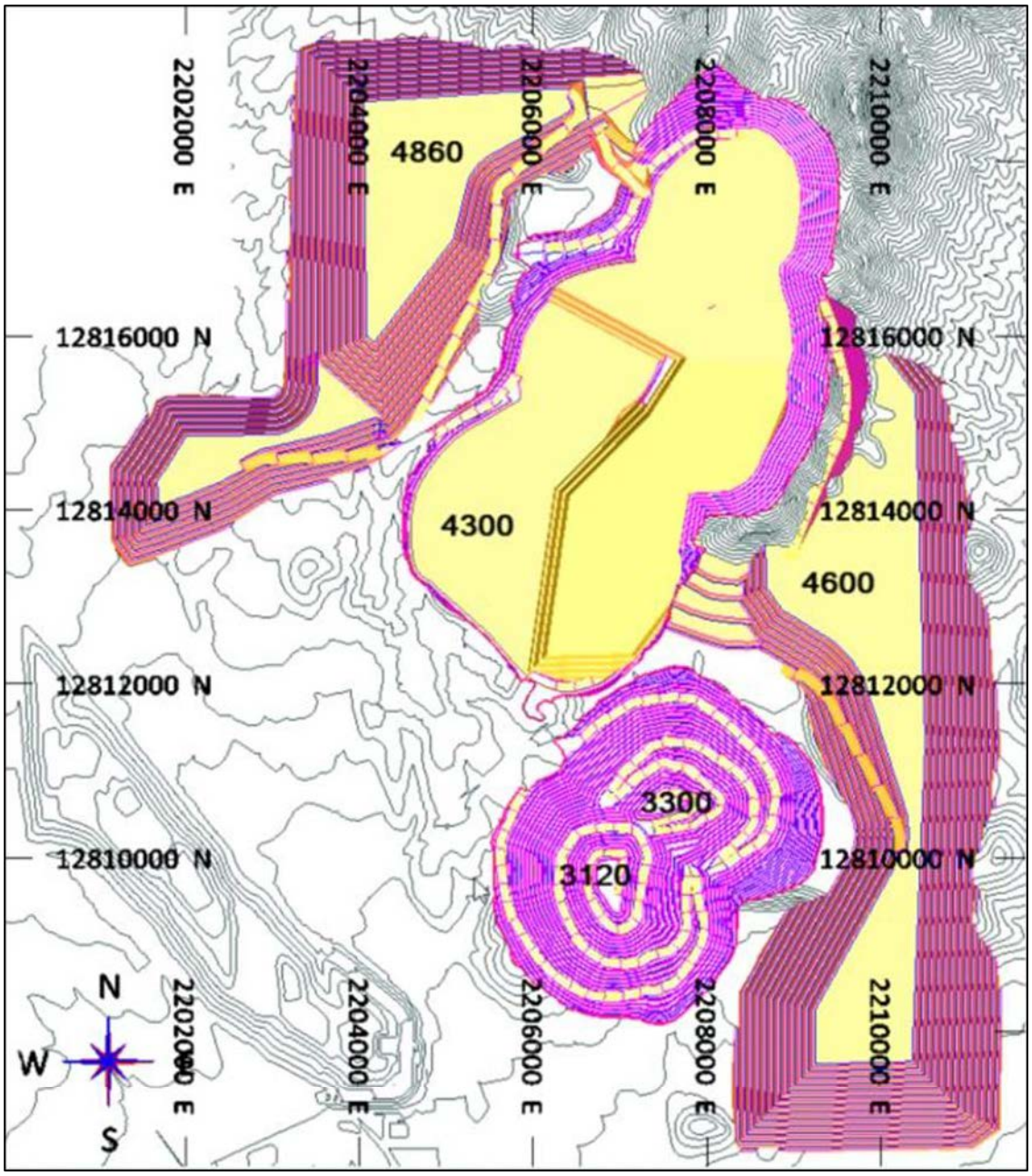


Figure 16-23: Mine Development Year 18

16.4.11 Engineering and Grade Control

The mine engineering group will be responsible for short-, medium- and long-range planning as well as day to day grade control functions and maintenance and monitoring of the dispatch system which will control the movement of trucks, shovels and drills.

Geotechnical engineers will monitor slopes and collect information on structure, material characteristics, hydrology and waste characterization on an ongoing basis as the mine is developed in order to improve the mine design criteria and ensure operational efficiency. They

will also be involved in optimizing the blasting procedures to minimize wall damage while maximizing fragmentation.

Geologists and grade control technicians will be responsible for blasthole sampling, assaying and grade control. Grade control will be focussed on gold grade for the purposes of identifying ore and waste boundaries and separation between ROM and mill feed. Lithological characterization will also be important for metallurgical recovery predictions and ongoing column test-work.

Planning engineers will update mine plans at the short-, intermediate- and long-range scale as required. Stockpiling and milling cut-off grades will be adjusted over time in response to changing economic conditions and updated databases. Engineers will collect and evaluate mine operations equipment productivity and cost data to optimize ongoing operations.

Modern mine planning and geostatistical packages will be required for use in the engineering department to integrate the information coming from ongoing exploration, long range models, short range production plans and operational production data.

16.5 MINE EQUIPMENT

16.5.1 Summary

Mine equipment has been selected given the following considerations:

- The topographical challenges of the site including high vertical relief and steep slopes.
- The simultaneous distribution of multiple operating faces at several locations determined by the long-range plan.
- The necessity to minimize unit operating costs by using large scale mining equipment.
- Use of well proven equipment technology and coordination of operating machines using advanced systems.
- Use of equipment assembled with modular components in order to minimize onsite maintenance allowing maintenance personnel to focus on servicing and component replacement.

The mine will operate a primary fleet of 44.5 yd^3 diesel hydraulic shovels, 8 7/8” rotary drills and 250 ton end dump trucks.

The annual equipment requirements for the mine by year are summarized in Table 16-3.

Table 16-3: Production Fleet Requirement by Phase 2 Year

Year	Details	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Production Blasthole Drill	8 7/8"	2	2	2	3	3	3	3	3	3	4	4	3	3	3	2	2
Wall Control Drill	4 1/2' - 9"	1	2	2	2	3	3	3	3	3	3	2	2	2	2	1	
Hydraulic Shovel	2996 hp 44.5 yd^3	1	2	2	2	2	3	3	3	3	3	3	3	3	2	1	1
Wheel Loader	1739 hp 28 yd^3	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1
Haul Truck	2650 hp 250 ton	5	12	17	18	20	20	20	20	20	21	24	24	24	22	14	14
Track Dozer	600 hp	3	5	5	5	5	5	5	5	5	5	5	5	5	4	2	2
Wheel Dozer	620 hp	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Grader	290 hp 16 ft	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Water Truck	1450 hp 32,000 gal	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1
Wheel Loader	541 hp 10 yd^3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Haul Truck	825 hp 61 ton	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2
Excavator	524 hp 6 yd^3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Year	Details	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Tire Manipulator	Large Tire	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Vibratory Compactor	130 hp 7.5 ft	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Backhoe	105 hp 1.3 yd^3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Articulated Truck	450 hp 40 ton	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Fuel and Lube Truck	100 ton 8,000 gal	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tractor and Low Bed	160 ton	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Flatbed Hiab Truck	10 ton	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Rough Terrain Forklift	33 ton	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Shop Forklift	18 ton	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mechanics Truck	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Welding Truck	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Staff Pickup Trucks	1 ton Pickup	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Pit Services Pickup	1 ton Pickup	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Staff Pickup Trucks	1 ton Crewcab	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Pit Services Pickup	1 ton Crewcab	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Shovel Crew Flat Deck	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Shovel Crew Hiab	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Surface Crew Hiab	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Lighting Tower	8 Kw	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Hydraulic Hammer	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mine Rescue Vehicle	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

16.5.2 Major Mine Equipment Operating Parameters

The mine will operate 24 hours per day 365 days per year. Shift employees will work 12-hour shifts on a 28-day cycle.

In general, it is expected that major equipment will have an effective operating time of 50 minutes per hour. Equipment is expected to have 85% to 90% availability initially, declining with age.

Detailed equipment productivity calculations have been made on an annual basis for drills, shovels, and trucks. Support equipment operating time has been factored on an annual basis according to material movement.

16.5.3 Drilling & Blasting

16.5.3.1 Drilling

The primary blasthole drills will be diesel powered machines capable of drilling 8 7/8” holes single pass for a 30 ft (9.1 m) bench height including subgrade. They will be used for production hole drilling in ore and waste and can be configured for buffer row drilling on wall control patterns if required. Specialized wall control drills will be provided for the majority of the buffer rows and pre-shear holes. These drills can also be used for drilling sub-horizontal drain holes for wall slope depressurization.

The fleet will initially consist of two production units and one wall control drill. Production drill additions will be made in Year 7 and 11, wall control drill additions will be made in Year 4 and Year 7 with the fleet peaking at seven drills. Wall control drill replacements have been scheduled for two units in Year 11 and Year 12. Blasthole drilling requirements have been estimated on an annual basis according to the production schedule and wall control drilling requirements for pre-shear and trim blasting.

16.5.3.2 Production Blasting

Ore and waste will be mined on a 30 ft bench. Ore will be drilled using a burden and spacing of 20.0 x 23.0 ft. Waste will be drilled on a 23.0 ft x 26.5 ft pattern. Subgrade drilling will be 3.0 to 4.0 ft to allow even breakage to the design bench elevation. Blasthole cuttings will be sampled and assayed for grade control.

The wall control blasting will consist of two rows of 6 ½ in trim holes with a burden and spacing of 16.0 x 18.4 ft. These will be drilled with the wall control or production drills depending on equipment distribution through the pit development phases. The sub-grade drilling depth will be reduced in areas of final berm locations. Pre-shear holes, 4 ½ inches in diameter will be drilled at a 5 ft spacing on final walls.

Blasting will be carried out with a combination of ammonium nitrate and emulsion explosives. An overall blend of 75% ammonium nitrate/fuel oil (AN/FO) and 25% emulsion has been assumed. The overall production blasting agent consumption is expected to be 0.36 lbs/ton of material.

Blastholes will be single primed and initiated using non-electric methods. An explosive supply contractor will deliver bulk explosives to the borehole. The mine Drill & Blast Engineer will supervise the contractor.

16.5.3.3 Explosives Storage

The contractor will provide and deliver bulk explosives to the borehole where primers will be installed and tied in, crushed rock stemming will be placed in the hole collars and the contractor will initiate the blast. Explosives storage on site will consist of a magazine for packaged explosives and primers and a cap magazine.

16.5.4 Loading

At peak production, the loading fleet will consist of three 44.5 yd^3 diesel hydraulic shovels and two 32 yd^3 wheel loaders. The wheel loaders and two of the shovels will be required in Year 4 as deliveries permit, the contractor is phased out in the JSLA Backfill pit and pioneering development is completed on the JSLA East pit is completed. A third shovel will be required in Year 9 as the overall production rate increases from 75 to 81.0 Mton/y. Typical material distribution weighting between loading units will vary between 65% - 70% to shovels and the balance to the wheel loaders.

The loading equipment will operate two 12-hour shifts per day. Operating efficiencies of 83% are anticipated for the loading fleet. Annual average equipment availability is expected to be 90% when operations begin in Year 4 declining to 80% as equipment ages.

The productivity calculations assume good digging conditions, four to five pass loading of the trucks with an overall cycle time of 3.70 minutes for shovels and 5.2 minutes for wheel loaders.

16.5.5 Haulage

The haulage trucks proposed for Castle Mountain are 250 ton capacity rigid frame end dump trucks. The initial fleet requirement in Year 4 is 10 trucks. Additional trucks are added to the fleet over time until the fleet size peaks in Year 13 at 24 trucks. The truck fleet size and expected annual operating hours are shown in Figure 16-24.

The haulage trucks will operate two 12-hour shifts per day. Operating efficiencies of 83% are anticipated for the truck fleet. Equipment availability is expected to be over 90% when operations start declining as equipment ages. Truck fleet utilization of availability will typically be over 95%.

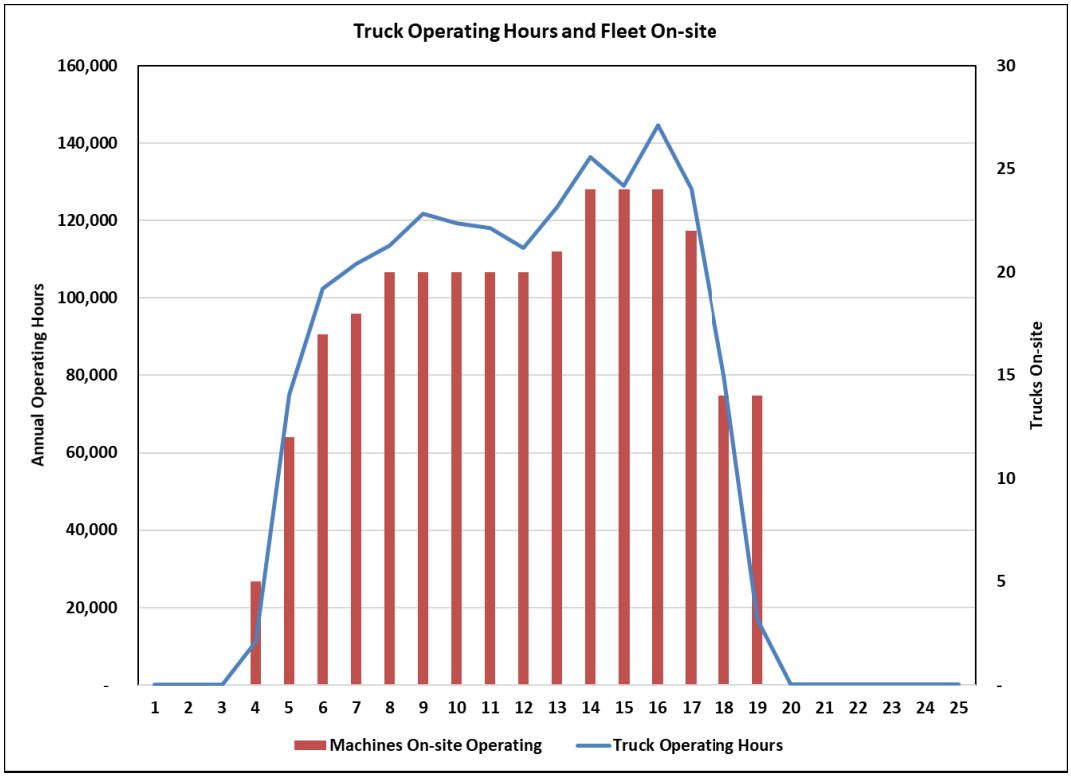


Figure 16-24: Truck Operating Hours and Fleet On-site

The cycle times for ore and waste were estimated for each bench and material destination for each year of production and were based on haul profile distances and road grades. These were then used to estimate haul truck productivities and overall fleet requirements.

A total of 12 haulage trucks will be delivered by the end of Year 4 with additions made during most years to Year 14 when the fleet peaks at 24 units.

16.5.6 Mine Support Equipment

The mining support equipment includes five track dozers, two-wheel dozers, three graders, two water trucks. Miscellaneous ancillary equipment is also required to service, maintain the major equipment and support ongoing open pit operations.

Track dozers will operate on ROM heap leach pad dozing and ripping, on active benches pushing back break and performing heavy dozer operations around operating shovels. In the open pit they will also build roads, prepare sinking cut faces, clean berms, scale walls and rip hard toes. On waste dumps the track dozers will maintain positive grades on the bench surfaces near the crest and provide safe berms for truck dumping.

Road graders and rubber tire dozers will maintain road, dump and bench surfaces to provide level running surfaces. Water trucks will be used in the road maintenance program to provide dust control and safe winter running conditions.

A complement of ancillary equipment as listed in Table 16-3 will also be available to perform service functions including fuelling, provide work area lighting, excavation capability for wall scaling, clean-up and ditching etc. as required to ensure a safe self sufficient mine operation.

Pick-up trucks and crew-cabs will be required for transportation of supervisors, technical staff and maintenance personnel.

Explosives will be delivered to the blasthole. The contractor will provide support equipment to pump wet holes, deliver blasting accessories and stem holes. The bulk delivery truck and storage facilities will be provided by the explosives contractor.

16.5.7 Manpower

The supervision and technical positions in the mine are summarized in Table 16-4.

Table 16-4: Mine Salaried Positions

Mine Supervision	
Mine Manager	1
Mine Superintendent	1
Mine Foreman	4
Drill & Blast Foreman	2
Mine Training Coordinator	2
Mine Shifter & Dispatcher	4
Mine Clerk	1
Subtotal	**15**
Mine Maintenance	
Maintenance Superintendent	1
Electrical Foreman	1
Maintenance Foreman	4
Maintenance Planner	2
Maintenance Clerk	1
Subtotal	**9**
Engineering & Geology	
Chief Mine Engineer	1
Senior Mine Engineer	1
Drill & Blast Engineer	1
Geotechnical Engineer	1
Senior Surveyor	2
Surveying Technician	2
Senior Mine Geologist	1
Mine Geologist	2
Environmental Coordinator	1
Grade Control Technical	4
Subtotal	**16**
Total	**40**

The mine will work 12-hour shifts with four crews. Maintenance will be undertaken with a combination of employees and equipment supplier technicians as required for specialized service functions. Hourly employees are summarized in Table 16-5.

Table 16-5: Mine Staff and Hourly Employees

Project Year	Y -2	Y -1	Y 1	Y 2	Y 3	Y 4	Y 5	Y 6	Y 7	Y 8	Y 9	Y 10	Y 11	Y 12	Y 13	Y 14
Salaried Employees																
Mine Supervision	15	15	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Mine Maintenance	8	9	9	9	9	9	9	9	9	9	9	9	9	9	4	4
Engineering & Geology	13	16	16	16	16	16	16	16	16	16	16	16	16	16	9	9
Subtotal	**36**	**40**	**39**	**39**	**39**	**39**	**39**	**39**	**39**	**39**	**39**	**39**	**39**	**39**	**27**	**27**
Hourly Employees																
Operations	58	119	138	143	148	158	156	156	150	156	167	157	166	148	93	81
Maintenance	39	65	65	65	71	76	76	76	76	78	78	78	77	60	42	20
Subtotal	**97**	**184**	**203**	**208**	**219**	**234**	**232**	**232**	**226**	**234**	**245**	**235**	**243**	**208**	**135**	**101**
Total	**133**	**224**	**242**	**247**	**258**	**273**	**271**	**271**	**265**	**273**	**284**	**274**	**282**	**247**	**162**	**128**

16.6 MINE ANCILLARY FACILITIES

16.6.1 Service Complex

A mine service complex will be located with service bays, warehouse, wash bays and fuel storage facilities.

16.6.2 Mine Electrical Power

Mine electric power distribution will be required for dewatering wells and limited lighting.

16.6.3 Mine Dispatch

A mine dispatch system will be installed to maximize equipment utilization productivity. The dispatch base station and central control will be located in the service complex. Units will be mounted on drills, shovels, loaders and trucks. The conceptual configuration would include GPS ground reference stations and repeaters. The system would interface with the mine planning system and survey system on drills.

16.6.4 Mine Water Management

Water infiltration into the pits is expected once the mine expands below the water table. Water will be removed by a mobile centrifugal dewatering pump and will be used as general make-up water at site offsetting the amount of raw water pumped from the wells.

16.6.5 Fuel Storage

The estimated fuel requirement, in Phase 2, for the mine equipment is shown in Figure 16-25. The annual quantity requirement varies from approximately 5.5 million gallons/ year in Year 5 to 9.7 million gal/year in Year 16 of the mine plan. Additional fuel is also required for preparation of AN/FO for blasting when conditions are dry. Approximately 6% fuel oil by weight is added to the ammonium nitrate prills. Fuel storage will be in two 20,000 gal tanks providing approximately two days storage. Proximity to Las Vegas allows for frequent delivery.

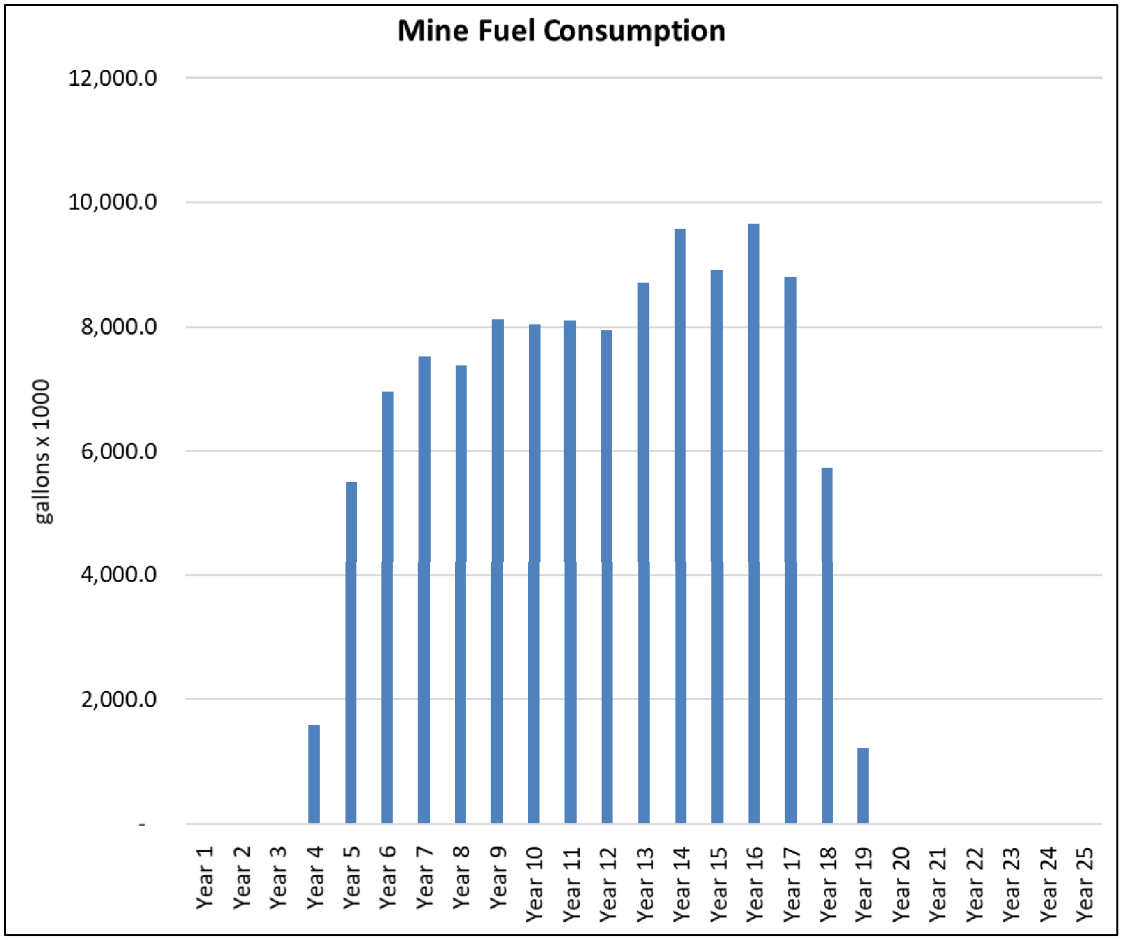


Figure 16-25: Fuel Consumption

16.7 MINE OPERATING COST ESTIMATE

16.7.1 Summary

The forecast operating costs for the open pit are divided into the following areas:

- General Mine Expense
- Drilling
- Blasting
- Loading
- Hauling
- Support Equipment – Roads & Dumps
- Contract Services

Operating costs are further subdivided within these cost centers as follows:

- Salaries & Wages
- Fuel & Power
- Consumables & Maintenance Parts and Outside Services

The Phase 1 and Phase 2 mine plan operating costs over the LOM are summarized in Table 16-6. Average unit costs were estimated to be $1.78/ton. The annual mine operating cost for Phase 2 starting in Year 6 is provided in Table 21-18.

Table 16-6: Summary of LOM Unit Operating Costs

Category	Units	Cost	Percentage
General Mine Expense	$/ton	$0.10	5.7%
Drilling	$/ton	$0.12	6.8%
Blasting	$/ton	$0.16	9.0%
Loading	$/ton	$0.28	15.9%
Hauling	$/ton	$0.72	40.7%
Roads & Dumps	$/ton	$0.29	16.1%
Contract Services	$/ton	$0.10	5.8%
Total	**$/ton**	**$1.78**	**100.0%**
Total	**$/ton processed**	**$6.17**	

16.7.2 General

Salaries and wages used in the mine operating costs have been set by Equinox to reflect their current base costs, burdens and shift premiums in the area.

The mine will operate diesel powered equipment. Diesel price was set at $2.75/gal for ongoing operations. Major equipment lubrication consumption was based upon current costs experienced at a nearby Equinox operation and supplier provided consumption rates.

Equipment operating costs for major equipment was obtained from equipment suppliers including Caterpillar, Komatsu, Sandvik and Epiroc. Components rebuild and replacement schedules were used to calculate annual operating costs based upon cumulative machine hours.

General mine expense includes all salaries for mine operations & maintenance management and geology & engineering. Allowances have been made for software licenses for dispatch and mine planning systems, supplies, communications, training and outside consulting services in support of operations.

Drilling costs represent 7% of the overall mining cost and will average $0.12/ton over the life of mine.

Blasting costs represent 9% of the overall mining cost and average $0.16/ton. The blasting cost estimate has been based upon the scheduled material movement schedule, expected powder factors for ore and waste, drill patterns and explosives supply component cost estimates by W.A. Murphy Inc. Equinox will provide diesel fuel onsite as required for AN/FO.

Loading costs represent 16% of the overall mining costs and will average $0.28/ton over the life of mine. These costs reflect a combination of wheel loaders and hydraulic shovels.

Haulage costs are the largest cost center and represent 41% of the total mining cost at $0.72/ton. Haulage costs are variable with time and changes in pit phases, depth, and heap leach pad height.

Initial haulage costs are $0.47/ton trending higher as the open pit and heap leach pad increase in size to $1.24/ton by Year 18 of the overall mine plan.

Roads, dumps and support costs represent 16% of the total mining cost and average $0.29/ton. This cost center includes operation of all support equipment for road, open pit, waste dump and heap leach pad maintenance.

The contract services cost center averages $0.10/ton and includes clearing & grubbing of open pits and waste dump areas, some road development and supply of magnesium chloride for dust control.

16.8 MINE CAPITAL COSTS

16.8.1 Capital Cost Estimate Summary

16.8.1.1 Pre-production Development

The capital cost estimate for mine pre-stripping is based upon a detailed mine development plan for material movement. Open pit development at JSLA will be undertaken by contractors building access to the upper benches on the east side and pioneering to 4540 bench where the owner's fleet can be phased into production. The pioneering work is planned for Year 3 and into Year 4 while the owner's fleet is being ordered, delivered, erected and commissioned. Phase 1 contractor rates were used as base cost with adjustment for drilling and blasting. The cost for pre-stripping is estimated at $36.8 million.

Clearing and grubbing of the southeast dump and JSLA pit area and stockpiling of topsoil is estimated at $2.1 million.

16.8.1.2 Mobile Equipment

The mine equipment fleet capital cost estimate is summarized in Table 16-7. Delivery, erection, commissioning and sales taxes are included in the equipment costs shown in the table. Tires are included in the equipment prices.

Mine equipment costs have for the most part been estimated based upon new equipment. Some used equipment has been included such as water trucks, fuel truck, low bed, tire manipulator and other low intensity use machines. A moderate percentage of used track dozers and haulage trucks purchased initially would speed up availability of equipment on site in the first year and also space out the rebuild requirements as the equipment ages.

Life of mine capital costs for Phase 2 are shown in Table 16-8.

Table 16-7: Mine Equipment Capital (Ongoing Additions and Replacements)

Typical Unit		Equipment Requirement		Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	TOTALS
			Unit Cost	($ x 1000)	($ x 1000)	($ x 1000)	($ x 1000)	($ x 1000)	($ x 1000)	($ x 1000)	($ x 1000)	($ x 1000)	($ x 1000)	($ x 1000)	($x1000)
Production Blasthole Drill	8 7/8"	Epiroc Pit Viper 235	$2,369,850	$4,740	$0	$0	$2,370	$0	$0	$0	$0	$0	$2,370	$0	**$9,479**
Wall Control Drill	4 1/2' - 9"	Epiroc - SmartROC D65	$966,787	$967	$967	$0	$0	$967	$0	$0	$0	$967	$967	$0	**$4,834**
Hydraulic Shovel	2996 hp 44.5 yd^3	Caterpillar 6060 FS	$10,680,651	$10,681	$10,681	$0	$0	$0	$10,681	$0	$0	$0	$0	$0	**$32,042**
Wheel Loader	1739 hp 28 yd^3	Caterpillar 994K	$6,083,223	$6,083	$6,083	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$12,166**
Haul Truck	2650 hp 250 ton	Caterpillar 793F	$4,576,122	$16,123	$32,033	$22,881	$4,576	$9,152	$0	$0	$0	$0	$2,887	$8,660	**$96,312**
Track Dozer	600 hp	Caterpillar D10T2	$1,549,344	$3,772	$3,099	$0	$0	$0	$0	$0	$0	$0	$3,099	$3,099	**$13,068**
Wheel Dozer	620 hp	Caterpillar 844K	$1,920,038	$3,840	$0	$0	$0	$0	$0	$0	$0	$3,840	$0	$0	**$7,680**
Grader	290 hp 16 ft	Caterpillar 16MG	$1,074,810	$2,150	$1,075	$0	$0	$0	$0	$0	$0	$2,150	$1,075	$0	**$6,449**
Water Truck	1450 hp 32,000 gal	Caterpillar 785G WTR MEGA	$1,700,996	$1,701	$1,701	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$3,402**
Wheel Loader	541 hp 10 yd^3	Caterpillar 988KXE	$946,602	$947	$0	$0	$0	$0	$0	$0	$0	$0	$0	$947	**$1,893**
Haul Truck	825 hp 61 ton	Caterpillar 773G	$944,054	$2,832	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$2,832**
Excavator	524 hp 6 yd^3	Caterpillar 390D L	$1,073,065	$1,073	$0	$0	$0	$0	$0	$0	$0	$0	$1,073	$0	**$2,146**
Tire Manipulator	Large Tire	Caterpillar 988K CWS TM30P	$763,996	$764	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$764**
Vibratory Compactor	130 hp 7.5 ft	Caterpillar CS64	$148,973	$149	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$149**
Backhoe	105 hp 1.3 yd^3	Caterpillar 440	$152,055	$152	$0	$0	$0	$0	$0	$0	$0	$0	$0	$152	**$304**
Articulated Truck	450 hp 40 ton	Caterpillar 740GC	$623,833	$624	$0	$0	$0	$0	$0	$0	$0	$0	$0	$624	**$1,248**
Fuel and Lube Truck	100 ton 8,000 gal	Caterpillar 777 Mega System	$1,230,179	$1,230	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$1,230**
Tractor and Low Bed	160 ton		$1,078,098	$1,078	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$1,078**
Flatbed Hiab Truck	10 ton		$183,175	$183	$0	$0	$0	$0	$183	$0	$0	$0	$0	$183	**$550**
Rough Terrain Crane	80 tonne	Linkbelt Rough Terrain RTC 8090	$944,968	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$0**
Rough Terrain Forklift	30 tonne	Hyster 700	$808,125	$808	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$808**
Shop Forklift	16 tonne	Taylor-360M Forklift	$377,125	$377	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$377**
Mechanics Truck		8100 National	$334,025	$334	$0	$0	$0	$0	$0	$0	$334	$0	$0	$0	**$668**
Welding Truck			$80,813	$81	$0	$0	$0	$0	$0	$0	$81	$0	$0	$0	**$162**
Staff Pickup Trucks	1 ton Pickup		$53,875	$539	$0	$0	$0	$0	$539	$0	$0	$0	$0	$539	**$1,616**
Pit Services Pickup	1 ton Pickup		$53,875	$323	$0	$0	$0	$0	$323	$0	$0	$0	$0	$323	**$970**
Staff Pickup Trucks	1 ton Crewcab		$64,650	$194	$0	$0	$194	$0	$0	$194	$0	$0	$194	$0	**$776**
Pit Services Pickup	1 ton Crewcab		$64,650	$194	$0	$0	$194	$0	$0	$194	$0	$0	$194	$0	**$776**
Pit Services Bus	10 Passenger		$43,100	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$0**
Shovel Crew Flat Deck			$161,625	$162	$0	$0	$0	$0	$162	$0	$0	$0	$0	$162	**$485**
Shovel Crew Hiab			$242,438	$242	$0	$0	$0	$0	$242	$0	$0	$0	$0	$242	**$727**
Surface Crew Hiab			$242,438	$242	$0	$0	$0	$0	$242	$0	$0	$0	$0	$242	**$727**
Surface Crew Stinger			$269,375	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$0**
Lighting Tower	8 kW	Amida	$26,507	$159	$0	$0	$0	$159	$0	$0	$0	$159	$0	$0	**$477**
Hydraulic Hammer		TB-XC Hydraulic Breaker	$199,338	$199	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$199**
Mine Rescue Vehicle			$80,813	$81	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$81**
Engineering Hardware & Software		Mine Planning & Geology	Variable	$797	$75	$75	$75	$75	$75	$75	$75	$75	$75	$75	**$1,547**
Mine Dispatch			Variable	$3,162	$667	$108	$135	$156	$119	$0	$0	$0	$135	$65	**$4,546**
		Total		**$66,983**	**$56,380**	**$23,063**	**$7,544**	**$10,509**	**$12,566**	**$463**	**$490**	**$7,191**	**$12,068**	**$15,313**	**$212,589**

Table 16-8: Mine Capital Cost Summary

		Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Total
Mobile Equipment	$ x 1000	$66,982.9	$56,380.1	$23,063.4	$7,543.7	$10,509.4	$12,565.9	$462.9	$489.8	$7,190.5	$12,067.7	$15,312.9	$75.0	$75.0	$75.0	$75.0	**$212,869.1**
Spares & Inventory	$ x 1000	$2,679.3	$2,255.2	$922.5													**$5,857.1**
Slope Monitoring Equipment	$ x 1000	$447.6	$1,301.7	$160.6	$587.3	$160.6	$160.6	$587.3	$160.6	$160.6	$762.9	$160.6	$160.6	$587.3	$160.6	$0.0	**$5,558.5**
Training Simulators	$ x 1000																
Development & Pre-Stripping	$ x 1000	$38,868.6	$2,460.3	$1,845.8	$0.0	$2,899.7	$3,742.9	$2,291.9	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	**$52,109.2**
Total	$ x 1000	**$108,978.4**	**$62,397.3**	**$25,992.3**	**$8,131.0**	**$13,569.7**	**$16,469.4**	**$3,342.1**	**$650.4**	**$7,351.1**	**$12,830.6**	**$15,473.5**	**$235.6**	**$662.3**	**$235.6**	**$75.0**	**$276,393.9**
Cumulative Total	$ x 1000	**$108,978.4**	**$171,375.7**	**$197,368.0**	**$205,499.0**	**$219,068.7**	**$235,538.1**	**$238,880.2**	**$239,530.6**	**$246,881.7**	**$259,712.3**	**$275,185.8**	**$275,421.4**	**$276,083.7**	**$276,319.3**	**$276,393.9**	

16.9 OPPORTUNITIES

- There are approximately 15 Mton of Inferred Mineral Resources within the ultimate reserve pit limits that are currently classified as waste. This material may represent a future opportunity.
- Modifications in some of the current pit designs or sequencing of phases may result in recovery of additional resources that were excluded from the Mineral Reserves due to ramp locations and access requirements in general.

16.10 RECOMMENDATIONS

- Mine designs were developed for the 20 ft bench height of resource model provided for mine planning. Mill-CIL feed is an important part of the overall plan for the Project and dilution on higher bench heights should be monitored going forward to determine if proper selectivity can be achieved in practice on larger benches.
- Wall slopes should also be monitored carefully, particularly in the areas where fault zones intersect haulage roads and where points occur at pit phase overlap areas.
- Waste backfill to completed pits may be further optimized to reduce haulage profiles during peak production periods.
- Alternative long-range planning schedules may reduce the number of operating phases in some years and improve equipment distribution.

17 RECOVERY METHODS

17.1 INTRODUCTION AND GENERAL DESCRIPTION

Current operations consist of a 14,000 short ton of ore per day (ton/d) run of mine (ROM) heap leach operation. The planned expansion for Phase 2 will include a 50,000 ton/d (45,400 t/d) ROM heap leach and a new 3,500 ton/d (3,200 t/d) crushing, milling and Carbon-in-Leach (CIL) plant for recovering gold and silver from mill grade ore. This section of the Report describes the facilities that will be required for the Phase 2 expansion. The design for the processing facilities is based on metallurgical testwork and analysis described in Section 13 of this Report.

For Phase 2, the heap leach pad will be designed to process 18.2 Mton (16.5 Mt) annually at an average life of mine grade of 0.012 oz/ton (0.41 g/t), while the mill will be designed to process 1.3 Mton (1.2 Mt) annually at an average LOM grade of 0.068 oz/ton (2.32 g/t). When considering both Phase 1 and Phase 2, operations will extend to approximately 19 years with an additional estimated three years of heap rinsing as part of reclamation where gold will continue to be leached and recovered.

The existing heap leach pad will be expanded to allow processing of the lower grade ROM ore at a rate of 50,000 ton/d (45,400 t/d) with a Carbon-in-Column (CIC) circuit to recover the gold and silver from the leach solution. The higher-grade ore will be processed in a 3,500 ton/d (3,200 t/d) crushing and milling circuit with gravity recovery, followed by a leach/CIL circuit for recovery of gold and silver from the gravity tailing.

A carbon handling circuit including acid wash, desorption (stripping), and carbon regeneration will be added to process carbon from both the CIC circuit and the leach/CIL circuit. The gold and silver recovered from the desorption circuit will be processed through EW cells to produce a sludge. The EW sludge will be processed using a retort oven for drying and mercury recovery, and then refined in a melting furnace to produce gold and silver doré bars.

The plant will be a conventional crushing and milling facility with a hybrid leach/CIL gold recovery circuit, cyanide detoxification and tailings filtration. There are no new or novel processing steps. Results from the test programs were used to develop the corresponding process design criteria, mechanical equipment list, flowsheets, and operating costs. Where appropriate, the design parameters used are supported by past production results. The plant design will include flexibility for treatment of all ore types as per testwork at design throughput.

The crushing circuit will operate at an availability of 75%, resulting in a nominal hourly throughput of 194 ton/h (176 t/h). The remainder of the plant will operate 24 hours per day, 365 days per year at an availability of 90%, resulting in a nominal hourly throughput of 162 ton/h (147 t/h). The carbon plant will be sized to process 18 tons (16 t) of loaded carbon daily (12 tons from the heap leach CIC circuit daily and 6 tons from the mill leach/CIL circuit every other day).

The estimated yearly process production summary is shown in Section 22 and was based on a detailed analysis of recovery from the many samples tested as described in detail in Section 13. Ore grades and relative amounts of mill ore and heap leach ore vary throughout the mine life. Delay time due to stacking and holdup in inventory for ounces recovered from the heap leach are considered on a month to month basis in early stages, but then are expected to reach a steady state for the remainder of the mine life until rinsing when the production of gold will diminish. Typical annual gold production for Phase 2 and total LOM gold production for the heap leach and mill are listed in Table 17-1.

Table 17-1: Phase 2 and LOM Gold Production

Ore	Avg. Gold Rec (%)	Avg. Annual Phase 2 Gold Production (Ounces)	Total Gold Production from Rinsing (Ounces)	Total Gold Production (Ounces)
Heap Leach Ph. 1 Years 1-5	-	-	-	189,000
Heap Leach Ph. 2 Years 6-19 (Production) Years 20-22 (Rinsing)	67*	142,000	236,000	2,095,000
Mill Years 6-19	94	80,000	N/A	1,108,000
Total (Phase 2)	-	222,000	-	**3,203,000**
Total (LOM)				**3,392,000**

* Gold Recovery increases to 74% once final rinsing is conducted.

The major process unit operations are illustrated in a simplified process flowsheet in Figure 17-1. Plant layout for both the heap leach CIC and mill are shown in Figure 17-2. A summary of the key process design criteria is provided in Table 17-2 and Table 17-3.

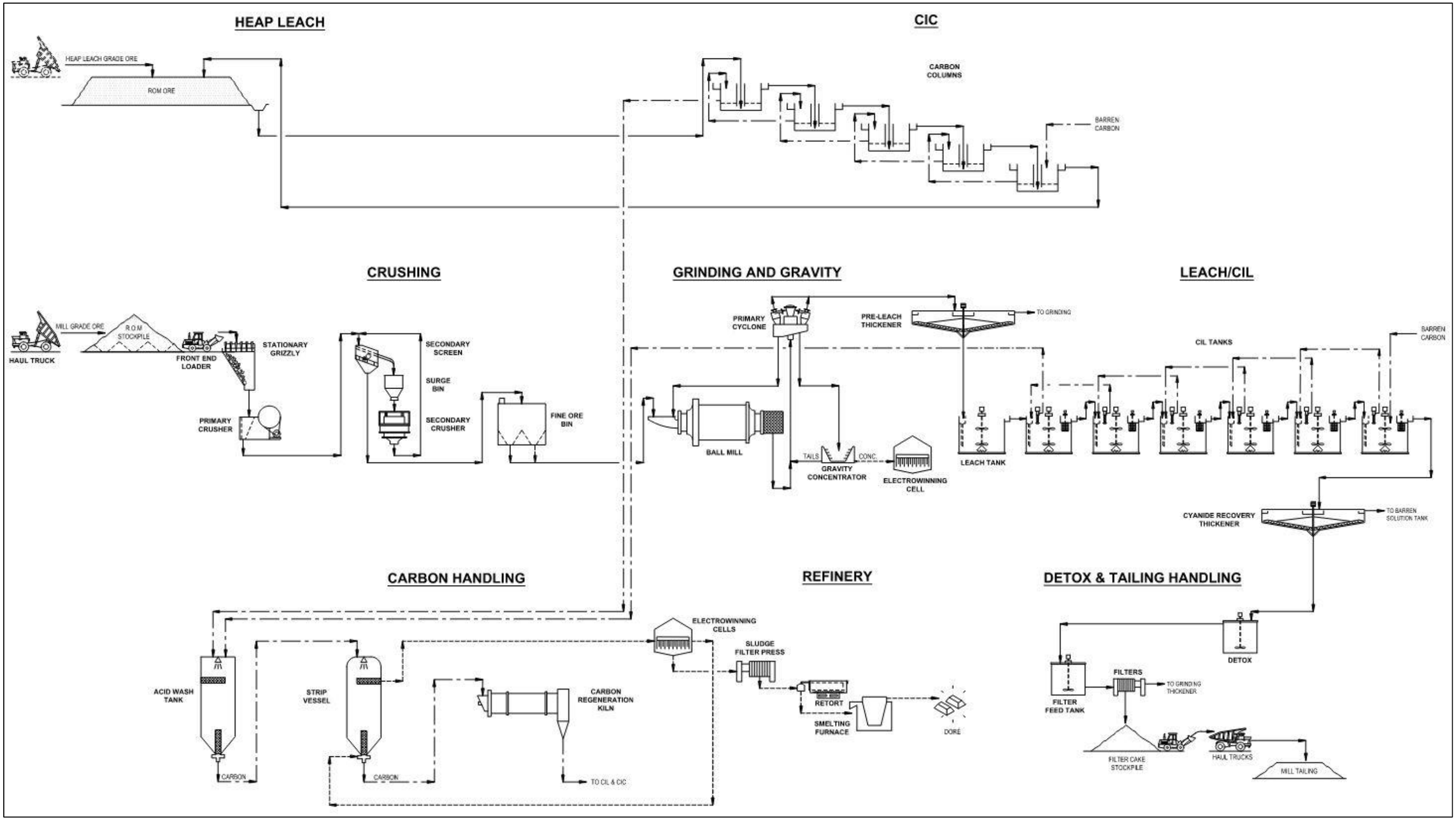


Figure 17-1: Overall Process Flowsheet

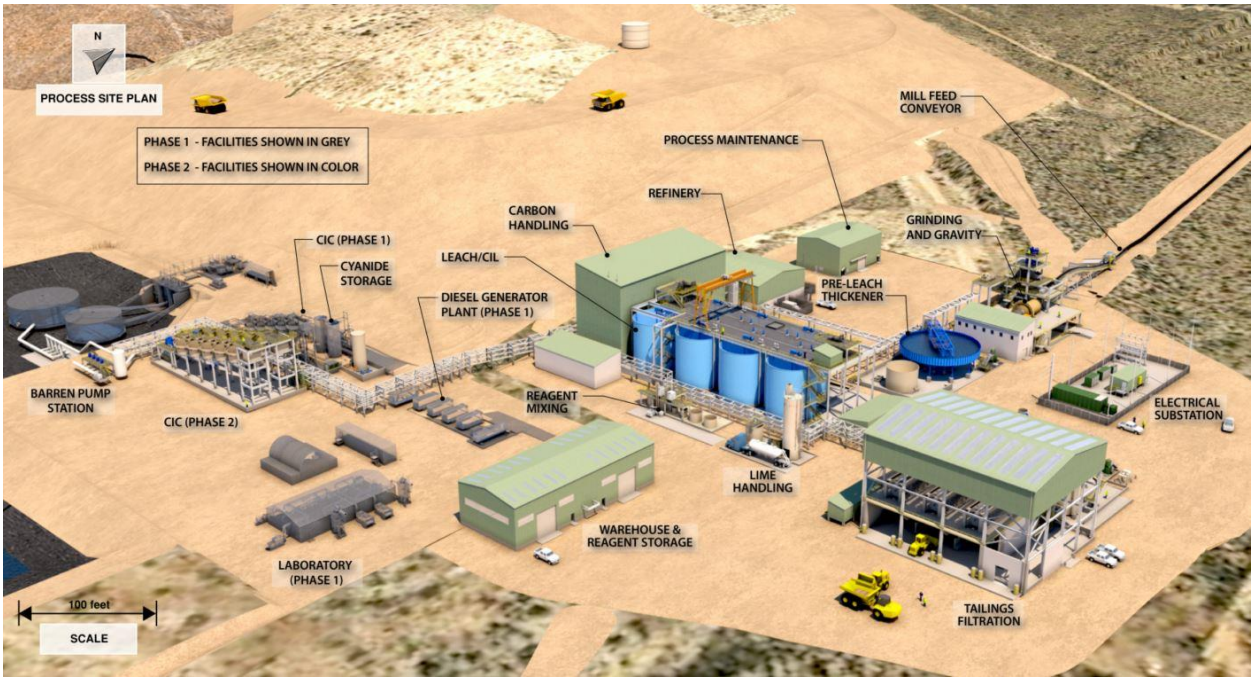


Figure 17-2: Process Plant Facility

Table 17-2: Major Process Design Criteria Summary – Heap Leach

Parameter	Unit	Value
Daily Processing Rate - Heap Leach	ton/d	50,000
Operating Days per Year	days	365
LOM Heap Feed Grade	oz Au/ton	0.012
ROM Feed Size, F_{100}	in	17
ROM Feed Size, F_{80}	in	7
ROM Feed Size, F_{50}	in	4
Lift Height	ft	25
Ultimate Stack Height	ft	300
Primary Leach Cycle	days	80
Saturation Moisture	%	10
Drain Down Moisture	%	9
Application Rate	gpm/ft^2	0.004
Barren Solution Flow	gpm	12,800
Barren Solution Cyanide Concentration	ppm	500
Pregnant Solution Flow	gpm	12,000
CIC Columns, Specific Flow Rate	gpm/ft^2	22.5
Carbon Loading	oz Au+Ag/t	100

Table 17-3: Major Process Design Criteria Summary – Mill

Parameter	Unit	Value
Daily Processing Rate - Mill	ton/d	3,500
Operating Days per Year	days	365
Availability, Crusher	%	75
Availability, Mill	%	90
LOM Mill Feed Grade	oz Au/ton	0.068
Specific Gravity	-	2.3
Crusher Feed Size, F_{100}	in	17
Crusher work Index	kWh/ton	12.1
ROM Stockpile Capacity	ton	100,000
Fine Ore Bin Capacity (live)	ton	3,500
Ball Mill Feed Size, F_{100}	in	0.5
Ball Mill Product Size, P_{80}	µm	150
Ball Mill Circulating Load	%	300
Bond Ball Mill work Index	kWh/ton	15.2
CIL Cyanide Concentration	NaCN/L	500
CIL Slurry Feed Density	%	45
CIL Retention Time	h	30
Carbon Loading	oz Au+Ag/t	80
Detox Feed, CN_{WAD}	ppm	125
Detox Discharge, CN_{WAD}	ppm	25
Detox Retention Time	h	2
Tailing Filter Feed Slurry Density	%	60
Final Tailings Cake Moisture (Wet Weight Basis)	%	18
Filter Cycle Time	min	20.5

17.2 MAJOR EQUIPMENT AND FACILITIES

The major equipment is summarized by each main process area in Table 17-4 and Table 17-5. Carbon from both the heap leach and the mill is handled in a common facility which is summarized in Table 17-6. Equipment sizing considers a range of operational parameters based on rheological properties of slurry anticipated where applicable.

Table 17-4: Major Process Equipment – Heap Leach

Item	Quantity	Description	Power
Barren Solution Pump	4	12 in Vertical Turbine	1,000 hp
Pregnant Solution Pump	4	8 in x 10 in Horizontal Centrifugal	150 hp
CIC Column	10	18 ft. diam. 5 per train	-

Table 17-5: Major Process Equipment – Mill

Equipment	Quantity	Description	Power
Primary Crusher	1	49 in x 37 in Jaw	175 hp
Secondary Crusher	1	60 in Standard Cone	500 hp
Ball Mill	1	16.5 ft diameter x 21 ft F/F	3,300 hp
Gravity Concentrator	1	Centrifugal Bowl, 48 in bowl diam.	60 hp
Pre-leach Thickener	1	68 ft diam. High rate	-
Leach/CIL Tanks	7	37 ft diam. x 40 ft height; Agitated	100 hp
Cyanide Recovery Thickener	1	68 ft diam. High rate	-
Filter Feed Pump	2	10 in x 8 in Horizontal Centrifugal	350 hp
Tailing Filter	3	8.2 ft x 8.2 ft (2.5 m x 2.5 m) Pressure filter, 64 chambers, 16 min cycle	100 hp

Table 17-6: Major Process Equipment – Carbon Handling and Refining

Equipment	Quantity	Description	Key Criteria
Acid Wash Vessels	2	FRP construction	6 ton capacity
Strip Vessels	2	Pressure vessel; Stainless steel construction	6 ton capacity
Carbon Regeneration Kiln	1	5 ft diam. x 50 ft long, Horizontal Propane-Fired Indirect	1,500 lb/h 18 ton/day
Mercury Retort	1	3 ft^3 Electric	30 kW
Electrowinning Cells	4	Sludging, 2000 amps @ 6 volts	-
Smelting Furnace	1	Induction Furnace	450 kW

17.3 PROCESS DESCRIPTION

17.3.1 Heap Leaching

17.3.1.1 Stacking and Leach Pad Operation

ROM ore will be delivered to the leach pad by the mining fleet.

Pebble Quicklime (CaO) will be added for pH control of the process from two 100 ton silos. The lime will be metered into a clamshell and dumped into the loaded trucks which will then deliver the ore to the active stacking area. Lime will be added in proportion to the tonnage of ore being hauled with an estimated consumption of 2.35 lbs/ton based on metallurgical testwork.

The ore haul trucks will operate on top of the lift being constructed. A ramp, or ramps, will be constructed to reach the top of each current lift. The trucks will direct-dump the ore on the current lift and a dozer will push the ore over the edge of the lift to form the expanding heap. The stacked ore will be deep-shank cross-ripped with the dozer prior to leaching. Ore will be stacked in 25 ft high lifts to a height of approximately 300 ft above adjacent native grades.

Prior to stacking a new lift over the top of an old one, the top of the old lift will be cross ripped to break up any cemented/compacted sections and to redistribute any fines that may have been stratified by the irrigation solution or rainfall.

17.3.1.2 Leach Pad Design

Several leach pad base grading options were evaluated to optimize the native terrain by minimizing earthworks cuts and fills while maintaining a solution collection system that maintains one foot or less of solution head over the primary liner as required by current site regulations. The native terrain within the property limits and the Phase 2 leach pad expansion area flows to the southeast towards Phase 1 and the historic leach pad.

Solution within the Phase 1 leach pad is collected via a series of 4 inch perforated corrugated HDPE pipes at close spacing (approximately 15 ft apart) that flow towards 18 inch perforated corrugated HDPE pipes as the main headers. Main solution collection piping headers are oversized to operate at a design flow of approximately 50% of the pipe's capacity to allow for adequate protection against pipe deflection and clogging. These 18 inch headers can drain an area of approximately 600,000 ft^2 or less at the proposed irrigation rate of approximately 0.004 gal/min/ft^2. These sub-cells then drain to the main perimeter solution collection channel which flows to the process plant. The channel has a robust design to operate under load of a multi-lift pad over the project duration. Smaller 4 inch collection header lengths have been minimized to provide less of an opportunity for pipe collapse and failure.

Phase 2 design considered both use of a single pad to be adjoined with the current Phase 1 pad as well as construction of a separate pad. Both options would use a solution collection channel running from North to South which minimizes the length of solution collection piping required to report solution to the main header. The single pad option, which is the basis for the feasibility study, requires ore to be backfilled over the top of the new solution collection channel while the separate pad option provided for an open solution collection channel without backfill. A single pad decreases the project footprint and disturbance area, improves logistics and hauling distance.

In order to mitigate concern over the backfilling of the solution collection channel, the solution collection channel will have a more robust pipe specification as well as a channel corridor which will be backfilled with a layer of competent rock on top of a porous waste rock in order to be free draining. Pipe junctions will be encased in concrete or other high strength materials to achieve proper fortification and assure solution flow. Figure 17-3 illustrates the basic solution pipeline corridor design concept.

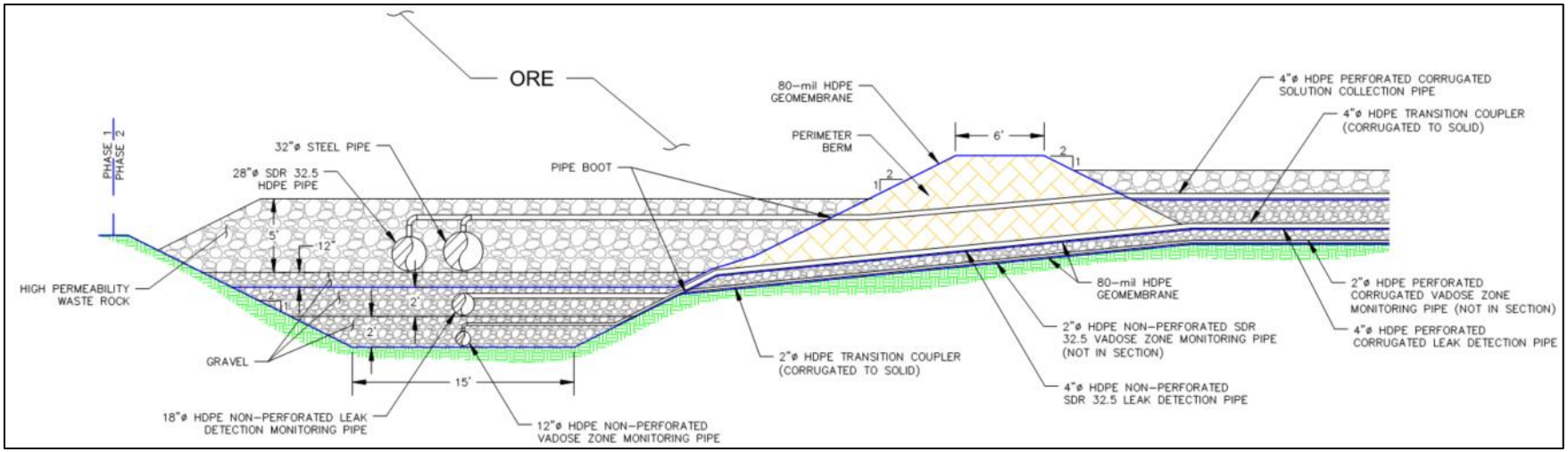


Figure 17-3: Heap Leach Pad Solution Corridor

The leach pad has been designed with a lining system in accordance with California Code of Regulations Title 27 requirements and International Cyanide Code recommendations which meets or exceeds the North American standards and practices for lining systems, piping systems and process ponds. These standards and the proposed leach pad are intended to minimize the potential for facility operations to impact soils, surface water, and groundwater in and around the site.

The ROM leach pad will be placed both on native alluvial soils and on the side slope of the existing closed historic heap leach pad. The new leach pad will be a multiple-lift, single-use type pad. Similar to the current Phase 1 design, the Phase 2 heap leach pad extension will be lined using a double-liner system consisting of prepared subgrade, a vadose zone monitoring system, a secondary 80 mil LLDPE geomembrane liner, a two-foot layer of gravel for leak detection, a primary 80 mil LLDPE geomembrane liner, and a two-foot thick layer of gravel and perforated HDPE piping network for liner protection and solution collection.

The prepared subgrade will consist of compacted 3/8" fine ore which was previously crushed, leached and rinsed on the historic heap leach pad. A minimum two-foot thick overliner of spent crushed ore also from the historic leach pad will be spread over the primary LLDPE liner to protect the liner from puncture and to provide a permeable blanket drainage layer for heap leach irrigation solutions. A puncture test was conducted for Phase 1 using the existing leached and rinsed ore with an 80 mil LLDPE liner and assumed a stacked ore height of approximately 400 ft above the liner. The puncture test showed little to no indentations with no punctures nor adverse stretching of the liner. Phase 2 heap leach design intends to stack to an elevation of 300 ft. Figure 17-4 illustrates the heap leach pad layers and liner.

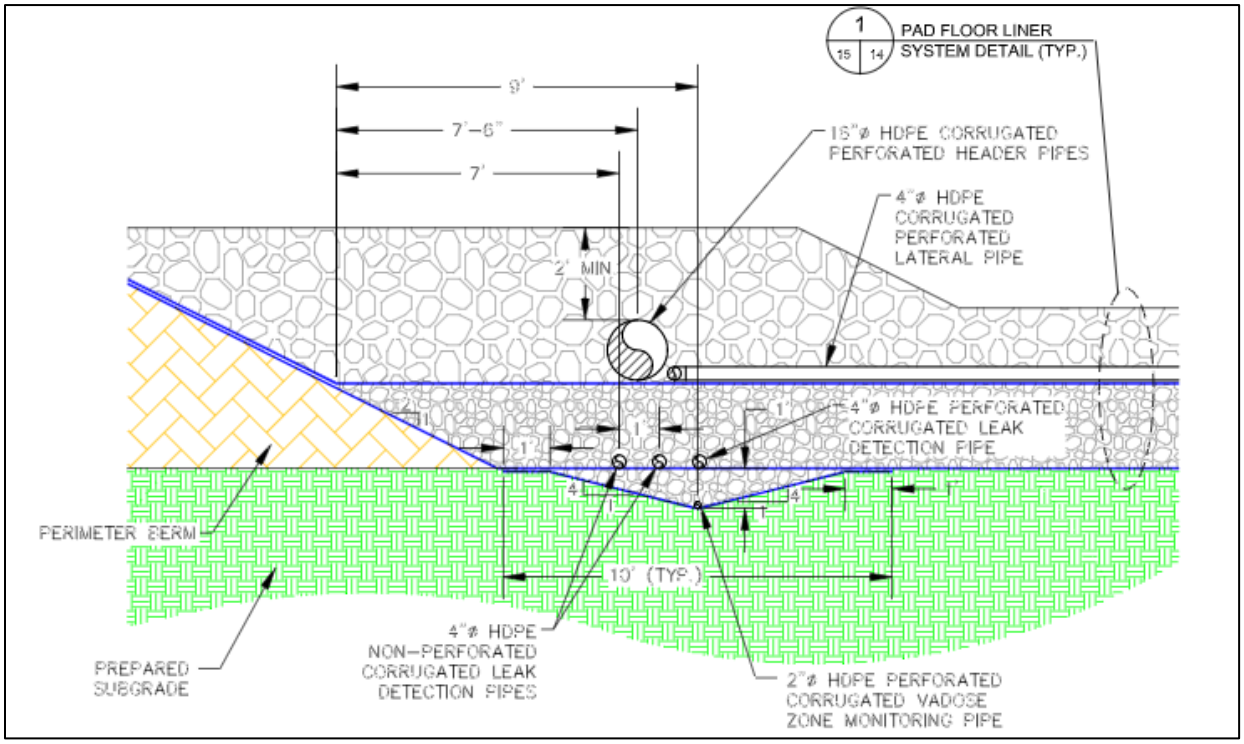


Figure 17-4: Heap Leach Pad Design Layers

The Phase 2 leach pad footprint will encompass an area of approximately 480 acres within the Project's permitted 3,910 acre Mine Property boundary. The top of the heap leach pad will extend to about 300 ft above adjacent native grades, and the maximum elevation of the heap leach pad will be approximately 4,600 ft amsl. Based on the difference between the proposed bottom grades and the proposed top of heap grades, the gross volume for the Phase 2 extension of the heap leach pad will be approximately 230 Mton.

17.3.1.3 Event Pond Design

Two event ponds will be used to manage storm solution at the heap leach facility. The Phase 1 Event Pond (23.5 M gal) is used for the current operations while the Phase 2 Event Pond (100 M gal) will be constructed as part of the expansion to handle the larger potential flows coming from the expanded heap leach pad. These ponds will not be used during normal operations remaining mostly dry and are intended to only receive solution during abnormal events such as a storm.

The Phase 2 Event Pond is designed to handle a 100-year, 24-hour precipitation event on the heap pad and pond areas and is sized based on the final ultimate leach pad area added as part of the Phase 2 expansion. Solution collected in the event pond will be returned to the process as soon as practical via portable pump. The event pond will be double-lined with a primary (upper) 80 mil HDPE geomembrane liner, a geonet and a secondary (bottom) 60 mil HDPE geomembrane liner. The pond will include a conventional leak detection system comprised of a sump and a set of riser pipes. Pond liner system details are shown in Figure 17-5.

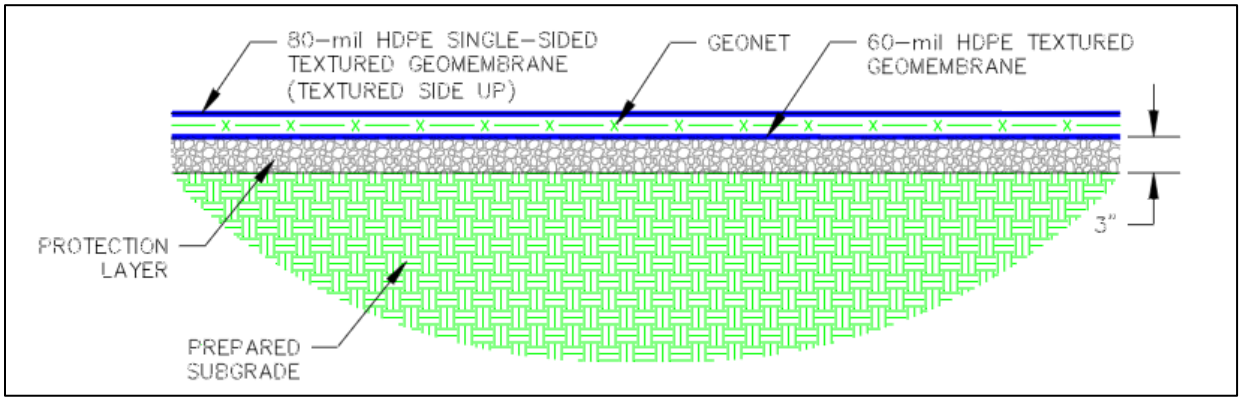


Figure 17-5: Event Pond Layers

17.3.1.4 Stacking Progression

The heap leach pad will be developed as a single pad abutted to the Phase 1 heap in four distinct campaigns throughout the course of the mine life. To minimize haul distances, the heap leach cells will be accessed via two haul roads: the existing haul route to the South or a new haul road providing access to the Northern extents of the pad. ROM ore from JSLA, Jumbo and Oro Belle pits will mostly be sent to cells 2A, 2B and 2C while ROM ore from South Domes will mostly be sent to cells 2C and 2D.

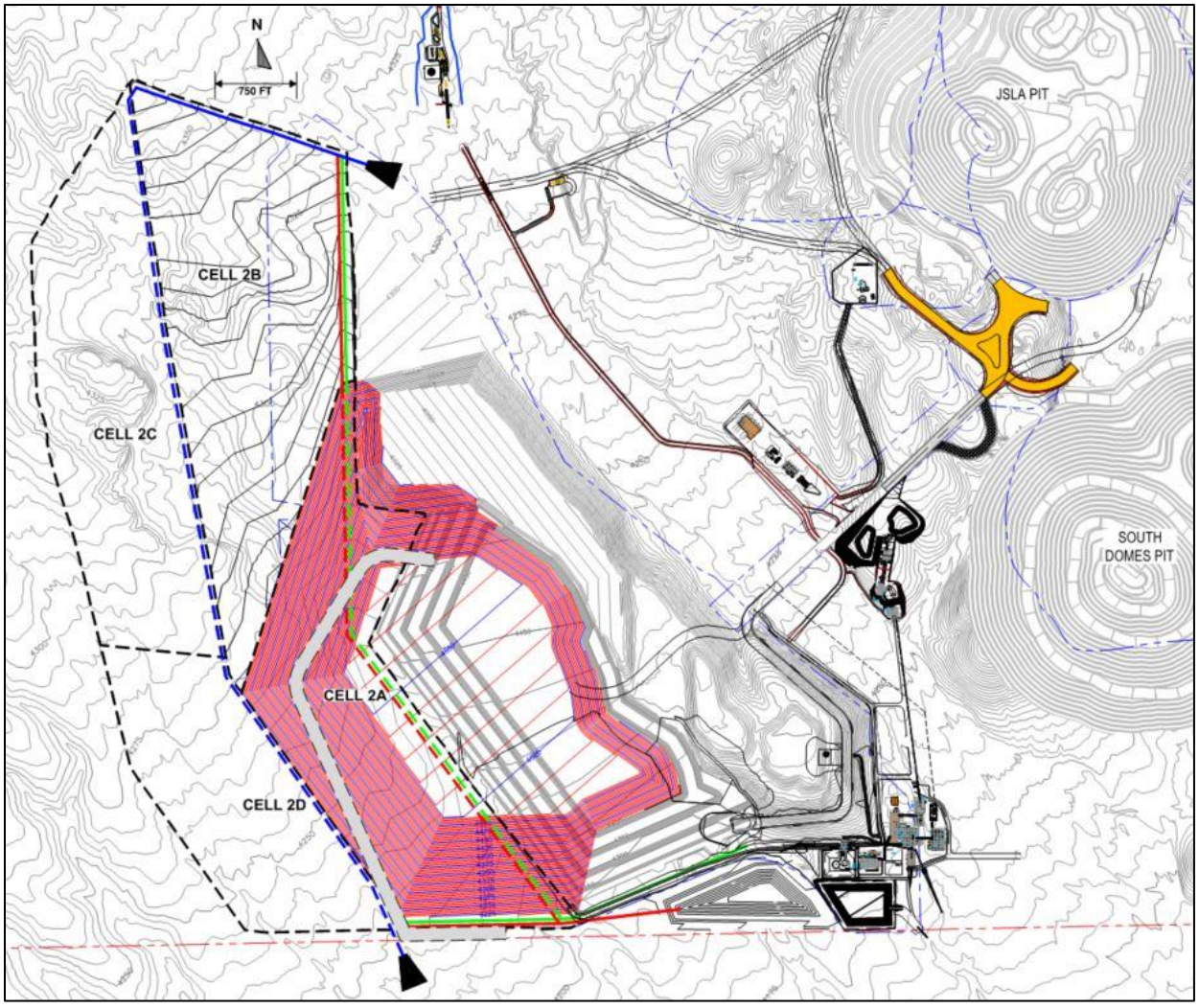


Figure 17-6: Stacking Cell 2A; (Phase 2 Years 1-4)

The initial capital project will include development of the first cell, cell 2A, which will accommodate 78 Mton of heap leach ore. This first cell will provide enough capacity for project operation through the first four years after Phase 2 startup. Ore will be stacked initially in the area just West of the historic heap leach pad over the top of the newly constructed solution collection channel and slowly expand upgradient to the West throughout the first year. Once material from the newly lined cell 2A area is up to the elevation of the Phase 1 pad, material will be placed on top of the newly combined Phase 1 pad and heap leach cell 2A. Heap leach cell 2A stacking plan is illustrated in Figure 17-6.

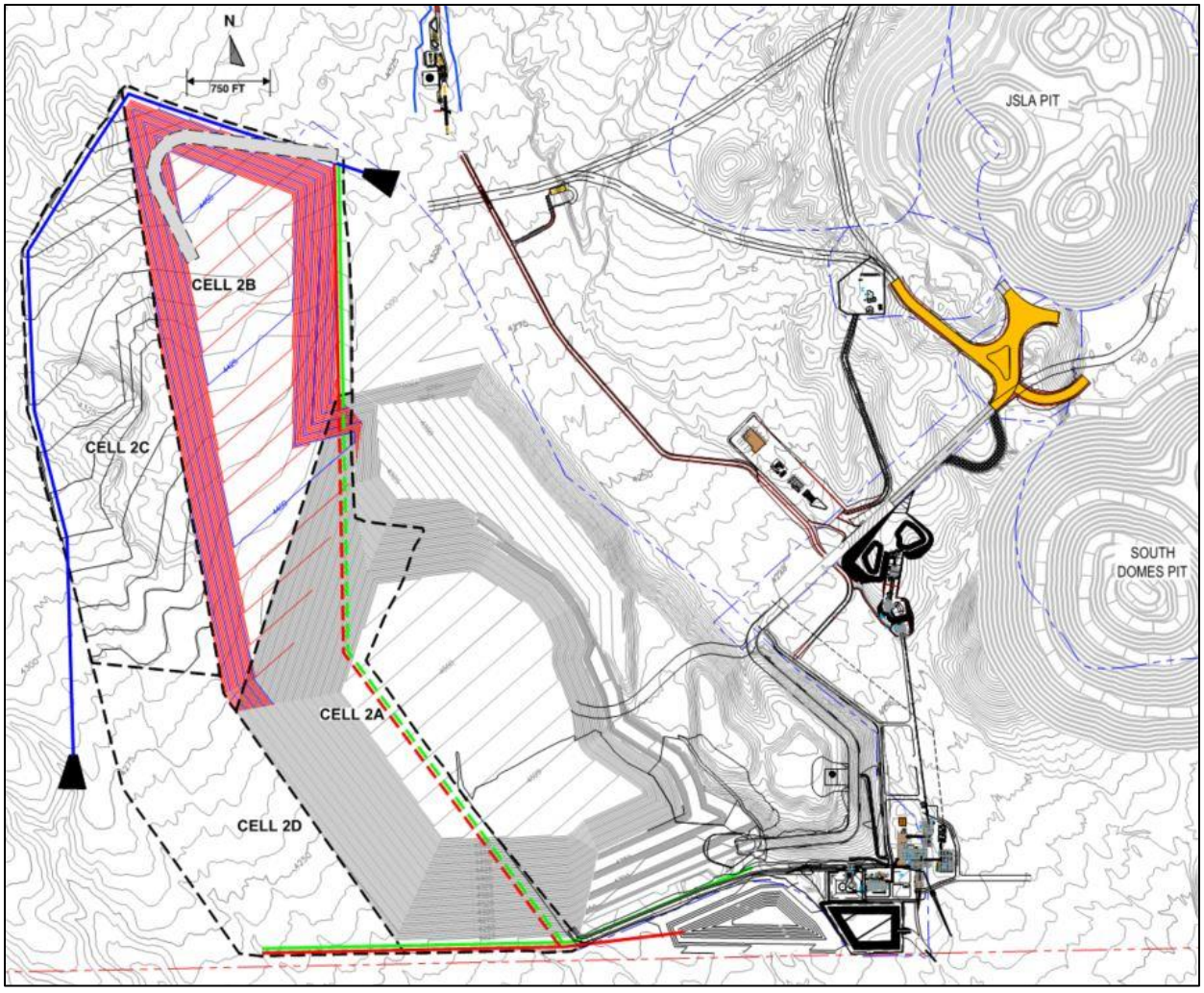


Figure 17-7: Stacking Cell 2B; (Phase 2 Years 5-7)

Cell 2B will accommodate 29 million tons of heap leach ore. The addition of the second cell will provide capacity for project operation through approximately 7 years of Phase 2 production. Early phases of Cell 2B will see ore stacked adjacent to the Cell 2A western slope. Material placements will then move upgradient to the North and West. Cell 2B stacking plan is illustrated in Figure 17-7.

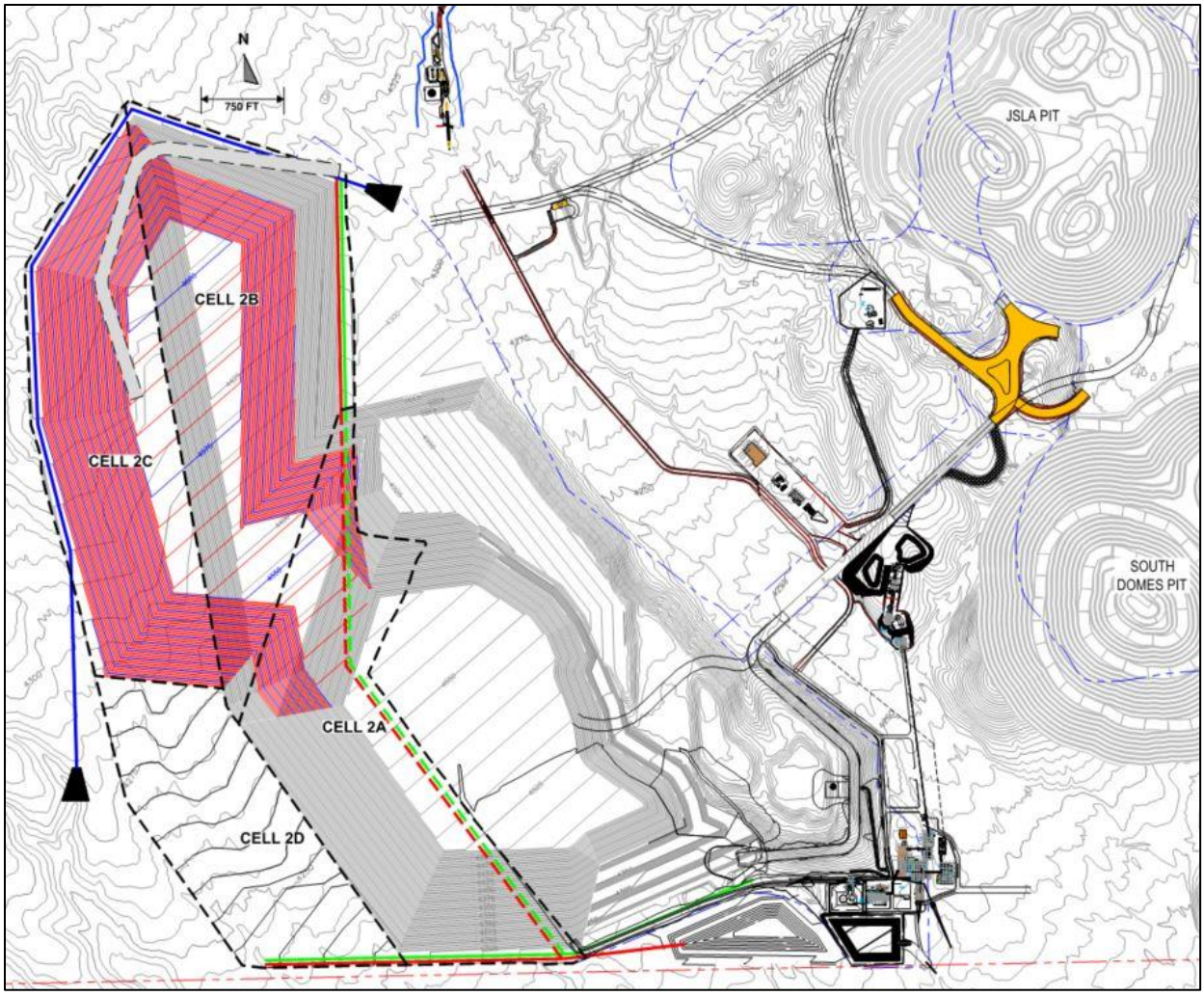


Figure 17-8: Stacking Cell 2C; (Phase 2 Years 7-10)

Cell 2C will accommodate 74 Mton of heap leach ore. This third cell will provide capacity for project operation through approximately 10 years of Phase 2 production. Early phases of Cell 2C will see ore stacked adjacent to the Phase 2B pad moving upgradient to the West. Upon matching the cell height of Cell 2B, Cell 2C material will be placed on top of Cell 2B until Cell 2C matches the Cell 2A elevation. At this point, each of the three Phase 2 cells will be merged into one pad surface. Cell 2C stacking plan is illustrated in Figure 17-8.

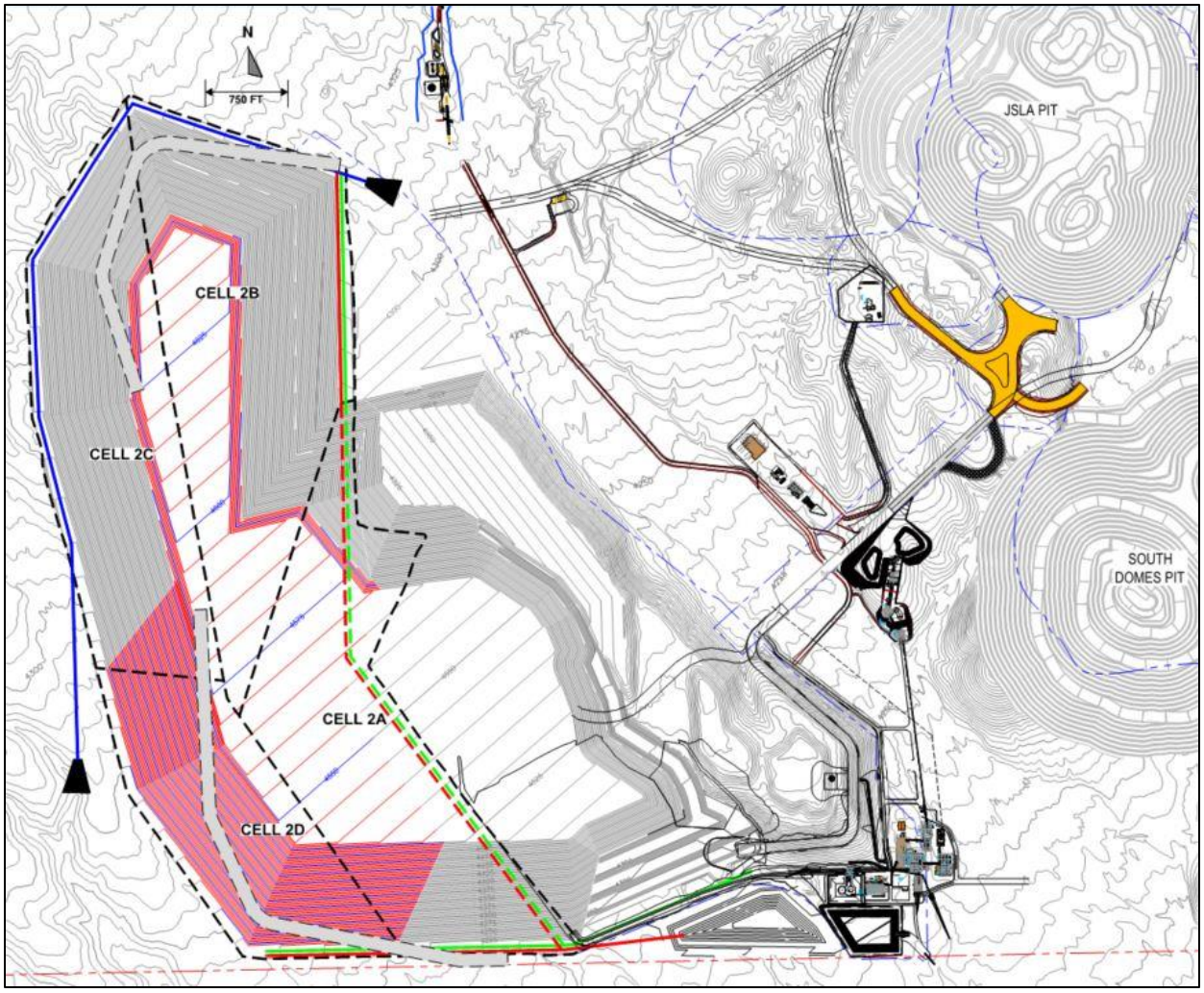


Figure 17-9: Stacking Cell 2D; (Phase 2 Years 11-14)

Cell 2D will accommodate 50 Mton of heap leach ore. This fourth cell will provide capacity for project operation through currently planned Phase 2 production. Early phases of Cell 2D will see ore stacked adjacent to the Phase 2A and 2C pads moving West upgradient towards the Western property boundary. Upon matching the adjacent cell height, material will continue to be placed to an ultimate height of approximately 300 ft above surrounding natural grade. Cell 2D stacking plan and ultimate heap is illustrated in Figure 17-9.

17.3.1.5 Leaching and Solution Handling

After a leach cell lift has been stacked and cross ripped, the irrigation system will be installed. Dripline emitters will be used to apply a dilute cyanide solution at an application rate of 0.004 gpm/ft^2 to the material. A primary leach cycle of 80 days has been selected for the ROM material based on the testwork. After primary leaching, the heap will freely drain and dripline emitters will be removed prior to cross ripping and subsequent stacking. Each lift is cross ripped both before and after leaching.

Barren solution exiting the CIC circuit will be recirculated to the heap leach pad. Make-up water for the heap leach pad will come from the mill process water tank which is used to recycle dilute cyanide solution. Barren leach solution pH will be maintained at a minimum value of 10.

Barren solution will be pumped to the top of the heap leach pad from the barren solution surge tank located near the leach pad, by four vertical turbine pumps at a nominal flow of 12,800 gpm. Cyanide solution and antiscalant are added to the barren sump as needed. Barren solution will pass through an in-line filter to remove any carbon or other foreign material from the solution to prevent plugging of the emitters and distribution system. This solution will be carried by a new HDPE pipeline to the base of the heap and then to a network of sub-headers and risers to the top of the heap where it is finally applied to the material by drip emitters.

Solution passing through the heap will dissolve the precious metal values and be collected in a network of perforated solution collection pipes, which feed to a common discharge point at the base of the heap. The solution will then be carried by gravity to a pregnant solution tank. Pregnant solution will be pumped from the pregnant tank to the adsorption carbon column circuit at the recovery plant.

17.3.1.6 Carbon Columns

The carbon adsorption circuit will consist of two trains of five cascading carbon columns. The pregnant solution will be pumped to the carbon adsorption circuit across a stationary trash screen for removal of any debris from the heap leach facility. The solution will flow by gravity from column 1 to column 5; the carbon will be pumped countercurrent to the main solution flow. The barren solution overflow from the final column will discharge via a safety screen to recover any carbon that may be flushed from the circuit and will flow by gravity to the barren solution surge tank. On average, 12 tonnes of loaded carbon from the first carbon columns (6 tonnes from each train) will be pumped to the acid wash and stripping circuits each day. The carbon will be advanced up the train, with reactivated barren carbon added to the fifth column. Existing carbon columns on site will be used during project start up to allow for time to transition and develop sufficient flow to new carbon columns.

17.3.2 Crushing and Crushed Ore Storage

Ore from the open pit mine will feed a crushing plant that consists of two stages of crushing. The plant will process 3,500 ton/d of ore, operate 24 hours per day and produce a final product with a P_{80} of ½ in. The crushing circuit will be designed for higher throughput than the rest of the plant to allow for catch up due to anticipated lower overall crushing circuit availability.

17.3.2.1 Crushing and Screening

ROM ore will be dumped onto stockpiles and a front-end loader (FEL) will be used to reclaim ore via a static grizzly with 24 inch openings. Ore will flow into a 20 yd^3 dump pocket, while any boulders will be removed for later reduction using a backhoe with a rock breaker attachment. An apron feeder will draw ore from the dump pocket and discharge onto a vibrating grizzly feeder. The vibrating grizzly oversize ore will feed directly into the 49 in x 37 in jaw crusher with an installed power of 175 hp. The minus 4 inch ore will bypass the crusher and feed directly onto the coarse ore transfer conveyor. The primary crushing stage will produce a product P_{80} of approximately 4 in with a closed side setting (CSS) of 4 in. A magnet will be installed over the coarse ore transfer conveyor to ensure any tramp metal is removed ahead of fine crushing.

Jaw crusher discharge will be combined with the vibrating grizzly undersize on the coarse ore transfer conveyor and will feed an 8 ft x 20 ft double deck inclined screen. The top deck of the secondary screen will have an aperture size of 1 inch and the bottom deck will have an aperture size of ½ in. The plus 1 inch material from the top deck and the plus ½ inch ore from the bottom deck will be conveyed to a surge bin ahead of the secondary cone crusher. The undersize from the bottom deck, minus ½ inch ore, will be the final product that will discharge onto the screen undersize transfer conveyor and ultimately report to fine ore bin via the final crushing product conveyor.

A belt feeder will withdraw ore from the bottom of the surge bin and feed it into a standard cone crusher with an installed power of 500 hp. The secondary crusher will operate in closed circuit and will reduce the ore to produce a product P_{80} of approximately 0.8 in. Crushed product will be combined with crushed material from the primary crushing stage on the coarse ore transfer conveyor and return to the secondary screen.

Between the screen undersize transfer conveyor and the final crushing product conveyor, a diverter gate will be installed to allow for recovery of crushed product material should the bin be temporarily unavailable.

A water spray system will be installed to suppress dust at the crusher dump pocket while cartridge type dust collectors will be installed to capture and control dust from the crushing and screening plant.

Any ore spillage will be returned to the nearest belt conveyor for processing. Precipitation falling on the crusher will be collected in a sump in the lowest level of the crusher structure and will be pumped to the process plant for use in the process.

The primary crushing facility will utilize a 24 ft high mechanically stabilized earth retaining structure to build up elevation to allow for proper vertical clearance between equipment within this facility. The retaining wall is backfilled with select structural backfill material while further extension of the pad is achieved using mine waste from Phase 2 mine pre-development activities.

A two stage crushing system was selected after completion of a high-level trade off study which investigated 2-3 stages of crushing as well as use of a semi-autogenous grinding mill (SAG) and pebble handling circuit. Cost implications from an operating and capital standpoint were investigated and it was determined based on preliminary pricing, that two stages of crushing offered optimized economics.

17.3.2.2 Fine Ore Bin and Reclaim

The crushing plant product will be conveyed to a fine ore bin. The bin will be fully enclosed and of steel construction and will provide 3,500 tons, or approximately 24 hours, of live storage capacity. Two draw points under the bin will provide ore to two reclaim belt feeders located underneath the bin. The reclaim feeders will discharge onto the ball mill feed conveyor. The feeders will be installed with variable frequency drives (VFD) to control the ore feed rate to the grinding circuit. Each belt feeder will be capable of providing the total plant throughput. Either or both feeders may be operated at any time. The speed of the feeders will be controlled by a control signal provided by a belt scale mounted on the conveyor downstream of the feeders. A clean up bin will be installed over the tail end of the ball mill feed conveyor to allow for recovery and clean up of any dribble material at the reclaim.

A cartridge type dust collector will be installed to capture and control dust from the reclaim feeders within the reclaim tunnel.

17.3.3 Grinding and Gravity Concentration

The grinding circuit will consist of a single stage ball mill with a gravity concentration circuit to recover any gravity recoverable gold and silver. The mill will operate in closed circuit with cyclones. A portion of the cyclone underflow will be processed through the gravity circuit. The grinding circuit will be able to process a nominal throughput of 162 ton/h (fresh feed), producing a final product P_{80} of 100 mesh (150 µm).

The grinding and gravity circuit will be located in an open building structure. The area will be serviced by a 50 ton mobile crane which will be shared across the plant site. The floor will be concrete with containment walls to contain process upsets within the grinding area.

17.3.3.1 Grinding

Reclaimed ore from the fine ore stockpile will feed a 16.5 ft x 21 ft long overflow ball mill via the ball mill feed conveyor. The mill will be supplied with rubber liners, a single 3,300 hp wound rotor induction motor with a VFD, a trommel screen, and a retractable feed spout/chute. Pebble lime will be slaked, and milk of lime will be added to the ball mill feed for pH control. An automated feeder will supply grinding media to the ball mill. Ground slurry will overflow from the ball mill onto the trommel screen attached to the discharge end of the mill. The trommel screen oversize will discharge into a trash bin for removal from the system, while the undersize will flow into the cyclone feed pump box.

Slurry from the cyclone feed pump box will be pumped to a cluster of four (2 operating/2 standby) 12 inch cyclones for size classification. Process water will be added to the ball mill feed and the cyclone feed sump to achieve the appropriate pulp density. The coarse cyclone underflow from one operating cyclone will flow by gravity back to the ball mill for additional grinding while the underflow from the second operating cyclone will flow by gravity to the gravity circuit. The fine cyclone overflow, at a final target product P_{80} of 100 mesh (150 µm), will flow by gravity to a vibrating trash screen ahead of the pre-leach thickener. The cyclones have been designed for a 300% circulating load. The grinding mill can operate at a pulp density range of 55%-70% solids without affecting grinding performance or water balance.

17.3.3.2 Gravity Concentration and Intensive Leach

Cyclone underflow from one operating cyclone will flow by gravity to the gravity concentrator scalping screen. With an aperture size of 10 mesh, the feed screen will remove any oversize particles prior to gravity concentration. The screen undersize will feed a semi-continuous batch gravity concentrator. Gravity recoverable gold will collect in the concentrate cone, while lower density material will flow out of the gravity concentrator tailings discharge port to the cyclone feed pump box. The scalping screen oversize will flow by gravity to the ball mill feed chute.

The gravity concentrator will be a batch operation. During a cycle, gravity recoverable gold will collect in the concentrate cone. At the end of the cycle the concentrate cone will be flushed with water, sending the concentrate to a storage hopper ahead of an intensive leach reactor (ILR). Once per day, the concentrate will be transferred from the storage hopper to the ILR for processing. After being transferred the concentrate will be pre-washed to remove slimes which are returned to the cyclone feed sump. The leach solution including concentrated cyanide, caustic

solution, and the leach accelerant LeachAid will be mixed and the leach cycle will be started. At the end of the leach cycle, the pregnant solution will be recovered, and the leach residue will be sent to the cyclone feed pump box. The pregnant solution will be directed to a dedicated EW cell where precious metals will be recovered.

17.3.4 Leaching

17.3.4.1 Pre-Leach Thickening

Cyclone overflow will flow onto a vibrating trash screen for removal of trash material. Oversize material will discharge into a trash bin, while screen undersize will flow by gravity to a 68 ft diameter pre-leach thickener. Flocculant and process water will be added as needed to the thickener feed to assist in the settling of fine solids and thickening. The flocculant addition rate will be adjusted by a variable speed metering pump. The high-rate thickener will thicken the slurry to 45-50% solids and a variable speed thickener underflow pump will pump the slurry to the leach circuit. The thickener overflow will flow by gravity to the non-cyanide solution tank to be used as make-up water in the grinding circuit.

The pre-leach thickener will be mounted on steel legs on foundations in a concrete containment area with slab on grade and cast-in-place walls will contain precipitation and process spills. A sump pump will transfer the contained water back to the pre-leach thickener.

17.3.4.2 Leach/CIL

The selected hybrid Leach/CIL circuit will consist of seven agitated tanks. The precious metals are leached from the ore and adsorbed onto activated carbon that is mixed within the slurry. The first one or two tanks will operate without any carbon to improve leaching efficiency. The overall circuit will provide approximately 30 hours of total retention time at 45% solids. It is expected that the slurry will arrive at the Leach/CIL circuit at a pH of 10.5. Milk of lime may be added to the circuit to adjust pH to maintain the desired alkalinity. Sodium cyanide (NaCN) may be added to any of the tanks and its addition rate will be controlled based on cyanide analyses. Process air will be piped to all tanks to maintain dissolved oxygen set points.

Slurry will advance from tank to tank using submerged vertical carbon pumper interstage screens and will exit the last tank reporting to the CIL carbon safety screen.

The Leach/CIL tanks will nominally contain 10 to 15 g/L of 6 x 12 mesh granular activated carbon to adsorb the dissolved precious metals from the slurry. Fresh activated carbon and regenerated carbon from the regeneration circuit will be pumped into the last Leach/CIL tank daily in 3 ton batches. Loaded carbon will be sent to the desorption plant daily, also in 3 ton batches.

Slurry discharging from the last Leach/CIL tank will flow to a CIL carbon safety screen fitted with 28 mesh screen panels. The purpose of this screen is to prevent accidental losses of activated carbon.

The oversize carbon from the safety screen will be collected and sent to the regeneration circuit. Slurry that passes through the screen will be pumped using a fixed speed pump to the cyanide recovery thickener.

The Leach/CIL tanks will be uncovered and the interstage screens will be serviced by a 5 ton gantry crane. A concrete containment slab on grade and containment walls will contain

precipitation and process spills. A sump pump will transfer this material back to the process. The concrete pad and containment area are sized to allow for an additional leach tank to increase leach residence time if it is required in the future.

17.3.5 Tailings Management

17.3.5.1 Cyanide Recovery Thickener and Tailing Detoxification

The CIL carbon safety screen undersize stream will report to the cyanide recovery thickener feed box. Dilution water and flocculant are added to the slurry to aid in settling which is then thickened to approximately 60% solids. Overflow solution containing cyanide from the cyanide recovery thickener is recycled to the barren solution tank for reuse in the process. The thickener will be operated to maximize underflow density and minimize the cyanide remaining in the slurry.

The cyanide recovery thickener underflow will be pumped by variable speed thickener underflow pump to the cyanide detoxification circuit, where cyanide will be destroyed using the SO_2/Oxygen process. The cyanide recovery thickener underflow will be sampled in the detox feed sampler.

In the cyanide destruction tank, residual free and Weak Acid Dissociable (WAD) cyanide will be oxidized to the relatively non-toxic form of cyanate by the SO_2/Oxygen process using sodium metabisulfite and oxygen, with copper sulfate as a catalyst as needed. An oxygen generator system supplying will be installed local to the detox tank. Milk of lime will also be added as needed to maintain a slurry pH in the range of 8.0 to 9.0. The more stable iron cyanides will be removed from the solution as an insoluble ferrocyanide precipitate. The cyanide levels will thereby be reduced to an environmentally acceptable level.

The detoxification will be accomplished in a single agitated tank that will provide a residence time of approximately 120 minutes based on the Cyanco test work report (Cyanco, 2020).

Discharge from the cyanide detox tank will be final plant tailing and will be pumped to the tailing filter feed tank.

A concrete containment slab on grade and containment walls will contain precipitation and process upsets in the cyanide recovery thickener and cyanide detoxification area. A sump pump will transfer the material back to the process.

17.3.5.2 Tailing Filtering

Detoxified slurry will be pumped to an agitated tailing filter feed tank. Slurry from the filter feed tank will be pumped using variable speed horizontal centrifugal pumps to three tailing filters (2 operating/1 standby). The tailing filters each utilize 8.2 ft (2.5 m) square mixed pack polypropylene plates (alternating recessed plates and membrane plates) that when closed provide 64 enclosed chambers for formation of filter cake. Mixed pack plates are recommended to optimize and assure moisture content specifications for material minerology characteristics expected to be processed. Each full cycle is estimated to take 16 minutes which includes: filling, filtration, air drying, cake discharge, cloth shaking and cloth rinsing. Filters will have the capability of cake squeezing and blowing if required.

The filter cake at approximately 18% moisture (by weight, wet basis) will discharge to a filter cake stockpile to be reclaimed by front end loader and loaded into articulated trucks for haulage to the filtered tailings facility east of the heap leach pad atop of the former Viceroy operations reclaimed

heap leach pad. Filtrate will discharge into a tailing filtrate tank and be pumped using a fixed speed horizontal centrifugal pump back to the early stages of the grinding process for re-use.

The filters are housed within a building with siding extended down the building sides an adequate length to protect equipment from climatic conditions, specifically ultraviolet exposure. The filters will be serviced by a dedicated overhead bridge crane and crane loading/unloading area adjacent to the process and within the filtration building.

A concrete containment slab on grade and containment walls will contain precipitation, wash down and process upsets in the area. A sump pump will transfer the material back to the process.

17.3.6 Carbon Handling

17.3.6.1 Acid Wash

Each day, six tons of loaded carbon is transferred from each CIC train and three tons of loaded carbon is transferred from the CIL circuit to a 6 ton carbon storage tank at different times of the day.

Loaded carbon will be transferred from each CIC train to the loaded carbon dewatering screens sitting above the acid wash tanks. The 30 mesh screen cloth will capture most of the carbon, which then will flow into the acid wash tank while the solution returns to the CIC circuit. Loaded carbon will be transferred from the CIL circuit to the CIL loaded carbon screen where the slurry will be washed from the carbon and returned to the CIL circuit while the loaded carbon will flow by gravity to a 6 ton carbon storage tank. Every other day 6 tons of CIL carbon will be treated.

Loaded carbon from both the CIC and the CIL circuits is treated in one of two 6 ton capacity acid wash tanks constructed of fiber-reinforced plastic (FRP). The carbon will be acid washed with a circulating 3% hydrochloric acid (HCl) solution to remove inorganic contaminants (i.e., calcium deposits, magnesium, sodium salts, silica, and fine iron particles). Organic foulants such as oils and fat are unaffected by the acid and will be removed after the elution step in the regeneration circuit using a horizontal propane fired kiln.

During the acid wash cycle, HCl solution will be pumped from the acid mix tank upward through the acid wash vessel, overflowing back into the acid mix tank. The carbon will then be rinsed with a caustic solution to neutralize any residual acid. After neutralization, the carbon will then be rinsed with fresh water to remove the remaining acid and any mineral impurities before transferring to the strip vessel.

A recessed impeller pump will transfer the acid washed carbon from the wash vessel into the strip vessel using transport water. The carbon transfer water comes from the closed circuit carbon transfer water system. Carbon slurry will discharge directly into the top of the strip vessel. Under normal operation, two acid wash and two strip cycles will take place per day. Every other day, a third acid wash and strip cycle will take place.

A concrete containment slab independent of the carbon strip area containment slab on grade and containment walls will contain precipitation and process spills in the acid wash area. A sump pump will transfer the material back to the process.

17.3.6.2 Stripping (Elution)

The carbon stripping process will be a pressure Zadra circuit utilizing barren strip solution to strip (desorb) the loaded carbon. Barren strip solution is prepared in the strip solution tank by adding cyanide, caustic (NaOH), antiscalant and water as needed. Gold will be removed from the carbon by circulating 290ºF caustic cyanide solution upward through the partially fluidized bed of loaded carbon, creating a pregnant gold and silver solution which will be pumped through the electrowinning cells for precious metal recovery. The solution exiting the electrowinning cells will be circulated back to the strip solution tank for reuse.

More specifically, the strip vessels will be stainless steel tanks, each with a capacity to hold approximately six tons of carbon. The loaded carbon from the acid wash circuit will be pumped into the top of the strip column and the excess water will be drained to the floor sump and returned to the process using a sump pump.

After the complete batch of carbon has been transferred, the strip cycle will be initiated by pumping solution containing approximately 1.25% (25 lb/ton) NaOH and 0.15% (3.0 lb/ton) NaCN from the strip solution tank through two heat exchangers, which will raise the temperature to 290ºF, into the bottom of the strip vessel.

After rising through the bed of carbon, the solution exiting the top of the vessel will be cooled below its boiling point by passing through the heat recovery exchanger prior to discharging to the EW distribution box. Heat from the outgoing solution will be transferred to the incoming cold barren solution prior to passing through the solution heater. The hot side of the final heat exchanger will be piped to a propane fired thermal fluid heating system.

Approximately 10 Bed Volumes (BV's) at a rate of 2 BV/h will be passed through the carbon to remove all precious metals. A Bed Volume is the volume of solution that occupies the space in the vessel when containing carbon. A final 2 BV of hot water will be used to wash the carbon at the end of the stripping cycle.

After the stripping circuit has been cooled down, the depleted carbon will be transferred with water to the reactivation circuit using a horizontal recessed impeller pump. The strip cycle will be complete in approximately 10 hours, allowing additional strips as needed.

Ammonia and mercury fumes from the strip solution tank will be combined with exhaust from the electrowinning cells and will be collected in a mercury abatement system.

A concrete containment slab on grade and containment walls, independent of the acid wash area, will contain precipitation and process spills in the carbon strip area. A sump pump will transfer the water back to the process.

17.3.6.3 Carbon Regeneration

The carbon regeneration circuit will thermally regenerate the stripped carbon, reactivating the pores and removing any organic foulants, such as oils and fats. Fresh activated carbon will be added to account for any carbon lost during the adsorption, desorption and regeneration processes.

A recessed impeller pump will transfer the stripped carbon from the elution vessel to the kiln dewatering screen. Oversize carbon from the screen will discharge by gravity into the kiln feed

bin. Screen undersize carbon, containing carbon fines and water, will drain by gravity into the carbon fines tank.

An indirect propane fired horizontal carbon regeneration rotary kiln will be utilized to treat 18 tons of carbon per day, equivalent to 100% regeneration of stripped carbon. The kiln will be heated to temperatures as high as 1,500ºF to remove organics from the surface of the carbon. The regenerated carbon from the kiln will flow by gravity into the carbon quench tank where it is cooled by fresh water and/or carbon fines water and is pumped over a carbon dewatering screen. The dewatering screen doubles as a dewatering screen and a carbon sizing screen where fine carbon particles will be removed. The coarse carbon particles in the screen oversize will drop into the regenerated carbon storage tank. Regenerated carbon will be pumped back to the carbon columns. The fine carbon particles and the bulk of the transfer water will pass through the screen and flow to the carbon fines tank.

Kiln off gas will be collected through ductwork and passed through a scrubber containing sulfur impregnated carbon to remove mercury vapor from the process gas before discharging to atmosphere.

Periodically, new activated carbon will be added to the system to replenish fine carbon losses. Carbon may be added to the agitated carbon attrition tank. The agitating action quickly wets the surfaces of the carbon and attritions the carbon particles to break up any lumps and remove loose edges.

Carbon fines from the carbon fines tank are recovered using a plate and frame filter to produce damp carbon cake. The filter cake may be sold for its metal or thermal value.

A concrete containment slab on grade and containment walls will contain process upsets in the carbon regeneration area. A sump pump will transfer the material back to the process.

17.3.7 Electrowinning, Retorting and Refining

Pregnant solution from the strip circuit will be pumped to the refinery for electrowinning (EW), producing a gold and silver sludge. The sludge will then be filtered, dried and refined in an electric induction furnace producing gold and silver doré bars.

The pregnant strip solution produced in the carbon strip circuit is sent to EW cells to recover the precious metals. EW is used to recover the precious metals from the pregnant solution. It is an electrolytic process where the precious metals are recovered from the solution by passing direct electrical current between electrodes (anodes and cathodes) immersed in the solution. As the current passes from the anode to the cathode, the precious metals loosely plate onto the cathode as a sludge.

17.3.7.1 Electrowinning

Electrowinning is accomplished in four EW cells operating in parallel. Each cell contains anodes (stainless steel punched plate) and cathodes (stainless steel mesh held in place by stainless steel bayonets and wire frames and suspended in cross linked polyethylene baskets). Each cell has a DC rectifier capable of delivering a current of 0 to 2000 amps at 0 to 9 volts.

The flow rate of pregnant solution through each cell is approximately 50-75 gpm. During electrowinning, the solution flows by gravity to the EW discharge box. From there, the EW

discharge pump delivers the solution to the strip solution tank. To prevent a build-up of impurities, a 15% daily bleed of barren solution will be pumped to the Leach/CIL circuit.

The sludge from the carbon circuit and ILR will be periodically washed off the cathodes using high pressure water and recovered as a damp cake in a plate and frame filter press. The filter cake will be dried in a retort furnace prior to smelting.

Vapor from the barren strip solution tank and the electrowinning cells will pass through a sulfur impregnated carbon scrubber before discharging a clean off-gas to the atmosphere.

17.3.7.2 Retorting

Filtered cake will be loaded into retort boats, or pans, for treatment in a retort furnace. The pans will be placed in a mercury retort system for several hours. The retort will heat the filtered cake to approximately 1,200ºF to vaporize mercury, which may be present in low concentrations. Retort vapor will be withdrawn from the retort by a vacuum pump, which will pull the vapor through a condenser where the mercury will condense and flow into a mercury collection compartment/tank. Mercury will be recovered from the tank periodically. Exhaust from the retort vacuum pump will pass through a sulfur impregnated carbon (SIC) filter before venting to atmosphere.

The retort, mercury condenser system, mercury collection tank, vacuum pump, and carbon filter will be supplied as a complete packaged system ready for utility hook-up and operation.

Following the retort cool down cycle, the dry sludge will be manually loaded into a furnace charge mixer along with fluxing material. The blended material will be manually charged to an electric induction furnace.

17.3.7.3 Refining

The dried filter cake (gold sludge) will be processed, along with flux, in an electric induction melting furnace. When the sludge and flux mixture become fully molten, the components will separate into two distinct layers: slag (on the top) and metal (on the bottom). The slag layer, containing most of the impurities, will be poured-off first into a conical slag pot. The remaining molten metal, containing the precious metals and minor impurities, will then be poured into bar molds. Doré will be sampled using vacuum tubes during pouring.

After cooling and solidifying, the metal bar (doré) will be dumped from the mold and slag will be knocked off by hand. The resulting doré bar will be further cleaned of residual slag and finished as required with a needle gun. The cleaned bars are then weighed and stamped with an I.D. number and weight. Doré bars, each weighing a total of approximately 35 to 40 pounds, will be the final product of the operation and will be stored in a vault awaiting shipment. This process will take place within a secure and supervised area, and the precious metal product will be stored in a vault until shipped off site.

Slag will be collected and returned to the ball mill.

Fumes from the melting furnace will be collected through ductwork and cleaned in a high temperature bag house dust collector before discharging through an exhaust control system, a vessel with sulfur impregnated carbon, to the atmosphere.

The refining building will be enclosed by concrete block walls with a steel framed roof and metal roofing. Water used for cleanup and any spills will be collected and pumped back into the process.

17.3.8 Reagents and Grinding Media

Reagents used within the plant will be mixed on-site and distributed via the reagent handling systems. These reagents include:

- Lime (CaO)
- Sodium cyanide (NaCN)
- Hydrochloric acid (HCl)
- Leach Aid
- Caustic soda (NaOH)
- Activated carbon
- Sodium metabisulfite (SMBS)
- Copper sulfate ($CuSO_4$)
- Flocculant
- Antiscalant

All reagent areas will be contained with sump pumps which will transfer any spills to their respective storage tanks. The reagents will be mixed, stored and then delivered to the heap leach, mill, Leach/CIL, acid wash, elution and cyanide destruction circuits. The capacity of the mix tanks will be sized to handle one day of production and the storage tanks will be sized to handle one and one-half days of production.

17.3.8.1 Cyanide (NaCN)

Sodium cyanide briquettes will be delivered to site by 20 ton (40,000 lb) isotainer trucks. The briquettes will be dissolved by circulating barren solution through the ISO container and transferring the dissolved cyanide into the heap leach cyanide dissolving tank and subsequently to the heap leach cyanide storage tank or to the mill cyanide storage tank. Caustic soda (sodium hydroxide) will be added as needed during dissolution to provide protective alkalinity. Cyanide will be mixed to a 24% solution concentration for use in the process and will be added to the ore on the heap leach pad and to ore in the Leach/CIL tanks to leach gold and silver. Cyanide solution will also be used to promote the removal of gold and silver from the carbon in the carbon stripping procedure.

The concentrated cyanide solution will be added to the barren solution pump box or the barren solution surge tank at a rate of 0.60 lb/ton of ore for the heap leach. The concentrated cyanide solution will be added to the intensive leach reactor and the Leach/CIL tanks at a rate of 0.05 lb/ton and 1.25 lb/ton ore, respectively. Cyanide will be used in the carbon strip circuit at a concentration of 0.2%.

17.3.8.2 Lime (CaO)

Quicklime will be delivered to the site in bulk by trucks. The bulk trucks will be pneumatically offloaded, using a blower, directly to two 100 ton cone bottom lime silos for use at the heap leach and one 100 ton cone bottom silo for use at the mill. The silos will be equipped with a bin vent type dust collector. The lime specification is 90 to 100% CaO.

Lime will be used in the ROM ore leach system for pH control. Lime will be metered from a silo into a clamshell by a screw conveyor. The clamshell will discharge the lime directly into each ore truck hauling ore to the ROM leach pad. The lime will be delivered at a rate of approximately 2.6 lb/ton of heap leach ore.

Lime will also be used in the mill for pH control. Lime will be fed from a silo into a detention slaker by a screw conveyor. Process raw water will be used to slake the lime to an 18% concentration of milk of lime (MOL). Slaked lime will discharge to the milk of lime mix tank and will be transferred to the milk of lime distribution tank. Lime will be delivered at a rate of approximately 3.0 lb/ton and 0.20 lb/ton (1g $Ca(OH)_2$/g CN_{WAD}) of mill feed ore to Leach/CIL and Detox circuit, respectively .

17.3.8.3 Hydrochloric Acid (HCl)

Hydrochloric acid will be delivered in bulk trucks at 30 to 33% concentration and will be offloaded directly into a hydrochloric acid storage tank. Acid will be pumped from the tank to the carbon acid wash circuit when needed.

Hydrochloric acid will be used in the carbon handling circuit to acid wash carbon. Raw water will be used to dilute the HCl from approximately 33% solution to 3 to 5% solution in the acid mix tank.

17.3.8.4 Sodium Hydroxide (Caustic Soda) (NaOH)

Sodium hydroxide (caustic soda or caustic) will be delivered to site in bulk trucks at 50% concentration and will be offloaded directly into a caustic storage tank.

Caustic soda solution will be used in the carbon stripping area to neutralize acidic solutions after acid washing the carbon and as reagent in the carbon elution process. In addition, caustic will be added as needed to the cyanide mixing system to maintain the proper pH of the cyanide solution thus preventing the generation of hydrogen cyanide gas.

17.3.8.5 Activated Carbon

Activated carbon (6 x 12 mesh) will be delivered in 1,100 lb bulk bags. The bulk bags will be stored on pallets. The carbon will be introduced into the carbon attrition tank where it will be slurried with water and conditioned to remove the friable edges of the carbon particles and the adhering carbon dust generated in transport. The slurry will be pumped over the carbon sizing screen with the coarse carbon particles added to the CIC and CIL circuits as needed. Carbon consumption is expected to be approximately 0.02 lb/ton heap leach ore and 0.11 lb/ton mill feed ore.

17.3.8.6 Sodium Metabisulfite (SMBS)

Dry SMBS will be delivered in 2,000 lb bags and will be stored on pallets in a reagent building. SMBS will be mixed using raw water in sodium metabisulfite mixing tank. After mixing is complete, the solution will be transferred to the sodium metabisulfite distribution tank. SMBS will be mixed to a 20% solution strength. SMBS will be pumped to the detox circuit using a metering pump. SMBS will be delivered at a rate of approximately 1.21 lb/ton of mill feed ore (4 g SO_2/g CN_{WAD}).

SMBS will be added to the tailing detoxification circuit as the primary source of SO_2 to oxidize free cyanide and weak acid dissociable (WAD) metal cyanide complexes (SO_2/air process).

17.3.8.7 Copper Sulfate ($CuSO_4$)

Dry copper sulfate will be delivered in 50 lb bags and stored in a dry area. The copper sulfate system will include an agitated mixing tank and a storage tank. Copper sulfate will be mixed to a 10% solution concentration. Copper sulfate will be added at 0.08 lb/ton ore (0.2 g $CuSO_4$/g CN_{WAD}), to the cyanide destruction circuit as needed to catalyze the reaction.

Copper sulfate will be pumped to the detox feed box tank using a metering pump.

17.3.8.8 Antiscalant

Antiscalant agents are used to prevent the build-up of scale in the process solution and heap irrigation lines. Antiscalant will be delivered in 250 gal totes supplied by the vendor. Totes will be stored on pallets in a containment area at the reagent storage building/warehouse.

Antiscalant will be added at the point of use to various clear water pump suctions using metering pumps directly coupled to suppliers' tote boxes to prevent scaling.

Antiscalant will be added to the suction of the barren solution pumps to mitigate scaling in the barren lines and drip emitters. Antiscalant will be used during the stripping process to prevent scaling of the heat exchanger plates.

17.3.8.9 Flocculant

Powdered flocculant will be delivered to site in 50 lb bags. Two vendor packaged mixing and dosing systems will be installed, one at each thickener, which will include a flocculant storage hopper, screw feeder, blower, wetting head, and mixing tank. Flocculant is mixed with raw water to produce a 0.1% mix strength. Flocculant solution will be aged in the flocculant mixing tank for a pre-set period before transfer to the flocculant storage tank for dosing to the thickener. Flocculant will be diluted at the point of use with raw water to a 0.01% strength.

The flocculant area will be serviced by a sump pump. Spillage generated within this area will be pumped to the thickener feed box.

17.3.8.10 Miscellaneous Reagents

Other chemicals such as dust suppressants will be received in totes and Leach Aid will be received in pails or other approved containers and stored as directed. In addition, fluxes (silica, nitre and borax) are required for smelting charge preparation and will be received in 50 lb bags and stored in a dry area at the reagent storage building/warehouse.

17.3.8.11 Consumption Rates

Heap leach and mill reagent consumption rates are based on metallurgical testwork.

Liners for the crushers and grinding mill have been estimated based on ore hardness and on experience at similar operations. Grinding media consumption for the grinding mill has been estimated on a lb/ton basis, mill power draw and abrasion index.

Table 17-7 summarizes the reagents used in the process plant and their estimated daily consumption rates. The table also includes other major process consumables.

Table 17-7: Summary of Process Area Consumables

Reagents	Consumption (lb/ton ore)	Package	Frequency	Storage Days
Heap Leach				
Pebble Lime; 90% active	2.58	20 ton Bulk truck	4 trucks/day	3
Sodium Cyanide	0.60	20 ton iso container	1 truck/day	4
Activated Carbon	0.02	1,100 lb. Super sack	40 bags/month	-
Antiscalant	0.04	20 totes per truck; 250 gal Tote	2 trucks/month	38
Mill				
Pebble Lime; 90% active	3.21	20 ton Bulk truck	Included above	7
Sodium Cyanide	0.47	20 ton iso container	Included above	*
Activated Carbon	0.11	1,100 lb. Super sack	Included above	-
Antiscalant	0.03	20 totes per truck; 250 gal Tote	Included above	-
Sodium Hydroxide	0.17	5,000 gal tanker	1 tanker/every 4 days	4
Flocculant	0.14	40 bags per pallet; 50 lb. bag	8 pallets/month	33
Hydrochloric Acid	0.10	5,000 gal tanker	1 tanker/every 3 days	3
Leach Aid (Est.)	0.003	-	-	-
Sodium Metabisulfite	1.21	20 supersacks per truck; 2,000 lb. Supersack	1 truck every 10 days	10
Copper Sulfate	0.08	40 bags per pallet; 50 lb. bag	5 pallets/month	36
Primary Crusher Liners	0.061	-		-
Secondary Crusher Liners	0.057	-		-
Grinding Mill Liners (Rubber)	0.08	-		-
Grinding Balls – 3 inch chrome steel	1.4	Direct dump to concrete bunker		-

* Sodium Cyanide solution for the mill will come from the heap leach storage system.

17.3.9 Process Water Balance

A water balance was developed for the Castle Mountain process facilities to characterize water flows within the process plant and heap leach to understand monthly usage rates. This results in determining the water available for recycling throughout the process and make-up water requirements. Make-up water needs will fluctuate with the amount of evaporation and precipitation events seen in each month specifically for the heap leach.

ROM ore is assumed to be relatively dry with a moisture content of 3%, while the saturation moisture of the ore is expected to average 10% and must be sustained for solution to begin flowing from the pad. This results in an average consumption of 668 gpm.

Climatic data, discussed in Section 18.5.1, is utilized in accordance with required irrigation moisture and the staged development of the lined heap leach pad to characterize the water

required to keep the heap leach properly irrigated and process solutions balanced within the process plant. A summary of anticipated evaporation losses through pan evaporation on the leach pad surface and from emitters as well as losses associated with ore wetting is shown below in Table 17-8.

Table 17-8: Summary of Heap Leach Water Demands

Month	Ore Wetting (gpm)	Net Evaporation* (gpm)	Total (gpm)
January	668	158	826
February	668	209	877
March	668	326	994
April	668	476	1,144
May	668	593	1,261
June	668	693	1,361
July	668	684	1,352
August	668	558	1,226
September	668	489	1,157
October	668	334	1,002
November	668	203	871
December	668	146	814
Average	**668**	**406**	**1,074**

* Net Evaporation is the combined effect of evaporation losses and precipitation gain.

In addition to the heap leach, the processing plant also requires make-up water to operate. Make-up water may be introduced to various locations within the process including the non-cyanide solution tank, acid wash circuit, tailing filter water tank, cyanide recovery thickener feed tank as well as for mixing of dry reagents. Water will also be used throughout the plant as seal water for pumps. Water is collected and recycled throughout the plant via area sump pumps. The average make-up water requirement of the mill is 110 gpm. See Table 17-9.

Table 17-9: Mill Water Demand Summary

Area	Percent Solids		Water Addition (gpm)	Water Recycle Flows (gpm)
	In	Out		
Crushing	97	96.5	3	-
Grinding	96.5	30	1338	-
Pre-Leach Thickener	30	45	-	647
CN Recovery Thickener	45	60	-	324
Tailings Filters	60	82	-	260
Total	**97**	**82**	**1341**	**1231**
Total (Make-Up)			**110**	

Raw make-up water will be pumped from several sources, including historic and newly developed well sites. The raw water for the process plant will be primarily pumped to the existing process

area raw/fire water tank for gravity distribution to the process plant. Make-up water sourcing and sitewide water management which includes usage for dust suppression, mining and other uses is further discussed in Section 18.5.

17.3.10 Air Supply and Distribution

Air compressors and receivers will provide air for operation and maintenance at the primary crushing area, the fine crushing area, and fine ore reclaim area. Plant air compressors will be located in a common Air Systems building central to the mill facility.

A plant air compressor will provide service and instrument air throughout the process plant. An air dryer will remove moisture in instrument air. Plant air and instrument air receivers will be provided. A dedicated compressor will provide air to the bottom of the Leach/CIL tanks.

An oxygen generator located at the tailing facility will provide oxygen to the cyanide destruction tank.

Tank mounted reciprocating air compressors will be installed for operation and maintenance at the truck shop and at the mill maintenance building.

17.3.11 Electrical Power Requirements

The estimated average running power load for process facilities is shown in Table 17-10. Electrical power supply is discussed in Section 18.7.1.

Table 17-10: Summary of Process Area Power Consumption

Code and Area Description	Estimated Running Load MW
Area 220 - Solution Handling	2.4
Area 280 - Carbon Adsorption	0.1
Area 340 - Reagents	0.2
Area 410 - Primary Crushing	0.2
Area 420 - Fine Crushing & Crusher Ore Storage	0.6
Area 430 - Grinding	2.2
Area 440 - Gravity Concentration	0.2
Area 450 – Leach/CIL	0.5
Area 460 - Tailing Handling and Filtration	0.8
Area 510 - Desorption and Carbon Regeneration	0.2
Area 520 - Electrowinning and Refinery	0.5
Area 620 - On Site Water Supply and Distribution System	0.2
Area 630 - Air Systems	0.2
Area 680 - Fuel Infrastructure	0.1
Total	**8.4**

17.3.12 Sampling

Samplers will be installed where samples are required for metallurgical accounting and process control purposes. Installation location and type of sampler are listed in Table 17-11.

Table 17-11: Sampler Location & Type

Location	Sampler Type
Mill Feed	Belt crosscut
Leach/CIL Feed	Pipe/Vezin
Detox Feed	Pipe/Vezin
Detox Discharge	Pipe/Vezin
Barren Solution to Pad	Pipe
CIC Feed (pregnant solution)	Wire
CIC Discharge (barren solution)	Wire
Electrowinning Feed (pregnant eluate)	Wire
Electrowinning Discharge (barren eluate)	Wire

These samplers will be installed in conjunction with totalizing flow meters and, where necessary, density meters to allow process control and allow a full plant gold balance to be completed.

In addition to the samplers above, sample ports will be available for equipment (e.g. electrowinning cells) to allow for manual grab samples. Access to equipment (e.g. carbon columns, cyclone) will allow for operators to grab samples as required.

17.4 INSTRUMENTATION AND CONTROLS

The key design criteria for the instrumentation and controls are to provide and implement sufficient supervisory and control to achieve design production rates, to enable stable process operations within design limits and to facilitate safe operation of all process and equipment.

Equipment and process will primarily be monitored and controlled remotely from a new central control room located at the grinding building, new satellite control room situated in the crusher facilities, and the existing control room from Phase 1. The control room operator will be able to input set points, open/close valves, start/stop motors/pumps/conveyors/equipment and visualize all alarms and interlocks via the process control systems human machine interface system.

Equipment and process parameters will be monitored and automated when it is deemed critical for process productivity and quality or is required to support human, equipment or environmental safety functions. Equipment will be field operated, where it is only required for infrequent actuation or activation with no significant impact on process, equipment or safety.

Intelligent type motor control centers will be located in electrical rooms throughout the facilities. A digital communication interface to the process control system will facilitate remote operation and monitoring of motor control center equipment. Field instrumentation and devices will be hardwired to the process control system via input and output modules.

The site-wide process communication system will be an industrial Ethernet CAT6a cable and fiber optic network, providing communication between the process controllers, the motor control

centers, remote input and output modules, vendor supplied skids, the control room(s) operator's workstations, and graphical interface consoles.

The following areas and associated process will be monitored and controlled:

- Comminution and conveying
- Leach/CIL
- Adsorption, desorption, regeneration
- Cyanide detox
- Reagents
- Process and fire water
- Process and instrument air
- Dewatering, filtering, and tailing disposal

18 PROJECT INFRASTRUCTURE

Existing infrastructure at Castle Mountain is well established with the current Phase 1 operations described in Section 5. The Phase 2 expansion will continue to utilize historic facilities and the recently built Phase 1 facilities to the greatest extent possible. Phase 2 infrastructure will increase in size to meet the expanded project parameters and include new site improvements to support the operation of the required new process and mining facilities. This section describes the new facilities required for Phase 2.

18.1 ACCESSIBILITY

18.1.1 Off-site Access Roads

The Castle Mountain Project is accessed primarily from Nevada State Route 164, also referred to as Nipton Road. The Nipton Road connects the town of Searchlight, NV to Interstate 15 in California via the town of Nipton. 7 miles Northwest of the town of Searchlight, NV is a signed access to Walking Box Ranch which also acts as site access for the Castle Mountain Project. From this point, a well maintained 25 to 30 foot wide dirt and gravel access road brings traffic 18.1 miles to the main access gate for Phase 1 operations.

Phase 2 operations will continue to utilize the same main access road with no further upgrades needed. Phase 2 will have a new access point/gatehouse which is located approximately 17.2 miles from Nipton Road.

The project overall site plan is shown in Figure 18-1.

18.1.2 Security Gatehouse

The security gatehouse is a 75 ft x 20 ft pre-engineered steel building with a security check-in space, a safety training area, offices, restrooms and a medical emergency area. Covered parking is included for housing of site medical transport. Other features include a helipad for emergency evacuation and a truck scale.

Entry is permitted with key cards. Light vehicle parking is provided offsite, immediately adjacent to the gatehouse for visitors, and truck parking is provided to stage deliveries prior to inspection and weigh in at the truck scale. The truck scale currently being used on site for Phase 1 will be relocated to the new gatehouse location with the Phase 2 expansion.

Mine and process plant staff will primarily report to site via mine site bussing from Searchlight, Nevada. Adequate space for safe and efficient loading and unloading is accounted for in the gatehouse staging area. Project personnel will be expected to change into work attire prior to arrival at the bus pick up point as no change house is included within the project plan.

18.1.3 Site Fencing

The project site will be completely fenced with 25,000 linear feet (LF) of a combination of 6 ft and 8 ft high chain link fencing surrounding the main process facilities, expanded heap leach pad and new filtered tailings facility. In addition to chain link fencing, 25,000 LF of desert tortoise fencing will be installed on a similar linear route as the chain link in all areas at elevations less than 4,400 ft amsl. 32,000 LF of expanded wire ranch fencing with appropriate signage will be placed around exterior boundaries bordering the pit and waste areas.

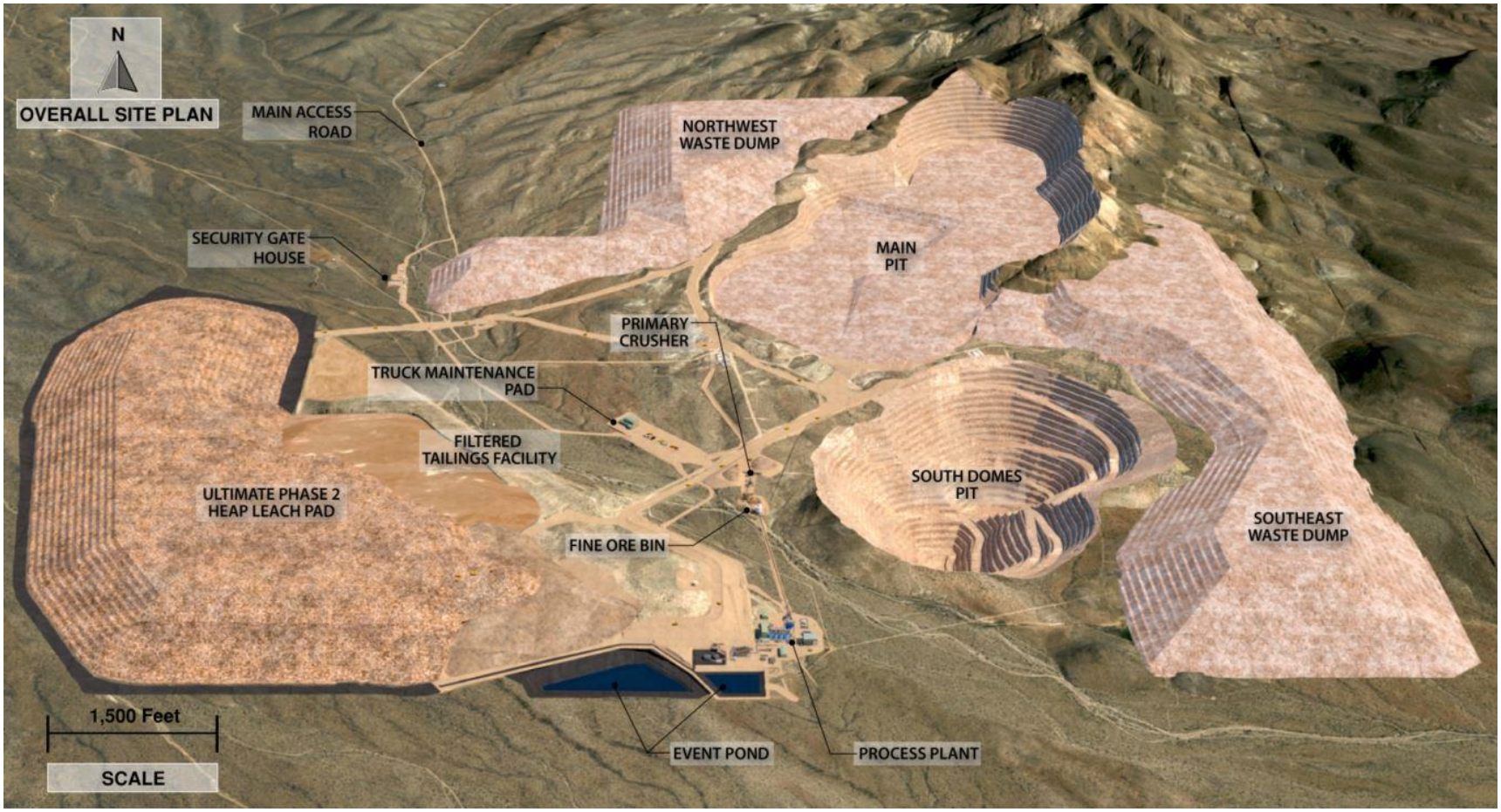


Figure 18-1: Overall Project Site Plan

18.1.4 On-site Access Roads

Upon entry through the gatehouse, the main on-site access road is designed to allow light vehicle traffic and truck deliveries to enter and have minimal exposure to the mining fleet bringing ore from the pits to the heap leach pad. The new northern haul road which connects the mine to the northern extents of the expanded Phase 2 leach pad area will cross over above the main on-site vehicle access road by means of a 40 ft wide corrugated multiplate tunnel crossing. The Phase 1 haulage corridor to the south will continue to operate in Phase 2 with the existing access road crossing; however, additional access roads on site have been added in a way to minimize interactions between haul traffic and light vehicles or truck deliveries.

18.2 SITE DEVELOPMENT

18.2.1 Mill Siting Study

As part of the feasibility study, four options were short-listed and considered for the location of the processing facilities including the pre-feasibility design with a centrally located mill and a tailings impoundment north of the heap. The effort focused on reducing capital and operating costs as well as improving operations and maintenance functionality.

The pre-feasibility design basis was determined to have higher capital and operating cost requirements partly due to the use of mechanical conveyance to deliver tailings uphill to the north side of the new expanded heap leach facility.

Of the other options, locating the mill adjacent to the current Phase 1 plant made the most sense, allowing for direct transfer of carbon between CIL/CIC to the desorption plant without needing to pump pregnant solution a substantial distance uphill. Operations, maintenance, traffic flow and security will also benefit by having a single consolidated processing plant on the southern end of the property. These advantages led to selecting the current general site plan layout, as shown in Figure 18-2, which illustrates the Phase 2 expansion facilities with respect to currently operating Phase 1 facilities.

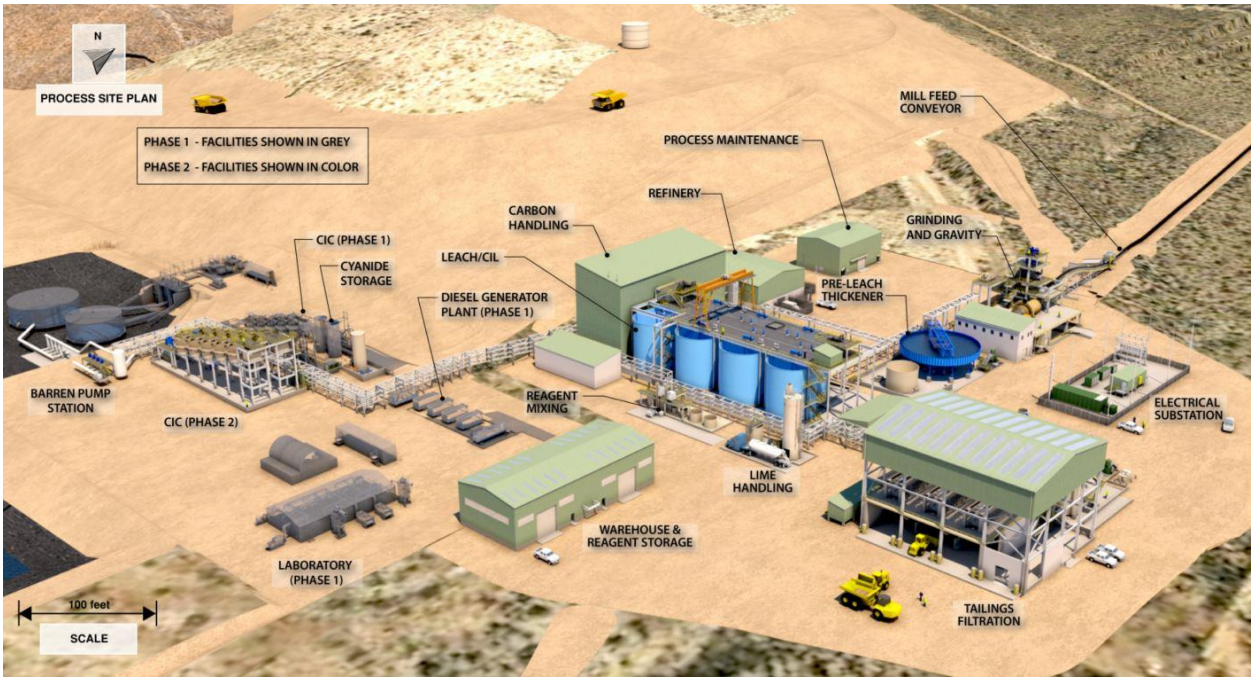


Figure 18-2: South Processing Plant 3D View Looking Northwest

The selected site plan was developed with most facilities located in close proximity to each other as well as the Phase 1 facilities to provide a compact layout which is easily accessible for operators and maintenance personnel. Emphasis was placed on minimizing new disturbance in the existing watershed/arroyo areas to allow for adequate natural drainage.

18.2.2 Topsoil Handling and Stockpile

Project topsoil will be stockpiled in designated topsoil reserve areas over the course of Phase 2 expansion development. Areas will be designated around the perimeter of the Phase 2 heap leach pad extents for topsoil removed as a result of the expanded heap leach pad while topsoil from the crushing plant, process plant and filtered tailings facility will primarily report to local areas in close proximity to their source near the South process plant. It is estimated that the expansion project initial heap leach pad, filtered tailings and plant area will generate approximately 425,000 yd^3 of topsoil which will be stockpiled for utilization during final reclamation.

18.2.3 Surface Plant Area Geotechnical Investigation

Two site geotechnical studies on site at Castle Mountain were completed in order to determine key project foundation design criteria, excavation characteristics and general recommendations for site earthworks in site areas specific to development of Phase 1 as well as facilities associated with the Phase 2 expansion.

A total of 29 test pits and 3 geotechnical borings were conducted in 2019-2020 to characterize project subsurface characteristics and how they may affect design and construction relating to facilities on site. These test pits and borings were specifically located in anticipated locations of major process facilities. Samples were collected from the boring and test pits and tested for expansion index, soil gradation, soil pH, resistivity and soluble contents. Based upon the laboratory data and field evaluation, no geotechnical fatal flaws were identified. The local soil

materials were characterized as suitable for construction materials for the various facility components.

The following contains a general summary of the findings of the investigation relating to Phase 2 facility locations:

- **Phase 2 North Site (Crushing and Ore Storage)** – This area was underlain by a relatively thin mantle of Colluvium over Tertiary Rhyolite Tuff in various stages of weathering. The Colluvium was described as dark yellowish brown, dry, loose silty sand with localized clayey areas, angular gravel and cobble-size volcanic fragments to a maximum of 7 inches in diameter. This layer ranged in thickness from 18 in to 30 in. Underlying Volcanic Rhyolite Tuff (considered the bedrock unit in this area) was encountered below these depths, of which, the top 24 in to 30 in was generally rippable with an excavator bucket.

- **Phase 2 South Site (Mill, Processing Plant and Refinery)** – This area was underlain by a thicker section of Alluvium and a relatively thinner mantle of Colluvium over Tertiary Volcanic Rhyolite Tuff in various stages of weathering. Test pit 5, located near the proposed process plant facility, showed an Alluvium characterized as dark yellowish brown and dry. Loose fine to coarse silty sand with sub-angular gravel and cobble-size volcanic fragments up to 6 inches in size was encountered to the total depth explored in this area of 9.5 ft. In the proposed location of the grinding mill, a Colluvium characterized as dark yellowish brown, soft clay with a trace of sand and angular volcanic fragments to 6 in was encountered to a depth of approximately 3.5 ft followed by Volcanic Rhyolite Tuff which was rippable to an additional 5 ft in depth.

Test pits sampled for characterization of Phase 2 facilities are shown in Figure 18-3.

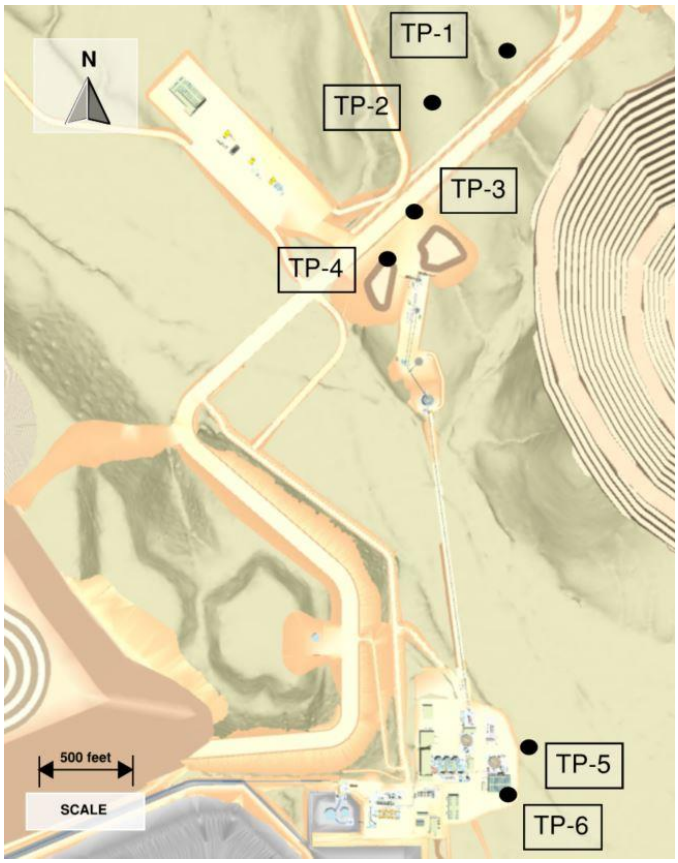


Figure 18-3: Phase 2 Test Pit Map (Process Plant)

18.2.4 Mine Geotechnical Investigation

Mine geotechnical recommendations have been provided by Call and Nicholas, Inc. (CNI) and were discussed in Section 15. (Call and Nicholas, 2020). As part of the wall slope recommendations, CNI recommended a crest offset of 300 ft (1.2 factor of safety) for critical infrastructure constructed on the western side of the South Domes pit. Stability analyses indicate that location and orientation of the Maverick fault could potentially lead to instability within 300 ft of the crest.

Crushing infrastructure, conveyors and fine ore storage all located on the western side of the South Domes pit adhere to this offset as the secondary crusher is the closest plant infrastructure and is at least 500 ft away from the ultimate pit edge.

18.3 MINE INFRASTRUCTURE

18.3.1 Truck Shop

The truck shop is a 185 ft x 100 ft shop facility and parts warehouse for maintenance of the property's mobile fleet. The truck shop includes 3 truck bays, 10 ton capacity bridge crane, tool crib, electrical shop and a second-floor mezzanine level with office space, restrooms and conference area. The truck shop has translucent panels to reduce lighting requirement.

18.3.2 Truck Fuel Storage and Dispensing

Phase 1 fuel storage and dispensing facilities will be relocated to the new truck shop pad and a new 20,000 gal off road diesel storage tank will be added to account for higher fuel consumption under expanded project requirements. Phase 1 on road diesel and gasoline equipment and storage will be relocated to the Phase 2 truck shop pad and are assumed to be substantial enough to service the expanded project needs.

18.3.3 Tire Pad

The tire pad is a 60 ft x 50 ft concrete pad specifically designed to allow for efficient change out and servicing of haul fleet tires. The pad includes a small tool room and electrical room as well as compressed air and nitrogen for haul tires.

18.3.4 Truck Wash

The truck wash is a 65 ft x 118 ft facility designed to allow for efficient washing of the property's mobile fleet. The truck wash includes a loader accessible sediment clean up bay, sludge drying pad, overflow basins and oil skimming system.

18.4 PROCESS PLANT INFRASTRUCTURE

18.4.1 Administration and Offices

Existing administrative and mine office facilities set up for current Phase 1 operations will continue to be utilized in similar capacity. These facilities consist of a modular office complex including office spaces and a conference area.

18.4.2 Process Maintenance Building

The process maintenance building is a 50 ft x 69 ft pre-engineered steel building intended to house maintenance activities associated with process equipment on site. The building is home to a 10 ton capacity bridge crane as well as a small parts and tool storage room and office space for maintenance supervision and technicians and restrooms.

18.4.3 Warehouse and Reagents Storage Building

The warehouse and reagents storage building is a 54 ft x 132 ft pre-engineered steel building housing 2,900 ft^2 of warehouse space and 2,900 ft^2 of storage space designated for process reagents. The building also includes secure storage areas, restrooms and a second-floor mezzanine with office space and a small conference area.

18.4.4 Laboratory

The existing lab facilities for Phase 1 are outfitted for assay work as well as metallurgical work and will continue to be utilized in similar capacity for Phase 2. The lab facilities have been sized to allow for the additional samples generated with the expanded operation and the addition of lab equipment with respect to the high-grade mill.

18.5 SITE WIDE WATER BALANCE AND SUPPLY

A site wide water balance was developed for the Castle Mountain property to use in planning for additional raw water. This analysis considers multiple scenarios and climatic conditions for evaporation and precipitation in wet and dry conditions. Castle Mountain is a zero discharge facility with the main water loss occurring via evaporation from the surface of the heap leach pad and filtered tailings facility. Water is also used in saturating the heap leach pad. Additional losses are via dust control mitigation for onsite roads and small projects, as necessary. The project water balance is shown in Figure 18-4.

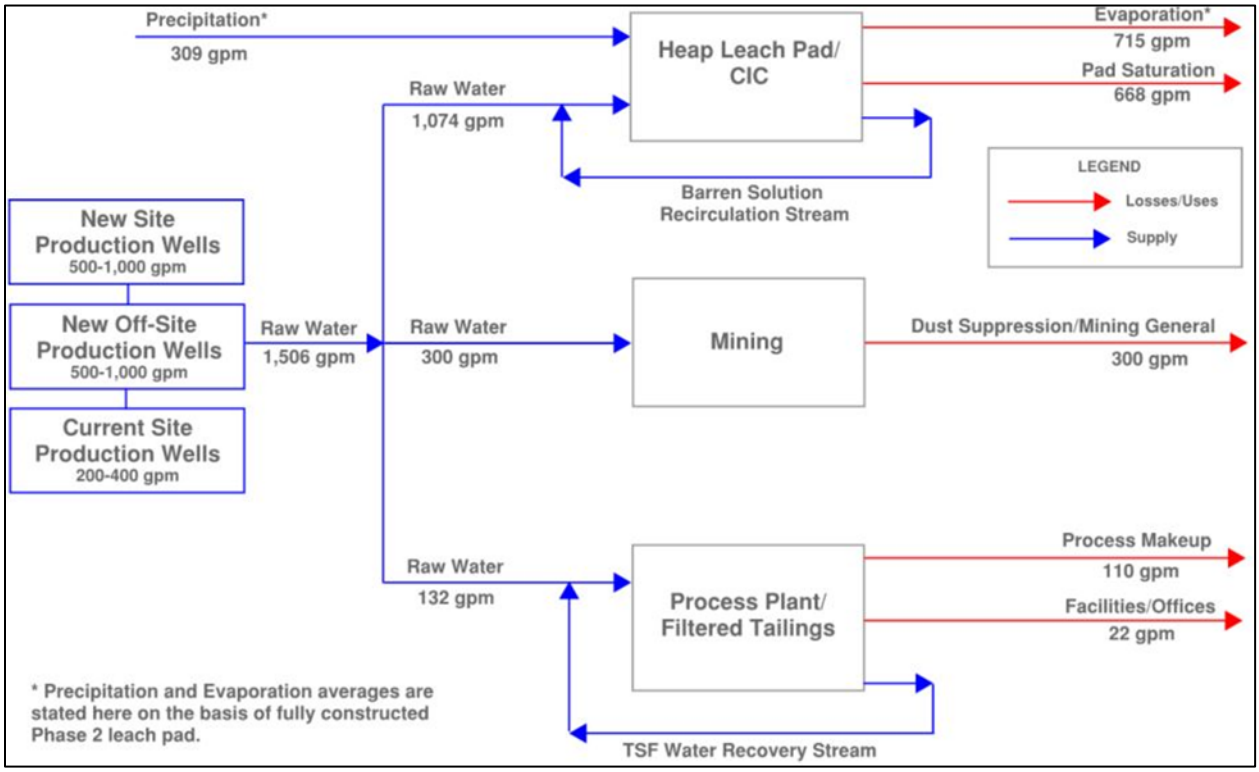


Figure 18-4: Sitewide Water Balance (Annual Average)

18.5.1 Climatic Data

The meteoric record used for this study was synthesized from multiple sources, since complete weather data for all the necessary variables was not available from the onsite weather station. The sources for the synthetic meteoric record were:

1. Onsite weather data from Castle Mountain (3 partial years of data)
2. Weather data from the Mountain Pass Mine (a nearby property with 27 years of temperature)
3. Surrounding regional weather stations (nearly 50 years of data)
4. PRIME grid estimate from the Prism Climate Group at Oregon State University (computer generated models based on multiple weather data sources)

The synthetic record for local weather was used to generate a deterministic model for temperature, precipitation, and evaporation. That data, along with the leach pad make-up water monthly average, is summarized in Table 18-1.

Table 18-1: Modelled Monthly Climate Data Summary

Month	Mean Monthly Precipitation (mm)	Mean Monthly Pan Evaporation (mm)	Mean Monthly Temperature (°C)	Leach Pad Make-up Water (gpm)
January	27.9	68.5	5.7	826
February	26.4	87.1	8.4	877
March	24.1	135.6	11.4	994
April	11.3	186.0	15.9	1,144
May	10.8	244.6	19.9	1,261
June	9.6	294.5	27.1	1,361
July	20.9	297.5	30.3	1,352
August	31.3	259.1	30.3	1,226
September	25.6	206.7	25.4	1,157
October	15.5	148.4	18.9	1,002
November	18.2	89.4	10.3	871
December	19.5	68.5	6.1	814
Average	**20.1**	**173.8**	**17.5**	**1,074**

The resulting climatic synthetic record was used in conjunction with the phasing of the leach pad liner and stacking plan to produce resulting ingress/egress flows to the project water balance around the heap leach pad and filtered tailings facility. These flows will vary year by year based on the leach pad evolution and for the purposes of the study a deterministic weather record was used to predict longer term conditions over the mine life. Climatic conditions such as wind speed, days of sunlight and humidity were not considered within this model.

18.5.2 Water Demand

In addition to the water demands listed for the process plant and heap leach described in Section 17, water usage for Phase 2 expanded operations was estimated for mining dust control, mining and general water usage at project facilities. These were then totaled with process needs to estimate site water make-up demand low, average and peak values. Table 18-2 shows the resulting summary of project water demands.

Table 18-2: Project Total Water Demands

Description	Low Demand (gpm)	Average Demand (gpm)	Peak Demand (gpm)
Heap Leach Pad Saturation	668	668	668
Heap Leach Net Evaporation*	146	406	693
Mill Water Demand	110	110	110
Mine Water Demand	200	300	400
Ancillary Facilities/Offices	22	22	22
Total	**1,146**	**1,506**	**1,893**

* Net Evaporation is the net combined effect of evaporation losses and precipitation gain.

To account for uncertainties in the weather model, a contingency has been applied to the average demand to assure adequate continuous design basis of pumping and delivery systems. The maximum evaporative loss was calculated as one standard deviation from the mean. The value of one standard deviation, estimated at 220 gpm, was incorporated into the water balance as an additional requirement for average make-up water. The added contingency of 220 gpm together with calculated average make-up results in an average annual demand of 1,726 gpm with an expected range from approximately 1,150 gpm to 1,900 gpm. Site water supply systems are sized to handle both peak instantaneous demands as well as continuous supply of the average including this contingency.

Opportunities to further reduce the water demand through greater use of onsite dust suppressants, strategic construction planning to construct leach pad cells during the wet season, and optimization of the heap leach make-up water requirements through efficiency improvements will continue to be studied and utilized through life of mine site development. Pumping and process monitoring systems will be designed to accommodate irrigation turn down at the heap leach pad and allow process management to select lower strategic water need set points. These adjustments can be made until dry and demanding conditions subside.

18.5.3 Water Supply

18.5.3.1 Site Water Supply

Phase 2 operations will require a continuous supply of water, generally averaging 1,500 gpm and up to 1,900 gpm under peak demand in the dry season. Supply of this make-up water will be met by a combination of sources from near site and off-site shown in Figure 18-5.

Three historical production wells, W-14, W-18, and W-45, which are already connected via existing underground pipelines to an existing 250,000 gal water tank, are estimated to provide 150 gpm total. This is referred to as the West Wellfield area located to the northwest of the Project site. The water tank feeds an existing underground line that terminates near the mine and administration office complex and facilities. This system is primarily used for dust suppression water under current operations and will continue in similar service for the expanded Phase 2 plans.

Two production wells, W-01 and W-02, were drilled and completed in 2017 and had pumps installed in 2019 at the start of Phase 1 construction. They are currently providing the majority of site water make-up for current operations. These wells are located at the edge of the JSLA pit and what will eventually be the South Domes pit, respectively, and are bedrock wells which are

estimated to be able to produce a combined total of up to 400 gpm. The wells have been fitted with new well pumps and serve a pipeline feeding the recently constructed 300,000 gal raw water tank located on top of the historical Viceroy heap area. The wells will continue to operate in the expanded Phase 2 plans.

Additional mine site production wells will be located in an area to the south and southwest of the process plant to provide additional make-up water for Phase 2. A series of five monitoring wells have been drilled in 2020 in the area south of the property and these holes have also served to evaluate groundwater potential and to improve the understanding of the hydrogeology in the basin fill and bedrock of Lanfair Valley. This recent work has been reported on by Clear Creek Associates, (Clear Creek, 2020a) and supplements surface geophysical surveys conducted in 2015, 2017, and 2018.

The results of the near site water investigation suggest that there are two aquifer systems in Lanfair Valley, a younger alluvial system that the West Wellfield taps, and a deep alluvial-volcanic aquifer that extends to depth of about 1,450 ft. Two of the five recent drill holes appear to be favorable for production well installations: one that penetrates the deep alluvial-volcanic aquifer, and another located in the bedrock aquifer. For the first one in the alluvial aquifer, the water table is at a depth of 490 ft and drilling indicates nearly 1,000 ft depth of aquifer showing high probability for a productive water zone. It is anticipated that, once developed, wells in this area will produce between 500 and 1,000 gpm of water. Further detailed investigations are recommended going forward, including an update to the local hydrogeological model and construction of a 14 in diameter steel-cased test well which could eventually serve as a production well. A groundwater model will be used with the information gained from the water exploration program to assess any impact that pumping the new well at its maximum rate may have on Piute Spring over the life of the mine and beyond.

18.5.3.2 Off-Site Water Supply

It is anticipated that supplemental make-up water will be required in addition to that reasonably available from the Lanfair basin in order to mitigate the stress that may be put on the local aquifers. Equinox has recently investigated the groundwater production potential of an area of the Ivanpah Valley near the town of Nipton, California, approximately 16 miles northwest of the mine. The investigation included conducting surface geophysical surveys using audio-frequency magnetotellurics (AMT) and gravity, the drilling and construction of an observation well to a depth of 605 ft, and the testing of an existing production well. The results were evaluated and reported by Clear Creek Associates, (Clear Creek, 2020b) and show that the aquifer is about 3,000 ft deep, comprised of unconsolidated basin fill alluvial materials, and is uniform in character both vertically and horizontally.

The aquifer was recently pump tested as part of the investigation and provided excellent results demonstrating a high hydraulic conductivity; however, testing was limited to low flow rates. Additional data from historical well field pump tests in other parts of the Ivanpah basin indicate a high probability for good water production and coupled with the fact that there does not appear to be a salt layer in the location tested as is encountered in the center of the basin that would act as a bottom boundary for the aquifer, it is expected that water production would be good. Production wells would likely yield between 500 and 1,000 gpm and possibly more. It is recommended to further evaluate this area with the installation of a production well to a depth of 1,500 ft.

Ultimately, it is expected that two new production wells will be installed near this location. These new exploration wells will be fully outfitted with new casing and pumps and serve an overland pipeline extending 30 miles following Nipton Road and then into site along the main access road. The pipeline will be pressurized by a 10,000 gal booster tank equipped with 350 hp booster pumps feeding the new 190,000 gal north tank located on top of the historical Viceroy heap area. This system will serve as the second major source for the expanded Phase 2 plans, contributing up to 1,000 gpm in make-up water capacity. Table 18-3 shows a water source summary.

Table 18-3: Water Source Summary

Description	Operating Wells	Capacity (gpm)
Current Site Production Wells (Phase 1)	4-5	200-400
New Site Production Wells (Phase 2)	1-2	500-1,000
New Off-site Wells (New – Phase 2)	2	500-1,000
Total	**7-9**	**1,200-2,400**

Figure 18-5 illustrates the general areas intended for water production.



Figure 18-5: Water Sourcing Map

18.5.4 Potable Water Distribution

Raw water will be treated using an on-site chlorinator system to meet applicable potable water standards. Treated water will be stored in a 10,000 gal polypropylene potable water tank. This water will be utilized throughout the plant site for general potable uses (i.e. restrooms, break areas, etc.) and will be sized appropriately for building occupancy. The estimated size for this demand based on current building plans and occupancy is 22 gpm.

18.5.5 Fire Water Protection System

The fire water system for project expansion will be divided into two areas: the process plant and the crushing and ancillary areas. The process area fire water system will be tied into the existing 10 in fire water gravity fed pipeline built as part of Phase 1 which feeds a hydrant at the generator station; this branch will then distribute throughout the new process plant and mill area to use in hydrants spaced at 300 ft.

The crushing and ancillary fire water system will consist of a new separate 34 ft x 32 ft water tank with 190,000 gal of capacity which will be fed from the new raw water system. Due to hydrant residual/static pressure requirements by the fire code, the Raw/Fire Water Tank built as part of the first phase of construction will not provide the necessary pressure at the crusher and ancillary facilities. Therefore, there is a need for the new tank as well as a listed/approved automatic diesel water pump package. The new tank will be located next to the fine ore bin and will be able to provide two hours of fire water retention as well as feed dust suppression systems relating to the primary dump pocket.

18.5.6 Non-Contact Water Management

Analysis was conducted to understand peak discharge and runoff volumes to determine requirements for managing of surface flows around and through the Castle Mountain site as they relate to the proposed improvements for Phase 2 expansion. The hydraulic analysis was conducted using the San Bernardino Hydraulic Manual Guidelines as basis for the review on the premise of a 24-hour, 100-year storm event. Watershed volumes and maximum surface water elevations were evaluated to develop criteria for effective handling of the water and to minimize erosion concerns. Figure 18-6 illustrates the contributing watershed areas which will require management around and through the project site.

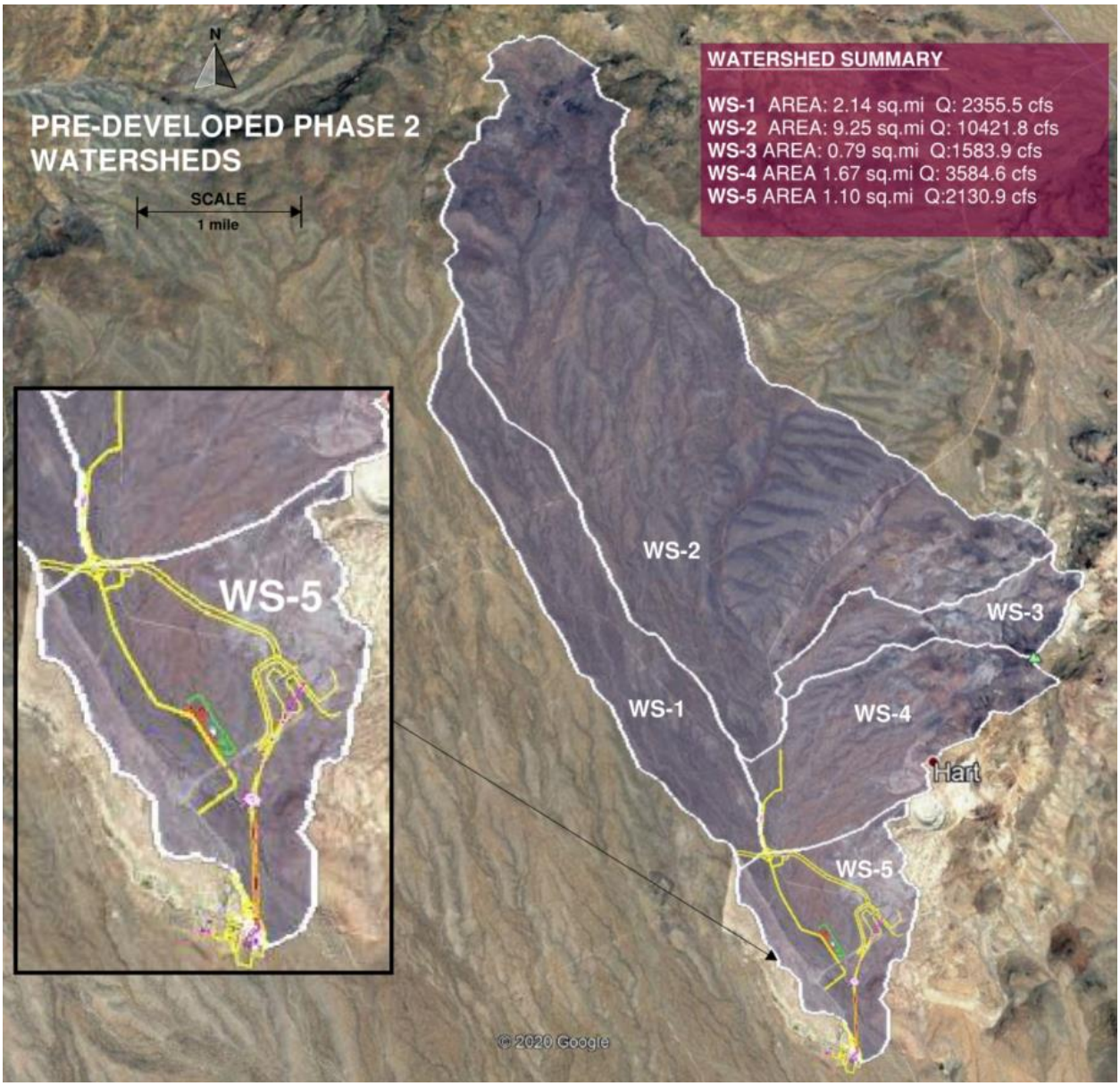


Figure 18-6: Castle Mountain Watershed Summary

Combined contributing watersheds considering a 24-hour, 100-year storm event of 5.19 in result in the need for handling of approximately 20,000 cfs (566 cms). Diversion channels and culverts around the North end of the heap leach pad and the Northern extents of the project site will direct flow around and through re-graded surfaces to the natural channel which has handled much of this flow historically. As mitigation for erosion control, channel armoring in the form of Reno/Gabion mattresses will be utilized at areas sharing a border with new process facilities. Figure 18-7 shows locations requiring reinforcement as part of the Phase 2 expansion.

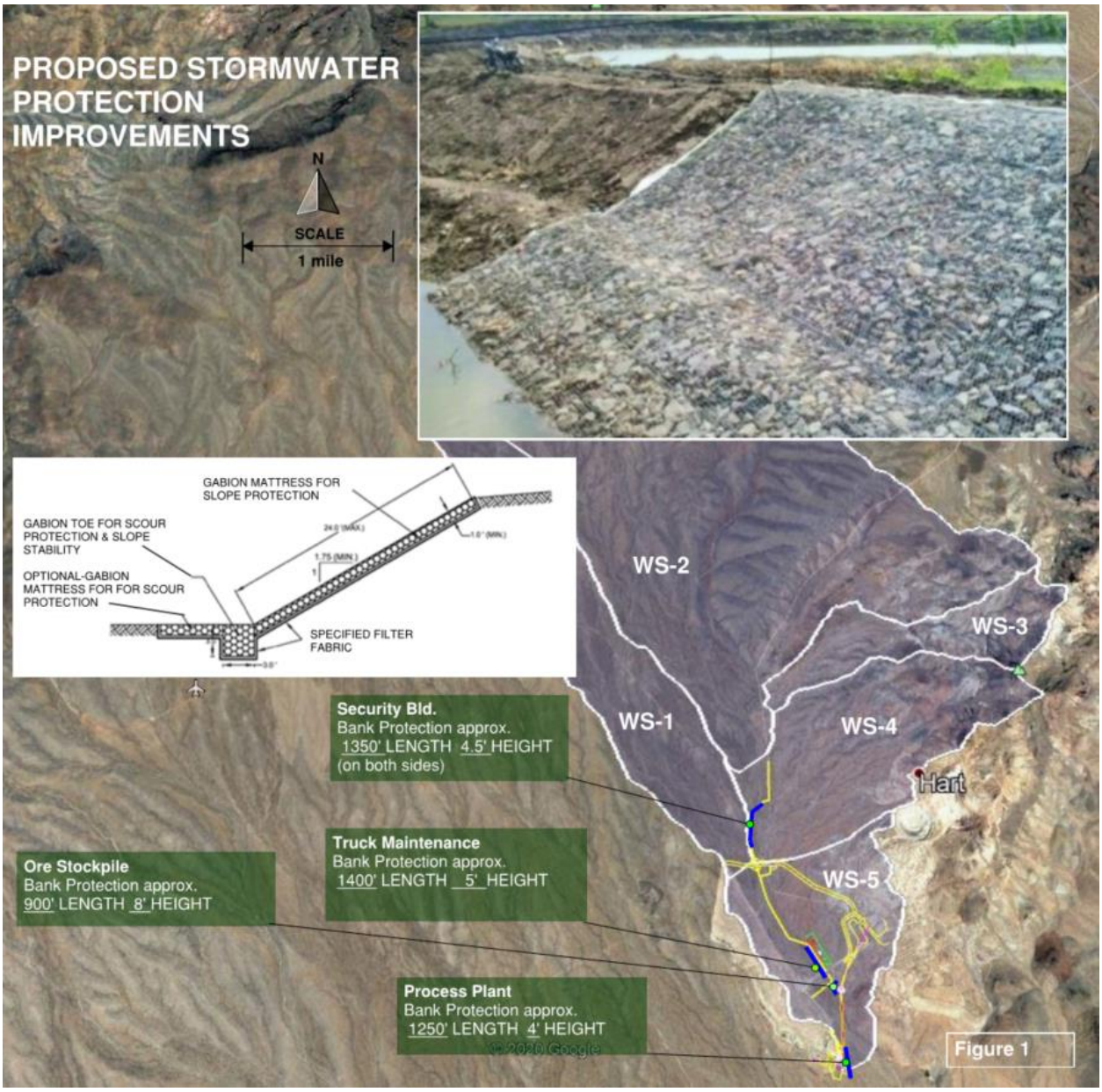


Figure 18-7: Stormwater Protection Plan

18.6 FILTERED TAILINGS FACILITY

18.6.1 Tailings Stacking Operation

Filtered tailings will be produced at a moisture content of 19% to 22% by dry weight basis (16-18% wet basis) and will be discharged into one of three reclaim chambers beneath the pressure filter deck of the tailings filtration building. This material will be recovered via front end wheel loader for loading into 40 ton articulated dump trucks. Filtered tailings material will then be transported along haul roads approximately 1 mile north of the main processing plant and dumped within a lined facility for spreading by dozer atop the reclaimed former Viceroy heap leach pad. Development of the filtered tailings facility will occur in four stages to allow for both the placement of appropriate volumes of material to match production and the rinsing of heap leach side slopes which will be covered by the final filtered tailings facility footprint. Rinsing is required to allow for recovery of residual remaining gold ounces within the heap as well as reduction of cyanide levels to compliant levels within the placed heap leach material prior to final reclamation.

Stacking of filtered tailings is considered best available technology for handling and placing of this type of material. By placing filtered tailings abutted to the new heap leach facility and on top of the historic leach pad the area of disturbance on the site will be minimized. This will increase the long-term stability on the western edge of the facility and allow integrated management of solution between the tailings and heap leach facility, allowing for further recycle of cyanide.

Upon Phase 2 mill start-up, tailings will be placed initially in a 1.5 million ft^2 graded and lined starter cell, V1. This facility will stand alone initially on top of the historic Viceroy heap leach pad. In order to allow for the facility to drain (primarily from precipitation events) into the adjacent heap leach pad, 600,000 yd^3 of gravel material from the pad will be removed from under the footprint of this cell and graded accordingly sloped towards the heap. This material is to be utilized in construction of the heap leach pad underliner and overliner as it expands in size and will be staged accordingly. Starter cell, V1 will contain 2.2 million yd^3 of tailings capacity and service mill production through the first 2 years. The starter cell is strategically sized to allow for placement of tailings while allowing for operations to begin the rinse process on the eastern slope of the Phase 1 heap. Starter cell V1 stacking plan is illustrated in Figure 18-8.

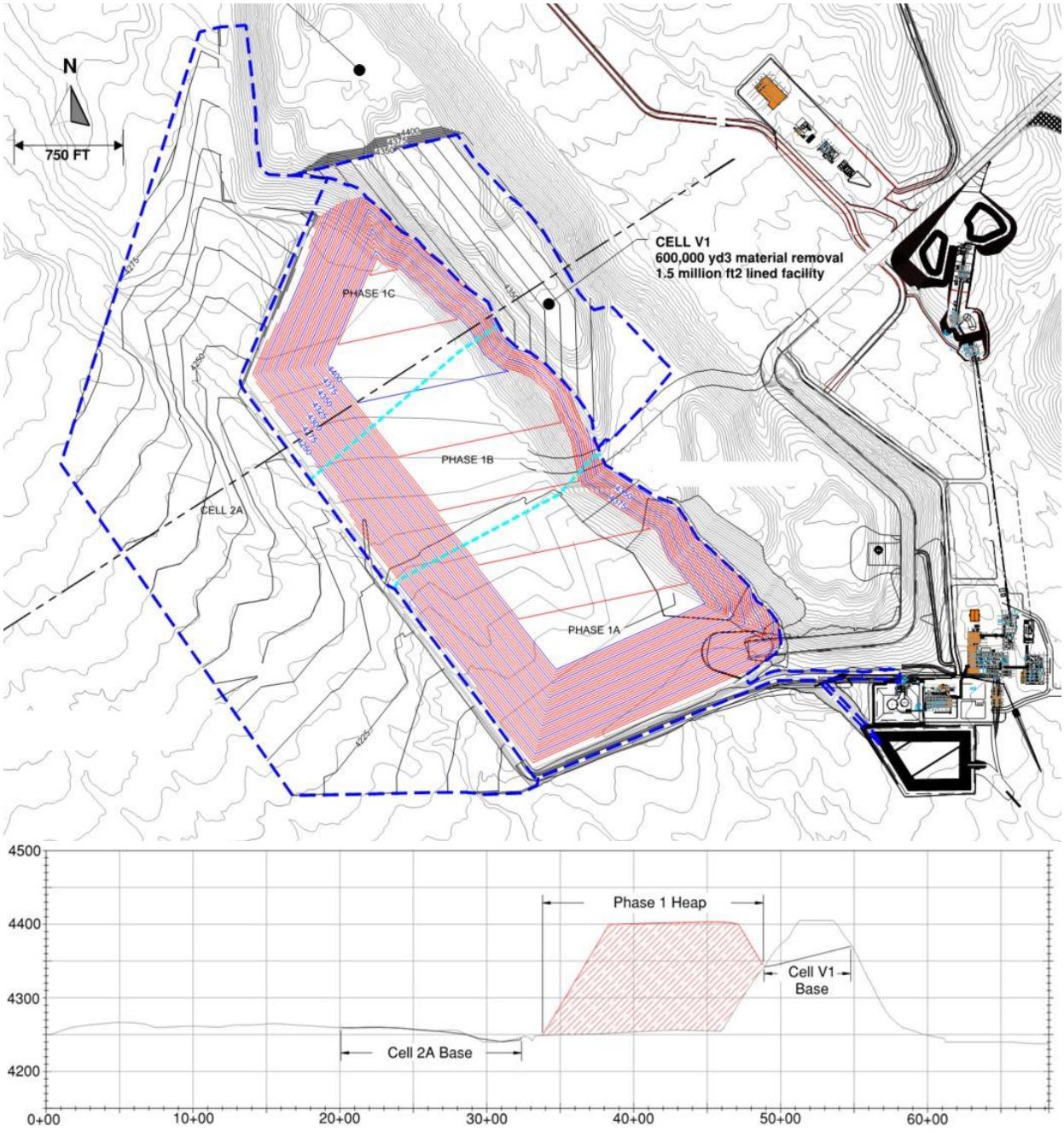


Figure 18-8: Tailings Stacking Cell V1 (Phase 2 Start-up)

Expansion of the tailings facility will occur in Year 3 after Phase 2 start-up and result in a newly lined and adjacent tailings placement cell V2 to the North of Cell V1. The combined capacity for tailings of cells V1 and V2 is 3.7 million yd^3 without extending up the sides of the Phase 1 heap and will allow for an additional 2 years of tailings placement (4 years total post Phase 2 start-up). Historical data has indicated that operations at Viceroy took approximately 3 years of rinsing to achieve acceptable residual levels of cyanide within the heap. Assuming a similar rinse period, these two cells will allow for adequate capacity to rinse the Phase 1 side slopes and allow for further placement of tailings on top of the Phase 1 heap slopes moving forward. Cells V1/V2 stacking plan is illustrated in Figure 18-9.

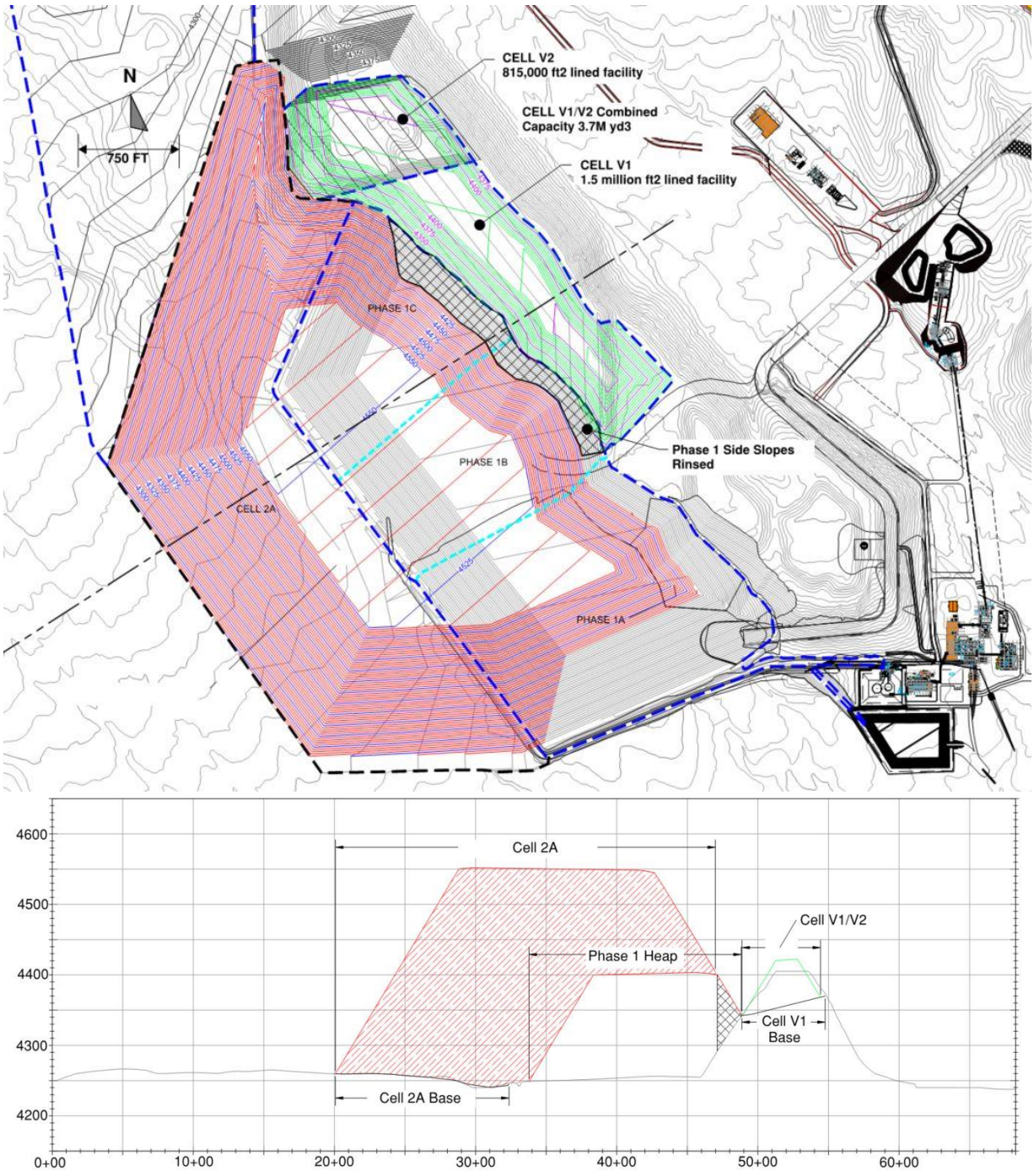


Figure 18-9: Tailings Stacking Cell V1+V2 (Through Year 4)

Upon completion of rinsing of the Phase 1 side slopes, placement of tailings in between cells V1 and V2 and the Phase 1 side slope can commence. This will increase the overall total capacity to 6.6 million yd^3 and provide adequate storage capacity through Year 7 of Phase 2 operations. Throughout utilization of these earlier cells, the Phase 2 Cell 2A heap leach pad will have been built up to final elevation. Once the eastern slopes of the pad come available and have been leached, rinsing will commence to allow for further stacking of the tailings abutted to this slope. Filtered tailings stacking plan through Year 7 is illustrated in Figure 18-10.

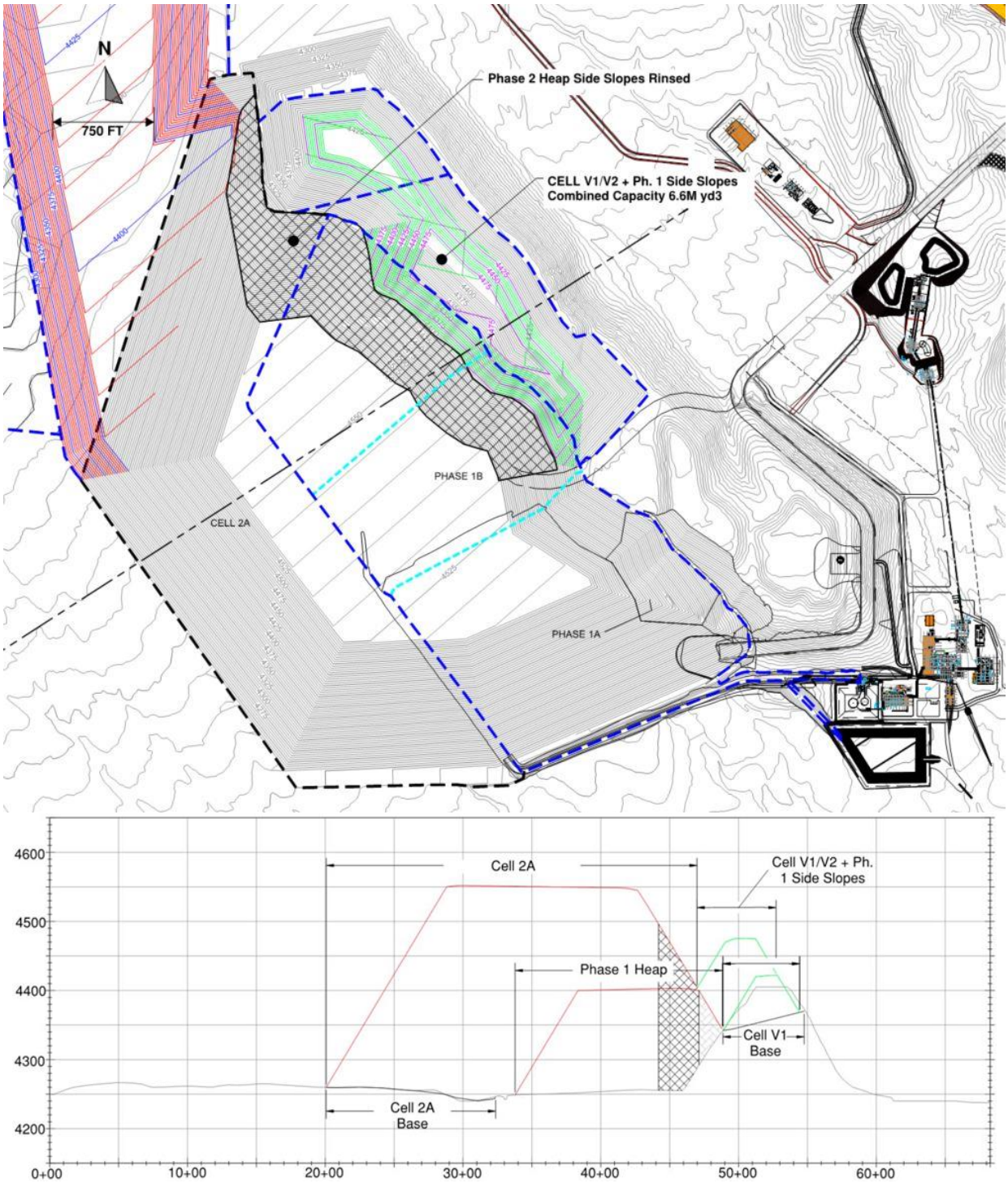


Figure 18-10: Tailings Stacking Cell V1+V2+Ph. 1 Slopes (Through Year 7)

Upon completion of rinsing of the Phase 2A side slopes, placement of tailings in between stacked filtered tailings cells and the Phase 2A side slope can commence. This will increase the overall total potential capacity to 16 million yd^3 and provide adequate storage capacity through the current life of Phase 2 operations (11 million yd^3) as well as the ability to handle future extensions to the life of mine plan. Filtered tailings stacking plan through Year 14 is illustrated in Figure 18-11.

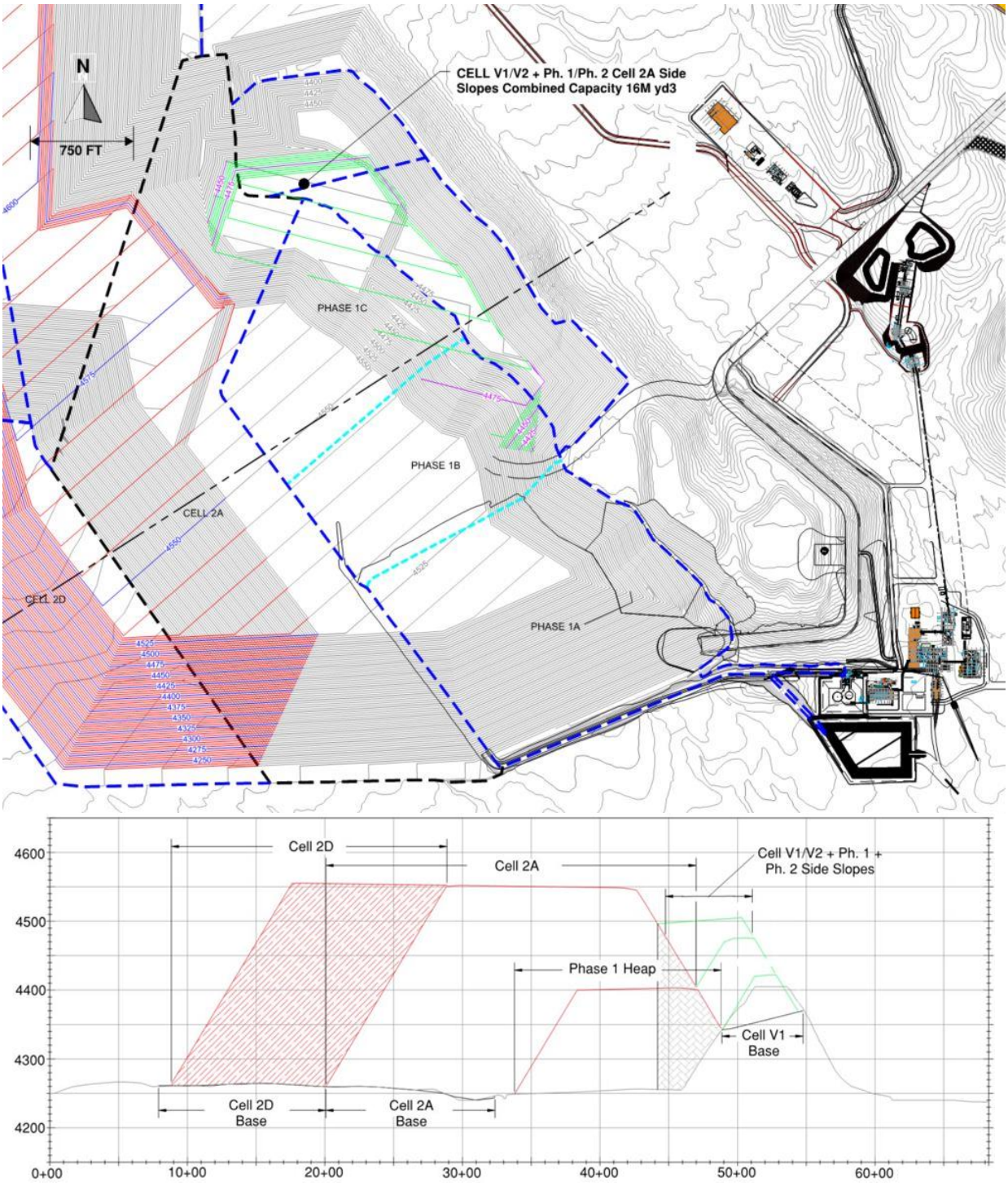


Figure 18-11: Tailings Stacking Cell V1+V2+Ph. 1+Ph. 2 Cell 2A Slopes (Through LOM)

The filtered tailings storage facility requires the management of partially dewatered tailings. Filtered tailings comprise an unsaturated cake with saturation levels ranging from about 50% to 85% and they typically are delivered to the pad at a moisture level above the optimum moisture required for compaction. Therefore, the tailings are spread and allowed to dry either through drainage and/or evaporation, prior to compaction.

Compaction will be handled by a padfoot vibratory steel drum compactor (CAT CP533 or equivalent). Studies of evaporation potential and compressibility were performed to identify an optimized lift thickness of approximately 20 in to 28 in which provides the greatest likelihood of achieving a minimum required density of 100 pounds per cubic foot (pcf), and assures stable slopes at 3 horizontal to 1 vertical to a maximum height of 125 ft above surrounding grade for the initial East facility or up to 205 ft above the spent ore of the historic heap leach pad. The drying and compaction of the tailings will assure that the stacked tailings will not experience strength loss from “contractive behavior”, either due to static liquefaction or to seismic liquefaction (i.e. from earthquakes).

Filtered tailings have a number of advantages over wet tailings disposal facilities including:

1. A reduction in overall water consumption.
2. Storage of a larger, denser volume of tailing on a smaller footprint.
3. The ability to perform concurrent reclamation.
4. Improved long term stability and reduction of stability risk.

18.6.2 Tailings Material Characterization

Filtered tailings facility design is generally a function of key material properties. In order to define the design criteria a series of material characterization tests were conducted on the two master composite samples described in Section 13.7.1, called the Main Pit composite and South Domes composite. The tests included hydrometer and sieve analysis, plasticity, consolidation properties, hydraulic conductivity, specific gravity, compaction testing, and triaxial shear strength testing, and results were provided by the MINES Group (MINES Group, 2020).

The two material samples were similar in many ways, but significantly different in others. The South Domes composite acted much like a non-plastic silty sand and the Main Pit composite acted more like a plastic clay. The design criteria were selected to enable proper storage within the facility for both types of material at varying times during mine operation.

18.6.3 Tailings Facility Design

Key resulting design criteria for the filtered tailings facilities can be seen in Table 18-4.

Table 18-4: Filtered Tailing Facility Design Criteria

Description	Units	Value
Tailings Storage Volume Required	ton	17,700,000
Average Delivery Rate	ton/day	3,500
Recommended Lift Height	m	0.5 - 1
Lift Cycle Times	days	6-35
Total Stack Height	ft	150
Side Slopes Required	-	3H:1V
Static Factor of Safety	-	⩾ 1.3
Facility Max. Volume Available	ton	22,200,000
Facility Base Area	ft^2	2,315,000

The filtered tailings facility will be a multiple-lift, single-use type pad utilizing a single-liner system consisting of prepared subgrade atop the historic Viceroy heap leach pad. The Viceroy heap facility will utilize a primary 80 mill LLDPE geomembrane liner allowing drainage to the Phase 2 heap leach lined facility. Figure 18-12 shows the Viceroy heap filtered tailings facility liner concept.

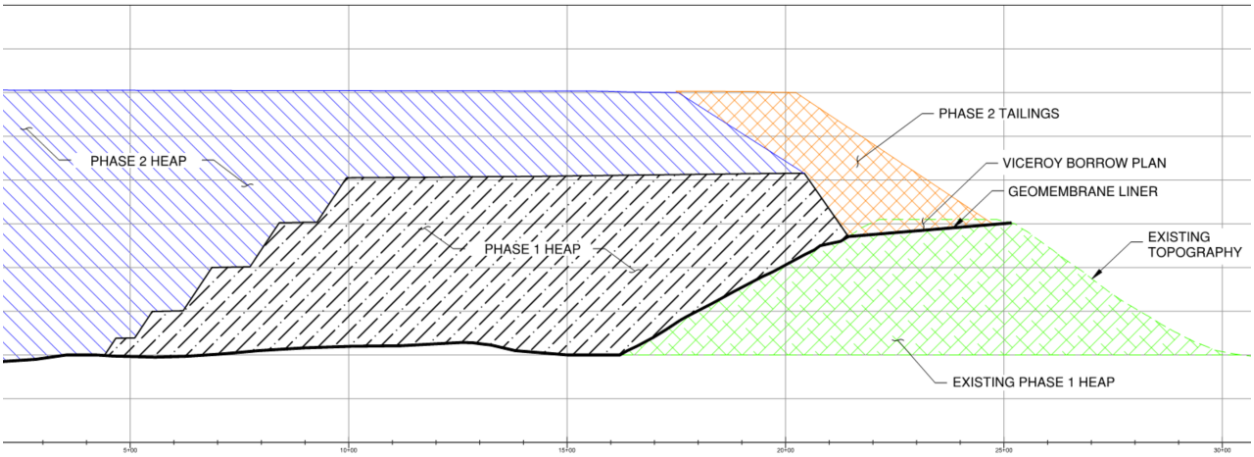


Figure 18-12: Filtered Tailings Design Layers (Viceroy Heap Facility)

For any given phase, it is assumed that about 90% of the lined area will be available for the stacking of tailings. The remaining 10% will be dedicated to access and drainage corridors with either bare liner or liner with a thin liner cover layer. Compaction to the minimum density of 100 pcf assures the existence of a stable structural embankment zone around the perimeter of the tailing facility.

The lift cycle is a function of the tailings production rate, lift thickness, and the available surface area for stacking and is a measure of the number of days the newly deposited tailings will be open and exposed to drying through evaporation prior to being covered by another layer of tailings.

The facility layout and phasing provide adequate room for the containment of any abnormally wet or weak tailing materials from occasional filter press upset conditions in a central core area, well behind the structural embankment.

The facility has been designed for the management of erosion from the exposed tailings surface. The Viceroy heap facility will be sloped and connected to the Phase 2 heap leach pad so as to allow drainage of rain events. Rain reporting from this facility will ultimately consolidate with solution flows within the heap and report to the solution collection pipe or lined channel and event pond.

Wind erosion is also a concern on the exposed tailings surface and will be managed during normal operations with the application of water and/or the use of chemical palliatives. Control of both water and wind erosion during reclamation and closure will be accomplished through the application of a surface armoring layer. Figure 18-13 illustrates the final life of mine filtered tailings footprint and site plan looking west.

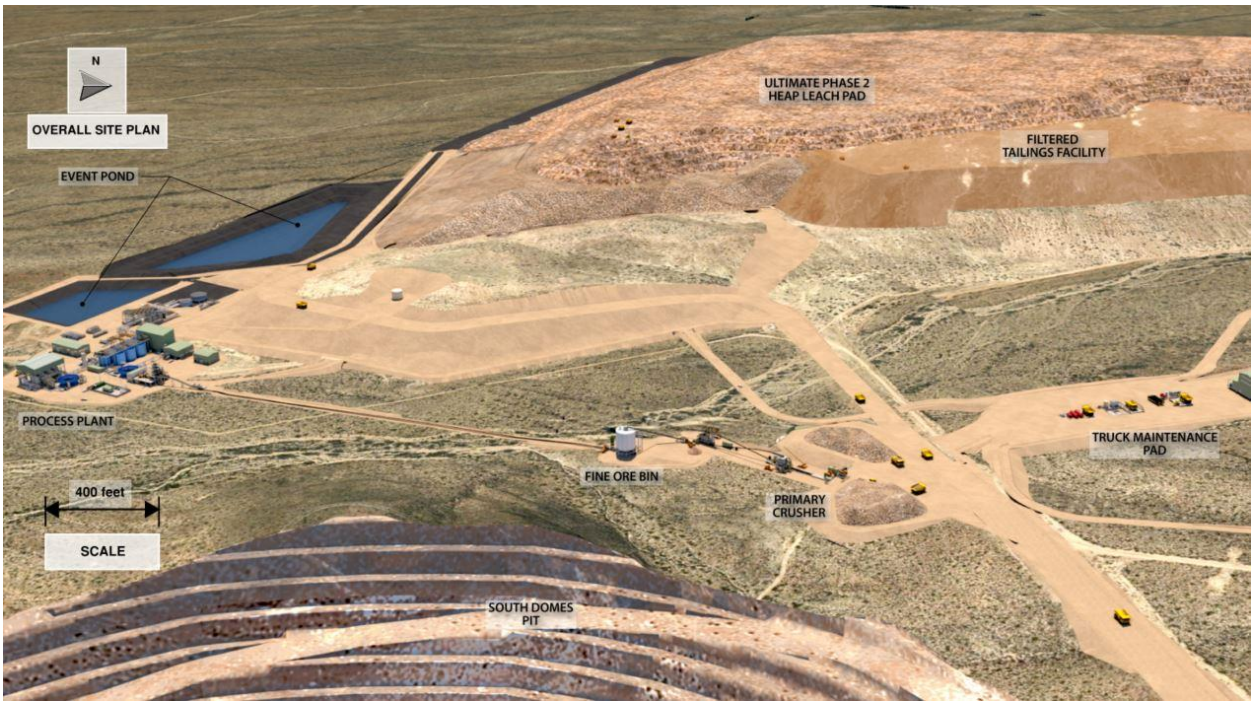


Figure 18-13: Site Plan Looking West

18.7 POWER

18.7.1 Power Supply

The project requirements are approximately 10 MW of power. Electrical power will be provided by connection to the grid at an existing Nevada Energy (NVE) sub-station near Searchlight, NV and routed to site via a new transmission line. The transmission line is expected to be managed in a co-operative arrangement between Southern California Edison (SCE) and NVE.

Power from the Searchlight sub-station will be provided via a 69 kV transmission line re-built by NVE and SCE to follow the existing right of way to the west occupied by active NV Energy equipment supplying Walking Box Ranch approximately 6.5 miles. It will then head South for approximately 17 miles along the site access road via newly constructed overhead line to the project sub-station on site. Figure 18-14 shows the intended transmission line route from Searchlight, NV.

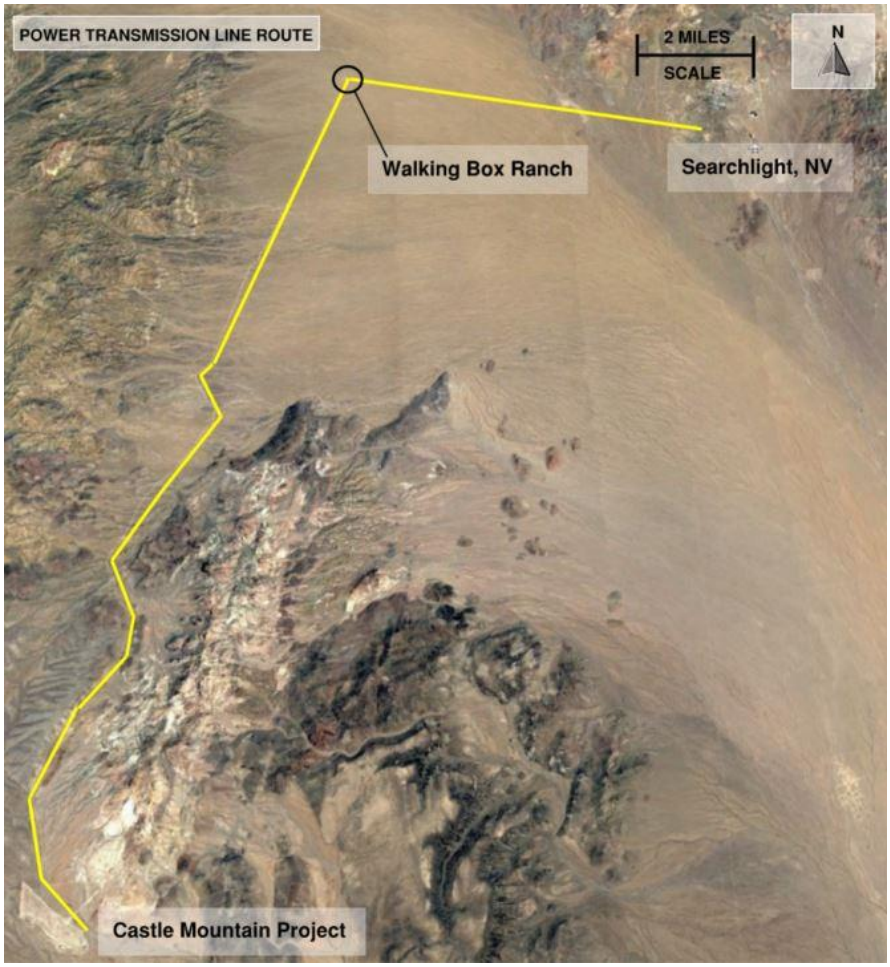


Figure 18-14: Power Transmission Line Route

18.7.2 Alternative Power Supply

Several alternatives have been examined for power supply using a natural gas-fired power plant. The options considered included a 3rd party power supply through a private power agreement (PPA) with a newly constructed gas power plant near Searchlight. In this case power would be routed to site on a 138 kV transmission line following a similar right of way to the permanent utility line described above. Another alternative considered is building an on-site gas power generating plant utilizing liquified natural gas (LNG) delivery from Topock, AZ.

Both options provide a feasible solution for the project, however connecting to the regional grid provides the added benefit of allowing incorporation of renewable power sources such as solar and provides for the lowest operating power rate for the life of the project.

The location and climate of the project area provides an ideal opportunity to implement solar power and take advantage of a plentiful renewable resource while reducing the project's carbon footprint. This potential opportunity has been investigated and is presented in Section 26.

18.7.3 Project Electrical Loads

In addition to the loads for the main process plant described in Section 17.3.11, power demands were estimated for the off-site demands and site ancillaries to determine a total demand load. Table 18-5 below summarizes the total anticipated Phase 2 estimated running load of 9.9 MW. Under the current plan of service by SCE, off site loads relating to the sourcing of water to the North would be serviced by SCE from their existing distribution line near Nipton, CA.

Table 18-5: Summary of Process Area Power Consumption

Code and Area Description	Estimated Running Load (MW)
On-site Process Facilities	8.4
On-site Ancillary Facilities	0.3
Off-site facilities (Water Sourcing)	1.2
Total	**9.9**

Project Phase 1 operations currently utilize four (4) Tier 4F, 455 kW diesel generators on site. These generators would be installed to act as emergency power back-up for key process needs such as agitator drives, the carbon regeneration kiln and ventilation needs.

18.7.4 Power Distribution

Power distribution on site will consist of a 4,160 V overhead distribution line from the main substation to the north process facilities including primary crushing, fine crushing and ore storage as well as ancillary facilities and existing facilities located towards the access gate and mine. 4,160 V power will also be distributed via underground duct bank to the process area electrical houses and transformed to 480 V and 120 V as required to power equipment, utility and instrumentation needs.

Uninterruptable power supplies will be used to provide back-up power to critical control systems. This equipment would be sized to permit operations to shut down and back up the computer and control systems and to facilitate start-up on restoration of normal generator power. Battery power packs would supply back-up power to fire alarm systems and egress lighting fixtures.

18.8 SEWAGE AND WASTE

18.8.1 Sewage Handling

On-site sewage will flow by gravity to local septic systems located in proximity to points of use. Septic systems and leach fields will be sized appropriately for building occupancy.

18.8.2 Solid Waste

Solid waste will be managed in dumpsters or other appropriate waste containers. All containers will be covered (or covered and weighted if covers are not attached) to reduce the potential for blowing trash and to prevent access by wildlife. Containers used on site will be labeled. Trash from office and lunch areas will be bagged. A licensed waste management company will transport collected waste to a dedicated offsite third party-controlled landfill site.

18.8.3 Hazardous Waste

Hazardous waste will be placed in drums, put on pallets, and stored in secure, impermeable, and appropriately sized containers, providing the required secondary containment, until being hauled offsite by a licensed contractor. Hazardous waste will be disposed of in a safe and environmentally sound manner using outside contractors.

18.9 COMMUNICATION & CONTROLS

The Castle Mountain Project currently has connection to an Internet Service Provider (Century Link) via the Crown Castle Tower, East Ridge Repeater, Big Chief Tower, and to the operating Phase 1 Administration Building. The Phase 2 expansion project will continue to utilize this connection.

The Phase 1 Administration Building is the starting point for the layout of the new Phase 2 Fiber Optic campus backbone for site communications including process, process cameras, security, fire, and VoIP/Data. The main fiber optic trunk will be routed from the Phase I Administration Building to the Phase 2 Grinding Area Server Room through an IT firewall to the Process Historian and on to the Process firewall. The Grinding Area Server Room will be the hub for distribution for other areas.

Further consideration was included for cyber security by the utilization of a UTM (Unified Threat Management) unit, a NIDS (Network Intrusion Detection System) unit, and a SEM (Security Event Management) linked to the Network Administration.

The existing control system utilizes a Rockwell Automation solution and Rockwell will be used for the Phase 2 expanded control system to ensure a common platform and the ease of merging the two systems. The plan is to leave the Phase 1 control system intact and undisturbed so that it may continue to function as operations requires, and it would then interface with the Phase 2 controls to allow operation from either control room.

Phase 2 servers that are located in the Grinding Area Server Room will be the central area for various areas' Programmable Logic Controller (PLC) to report to with the Human Machine Interfaces (HMI(s)) being located in the Grinding Control Room. Other HMI(s) would be located at the Primary Crusher Control Room to allow control of the Primary Crusher, Secondary Crusher, and Screen/Transfer up to Fine Ore Storage. All required information from the primary crushing area would still be trended and historized in the Grinding Servers.

19 MARKET STUDIES AND CONTRACTS

No market studies or contracts were conducted for the Project.

The process facility will produce gold doré bars which are routinely sold to third party refiners. The feasibility study assumes the refining and transportation costs will be $1.51 per ounce of gold and the refiner will pay 99.5% of the value for the gold.

20 ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT

The Castle Mountain Mine encompasses both public and private land, accordingly, the County of San Bernardino and the United States Bureau of Land Management (BLM) have historically served as co-leading agencies for implementing environmental review. The 1990 Environmental Impact Statement / Environmental Impact Report (1990 EIS/EIR), the 1998 Castle Mountain Mine Expansion project Environmental Impact Statement / Environmental Impact Report (1998 EIS/EIR), and the 2020 BLM Environmental Assessment cumulatively provided the impact analysis, mitigation and resulting lead agency authorization for current mine operations.

The Castle Mountain Mine historically acquired all relevant lead agency (discretionary) and local (non-discretionary) operating permits commencing in 1990 until activity at the mine was largely suspended by 2005 (after which some discretionary permits were relinquished). Reclamation became a significant focus beginning in 2001 and continued until about 2006, followed by a reclamation monitoring period of approximately six-years. Monitoring concluded after the lead agencies determined that reclamation success standards were achieved by 2012. During periods of suspended activity, the site operated through implementation of an approved Interim Management Plan (IMP) which preserved the validity of certain permits until termination of the IMP concurrent with resumed mining at the project site.

In January 2019, CMV submitted an application to the co-lead agencies to consider and approve minor modifications to the approved Mine Plan and Reclamation Plan (Mine and Rec Plan). Through their review of the plan amendment application, both agencies determined the proposed changes to be minor in scope, and the resulting environmental impact was adequately analyzed both through the 2020 Environmental Assessment (EA) and during previous California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) reviews conducted to date.

On August 23rd, 2019, the County Land Use Services Department approved minor revisions to the Mine and Reclamation Plan and issued a revised Mining Conditional Use Permit (CUP) and Reclamation Plan 90M-013 which expires December 31st, 2035. This revised mining CUP, in addition to the 1998 CUP and associated environmental review, provide the basis and authorization for current mine operations at the project site. While mineral exploration can sometimes be considered synonymous with “active mining”, for the sake of this discussion, active mining operations resumed in 2020 with active open pit mining and cyanide heap leaching.

Regarding the most recent BLM NEPA analysis, the 2020 EA, most of this analysis was specific to the installation of five new groundwater elevation monitoring wells at the project site. After completing the EA and responding to public comments, the BLM issued a Decision Record and Finding of No Significant Impact (FONSI) and approved the revised Mine and Reclamation Plan on February 27th, 2020.

Historic and current resource monitoring on the Project site include the following:

- Groundwater elevations in water production wells and regional monitoring wells.
- Flow and water quality monitoring at Piute Springs.
- Groundwater quality in monitoring wells located near the leach pad and mining operations.
- Stormwater surveillance.

- Vegetation inventories and propagation of indigenous plant communities.
- Dedicated programs surveying the movements and tracking of desert tortoise, bighorn sheep, bats, golden eagle, etc.
- Additional wildlife monitoring programs as applicable.
- PM-10 perimeter air monitoring.
- Meteorological weather station monitoring.

Mine expansion is expected to require new or updated environmental review (likely in the format of an EIS/EIR) as well as several new state and federal permits and amendments.

20.1 ENVIRONMENTAL STUDIES

In 2017 and 2018, several flora, fauna, hydrology, and cultural resource studies were performed to confirm whether the original baseline studies are still representative of the environmental, ecological, and cultural resources at the Project site. To date, these studies have all indicated that there have been no significant changes to site baseline conditions, so a combination of the previous EIS/EIR(s) analysis, combined with ongoing updates associated with mine expansion will properly characterize potential resource effects from mine expansion activity.

20.1.1 Flora and Fauna

Floral and faunal assessments generally target species that are state or federally protected and identified as potentially present at the Project site. Assessments are completed by expert consultants respective to each specific resource, and in some instances, multiple individual assessments are required to completely document a species and its abundance (or absence) at the Project site. Local, state and federal protections may include:

- Federal listing to the Endangered Species Act (ESA)
- State listing to the California Endangered Species Act (CESA)
- The Bald and Golden Eagle Protection Act
- BLM Special Status Species
- State protected species
- Local county ordinances

20.1.1.1 Flora

A multitude of botanical reports spanning over 30 years have confirmed that no state or federal threatened or endangered plant species are known or expected to occur on or adjacent to the Project.

There are multiple plant species listed as a BLM Special Status Species (SSS) with the potential to occur at the Project site. These species are in part defined through a rare plant ranking system developed by the California Native Plant Society. One species on the list that is known to occur on the Project site is the rosy two-tone beardtongue (penstemon bicolor ssp. roseus). The presence of this species is attributed to the success of reclamation work performed to date at the Project site. The species is most frequently documented as occurring on reclaimed mine land because of its inclusion in the revegetation seed mixture used at the Project site. In addition, it

appears this species requires land disturbance for successful seed germination[1]. Ongoing mitigation used at the Project site includes transplantation and annual seed collection of the species, these practices will continue indefinitely.

Though not a state or federally protected species, the eastern Joshua tree is also prevalent throughout the Project area. Nonetheless, impact to this species is mitigated through salvage and transplant to onsite plant nurseries, salvage and donation to third parties, and collection of seed for use in future revegetation.

20.1.1.2 Fauna

The Project area has a wide variety of habitat types from high elevation rocky slopes to desert washes and grasslands that can support a variety of wildlife species. Wildlife that is most often the focus for resource assessments include:

- Desert Bighorn Sheep (ovis canadensis nelsoni)[2]
- Desert Tortoise (Gopherus agassizii)
- Bats
- Raptors (Golden Eagle)
- Mountain Lion

Nelson's Bighorn Sheep is listed as a state fully protected species though not listed as either state or federally protected as threatened or endangered. Sheep are often seen at the project and prefer steep, less vegetated rocky terrain as a means to avoid and escape predators. The original water guzzler at the Project site provides the sheep and other wildlife with a water supply through the dry summer months. As of late 2020, a second wildlife guzzler has been installed north of the mine pits. This guzzler is the result of a cooperative project with the Society for the Conservation of Bighorn Sheep (SCBS) and it provides a secondary option for sheep access to water that has historically been provided by the main guzzler. Additional cooperation is also ongoing with California Dept. of Fish & Wildlife experts regarding monitoring of the sheep including annual health assessments, collaring and species tracking.

The desert tortoise is listed as a "threatened" species by Federal and State authorities. Desert tortoise habitat is found in some portions of the Project area, though no Project lands are considered critical habitat. Tortoises occupy a variety of habitats from flats and slopes dominated by creosote bush scrub at lower elevations to rocky slopes in higher elevations dominated by black brush scrub and juniper. They can be found in elevations from sea level to 7,300 ft. and prefer elevations between 1,000 ft. to 3,000 ft. Federal law prohibits activities resulting in harm or "take" of listed species and provides significant penalties for violations. However, the law also provides procedures for legally impacting threatened or endangered species under certain circumstances. Two Biological Opinions[3,4] permit the disturbance of up to 1,128-acres of tortoise habitat and a "take" permit in the form of direct mortality to ten desert tortoises at the Project site and access roads. Historic records indicate two desert tortoise mortalities were reported along

[1] All known occurrences at the project site are located in conjunction with recent land disturbance activity.
[2] Peninsular bighorn sheep (ovis canadensis nelsoni) and Sierra Nevada bighorn sheep (ovis canadensis sierrae) are the only subspecies protected at both the federal and state level as threatened under their respective endangered species acts. Neither of these species are found at the Project site.
[3] 1990 U.S. FWS Biological Opinion #1-6-90-F-24
[4] 1997 U.S. FWS Biological Opinion #1-8-97-F-37

the access roads in the 1990s, though it is unclear whether these were attributed to mine operations or other causes related to public use of the open mine access road.

The need to protect the desert tortoise during construction and operation at the Project has always been important to CMV. CMV has committed previously to specific project changes, specifically during the 1990 and 1998 EIS/EIRs. For example, mine access roads were re-aligned to avoid higher quality desert tortoise habitat, almost five miles of desert tortoise fence was installed to exclude the tortoise from the most active areas of the Project, as well as additional compensatory mitigations provided by CMV. Between 1990 and 1998, over 920-acres of mitigation land was purchased by CMV and transferred to the U.S. BLM, as well as a deposit of $92,000 by the mine operator to U.S. BLM. Cumulatively, these concessions permit disturbance to 1,128 acres of desert tortoise habitat that would potentially be impacted by project operations. Other mitigations were also incorporated into County, BLM, and U.S. FWS permit conditions such as construction of perimeter exclusion fencing, speed limits on area roads, raven monitoring, the requirement of biological monitors during mine activity outside of fenced areas, tortoise awareness training, and annual reporting on species activity, to name but a few protective/compensatory mitigations required at the Project to lessen impact to desert tortoise. These mitigations coupled with the low density of tortoise found at the Project site throughout 30 years of monitoring and studies, provided for the U.S. FWS determination that the Project will not result in “jeopardy” or harm to the desert tortoise population.

Other faunal species that were identified for further assessment include bats, raptors (particularly the golden eagle), and potentially, mountain lion. Mitigation measures include, but are not limited to, fencing, netting, lighting placement, and strategic powerline design were considered as part of the wildlife impact mitigation strategy.

While additional faunal assessment surveys are planned for 2021, to date, all recent surveys have supported the baseline characteristics formed by previous impact studies conducted at the Project site. Therefore, any significant new information or changed circumstance regarding any state or federally protected species that has the potential to suffer project related impact is not anticipated.

20.1.2 Air Quality and Greenhouse Gas Emissions

Sources of air pollution are those with potential to emit (PTE) criteria pollutants or toxic air contaminants. All potential sources of air emissions, including both stationary and mobile sources, are reviewed, inventoried, and modeled during the lead agency NEPA and CEQA process. The NEPA and CEQA process also includes an evaluation of greenhouse gas (GHG) emissions associated with the proposed Project. Following NEPA and CEQA impact analysis and upon subsequent approvals, stationary sources of criteria and toxic air contaminant emissions are evaluated for local air district permitting.

Baseline air quality levels for particulate matter 10 microns or smaller (PM_{10}) at the project fence-line were developed during original project permitting in the 1990’s. Renewed monitoring began in 2020 with the installation of four air monitoring stations located at one upwind and two downwind fence-line locations. All locations are equipped with a Met One Instruments E-BAM model (E-BAM) using a PM_{10} Omni-directional Inlet. One of the downwind locations is also outfitted with a Met One Instruments E-BAM Plus model unit (E-BAM Plus). The E-BAM Plus has been designated and approved by the United States Environmental Protection Agency (USEPA) as a Federal Equivalency Method (FEM) for measurement of PM_{10}, as set forth in 40 CFR Part

53. The addition of the E-BAM Plus unit affords comparison and traceability to a PM_{10} FEM monitoring method.

Meteorological data is also collected at the Project site by a modeling quality 10-meter meteorological tower. Parameters recorded include:

- Wind speed (avg. and max. gust) and direction
- Temperature (at 2 and 10 meters above ground level)
- Relative humidity
- Barometric pressure
- Solar radiation
- Precipitation
- Evaporation (pan) depth and rate

Project GHG emissions are defined by the EPA in two different areas as follows:

- Scope 1 emissions are the most significant and are generated by the mobile mining equipment fleet through the burning of diesel fuel.
- Scope 2 emissions are less significant and are generated indirectly through the generation of power off-site by the utility.

Project GHG may be offset by purchasing renewable energy credits or by direct connection to a renewable energy power plant. The use of renewable energy has been extensively investigated and the Castle Mountain site offers high potential for reducing reliance on conventional power generation. A solar plant using photovoltaic technology has been examined in detail and presents an excellent opportunity to the Project to reduce GHG emission and lower reliance on electrical power provided by utilities. Utilization of a solar plant prior to Phase 2 start-up would also have the added benefit of eliminating the need for operating the current diesel generators on site. The solar plant opportunity is summarized further in Section 26. Options will be further assessed to lessen project impacts related to GHGs. Criteria pollutants or toxic air contaminants will be further reduced for mine expansion through continued use of mobile equipment classified as meeting Tier 4 emission standards.

20.1.3 Hydrology and Hydrogeology

The Lanfair Valley surface water drainage area is approximately 340 mi^2 in size. The maximum basin dimensions are approximately 20 miles (east to west) and 17 miles (north to south). The topographic relief on the basin floor is relatively low with gradients varying from 50 ft. to 200 ft. per mile. The mountain slopes lying above the alluvial floor represent approximately 80 mi^2, or about 24% of the total watershed. Streams (washes) within the valley are ephemeral and flow only in direct response to precipitation or snow melt. One exception is the perennial Piute Springs, located about 15 miles southeast from the mine. The Colorado River lies 28 miles east of the Project.

20.1.3.1 Piute Springs

Piute Springs is a significant perennial spring located approximately 15 miles southeast from the Project site, in the Piute Mountain range. Potential mine related impact to Piute Spring has been extensively studied since the late 1980's at the Castle Mountain region. Multiple hydrogeologic studies completed to date have arrived at the same conclusion, which is that available evidence

suggests water use at the mine site is not expected to significantly impact water flow at Piute Springs. Historical data spanning many years does show that spring flow naturally fluctuates, and this is generally attributed to seasonal and climactic effects experienced throughout the entire Mojave region. CMV maintains a network of groundwater monitoring wells that provide an early warning system[5] for any future potential impact to Piute Springs. Groundwater elevations are routinely recorded from a network of five monitoring wells.

The potential for future impact to Piute Spring, specifically related to mine expansion, will again be addressed by renewed hydrogeologic investigation and groundwater modeling to account for an expected increase in water use at the Project site.

20.1.3.2 Water Production and Use

The water source for operations is groundwater. All water required for the current mine operation is produced from two historical well fields, the West Well Field (WWF) and the East Well Field (EWF). WWF wells predominantly source water from wells drilled into saturated alluvium northwest from the main project area, whereas EWF wells source water from deep bedrock wells located along large fault zones throughout the mining area. The latter will also function as pit dewatering wells as mine pit depth increases. Five wells are currently available from the WWF and the EWF. The WWF wells are predominantly used to provide potable water to mine facilities.

The current permitted annual water use for the Project is 625 acre-feet per year. Proposed mine expansion activity anticipates an average water use of up to four times the current rate of water extraction during the dry season. The Project would extract water from multiple well fields, both existing and new, located in the Lanfair water basin and adjacent basins to the Project. The project will continue to conserve water by use of low evaporation drip emitters, burying drip emitters when feasible, limiting water in ponds with larger evaporative losses, use of binders and dust collectors that limit water needs for dust suppression and using extensive water recycling in the process. In addition, by drawing water from multiple well fields in different water basins, water is drawn from a larger area which lessens the demand on a single well field/aquifer. Further groundwater mathematical modeling is being undertaken to evaluate potential impacts. Water production and use is further discussed in Section 18.5.3.

20.1.3.3 Water Monitoring

Ten groundwater monitoring wells are located throughout the project area. Some wells are compliance (detection) monitoring wells associated with operation of the heap leach pad and ponds, while the primary function of others is for monitoring groundwater depth. Groundwater depth monitoring serves as an early warning detection system for potential impacts on the regional aquifer systems and the more distant Piute Springs. Water quality measurements were taken at several wells throughout the operation. Water quality sampling and monitoring resumed in 2020 under the direction of the California Regional Water Quality Control Board (RWQCB), Colorado River Basin Region, which will continue until final closure of the Project site. Currently, there are no known water quality impacts at or adjacent to the Project site, as a result of past or present commercial scale gold mining at the Project site.

Additional hydrological work has been conducted and/or is in progress to support both current mine operations and mine expansion. Groundwater models for the Project area continue to be

[5] Supplemental Plan for Groundwater Monitoring, Geo-Logic Associates, February 2019.

updated to estimate potential impacts associated with mine expansion. Additional monitoring wells have been installed south of the leach heap. These wells are used both for groundwater elevation monitoring and to provide additional aquifer characterization which may be used to guide the design of a potential water supply for mine expansion.

20.1.4 Cultural Resources

Cultural resources are places or objects that are important for scientific, historic and/or religious reasons to cultures, communities, groups, or individuals. Cultural resources include historic and prehistoric archaeological sites, architectural remains, structures, and artifacts that provide evidence of past human activity and places of importance in the traditions of societies or religions. Section 101 of the National Historic Preservation Act (NHPA) establishes procedures for determination of eligibility for listing historic and archaeological sites on the National Register of Historic Places (NRHP).

The earliest dated period of human occupation in the eastern Mojave Desert is estimated to be over 10,000 years following the last period of glaciation. As the climate became warmer and more arid, subsistence practices caused the inhabitants to change their way of life and became a more migratory society. The final period of human occupation in the region prior to Euro-American expansion was the Shoshonean Period. Southern Piute groups migrated southward replacing the Mojave groups.

In 1907, historic gold mining development in proximity to the current Project area created the town of Hart, one of several towns established in the Lanfair Valley. The population of the town ranged from 400 to 700 within two months of its founding. The 1910 census listed 40 residents and shortly thereafter was abandoned. Cultural resource field studies were undertaken as part of past environmental reviews to identify if there were any significant sites to be considered for inclusion in NRHP and/or the California Register of Historic Resources (CRHR). The field studies evaluated both historic and prehistoric resources at the Project site.

A multitude of surveys were completed between 1987 and 1998 on project and adjacent land. The former Hart townsite was itself found ineligible for listing to the NRHP in 1998. However, within the 3,910-acre approved project area, seven sites were deemed significant enough to warrant potential eligibility to the NRHP. All seven sites have been avoided as mitigation. Additional mitigation measures include a chain link fence built around the Hart town site cemetery and a 300-foot buffer zone separating the cemetery from the North Overburden Site. The remains of three individuals from the old Hart town are presumed buried at the cemetery. More recent Class III cultural resource surveys were completed in 2018 and produced an additional two sites that could be eligible for NRHP listing. Additional Class III investigation was completed in 2020 and a final report expected in 2021. Preliminary results have yielded one new and potentially eligible site. Regarding the ten potentially significant sites that have been avoided, at least two are not expected to be impacted by mine expansion, four may be removed as eligible sites, and the remaining four sites are scheduled for further investigation and (potentially) treatment plans may be warranted.

During previous and current operations, no paleontological or archaeological deposits were uncovered during the construction and operational phases of the Project.

20.1.5 Acid Rock Drainage Potential

Samples of mineralized ore, waste rock, and overburden, were subjected to geochemical testing during prior environmental review to evaluate the acid rock drainage (ARD) potential, acid generation potential, and extractable metals. The average neutralization potential (NP) was 54.3 tons $CaCO_3$/1,000 tons of material. The acid generating potential (AP) was 2.4 tons $CaCO_3$/1,000 tons of material resulting in an NP:AP ratio of 22.6. An NP:AP ratio greater than 3 or 4 is considered to have enough buffering capacity to mitigate hazards associated with acid rock drainage.

The 1998 EIS/EIR analyzed the potential for acidic conditions in pit water and found, once again, the acid-generating sulfide minerals found in project ore and waste rock are very limited, and the natural alkalinity provided by the rock, soils, and surface water inflows further minimize the potential for acidification of the pit water. The current permits require analysis for ARD potential in the pit water. Any pit containing poor water quality water would have to be backfilled. The surfaces of these backfilled pits would consist of coarse material to allow infiltration of meteoric waters to minimize ponding.

There was no evidence of ARD during the previous operations, and mine pit water at the bottom of Leslie Anne Pit did not show any signs of sulfidic oxidation. Based on historic analytical data and the previous operational experience, the potential for ARD is quite low. Notwithstanding the historical record documenting a low potential for acid rock drainage impacts, additional studies will occur to further document this potential within any underlying areas of potential mine expansion.

20.1.6 Visual Impact

Visual impact to the viewshed of the Lanfair valley has been assessed during each of the previous EIS/EIR reviews that concluded in 1990 and 1998. Viewshed impact was found not significant (after mitigations) in the 1990 EIS/EIR, but then found significant and unavoidable[6] in the 1998 EIS/EIR. The actual viewshed impact resulting from Viceroy operations at the project site was less than anticipated based on the very successful land reclamation and revegetation programs conducted at the Project site. It is anticipated that mine expansion will create significant and unavoidable visual impacts during active mining, even if they are found less than significant post mining. Further visual impact assessments will be undertaken to determine significance.

Irrespective of the final significance determination, public lands at the southern end of the Castle Mountain range, and encompassing the current and proposed mine expansion area, are classified as Class IV visual resource[7] lands. By definition, this ranking class assumes (permits) a high degree of modification to the natural landscape that may be a major focus of viewer attention. In summary, a finding of significant and unavoidable impact during active mining follows the findings of past assessments at the Project (1998 EIS/EIR) and is well within the land use planning objectives assigned to Visual Resource Class IV lands.

[6] Visual Impacts and Air Quality were the only two resource categories found as significant and unavoidable by the 1998 EIS/EIR report.
[7] BLM's regional (and most recent) land use plan covering public lands surround the project site is known as the Desert Renewable Energy Conservation Plan (DRECP). This land use planning amendment established a visual resource ranking classification from Class I (most protective against modification of the natural environment) to Class IV (least protective).

Visual impact mitigation measures will be taken during project design development such as selection of neutral desert paint colors for all facilities, tanks, and infrastructure, and design specifications requiring use of dark sky friendly plant and access lighting to minimize light pollution. Mitigation for impact to visual resources is further discussed in section 20.5, Mine Closure and Reclamation.

20.2 PROJECT PERMITTING AND PERMITTING PROCESS

20.2.1 Federal and State Environmental Reviews

Environmental impact review of mine development projects in this jurisdiction must comply with both state and federal impact review and planning analysis.

At the state level, the CEQA provides the mechanism for environmental review and additional planning and reclamation requirements are afforded through County implementation of California's Surface Mining and Reclamation Act (SMARA). Environmental review is conducted on the federal level through the NEPA process.

The federal lead agency with responsibility for the Project is the BLM. The California state lead agency for the Project is the County of San Bernardino (County). Both agencies cooperate to prepare a single environmental review document. The EIS/EIR, federal, state, county, and local agency officials review and comment on the analysis provided through the CEQA and NEPA process.

There are also multiple public review and comment periods as part of the scoping and public involvement process initiated by a Notice of Intent on the proposed action published in the Federal Register. Once the co-lead agencies complete and publish a Final EIS/EIR, then subsequently, each of the lead agencies prepare their respective approvals. The BLM issues a Record of Decision (ROD) and associated project stipulations to satisfy project specific mitigation measures adopted by the agency to lessen project impacts. The County will hold a final (public) hearing where the Planning Commission will ultimately vote to certify the EIR and approve (or deny) the CUP for the Project and associated conditions of approval, which similar to the BLM, provide mitigation to lessen project impacts.

Once lead agency operating permits have been granted, CMV can apply to remaining local, state, and federal agencies who issue further discretionary and non-discretionary permits.

20.2.2 Discretionary Operating Permits

Discretionary permits are those which can be denied following the completion of the specific permitting process; that is to say, completion of all required elements of the permitting process does not guarantee project approval by the lead agency. Project lead agency operating permits are generally issued following successful completion of the discretionary project review process that includes impact analysis, comparison to alternative actions, and public participation and comment. Aside from the lead agency discretionary permits (discussed above), additional discretionary authorization is required from the California regional Water Boards for operation of mine waste units; the resulting permit is known as a Waste Discharge Requirements (WDR). This is also a discretionary permit process that ends with a public hearing and vote by the regional water quality control board membership; all before a permit can be issued.

The Colorado River Basin Region RWQCB regulates surface and groundwater quality for waters of the state and waste discharges to land/water for the Project area, pursuant to California Water Code, and Title 27 California Code of Regulations (CCR). Specific to the type of activity at the Project site, the RWQCB regulates discharges of mining waste, operation of a waste management unit for treatment, storage, or disposal of a mining waste (mining unit), and for stormwater discharges associated with industrial or construction activity.

For a mine operation, the water board typically considers the heap leach pad and detoxified, filtered mill tailings (and ponds) as a Group B mining unit, and overburden rock piles as Group C mining units (or mining waste), per Title 27 of the CCR. While overburden is technically a recognized waste, a Group C mine waste is not expected to affect surface or groundwater quality.

A mine operator receives RWQCB approval to operate a mining unit after submitting a Report of Waste Discharge (ROWD) report and application. Once the ROWD application is deemed complete, a draft WDR permit will be issued for a 45-day public comment period. Following a response to applicable comments (and making any corresponding changes to the draft WDR permit), the RWQCB will assign a hearing date to the full regional water board membership where staff (and the applicant) will review the case file with the regional water board members during a public hearing. The hearing culminates with a vote of the board members either in favor of the RWQCB staff recommendation (to approve) the WDR permit, or alternatively, to deny it.

The RWQCB regulated mining units currently in operation at the Project site are operated under recently approved (June 2020) WDR Permit No. R7-2020-0004. A new or revised permit will be required for mine expansion facilities documented in this technical report.

20.2.3 Non-Discretionary Operating Permits

Nondiscretionary permits are generally those types of permits whereby once the permit process is successfully completed by an applicant, the issuing agency must issue a permit, there is no discretion for them not to issue if all requirements have been satisfied. Aside from the lead agency permits, most remaining local, state, and federal agency permits are non-discretionary type operating permits which are obtained for a project after the lead agency environmental analysis has been completed, mitigation measures assigned, and the proposed action authorized by the lead agencies. Noteworthy permits that will be necessary to construct and operate mine expansion facilities are found on Table 20-1. It should be noted that all the permits found on Table 20-1 are active at the current Project site; so, in some cases a new permit will be required, while other permits might be amended, or retained in current form.

A few of the more substantial non-discretionary permit processes are discussed in more detail in the ensuing sections 20.2.4 to 20.2.6 found below.

Table 20-1: Castle Mountain Mine Permit Requirements

Agency	Permit	Action Authorized	Permit Modification Required (For Mine Expansion)
U.S. Bureau of Land Management	Record of Decision (ROD)	Mining[8] – Federal	YES – Additional NEPA review; new ROD required
San Bernardino County	Mining Conditional Use Permit (CUP)	Mining[9] – State/County	YES – Additional CEQA review; new CUP required
National Park Service	Decision Record	Continued Existing Use (WWF) and access agreement	Temporary NPS Authorization[10] is currently provided.
U.S. Bureau of Land Management	Right-of-Way Lease (ROW)	Construction of roads/utilities	YES – New or amended ROWs required
U.S. Fish & Wildlife Service	Biological Opinion (BO) Authorizing Take	Take of Desert Tortoise (federal)	YES – Additional US FWS Section 7 Consultation; new Biological Opinion
Colorado River Basin Regional Water Quality Control Board (Region 7)	Waste Discharge Requirements (WDR)	Operation of: Heap Leach Pad and Ponds, Overburden	YES – Amended Waste Discharge Requirements for expanded heap leach facility (and support), and expanded overburden piles
Mojave Desert Air Quality Management District	Authority to Construct and Operate	Permit to emit air pollutants	YES – New ATC permits for new sources with the potential to emit air pollutants.
California Dept. of Fish and Wildlife	1602 Lake and Streambed Alteration Agreement	Disturbance to state jurisdictional drainage features	YES – Delineation of new land disturbance
California Dept. of Fish and Wildlife	2081 Incidental Take Permit	Take of Desert Tortoise (state)	POTENTIALLY[11]
U.S. Army Corps. of Engineers	Jurisdictional Determination[12]	Disturbance to Waters of the United States	POTENTIALLY – Additional delineation of new land disturbance is required to determine jurisdiction
Colorado River Basin Regional Water Quality Control Board (Region 7)	Industrial and/or Construction Stormwater General Permits	Discharge of pollutants or the prevention thereof, relating to industrial/construction activity	YES – Amended Stormwater Pollution Protection Plans will be required

[8] Including activities ancillary to mining.
[9] See note 8.
[10] Once NPS completes review of the pending Plan of Operations, and issues a permanent authorization, no further permitting modification is expected in association with mine expansion.
[11] At this project, CDFW historically has accepted the U.S. FWS Biological Opinions and not required a separate 2081 permit, nonetheless, this will be reviewed during mine expansion.
[12] If necessary, a Section 404 permit, likely a Nationwide Permit

Agency	Permit	Action Authorized	Permit Modification Required (For Mine Expansion)
San Bernardino County Fire Dept., Hazardous Materials Division	Hazardous Materials Business Plan	Storage and use of regulated hazardous materials	YES – HMBP will have to be amended to account of new/increased material quantity
San Bernardino County Fire Dept., Hazardous Materials Division	Hazardous Waste Generator/Handler	Handle/generate hazardous waste	YES – HMBP will have to be amended to account of new/increased material quantity
San Bernardino County Fire Dept., Hazardous Materials Division	California Accidental Release Plan (CalARP), Risk Management Plan	Above threshold storage of Sodium Cyanide	YES – HMBP will have to be amended to account of new/increased material quantity
San Bernardino County Public Health, Environmental Health Services	Public Water System Permit	Operate of state public water system	NO – Potential for minor modification
San Bernardino County Public Health, Environmental Health Services	Domestic Waste Discharge Permit	Install/operate a domestic sewage system	NO
San Bernardino County Building and Safety Dept and Office of the Fire Marshal	San Bernardino Building & Safety, and Fire Dept. construction permits	New/modified building construction	YES – New building and safety and fire permits will be required prior to construction

20.2.4 BLM Right-of-Way Permits

Right-of-way (ROW) permits may be required for certain access roads, water pipelines, and power line transmission corridors if changes to current systems are included with mine expansion. CMV has maintained right-of-way access across BLM managed roads through their inclusion in the current mining plan of operation and resulting 1998 Record of Decision and the 2020 Decision Record. Other, new, ROW lease agreements with the BLM, and potentially other agencies, will likely be required for installation of new infrastructure such as power or water lines associated with mine expansion.

20.2.5 Local Air District

The Mojave Desert Air Quality Management District (MDAQMD) is the local air district and enforces local district rules, California Air Resources Board (CARB) rules and regulations, and federal USEPA rules and regulations, as they apply to stationary sources of air pollution, including sources of fugitive dust.

20.2.5.1 Mobile Sources

Mobile sources most common at mine sites are heavy, diesel-fueled equipment which are regulated under a CARB rule known as the In-Use Off-Road Diesel-Fueled Fleets Regulation. Reporting and compliance are managed through the state's Diesel Off-Road On-Site Reporting System (DOORS), which is an online registration and management system that tracks mobile fleets. Regulated mobile fleets must be registered with DOORS. With some exceptions, all mobile equipment engines at the current Project site are classified as Tier 4 Interim or Tier 4 Final, which produce the lowest available level of PTE. The mobile fleet proposed for the mine expansion will continue to use mostly Tier 4 equipment.

20.2.5.2 Stationary Sources

Stationary sources (including what are commonly referred to as point sources) with the potential to emit air pollutants (including criteria and toxic air contaminants) must be permitted through the air district prior to construction and operation. The initial permits are known as Authorities to Construct (ATC) and transition into Permits to Operate (PTO) following construction and startup of operations. Once the operator is aware of the types of equipment (with PTE) and air emission control devices that will be used, applications and supporting documentation are submitted to the air district. MDAQMD staff will inform the applicant within 30 days if the application is complete, and permits are generally issued within the following 90 days. However, for more complicated project permits, a longer time period may be required.

Operating permits issued under Title V of the Clean Air Act (Title V permits), are also procured when potential emissions are above specified thresholds (often referred to as "major source" facilities), for specified non-major sources subject to regulation under the National Emissions Standards for Hazardous Air Pollutants (NESHAP), or in other specialized cases. For the proposed mine expansion operations, the Project would be subject to NESHAP Subpart EEEEEEE, and thus would be required to obtain a Title V operating permit, regardless of the level of emissions. Applications for Title V permits must be submitted within 12 months of commencing applicable operations.

GHG emissions from stationary sources are evaluated under CARB's Mandatory Reporting Rule (MRR), CARB's Cap-and-Trade Program, and USEPA's Greenhouse Gas Reporting Program

(GHGRP). Depending on the level of emissions, reporting may be required under one or both of the CARB MRR program and USEPA GHGRP, and the procurement of carbon allowances may be required under the CARB Cap-and-Trade Program. Both reporting and allowance procurement are annual requirements, as applicable. GHG emissions from stationary sources may also be covered under the Prevention of Significant Deterioration (PSD) and Title V Operating Permit Programs when GHG emissions are above specified levels.

Fugitive dust air quality issues are addressed both by individual ATCs and District Rule 403 that requires the operator to maintain a district approved Dust Control Plan, which the Project maintains. Additional mitigation measures are also prescribed by the lead agency operating permits that focus on dust suppression primarily due to vehicular traffic, drilling, crushing, screening, and stockpiling of mined materials. Fugitive dust in the form of PM_{10} is currently monitored at the Project site fence-line (project boundary) through continuous operation of four E-BAM air particulate monitoring stations.

20.2.6 Water Extraction Rights

Per California laws and judicial precedent pertaining to groundwater rights, CMV has maintained its historic overlying water rights to groundwater aquifers in the Lanfair basin by using extracted water for beneficial use within the basin. Additionally, Annual Notices of Groundwater Extraction are filed each year with the RWQCB for all existing water wells (Table 20-2). Historical borehole and well locations are shown in Figure 20-1.

Table 20-2: Active Water Rights

#	Record #	Well ID	In Use	GPM (avg.)	Proof of Use (Annual Report of Water Extraction)
1	G363178	W-18P	Yes	50	July 2020
2	G363181	W-14P	Yes	50	July 2020
3	G363645	W-45P	Yes	15	July 2020
4	G363635	W-42	No	NA	July 2020
5	G363603 (new Rec. # pending)	W-001	Yes	150	Pending new Rec. #
6	(new Rec. # pending)	W-002	Yes	150	Pending new Rec. #

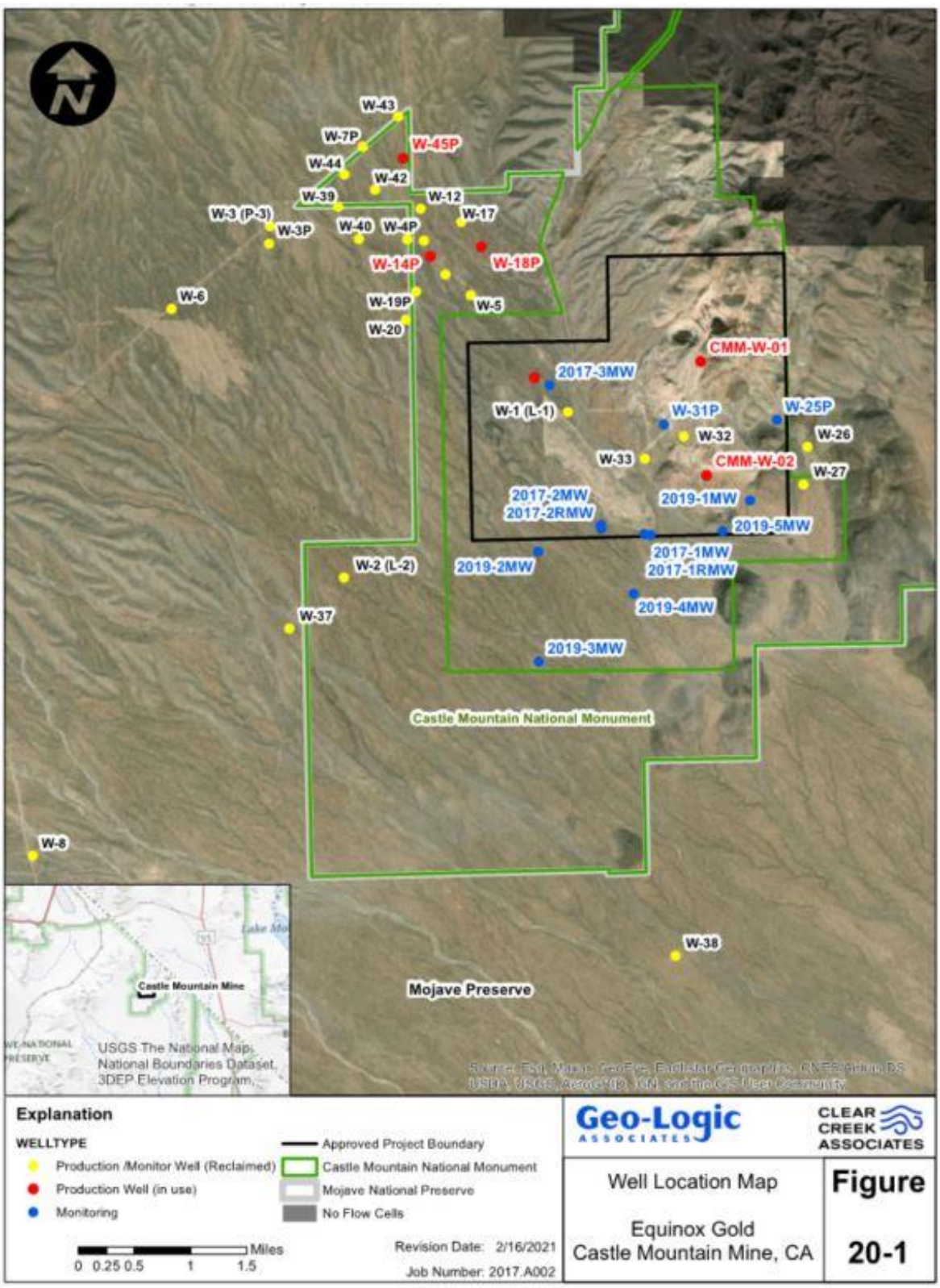


Figure 20-1: Historical Borehole and Well Locations

20.3 LAND USE AND PROPERTY

20.3.1 Mojave National Preserve

The Mojave National Preserve (the Preserve) was established on October 31st, 1994 through the California Desert Protection Act. The Preserve is managed by the National Park Service and is comprised of 1.6 million acres to the west, east, and south of the Project. Current mine facilities are not located inside the Preserve though historically some water production wells, and groundwater monitoring wells were located within the Preserve boundary. These facilities and the related operation of the WWF are recognized by and included in the approved Management Plan for the Mojave National Preserve. Mine expansion at the Project site will not conflict with public lands in the Preserve managed by the National Park Service.

20.3.2 Castle Mountains National Monument

The Castle Mountains National Monument (CAMO) was established on February 12, 2016, through an executive order signed by President Barack Obama, as authorized under the Antiquities Act. The reserved Federal lands encompass approximately 20,920 acres and the boundaries fall between the Project site, and the Mojave National Preserve on all four sides. The Secretary of the Interior manages these lands through the National Park Service, pursuant to applicable authorities, consistent with the purposes and provisions of the proclamation.

Shortly after the creation of CAMO, CMV began cooperation with the National Park Service to correct errors evident of the proclamation process, most significant being the presence of the Project's WWF facilities located partially within CAMO. A Plan of Operation describing these facilities, and their continued operation, was prepared and submitted to park staff in 2018 and a final decision is expected in 2021. However, until that time, current Project operations within the monument are regulated and authorized by the National Park Service through a Temporary Authorization permit granted by the National Park Service. It is expected that mine expansion activity (namely continued use of the WWF water system) co-located within the monument will operate under a park service approved Plan of Operations.

20.4 SOCIAL AND COMMUNITY IMPACT

The Project site is located near the California-Nevada border in eastern San Bernardino County. As noted above, it is essentially surrounded by both the Mojave National Preserve and the more recent Castle Mountains National Monument, both of which place restrictions on the activities allowed within these conservation focused park units. Aside from conservation, generally low impact land use activities prevail in the undeveloped desert areas of eastern San Bernardino County, California and in the adjacent southern Clark County, Nevada. One exception is that in many instances, historic land use activities such as livestock grazing, and mining have been replaced more recently by large commercial scale solar power generating plants. Transportation and utility corridors are also located throughout the region including Interstate and State highways, county and local roads, railroads, power transmission lines, utility pipelines, and communication stations.

Mining has been a continuous activity in eastern San Bernardino County and southern Clark County for the past century, even though many small- to intermediate-sized mine operations have shut down in the surrounding Mojave region (e.g. Vanderbuilt, Colosseum, and Morning Star mines). Many existing and former towns were founded as mining communities, including Searchlight, NV, Mountain Pass, Ivanpah, and Hart in California, and Henderson in Nevada.

Recreational use of land adjacent to the Project site is similar to the activities found throughout the Mojave desert region and includes casual use enjoyment of the area's natural and historic resources, off-highway vehicle (OHV) touring, sightseeing, hiking, bird watching, hunting, stargazing and rock collecting.

Small communities are scattered throughout this region of the Mojave Desert along major transportation corridors, such as Interstate 15, Interstate 40, and the Union Pacific and BNSF Railroads. Towns such as Baker and Needles (California) provide services to highway travelers and are long-established railroad and trade/service centers for the surrounding desert region. Privately owned lands are interspersed in the desert regions although these residences are becoming less common as large tracts of land are set aside for renewable power generation, land conservation usually in the form of a National Monument, an Area of Critical Environmental (ACEC), or restricted access Department of Defense land.

The nearest communities are Searchlight, NV, located about 16 miles by direct line to the northeast, and Nipton, CA approximately 16 miles by direct line to the northwest. The Project site is not visible by California or Nevada communities and is only visible by a small handful of private residencies located throughout the Mojave National Preserve as private inholdings. The inholdings are mostly undeveloped, though some have developed structures that are mostly habituated only part of the year (usually not during the hot summer months). The nearest developed inholding lies approximately five miles south of the project. CMV maintains an active relationship with most of these private residences through the Mojave Landowners Association.

Of the two nearest population centers, Searchlight is a municipality but Nipton is an unincorporated community with less than a dozen residents in the local RV park and one separate private residence west of the railroad tracks that bisects the town limits. Public services in the desert communities are limited. Baker is the nearest California town with educational, fire, ambulatory, and police services and is located 54 miles due west from the Project site. Searchlight and Laughlin, NV have limited educational, fire, ambulatory, and police departments, and community medical facilities. Other goods and services are available from the larger regional urban centers of Las Vegas/Henderson, NV and Barstow and Victorville/Apple Valley on the western edge of the Mojave Desert in California.

There are no housing or public services at the Project site. Most employees live in Nevada with a small number residing in California.

Other than mining employment, most workers are employed in industries such as tourism, trade, and services or, in the case of southern Clark County, the gambling and hospitality industry.

Local community stakeholders include local private landowners (Mojave Landowners Association); the towns of Searchlight, NV, and Nipton, CA; the National Park Service; the BLM and a diverse group of conservation focused non-governmental organizations. CMV has existing and planned communications and outreach with all parties.

20.5 MINE CLOSURE AND RECLAMATION

Mine closure and reclamation are addressed in the Mine and Reclamation Plan approved by the project lead agencies (San Bernardino County and BLM). SMARA outlines the State's regulatory and statutory requirements that are implemented by San Bernardino County as the project lead agency. The State Division of Mine Reclamation (DMR) enforces SMARA but often defers primacy to the local lead agency to enforce SMARA, in this case San Bernardino County. BLM

reclamation requirements are outlined in 43 CFR §3809.5 and in the project-specific Records of Decision. While both lead agencies have an oversight role regarding mine reclamation, the State (county) generally takes a lead role. The BLM and State/County relationship is managed through multiple active Memorandum of Understanding (MOU) agreements between the BLM California State Office and the California State Mining and Geology Board.

The Project has filed a series of updated Mine and Reclamation Plans pursuant to state and federal requirements. The original Mine and Reclamation Plan was approved in September 1990, a revision was approved in January 1998, and the most recent revision is dated July 15, 2019.

During the previous operations, reclamation activities included a formal revegetation research program; salvaging plants and cacti for later transplantation back in the reclaimed areas; establishing a greenhouse/nursery; creating a propagation area for native plants; local seed collection; and maintaining several control areas at various representative re-vegetated sites across the mine. A research program to identify and test for successful desert revegetation and reclamation techniques was instituted until about 2001. Research topics included seed treatment and germination; plant propagation; pest management; plant salvage; soil stockpile management; plant hormone use; vesicular-arbuscular mycorrhizae use; plant/water relationships; plant spacing patterns; and density, diversity, herbivory, and irrigation design. The nursery-grown plants and salvaged plants temporarily stored at the Castle Mountain Mine greenhouse and nurseries were transplanted onto rehabilitation areas around the Project. The successes (and failures) from these research initiatives formed the backbone of the ultimately successful revegetation program at the Project site. Completed reclamation and revegetation at the Project site is often recognized as one of the best regional examples of successful mine reclamation, and many of these successful strategies have been retained for future use.

Interim reclamation activities commenced in June 2001 and continued through 2005. Most site infrastructure including maintenance and electrical shops, administration and warehouse buildings, primary, secondary, and tertiary crusher facilities, laboratory, refinery and change buildings were removed from the site. At the request of the government agencies, several facilities were not reclaimed including a 250,000 gal water tank, some of the water production wells, and various access roads (as part of the region's fire prevention efforts). The heap leach pad, process plant and lined ponds were the last facilities reclaimed and areas revegetated from 2005 to 2007 after the regional water board recertified the heap leach pad material from a Group B to a Group C mine waste. Group C mine waste poses no impact to groundwater or surface water quality.

Overburden piles were recontoured to conform to requirements of the approved Mine and Reclamation Plan. The heap leach piles were constructed to provide vertical relief by stacking at different total heap heights instead of one uniform upper elevation. The north and south overburden piles had mounds added to the surface to create vertical relief. Placement of overburden to cover the north and south clay pits was also undertaken. This was a mitigation the operator agreed to conduct, to remove the blight on the land from previous clay quarries that were abandoned and not reclaimed. In 2010, the section of the power transmission line from site to Walking Box Ranch was removed. Future mine reclamation related to mine expansion will follow these similar reclamation and revegetation strategies that have produced successful results.

Over 2,000 plants were transplanted in the rehabilitation areas in 1996 and an additional 8,203 plants were transplanted in 2001. Native seed was collected in the immediate area of the mine. In 2005-2006, 1,242 plants were transplanted to the heap leach area. Areas of the reclaimed mine site were aerially seeded or hand-broadcast with native seeds. By 2007, most plant transplants

and seeding were complete and by 2012 the Project had satisfied the revegetation objectives for plant density and diversity which defined the release criteria for successful reclamation of the Project site. The extensive efforts made to revegetate the site, as near to its natural state as possible, have produced excellent vegetation communities that closely match the species richness and diversity of the surrounding natural landscape.

The current reclamation plan is contained in the document titled “Mine Plan and Reclamation Plan Ver.2.1 (90M-013)”. The reclamation plan includes a statement of purpose, goals, schedule, and metrics for success. The plan focuses on revegetation and restoration of the Project site to a condition as close as possible to that of the site before disturbance. This includes natural plant assemblages, visual compatibility with natural land contours, conditions of safety for the public, and restoration of habitat for indigenous wildlife species. The plans include decommissioning of mining facilities and structures, maintenance and management of reclaimed areas, and post-mine considerations for hydrology, groundwater, and drainage, erosion, and sedimentation. The plan envisages returning the land for recreational and wildlife use after mine closure and reclamation.

All Water Board regulated facilities will be closed in accordance with CCR Title 27.

Future amendments to the mine and reclamation plan to account for mine expansion are expected to include facility decommissioning, land recontouring, and revegetation as has been described herein, due to the success of the previously documented reclamation effort. This project site is not statutorily required to backfill mined pits, as the approved reclamation plan and financial assurance dates before state implementation of the Backfill Regulation on December 18, 2002. However, voluntary backfilling of certain parts of the mine will be included in the future amendment to the mine and reclamation plan.

20.5.1 Financial Assurance

CMV is required to post financial assurance mechanisms with the various state and federal agencies pursuant to the governing laws and regulations. Most financial assurance mechanisms are in the form of surety bonds issued to the Project by commercial carries. The agencies usually have a requirement for the project proponent to produce an annual Financial Assurance Cost Estimate (FACE) report and increase or decrease the total assurance accordingly. At the Project site, the County administers the reclamation bond for both the project lead agencies (County and BLM). This bond was most recently increased in 2021 to approximately $3,742,611. An additional FACE report was recently approved by the Colorado River Basin RWQCB for cleanup and closure of water board regulated facilities, namely the heap leach pad and ponds. This bond will be established in 2021 at $4,137,230 and will bring the total 2021 anticipated project bonds to $7,879,841.

Bonds will continue to be reviewed on an annual basis and increased or decreased based on new liability and inflation or to account for completed mine reclamation, respectively. Bonds will similarly be increased based on new liability associated with the mine expansion.

21 CAPITAL AND OPERATING COSTS

21.1 CAPITAL COST ESTIMATE

Capital costs for the Castle Mountain Project have been estimated by M3, NMS, GLA, and The MINES Group with appropriate input from Equinox. All costs are in US dollars ($). The estimate was broken down by Work Breakdown Structure (WBS) and organized into specific areas of responsibility as follows:

- M3 – Site Infrastructure, Heap Leach Solution Handling, Crushing and Ore Storage, Process Plant and Gold Refinery, Ancillary Facilities, Raw Water Pumping and Distribution, Main Substation and Power Distribution, Indirect Costs (Contractor Indirects, EPCM, Commissioning, Working Capital, First Fills, Sales Tax etc.) Contingency, Reclamation
- NMS – Mining Equipment Costs, Slope Monitoring Equipment, Mining Clearing, Grubbing and Pre-Strip
- GLA – Heap Leach Pad Expansion and Filtered Tailings Facility
- Equinox – Owner's Cost (Pre-Production Labor, Insurance, Permitting, Legal etc.), Utility Transmission Line (2018 PFS estimate)

The initial and sustaining capital costs are summarized in Table 21-1.

Table 21-1: Capital Cost Summary

Item	Initial ($M)	Sustaining ($M)	Total ($M)
Mine Mobile Equipment[1]	154	70	224
Mine Development	41	11	52
Mine Total	**195**	**81**	**276**
General Siteworks	11	-	11
Heap Leach and Solution Handling	38	56	94
Process Plant	62	-	62
Tailings Filtration and Storage	16	1	17
Infrastructure	41	-	41
Freight	8	-	8
Direct Plant and Infrastructure Total	**176**	**57**	**233**
EPCM, Vendor Support and Other Indirects	51	-	51
Transmission Line	15	-	15
Owner's Cost, Working Cap and Taxes	40	-	40
Sub-total Plant and Infrastructure	**282**	**-**	**-**
Contingency[2]	33	9	42
Total CAPEX	**510**	**147**	**657**
Less Leased Mining Equipment	***121***	**-**	***(121)***
Total CAPEX (with Leased Mining Equipment)	**389**	**-**	**536**

Note 1: Mining equipment includes all applicable sales tax.
Note 2: Contingency not included for mining and working capital.

The initial capital costs by main area are shown in Table 21-2.

Table 21-2: Summary of Initial Capital Costs by Area

Area	Cost ($M)
TOTAL Mining	**195**
General Site	11
Heap Leach Solution Handling	10
Carbon Adsorption	6
Heap Leach	28
Crushing and Ore Storage	16
Grinding and Gravity	12
Leach/CIL	10
Tailings Handling and Filtration	15
Filtered Tailing Storage Facility	2
Desorption and Carbon Regeneration	8
Electrowinning and Gold Refinery	4
On-site Water Supply, Storage, Distribution	3
Off-site Water Supply	18
Sub-station and Electrical Distribution	5
Process Plant Utility, Mobile Equipment and Ancillaries	9
Reagent Mixing and Storage	5
Mining Fleet Service Facilities	6
Freight	8
TOTAL Direct Plant and Infrastructure Costs	**176**
Construction Indirects (i.e. mobilization, bussing, facilities)	15
EPCM	31
Vendor Supervision and Commissioning Support	2
Spare Parts (Capital and Commissioning)	1
First Fills and Operating Spares	2
Transmission Line	15
Working Capital	16
Owner's Cost	16
County Sales Tax	8
TOTAL Indirect Plant, Infrastructure and Owner's Costs	**106**
Contingency	33
TOTAL CAPEX	**510**
Less Leased Mining Equipment	***(121)***
Total CAPEX (with Leased Mining Equipment)	**389**

The initial capital costs by commodity for Process and Infrastructure are shown in Table 21-3.

Table 21-3: Summary of Process Plant Initial Capital Costs by Commodity[1]

Item	Supply Cost ($M)	Labor Costs ($M)	%
Sitework	15.3	14.4	16.9
Concrete	5.7	8.1	7.8
Structural & Architectural	8.7	6.1	8.4
Mechanical Equipment	39.2	5.4	25.3
Piping	14.1	11.4	14.5
Electrical Equipment	9.1	1.0	5.7
Electrical Bulks	4.9	3.3	4.7
Instrumentation	3.1	1.7	2.7
Sub-Total	**100.1**	**51.4**	
Construction Equipment	16.7		9.5
Freight	8.0		4.5
Total			**100.0**

Note 1: Excludes Transmission Line Direct Cost

Total initial capital cost is estimated at $389 million excluding the mining equipment fleet which is estimated at $121 million and expected to be leased to own over five years, or a total of $510 million considering the fleet purchased upfront. Sustaining capital costs for the project are primarily accounting for mining and additional stages of the heap leach pad and filtered tailings facility development. Total sustaining capital costs during production until closure are $147 million. Closure costs totaling $22 million are included separately for the end of mine life.

The estimated capital costs for Phase 2 of the Castle Mountain Project are considered to have an accuracy of -10% to +15% and are estimated in Q4 2020 US dollars. Allowance for escalation and foreign exchange fluctuation has not been included. The Project will be primarily sourced from the United States (> 90%) and have minimal exposure to currency risk.

The estimated costs are based on this project being executed by an experienced EPCM contractor(s) in the hard rock mining industry. In addition, it is assumed that all contracts and subcontracts are based on a lump-sum basis or a competitively bid unit cost basis, such as per cubic yard of concrete placed.

21.1.1 Design Basis

The cost estimate is based on preliminary engineering including 250 feasibility level design drawings for the mill & infrastructure, heap leach pad expansion, filtered tailings facility, and supporting ancillary facilities covering all engineering disciplines. The entire facility has been developed in AutoCAD® Plant 3D. The drawings and the process design criteria were used as basis for detailed material take-offs for all disciplines and development of an equipment register to define the mechanical, electrical and instrumentation needs of the project. Table 21-4 summarizes the reference documents available for estimation purposes.

Table 21-4: Reference Documents Summary

	Drawings and/or Documents
Engineering Design Drawings:	
Flowsheets	19
General Arrangements	53
Architectural	sketches
Civil	22
Concrete	4
Structural Steel	Yes
Piping and Instrumentation Diagrams (P&IDs)	123
Electrical Schematics	35
Instrumentation Schematics	Yes
Engineering Specifications:	
Project Standards and Site Conditions	Yes
Process Design Criteria	Yes
Project Scope of Facilities	Yes
Equipment Specifications	Data Sheets Only
Engineering Lists and Logs:	
Equipment List (with Buildings)	Yes
Valve List	Yes
Cable Schedule	Yes
Instrument Log	Yes
Other References:	
Material Take-Off's:	
Civil	Yes
Concrete	Yes
Structural Steel	Yes
Mechanical sketches	No
Piping	Partial*
Electrical	Partial*
Instrumentation	Yes

* Piping drawings developed for large solution lines and raw/fire water distribution. Electrical physical drawings developed for main substation. No in-plant electrical physical drawings were developed.

21.1.2 Installation Cost Basis (Labor Rates and Construction Equipment)

Labor rates for the process plant and infrastructure estimate are based on a weighted average of prevailing non-union shop wages from a published source (Davis-Bacon; 50%) and actual labor rates on site for Phase 1 construction (50%). Craft labor has been estimated at the overall average rates illustrated in Table 21-5 and this includes both Direct and Indirect Costs of the contractor

such as fringe benefits, social burden, overtime adjustment, contractor supervision, overhead and profit.

Table 21-5: Labor Rates

Craft	Labor Rate ($/h)
Bricklayer	51
Carpenter	59
Cement Mason	51
Electrician	60
Ironworker	70
Laborer	37
Millwright	74
Operator	60
Pipefitter	66

Resulting blended crew labor rate for the project, by discipline or commodity and based on a weighted average of crew mix is shown in Table 21-6. The rates below are not all-inclusive rates and exclude, subsistence, travel time, construction equipment, mobilization, and demobilization. These items are estimated separately within the capital estimate. Labor rates are based on 50-hour work weeks.

Table 21-6: Blended Crew Rate

Discipline	Labor Rate ($/h)
Civil	45
Concrete	59
Reinforcing Steel	70
Structural	70
Mechanical Equipment Installation	74
Piping	69
Electrical	59
Instrumentation & Controls	57

Labor rates for the heap leach pad and filtered tailings estimates are based on current and proposed labor rates from Phase 1 construction.

Construction equipment costs were estimated according to the tasks performed and the hours involved. This results in a direct cost for the process plant (excluding the heap leach and filtered tailings facility) of approximately $11/h based on 700,000 man-hours. This rate varies significantly based on discipline from very low for electrical and instrumentation to above $15/h for architectural and steel.

Construction equipment for the heap leach and filtered tailings facility requires use of larger equipment and results in a direct cost of approximately $45/h based on 200,000 man-hours. Overall, this totals $16.7M. Small tools, man-lifts, construction generator sets etc. are included as an allowance within the contractor field labor rate.

21.1.3 Process & Infrastructure Equipment Cost Basis

Major process mechanical and electrical equipment were identified based on the project design basis and appropriate criteria. Prices were then solicited for the major equipment depicted on the flow sheets and/or the equipment register. M3 obtained budgetary quotations from a minimum of three qualified suppliers for all major packages. Major capital equipment categories for this project included mechanical, structural, and electrical. Received proposals were then evaluated for technical compliance and an average or median cost used in the estimate. The selected mid-point price is intended to allow for some growth allowance. For other equipment, M3 used firm and budgetary pricing data from recent M3 projects.

Pricing sources for major equipment (>$50,000 capital cost anticipated) in this estimate were as follows:

- 89% budgetary quotes (140 of 157 equipment items)
- 3% informal quotes (4 of 157 equipment items)
- 8% from M3 historical data for similar equipment (13 of 157 equipment items)

21.1.4 Bulk Commodities Cost Basis

Bulk material pricing was estimated through a combination of budgetary proposals, data from recent projects in the region, and actual pricing from Phase 1 construction as well as check reviews by local contractor.

Earthworks – Earthworks and liner quantities for the expanded heap leach pad, filtered tailings facility, new event pond and solution collection channel were estimated by GLA based on design drawings and specifications. Geomembrane liner includes a 12% provision for waste. Contingency includes an allotment of $4.1M to screen the material, which was not required for Phase 1 and may not be required for Phase 2.

Earthworks quantities for the process plant and project infrastructure were estimated by M3 on a similar basis. Unit costs were based on costs for recently completed Phase 1 development construction. These rates were then validated by M3 using their recent project internal database for projects local to the area. Earthworks unit rates are shown in Table 21-7.

Table 21-7: Earthworks and Liner Unit Rates

Description	Unit	Unit Cost ($/Unit)
Pad Clearing and Grubbing	acre	1,350
Topsoil Removal (Heap Leach Pad; 1 ft. thick)	acre	4,840
Pad Cut – From Cell and Ponds	yd^3	2.75
Pad Fill – Haul and Place in Cell	yd^3	3.00
Liner Subgrade Preparation (3 in depth)	yd^3	4.60

Description	Unit	Unit Cost ($/Unit)
80 mil LLDPE Geomembrane (Supply & Install)	ft^2	0.65
80 mil HDPE Geomembrane (Supply & Install)	ft^2	0.65
60 mil HDPE Geomembrane (Supply & Install)	ft^2	0.60
5 mm Geonet (Supply & Install)	ft^2	0.45
Overliner (Sourced from Historic Heap)	yd^3	4.60
Filtered Tailings Facility Surface Preparation	acre	7,421
Diversion Channel Excavation	yd^3	3.59
Channel Rip-Rap Lining	ft^2	4.00
Main Process Plant Cut to Fill	yd^3	5.74
Process Plant Finish Grading	yd^2	0.92

Concrete – Concrete quantities for the process plant were estimated by M3 based on developed design drawings, specifications and equipment loading diagrams from budgetary proposals. Quantity estimates, site layouts and plans were provided to two general contractors for review and they provided budgetary estimates. The resulting average supply and placement rate has been estimated at $1,250/$yd^3$ for an all-in concrete unit rate. This rate includes formwork, concrete supply, reinforcement steel and curing. A factor of 5% has been applied for waste and miscellaneous pads.

Structural Steel – Structural steel quantities for the process plant and ancillary buildings were estimated by M3 based on design drawings. Material take-off values were determined for light, medium and heavy steel as well as grating, handrail, stairs, etc. Unit costs for steel including installation labor and equipment requirement were based on recently completed M3 projects in the area. These estimated costs are shown in Table 21-8.

Table 21-8: Structural Steel Unit Rates

Description	Unit	Unit Cost ($/Unit)
Light Steel (Supply and Install)	ton	7,025
Medium Steel (Supply and Install)	ton	4,825
Heavy Steel (Supply and Install)	ton	4,185
Steel Grating	ft^2	34
Handrail	ft	61
Stairs	ft (vert.)	688
Steel Detailing	lb	0.20

Piping – Piping, fittings and valve costs are based off material take-offs from site plans and project layouts as well as project P&IDs developed for all major systems throughout the processing plant and ancillary supporting areas. Piping material costs in general were sourced from a combination of quotes from local suppliers and M3 internal database of recently completed projects in the region.

Electrical and Instrumentation – Major electrical equipment such as transformers, switchgear, motor control centers (MCCs) and variable frequency drives (VFDs) costs are based on budgetary supplier proposals as described above in 21.1.3 for equipment costs. Electrical bulks such as cables, cable tray and conduit have been estimated based on material take offs generated using site plans and project layouts as well as project single line diagrams and electrical house preliminary plans. Instrumentation and control costs have been estimated in similar fashion.

21.1.5 Cost Basis (Freight)

Freight, customs, and duties have been included as a percentage (8%) of equipment and material costs in the estimate for domestically sourced equipment. It is recognized that bulks and smaller equipment will likely have a much lower percentage, but the 8% also comprises factory and/or in-transmit warehousing, inspections, port charges, road and rail charges, freight forwarding as well as actual freight costs. Freight costs were further validated using vendor budgetary freight pricing on major equipment.

21.1.6 Cost Basis (Indirect Costs)

Indirect costs included as part of the project capital estimate are as follows:

- Mobilization/Demobilization
- Contractor Personnel Bussing
- Temporary Construction Facilities and Power
- EPCM
- Vendor Supervision of Specialty Construction
- Vendor Pre-Commissioning and Commissioning Services
- Capital Spares
- Commissioning Spares
- First Fills and Operating Spares
- Working Capital
- Sales Tax
- Owner's Costs
- Contingency

Mobilization/Demobilization – Cost is included at 1.5% of total direct costs except for civil which is included at 5% of total related direct costs.

Contractor Personnel Bussing – Bussing cost unit rates were estimated by Equinox and M3 applied the total direct manhours required for project construction to obtain an overall value. Bussing service using 50 plus passenger will be contracted out of Henderson, NV. Contractor personnel would be bussed to site from a gathering/parking area near Searchlight, NV.

Temporary Construction Facilities and Power – Cost is included at 0.5% of total direct costs for temporary construction facilities and 0.1% of total direct costs for supplemental temporary construction power for the facilities.

EPCM – EPCM costs are factored as percentages of constructed costs as shown in Table 21-9. except heap leach pad and filtered tailings design. Heap leach pad and filtered tailings design costs are included based on budgetary estimate from GLA, which is $375,000. Constructed costs include direct costs plus mobilization and construction utilities.

Table 21-9: EPCM Indirect Costs

Activity	% of Constructed Costs
Management	0.75%
Engineering[1]	6.00%
Project Services	1.00%
Project Controls	0.75%
Construction Management	6.50%
Total EPCM (before fee)	**15.00%**
EPCM Fee	1.50%
EPCM Construction Trailers	0.20%

Note 1: % Basis not utilized for heap leach pad and tailings facility engineering as noted.

Vendor Supervision, Pre-Commissioning and Commissioning – Cost is included at 1% of total direct costs for each of these elements for a total of 3%.

Capital Spares – Cost is estimated using budgetary proposals from equipment suppliers. The following equipment is anticipated:

- Cone Crusher Motor
- Ball Mill Motor
- Pinion Assembly including bearing
- Trunnion Bearings (Pad and Thrust)
- Ball Mill VFD Module
- Cyclone Feed Pump
- Interstage Screen
- Conveyor/Feeder Common Motors
- Barren and Pregnant Solution Pump VFD Phase Modules

Commissioning Spares – Cost is included at 0.5% of plant equipment costs.

First Fills and Operating Spares – First fill requirements were determined by project design criteria to service the project for a period of 3 months. In similar fashion, 3 months of operating spare parts were assumed to carry the project well into full operations.

Sales Tax – Combined State of California and San Bernardino County sales tax is included at 7.75% applied to plant equipment and material cost without freight.

Working Capital - Working capital for the Project is estimated to be $15.5 million for Phase 2. The working capital is the capital required for operations before any revenue from Phase 2 ounces is produced by the mine and is based on the operating costs for the mine, process, and G&A costs for the Project.

Owner's Cost – Owner's cost was developed by Equinox and has been estimated specifically for the execution phase of the project including detailed engineering, procurement, and construction support. The detailed breakdown is shown in Table 21-10.

Table 21-10: Owner's Cost Summary

Description	Cost ($000)
Preproduction Labor - Plant	2,211
Preproduction Labor - Mine	2,173
Total Owner's Project Mgmt. Team	1,489
Construction/Commissioning Power	400
Access Road (Improvements)	400
Construction Support Vehicles	248
Additional Trucks (F-150 Supercrew)	360
Safety	360
First Aid and Medical (Construction)	400
Road Signage	60
Temporary Trailers – Owner's Team	40
Sanitation Facilities	360
Insurance (COC, Liability, Marine)	4,200
Environmental and Permitting	450
Community Relations, Lobbying	450
Consultants	180
Operations Training	400
Operations Readiness	200
Geotech Testing	150
Metallurgical Testing	150
Legal Fees	540
Accounting Fees	180
Communications (Upgrades)	360
IT Purchases	50
SAP	200
Furniture	75
Travel (Additional to Project Team)	90
TOTAL Owner's Cost	**16,176**

Contingency – Cost Contingency is an amount added to an estimate to allow for items, conditions, or events for which the area, occurrence, and/or effect is uncertain, and that experience shows will likely result in additional costs. These costs are typically estimated using statistical analysis or judgment based on past asset or project experience.

Contingency excludes:

- Major scope changes such as changes in product specification, capacities, building sizes, and location of the asset or project,
- Extraordinary events such as major strikes and natural disasters,

- Management reserves, and
- Escalation and currency effects.

Contingency is included at a percentage of the total contracted cost including commissioning and spare parts. Contingency is calculated on a discipline basis, and then applied across each area. The values assigned have been established through an analysis of the level of detail included in estimating the value. For example, as a very high percentage of equipment has been quoted it is considered to have a high level of accuracy and therefore 10% contingency is considered reasonable. The basis for contingency for each discipline is shown in Table 21-11.

Table 21-11: Project Contingency Basis

Activity	% of Constructed Costs	Contingency ($M)
Civil/Sitework	15.0	4.4
Concrete	12.5	1.7
Structural Steel	12.5	1.6
Architectural	12.5	0.3
Mechanical	10.0	4.4
Piping	15.0	3.8
Electrical	12.5	2.3
Instrumentation	12.5	0.6
Construction Equipment	10.0	1.7
Contractor Indirects	10.0	8.4
Heap Leach Overliner	Estimated by GLA	4.1
Total		**33.3**

*Contingency is also applied to the transmission line cost and is not included in the costs listed above.

21.1.7 Mining Capital Cost

Initial mining capital costs are based on converting to an Equinox owned mining fleet from the contract-based fleet being utilized for Phase 1 operations, necessary parts and spares for the fleet, as well as slope monitoring equipment and mine development and pre-stripping. A major part of the mining equipment fleet could be leased which results in a reduction of $121 million of initial capital. Leasing the mining equipment adds to the operating cost; however, the net impact is an improvement to the Internal Rate of Return (IRR). Initial capital and fleet are summarized in Table 21-12. Costs for the mobile mining fleet have been based on budgetary quotations from a minimum of two qualified suppliers and often three or four.

Table 21-12: Mining Initial Capital Summary

Description	Cost ($M)
Mobile Equipment	146.4
Spares and Inventory	5.9
Slope Monitoring Equipment	1.9
Clearing and Grubbing (Mine)	4.5
Initial Pre-Strip	36.8
Total	**195.5**

Key mining equipment is summarized in Table 21-13. Details on the mining equipment fleet can be found in Section 16. The initial capital costs included here are for the mobile equipment purchased in the first 3 years of the expansion.

Table 21-13: Mining Equipment Summary

Equipment	Details	Total
Production Blasthole Drill	8 7/8"	2
Wall Control Drill	4 1/2' - 9"	2
Hydraulic Shovel	2996 hp 44.5 yd^3	2
Wheel Loader	1739 hp 28 yd^3	2
Haul Truck	2650 hp 250 ton	17
Track Dozer	600 hp	5
Wheel Dozer	620 hp	2
Grader	290 hp 16 ft	3
Water Truck	1450 hp 32,000 gal	2
Wheel Loader	541 hp 10 yd^3	1
Haul Truck	825 hp 61 ton	3
Excavator	524 hp 6 yd^3	1
Tire Manipulator	Large Tire	1
Vibratory Compactor	130 hp 7.5 ft	1
Backhoe	105 hp 1.3 yd^3	1
Articulated Truck	450 hp 40 ton	1
Fuel and Lube Truck	100 ton 8,000 gal	1
Tractor and Low Bed	160 ton	1
Flatbed Hiab Truck	10 ton	1
Rough Terrain Forklift	32 ton	1
Shop Forklift	18 ton	1

21.1.8 Sustaining Capital Cost

Sustaining capital costs for the expansion of the Castle Mountain Project have been estimated and are primarily for continued development of the heap leach pad and filtered tailings as well as mining activities. Sustaining capital costs for the heap leach pad and filtered tailings include indirect costs and contingency. Mining sustaining capital costs reflect the cost of operating the

new mobile mining fleet to handle the provision of ore to the process plant as well as stripping and placement of waste material. Equipment for slope monitoring, fleet spares and inventory, and development costs are included as well. Sustaining capital costs allotted for Phase 2 are shown in Table 21-14.

Table 21-14: Summary of Sustaining Capital Costs

Ph. 2 Year	Mining ($M)	Plant & Infrastructure ($M)	Leach Pad/Event Pond ($M)	Filtered Tailings ($M)	Total Cost ($M)
1	1.8	-	3.4	-	5.2
2	8.1	-	-	-	8.1
3	13.6	-	-	1.3	14.9
4	16.5	-	27.0	-	43.5
5	3.3	-	-	-	3.3
6	0.7	-	-	-	0.6
7	7.3	-	22.2	-	29.5
8	12.9	-	-	-	12.8
9	15.5	-	-	-	15.5
10	0.2	-	12.6	-	12.8
11	0.7	-	-	-	0.7
12	0.2	-	-	-	0.2
13	0.1	-	-	-	0.1
14	Reclamation – 3.5				3.5
15	Reclamation – 3.5				3.5
16	Reclamation – 15.0				15.0
Total	**80.9**	**-**	**65.2**	**1.3**	**169.4**[1]

Note 1: Including reclamation

The estimated sustaining capital costs for the expansion of the Castle Mountain Project are considered to have an accuracy of -10% to +15% and are estimated in Q4 2020 dollars.

21.1.9 Mining Sustaining Capital Cost

Table 21-15 shows the mining sustaining capital cost summary including both planned initial capital and sustaining capital requirements.

Table 21-15: Mining Sustaining Capital Cost Summary

Description	Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Mobile Equipment	$000	-	$7,543.6	$10,509.4	$12,565.9	$462.9	$489.8	$7,190.5	$12,067.7	$15,312.9	$75.0	$75.0	$75.0	$75.0
Spares & Inventory	$000	-	-	-	-	-	-	-	-	-	-	-	-	-
Slope Monitoring Equipment	$000	-	$587.3	$160.6	$160.6	$587.3	$160.6	$160.6	$762.9	$160.6	$160.6	$587.3	$160.6	-
Development & Pre-stripping	$000	$1,845.8	-	$2,899.7	$3,742.9	$2,291.9	-	-	-	-	-	-	-	-
Total	**$000**	**$1,845.8**	**$8,130.9**	**$13,569.7**	**$16,469.3**	**$3,342.0**	**$650.4**	**$7,351.1**	**$12,830.6**	**$15,473.5**	**$235.6**	**$662.3**	**$235.6**	**$75.0**

21.2 OPERATING COST ESTIMATE

21.2.1 Summary – Operating Cost

Operating costs are broken down by area including mining, process plant and G&A. G&A staffing plans and wages were estimated by Equinox. Processing and tailings haulage were estimated by M3 and include the combined heap leach and mill facilities. Mining was estimated by NMS. Mining equipment purchase costs are all considered capital costs and excluded from operating costs. Table 21-16 shows a summary of operating cost elements over the course of Phase 2.

Table 21-16: Operating Cost Phase 2 Summary

Description	Unit Cost ($/ton mined)
Mining	1.75
Description	**$/ton ore**
Mining	6.20
Processing (Total)	2.45
G&A	0.65
Sub-Total	**9.30**
Refining and Transportation	0.02
Total	**9.32**

Table 21-17 shows a summary of operating cost elements over the course of the mine life.

Table 21-17: Summary of Annual Operating Cost

Phase 2 Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
Units	**$M/y**	**$M/y**	**$M/y**	**$M/y**	**$M/y**	**$M/y**	**$M/y**	**$M/y**	**$M/y**	**$M/y**	**$M/y**	**$M/y**	**$M/y**	**$M/y**	**$M/y**	**$M/y**	**$M**
Mining	100.0	118.5	120.9	128.0	130.4	123.5	122.0	134.4	137.1	124.0	128.5	115.6	69.2	14.8	-	-	**1,567**
Processing	44.9	45.5	45.5	45.5	45.3	45.5	45.6	45.6	45.3	45.6	45.6	44.8	41.4	25.8	4.7	3.5	**620**
G&A	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.1	9.8	3.4	2.5	**164**
Annual Cost	**156.8**	**175.3**	**177.7**	**184.8**	**187.2**	**180.3**	**178.8**	**191.2**	**193.9**	**180.8**	**185.3**	**171.7**	**121.7**	**38.2**	**8.1**	**6.0**	**2,351**
Units	**$/ton**	**$/ton**	**$/ton**	**$/ton**	**$/ton**	**$/ton**	**$/ton**	**$/ton**	**$/ton**	**$/ton**	**$/ton**	**$/ton**	**$/ton**	**$/ton**	**$/ton**	**$/ton**	**$/ton processed**
Mining	5.18	6.07	6.13	6.58	6.87	6.33	6.13	6.97	7.15	6.32	6.58	6.17	4.14	4.77	-	-	**6.20**
Processing	2.31	2.33	2.33	2.33	2.33	2.34	2.33	2.33	2.33	2.35	2.33	2.38	2.58	6.89	-	-	**2.45**
G&A	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.60	0.69	2.62	-	-	**0.65**
Annual Cost	**8.10**	**8.99**	**9.05**	**9.50**	**9.79**	**9.25**	**9.05**	**9.89**	**10.07**	**9.24**	**9.50**	**9.15**	**7.41**	**14.28**	**-**	**-**	**9.30**

21.2.2 Mining Operating Cost

Mining Operating costs were developed by NMS using the developed mine plan for the project. The mining fleet and operations will be fully self-performed by Equinox. Labor costs were developed based on a staffing plan and rate schedule from Equinox based on current Phase 1 operations and forecasted rates for personnel required for staffing. No contingency is applied to the estimated operating costs generated. Table 21-18 summarizes the Phase 2 mining operating cost including mining labor, energy, consumables (parts, explosives etc.), contract services and consumables tax.

Table 21-18: Operating Cost Summary

Description	Units	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Total	Average ($/t mined)
General Mine	$/y	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.8	5.1	1.7	89.5	0.10
Drilling	$/y	6.0	7.0	8.0	9.9	9.7	10.3	10.0	10.2	10.5	9.2	9.6	8.1	3.0	0.4	111.8	0.12
Blasting	$/y	8.9	10.5	11.1	12.8	11.9	12.5	12.5	13.5	13.8	12.0	12.7	10.8	5.1	1.0	149.0	0.17
Loading	$/y	16.0	23.4	21.0	24.9	21.7	19.6	24.2	27.2	23.5	21.9	17.7	15.2	6.2	1.2	263.6	0.29
Hauling	$/y	39.8	51.4	48.5	50.3	57.1	54.0	47.6	57.8	63.0	54.2	60.7	55.8	35.5	7.4	683.1	0.76
Roads & Dumps	$/y	20.4	19.1	22.5	19.5	20.7	20.2	20.6	18.6	19.3	19.6	20.7	18.8	14.0	3.0	257.0	0.30
Contract Services	$/y	2.0	0.1	3.0	3.9	2.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	12.8	0.01
Total	$/y	**100.0**	**118.5**	**120.9**	**128.0**	**130.4**	**123.5**	**122.0**	**134.4**	**137.1**	**124.0**	**128.5**	**115.6**	**69.2**	**14.8**	**1,566.9**	**1.75**

21.2.2.1 Mining Labor

Mining labor costs were estimated by NMS for the expanded project. Mining activities including supervision, engineering, and geology as well operators and maintenance personnel will begin ramping up before the start of Phase 2, increasing to 240+ quickly and topping out at 284 employees in Year 9. Figure 21-1 shows the anticipated manpower throughout development of the mine. Table 21-19 shows the anticipated peak staff list (Year 9).

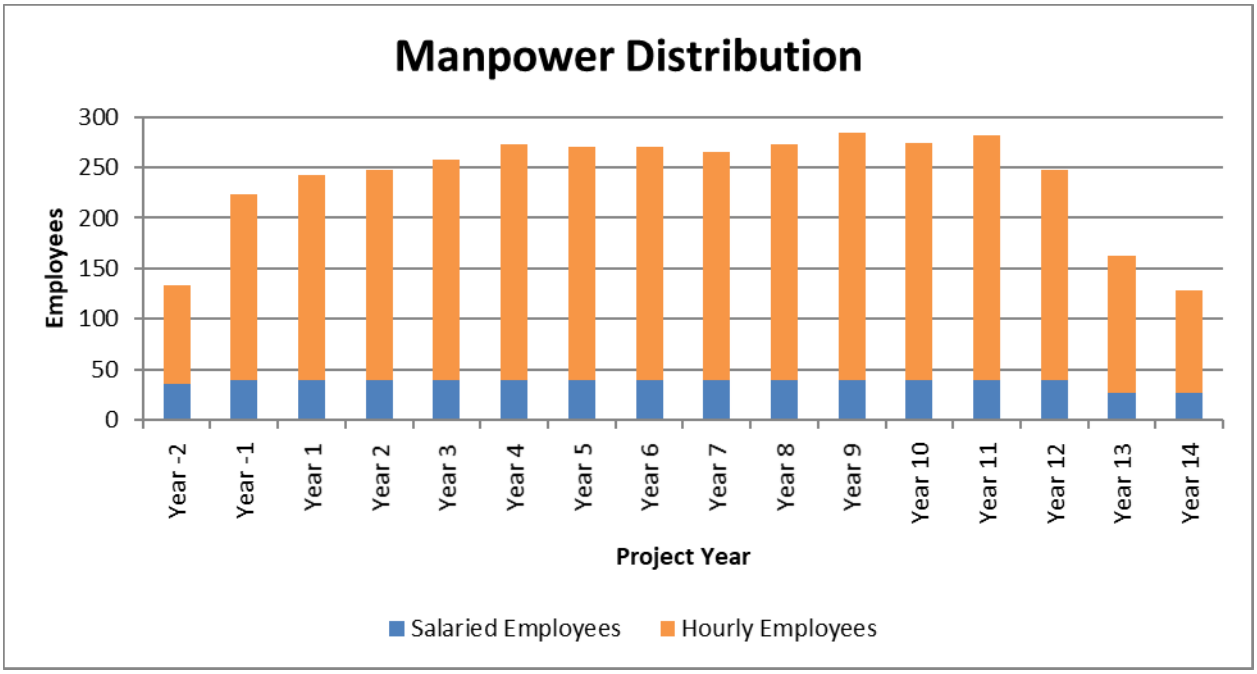


Figure 21-1: Mining Labor Plan

Table 21-19: Mine Staffing (Peak – Year 9)

Description	Qty
Mine Manager	1
Mine Superintendent	1
Mine Foreman	4
Drill and Blast Foreman	2
Mine Training Coordinator	1
Mine Shifter & Dispatcher	4
Mine Clerk	1
Mine Supervision (Total)	**14**
Mine Maintenance Superintendent	1
Electrical Foreman	1
Maintenance Foreman	4
Maintenance Planner	2
Maintenance Clerk	1
Mine Maintenance (Total)	**9**

Description	Qty
Chief Mine Engineer	1
Senior Mine Engineer	1
Drill & Blast Engineer	1
Geotechnical Engineer	1
Senior Surveyor	2
Surveying Technician	2
Senior Mine Geologist	1
Mine Geologist	2
Environmental Coordinator	1
Grade Control Tech	4
Engineering and Geology (Total)	**16**
Operations (Hourly)	167
Maintenance (Hourly)	78
TOTAL	**284**

21.2.2.2 Mining Equipment Fuel

Mining operating costs assumes $2.75/gal diesel. Diesel costs by mining operation and equipment were estimated. Total diesel consumption for the owners fleet during Phase 2 is estimated at 113.8 million gal with an annual peak of 9.7 million gal.

21.2.2.3 Drilling and Blasting

Unit operating costs ($/ton mined) relating to drilling and blasting in Phase 2 Year 1 to 14 are shown in Table 21-20 including appropriate fuel costs. Blasting includes emulsion handling, charging and accessories.

Table 21-20: Drilling and Blasting Unit Costs

	Labor ($/ton)	Energy ($/ton)	Consumables ($/ton)	Tax ($/ton)	Total Unit Cost ($/ton)
Drilling	$0.043	$0.025	$0.061	$0.005	$0.133
Blasting	Supply Contract		$0.163	$0.013	$0.176

21.2.2.4 Loading and Hauling, Roads and Dumps

Unit operating costs ($/ton mined) in Phase 2 Years 1 to 14 relating to loading, hauling, roads and dumps are shown in Table 21-21 including appropriate fuel costs.

Table 21-21: Loading, Hauling, Roads & Dumps Unit Costs

	Labor ($/ton)	Energy ($/ton)	Consumables ($/ton)	Tax ($/ton)	Total Unit Cost ($/ton)
Loading	$0.057	$0.067	$0.173	$0.013	$0.311
Hauling	$0.165	$0.189	$0.412	$0.032	$0.798
Roads & Dumps	$0.135	$0.069	$0.104	$0.008	$0.316

21.2.2.5 Contract Services

Clearing and grubbing as well as supply of magnesium chloride for dust control in Phase 2 Years 1 to 14 are assumed to be on a contract basis and are estimated at $0.114/ton mined.

21.2.3 Process Plant Operating Cost

Operating costs were developed using reagent, grinding media and power consumptions based on the process flow sheet. Labor costs were developed based on a staffing plan and rate schedule from Equinox based on current Phase 1 operations and forecasted rates for personnel required for staffing. No contingency is applied to the estimated operating costs generated (see Table 21-22 and Table 21-23).

Table 21-22: Summary of Process Operating Costs by Area (Typical Processing Year)

Area Description	Typical Annual Cost ($M/y)	Typical Unit Cost ($/ton processed)
Heap Leach/Solution Handling	20.7	1.07
Crushing & Ore Storage	2.3	0.13
Mill/Leach/Detox/Filtration	13.3	0.66
Desorption, Regeneration and Refinery	3.8	0.20
Reagents, Utilities, Ancillaries	5.3	0.27
TOTAL	**45.5**	**2.33**

Table 21-23: Summary of Process Operating Cost by Use ($M/y)

Phase 2 Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
Labor	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	1.6	1.2	165.2
Process Plant Power[1]	6.8	7.1	7.1	7.1	7.0	7.1	7.1	7.1	7.0	7.1	7.1	6.9	6.4	4.0	0.6	0.4	95.9
Reagents & Consumables	22.9	23.2	23.2	23.2	23.1	23.2	23.3	23.3	23.1	23.3	23.3	22.7	20.0	7.7	2.3	1.7	309.5
Maint. Parts & Repairs	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.5	1.9	0.2	0.1	35.9
Process Mobile Equip Fuel	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.6	0.1	0.1	13.5
Annual Cost	44.9	45.5	45.5	45.5	45.3	45.5	45.6	45.6	45.3	45.6	45.6	44.8	41.4	25.8	4.8	3.5	**620.0**
$/ton	2.31	2.33	2.33	2.33	2.33	2.34	2.33	2.33	2.33	2.35	2.33	2.38	2.58	6.89	-	-	**$2.45**

Note 1: Raw Water Systems and Ancillaries included in G&A.

21.2.3.1 Process Plant Labor

Process plant labor costs were estimated by M3 for the expanded project increasing the Phase 1 workforce to 121 resulting in an increase to $11.6 M/y annually ($0.59/ton of processed ore). These costs include process plant operations and maintenance labor, lab technicians, operators, mechanics, and electricians etc. Process plant labor staffing plan is summarized in Table 21-24.

Table 21-24: Process Plant Staffing

Description	Qty
Process Manager	1
Process Superintendent	1
Metallurgist/Process Engineer	1
Process Foreman	4
Heap Leach Supervisor	1
Crusher Supervisor	1
Clerk	1
Total Process Admin	**10**
Heap Leach - Piping ROM Ore	12
Heap Leach Helper	4
Primary Crusher Operator	4
Loader Operator	4
Crushing Helper	4
Grinding/Gravity Operator	4
CIL & Thickening	4
Filtration & Clarification	4
Filter Tails - Truck Stacking	12
Grinding/Tailings Helper	4
ADR Operator	8
Refinery Operator	2
Total Process Operations	**57**
Maintenance Supervisor	2
Maintenance Planner	1
Mechanics	12
Electrician	2
Instrument Tech	1
Total Maintenance	**18**
Lab Manager	1
Assayers	4
Sample Preparation Labor	16
Met Tech	2
Total Lab	**23**
TOTAL	**121**

21.2.3.2 Electrical Power

Power consumption is based on developed project equipment list connected kW discounted for operating time per day and anticipated equipment loading level. The cost of power is $0.103/kWh based on construction of a utility transmission line to site. Alternative power supply options that may improve these costs are being investigated (see Table 21-25).

Table 21-25: Power Cost Summary

Area Description	Annual Power Consumption (MWh/y)	Annual Cost ($M/y)	Power ($/ton processed)
Heap Leach/Solution Handling/CIC	20,700	2.0	0.12**
Crushing & Ore Storage	4,700	0.5	0.39***
Mill/Leach/Detox/Filtration	31,100	3.2	2.50***
Desorption & Regeneration/Refinery	10,600	1.1	0.06
Reagents/Lab	1,600	0.2	0.01
Ancillaries and Utilities (G&A)	4,700	0.5*	0.02
Raw Water Systems	11,500	1.2*	0.06
TOTAL	**84,900**	**8.7**	**-**

* Included with G&A costs.
** Based on only heap leach ore; all others based on total ore unless noted.
*** Based on only mill ore.

21.2.3.3 Reagents and Consumables

Reagents and consumables consumption rates were determined from metallurgical test data, current on-site Phase 1 consumption rates and/or industry best practice. Budget quotations and current existing contracts were used as basis for reagent supply from local sources including estimated freight. Table 21-26 and Table 21-27 summarize annual consumptions and costs of reagents and process plant consumables.

Table 21-26: Reagent Cost Summary

Description	Consumption (lb/ton)	Annual Consumption (ton/y)	Annual Cost ($M/y)
Pebble Lime (Heap)	2.58	23,543	3.5
Pebble Lime (Mill)	2.99	1,910	0.3
Pebble Lime (Detox)	0.22	143	< 0.1
Sodium Cyanide (Heap)	0.60	5,475	11.4
Sodium Cyanide (Mill)	0.47	300	0.6
Antiscalant (Heap)	0.04	365	1.1
Antiscalant (Mill)	0.002	1	< 0.1
Carbon (CIC)	0.02	175	0.4
Carbon (CIL)	0.11	70	0.2
Flocculant (Grinding)	0.07	45	0.1
Flocculant (Detox)	0.07	45	0.1
Caustic Soda (Grinding)	0.008	5	< 0.1
Caustic Soda (ADR)	0.16	102	0.1
Leach Aid	0.003	2	< 0.1
Hydrochloric Acid	0.10	64	< 0.1
Sodium Metabisulfite	1.21	775	0.7
Copper Sulfate	0.08	51	0.1
Fluxes	0.001	1	< 0.1
TOTAL			**18.9**
TOTAL ($/ton - Heap)		**0.93**	
TOTAL ($/ton - Mill)		**1.82**	

Table 21-27: Consumables Cost Summary

Description	Consumption	Annual Consumption (unit/y)	Annual Cost ($M/y)
Crushing Liners (Prim/Sec)	0.06 lb/ton	78 ton	0.2
Grinding Liners	0.08 lb/ton	53 ton	0.1
Mill Grinding Media	1.83 lb/ton	1,170 ton	1.2
Filter Cloth	-	-	0.5
Propane	1.7 gpm	894,000 gal	0.9
TOTAL			**2.9**
TOTAL ($/ton – Mill)		**2.35**	
Drip Emitters	-	-	0.4
TOTAL			**0.4**
TOTAL ($/ton – Heap)		**0.02**	

21.2.3.4 Maintenance Parts and Outside Repairs

Parts are estimated using 5% of a project area's mechanical equipment cost and 2% of a project area's electrical equipment cost on an annual basis. Outside repairs are estimated at 10% of an area's parts cost on an annual basis. Maintenance labor is included in the process plant labor count and cost mentioned previously.

21.2.4 General and Administrative Costs

Equinox provided an estimate for the G&A costs for the expanded project of $9.7 M/y. These costs include general and administrative labor, property costs, legal fees, outside services, insurance, public relations, recruiting and other general costs. G&A costs are summarized in Table 21-28 and G&A staffing plan is summarized in Table 21-29.

Table 21-28: General and Administrative Cost Summary

Description	Annual Cost ($M/y)
Labor and Fringes	4.5
Insurances	1.0
Property Taxes	1.5
Community Relations	0.5
Legal Fees	0.5
Consultants	0.3
General Site Power and Maintenance	1.9
Other General Expenses	1.3
TOTAL	**11.5**
TOTAL $/ton	**0.59**

Table 21-29: General and Administrative Staffing

Description	Qty
General Manager	1
Administrative Assistant	1
Controller	1
Assistant Controller	1
Senior BI Specialist	1
Accountant	1
Accounts Payable Clerk	1
Accountant Analyst	1
Administration & Accounting	**8**
Materials Superintendent	1
Purchasing Specialist	1
Data/Inventory Analyst	1

Description	Qty
Repairables and Cores Coordinator	1
Warehouse Supervisor	1
Warehouse Technician	1
Warehouse/Purchasing	**6**
IT Specialist	1
IT Specialist Jr	2
IT	**3**
Human Resources Manager	1
Senior Human Resources Generalist	1
Human Resources Generalist	1
Recruiter	1
Benefits Specialist	1
Payroll Specialist	1
Human Resources Assistant	1
Human Resources	**7**
Safety Supervisor	1
Senior Health and Safety Coordinator	1
Senior Health and Safety Specialist	1
Health and Safety Coordinator	1
Health & Safety Specialist	1
Security	4
Health and Safety	**9**
Environmental Manager	1
Environmental Sr. Coordinator	1
Environmental Coordinator	1
Environmental Specialist	1
Environmental Admin Technician	1
Environmental	**5**
TOTAL	**38**

22 ECONOMIC ANALYSIS

22.1 INTRODUCTION

This section presents the cash flow forecast model for the Phase 2 project. This is used in the financial evaluation to determine the Net Present Value (NPV), payback period (time in years to recapture the initial capital investment), and the Internal Rate of Return (IRR) for the Phase 2 expansion project.

Annual cash flow projections were estimated over the life of the mine based on the estimates of capital expenditures, production cost, and sales revenue. The sales revenue is based on the production of a gold bullion. The estimates of capital expenditures and site production costs have been developed specifically for this project and have been presented in earlier sections of this report.

For the purposes of this cash flow forecast, the Phase 2 project is considered to have a construction time frame of approximately 24 months. The project is complete once the Phase 2 ROM heap leach pad and the process plant have been constructed, commissioned and are operating.

The following key parameters were used in the construction of the cash flow model and the economic results:

- Gold price at $1,500/oz,
- 100% equity financing with no debt component, and
- Revenues and costs reported in constant Q4 2020 U.S. dollar terms without escalation.

This analysis was completed primarily utilizing a Microsoft Excel-based discounted cash flow model. Currency is provided in US dollars.

22.2 SUMMARY ECONOMIC ANALYSIS

Table 22-1 presents the summary economic analysis results for the Phase 2 project at $1500/oz gold price.

Table 22-1: Summary Phase 2 Financial Results

Category	Units	Value	
Production Summary			
Phase 2 Ore material mined	Mton	894	
Phase 2 Ore tons processed	Mton	253	
Phase 2 Life (Processing)	y	14	
Phase 2 Life (Processing + Rinsing)	y	17	
Heap Leach Ore	Mton	235	
Head grade	oz/ton	0.0119	
Recovery	%	74	
Recovered Gold	koz	2,095	
Mill Ore	Mton	18	
Head grade	oz/ton	0.0665	
Recovery	%	94	
Recovered Gold	koz	1,108	
Total Recovered Gold	koz	3,203	
Total Payable Gold	koz	3,187	
Capital Costs			
Phase 2 Initial Capital	$M	510	
Sustaining Capital	$M	147	
Operating Costs			
Mining	$/ton mined	$1.75	
Mining	$/ton processed	$6.20	
Processing	$/ton processed	$2.45	
G&A	$/ton processed	$0.65	
Refining and Transportation	$/ton processed	$0.02	
Total Operating Cost	$/ton processed	$9.32	
Total Production Cost	$/ton processed	$806	
All-In Sustaining Cost	$/oz Au	$858	
Economic Indicators			
		Without Leasing	**With Leasing**
Internal Rate of Return (IRR), Pre-tax	%	18.9	19.7
Internal Rate of Return (IRR), After-tax	%	17.5	18.3
Undiscounted Cashflow, Pre-tax	$M	1,550	1,539
Undiscounted Cashflow, After-tax	$M	1,280	1,268
Net Present Value (NPV) @5%, Pre-tax	$M	784	784
Net Present Value (NPV) @5%, After-tax	$M	639	639
Payback Period (Based on After-tax)	y	5.3	5.4

22.3 MINE PRODUCTION STATISTICS

Mine production is reported as ROM heap leach grade ore, Mill grade ore and waste from the mining operation. The annual production figures were obtained from the mine plans as reported earlier in this report. Phase 2 production is defined as all ounces placed and processed after the beginning of LOM Year 6 within the project mine plan.

The life of mine ore, waste quantities and ore grade are presented in Table 22-2.

Table 22-2: Phase 2 Ore, Waste and Metal Grades

	Material Moved (Mton)	Gold Grade (oz/ton)
Heap Leach Ore	235	0.0121
Mill Ore	18	0.0685
Waste	641	-
Total	**894**	**0.0157**

22.4 PLANT PRODUCTION STATISTICS

ROM heap leach grade ore will be processed on a conventional heap leach pad, and the mill ore will be processed using a crushing and grinding circuit. Gold will be recovered using carbon columns for the heap leach ore and a hybrid leach/CIL circuit for the mill ore. A conventional carbon desorption, electrowinning, and refinery plant will produce a gold doré bar.

The estimated gold recoveries which were used are presented below:

- The average recovery for the ROM heap leach ore with rinsing: 74%
- The average recovery for the mill ore: 94%

Marketing Terms

A doré bar will be produced and sent to a precious metal refinery. The refining charges are negotiable at the time of the agreement. The refining terms and transportation charges used in this analysis are shown in Table 22-3.

Table 22-3: Marketing Terms

Description	Term Basis
Payable Gold (%)	99.5%
Refining Charge ($/oz)	$0.56
Transportation Charges ($/oz)	$0.95

22.5 PRODUCTION SCHEDULE PARAMETERS

The Phase 2 project from an economic analysis perspective begins with the commitment to detailed engineering activities and procurement of major equipment in preparation for construction which is expected to start 2.5 years ahead of start-up. The period of project execution resulting in significant capital spend with construction activities will begin approximately 2 years prior to full

operations starting. Figure 22-1 and Table 22-4 below illustrates Phase 2 project related activities through project start up..

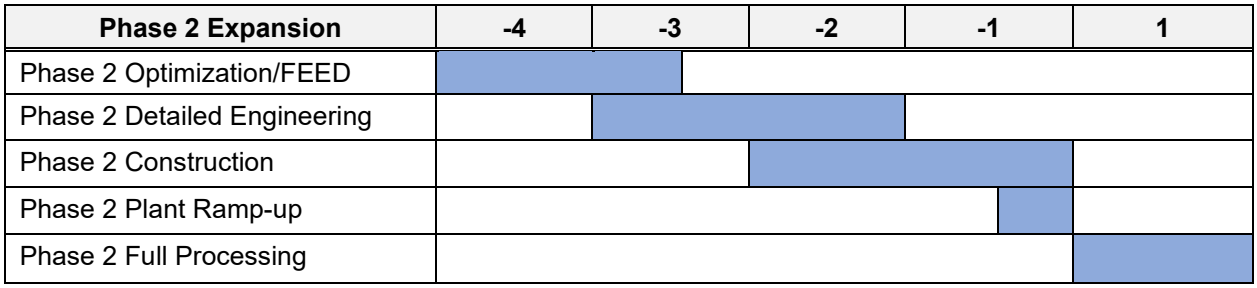


Figure 22-1: Phase 2 Schedule

Table 22-4: Phase 2 Initial Capital Spend Plan

Phase 2 Year	Ore Production (kton/y)	Mining Initial Capital Spend ($M)	Plant Initial Capital Spend ($M)	Working Capital ($M)	Total ($M)
Pre-Prod Year -3	5,150	-	28	-	**28**
Pre-Prod Year -2	5,150	109	204	-	**313**
Pre-Prod Year -1	11,150	62	68	14	**144**
Phase 2 Prod Year 1	19,300	24	-	1	**25**
Expanded Operations	19,500	Sustaining	Sustaining	N/A	-

22.6 CAPITAL EXPENDITURE

22.6.1 Initial and Sustaining Capital

22.6.1.1 Initial Capital

The financial indicators have been determined with 100% equity financing of the initial capital. The initial capital costs included in the financial model are shown below and detailed in Section 21. Table 22-5 summarizes the initial capital cost of the Phase 2 expansion. The planned capital cost spend by quarter is shown in Figure 22-2.

Table 22-5: Initial Capital Cost Summary

Area	Initial Capital ($M)
Mine	195
Process Plant and Infrastructure	282
Contingency	33
Total CAPEX	**510**
Less Leased Mining Equipment	*(121)*
Total CAPEX (with Leased Mining Equipment)	**389**

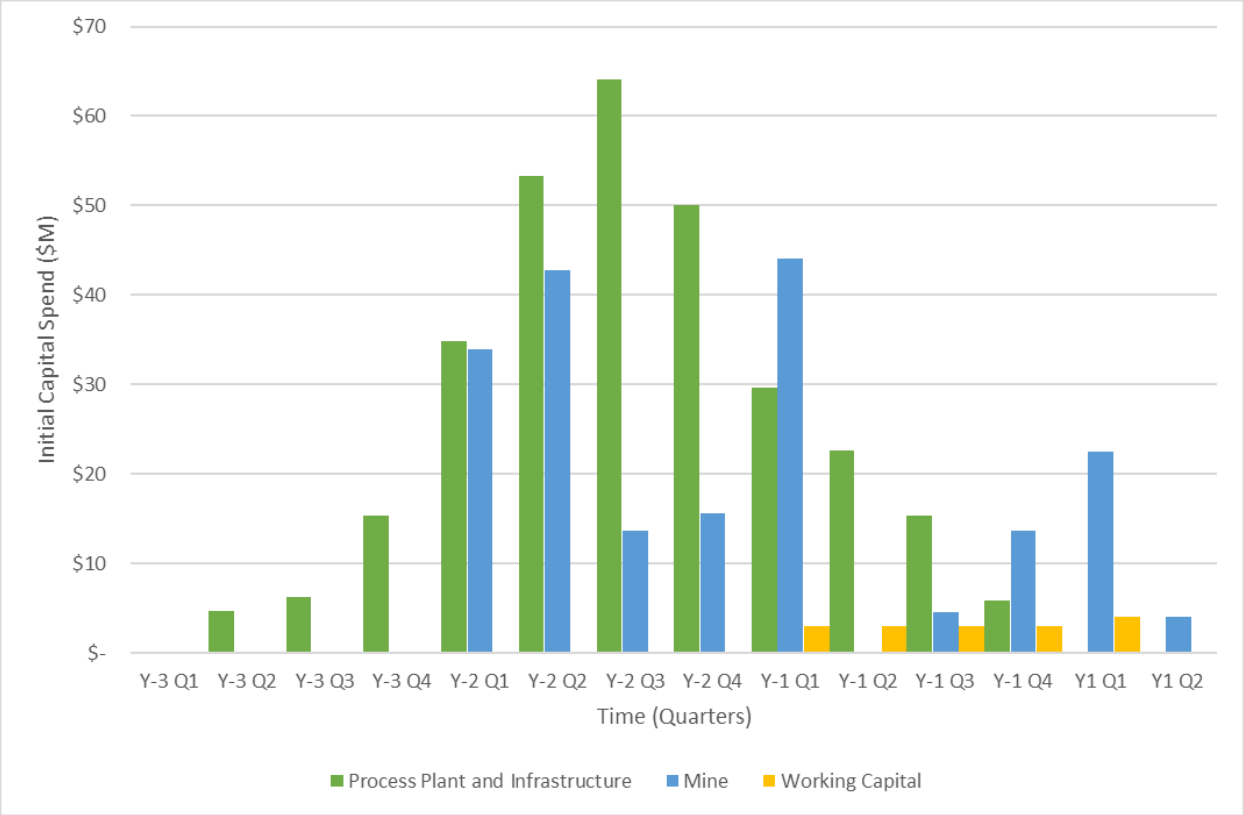


Figure 22-2: Initial Capital Spend Plan (Quarterly)

22.6.1.2 Sustaining Capital

Sustaining capital expenditures during the production period have been included in the financial analysis. The sustaining capital contained in the financial model is estimated at $147 million.

22.6.2 Working Capital

Working capital for the Project is estimated to be $15.5 million for Phase 2. The working capital is the capital required for operations before any revenue from Phase 2 ounces is produced by the mine and is based on the operating costs for the mine, process, and G&A costs for the Project. All the working capital is recaptured at the end of the mine life and the final value of these accounts is $0.

22.6.3 Salvage Value

An allowance for salvage value has been included in the cash flow analysis which was based on 5% of the capital cost of equipment and is estimated at $2.5 million.

22.6.4 Reclamation/Closure Costs

Reclamation and closure costs are estimated to be $22.0 million and account for activities required to comply with anticipated future amendments to the mine and reclamation plan for mine expansion. These activities include facility decommissioning, land recontouring and revegetation.

22.7 NET REVENUE

Net revenue was determined by applying estimated gold prices to the payable gold estimated for each year. Sales prices have been applied to all life of mine production without escalation or hedging. The revenue is the value of payable metals sold minus treatment and transportation charges. The gold sales price used in the evaluation is $1,500/oz.

22.8 ROYALTIES

Royalty payments are included for several royalties; the estimated royalty payments for the life of the mine totals $213.6 million and are shown in Table 22-6.

Table 22-6: Royalties Summary

Claim/Patent	%	Phase 2 Total Royalty ($000)	Owner
Turtle Back	5	288	Conservation Fund
Milma	5	288	Conservation Fund
Golden Clay	5	78,303	Huntington Tile
All Claims	2.65	126,569	Franco-Nevada
Pacific Clay	2	8,132	American Standard

22.9 OPERATING COST

Life of mine Cash Operating Costs include mine operations, process plant operations, general administrative cost and refining/transportation charges. Table 22-7 shows the estimated operating cost by area per ton of ore processed.

Table 22-7: Operating Cost Summary

Description	Unit Cost ($/ton mined)
Mining	1.75
Description	**$/ton ore**
Mining	6.20
Processing (Total)	2.45
G&A	0.65
Sub-Total	**9.30**
Refining and Transportation	0.02
Total	**9.32**

22.10 TAXATION

Taxable income for income tax purposes is defined as metal revenues minus operating expenses, royalty, property and severance taxes, reclamation and closure expense, depreciation, and depletion. Income tax rates for state and federal are as follows:

- State rate: 8.8%

- Federal rate: 21.0%

Income taxes were calculated on the taxable income described above using the federal and state rates.

22.10.1 Depreciation

Depreciation was calculated using the MACRS (Modified Accelerated Cost Recovery System) which is the tax depreciation system used in the United States. Under MACRS, fixed assets are assigned to a specific asset class, which has a designated depreciation period. The majority of fixed assets were assigned a 7 year depreciation period.

22.10.2 Depletion

The percentage depletion method was used in the evaluation. It is determined as a percentage of gross income from the property, not to exceed 50% of taxable income before the depletion deduction. The gross income from the property is defined as metal revenues minus downstream costs from the mining property (smelting, refining and transportation). Taxable income is defined as gross income minus operating expenses, overhead expenses, depreciation, and state taxes.

22.11 PROJECT FINANCIAL INDICATORS

The financial evaluation presents the determination of the Net Present Value (NPV), payback period (time in years to recapture the initial capital investment), and the Internal Rate of Return (IRR) for the project. The evaluation shows the following financial indicators without leasing of the mining equipment:

- Undiscounted Cashflow, After-Tax: $1,280 million
- NPV @ 5%, After-Tax: $639 million
- IRR %, After-Tax: 17.5%
- Payback (y): 5.3

The evaluation shows the following financial indicators should mining equipment be leased:

- Undiscounted Cashflow, After-Tax: $1,268 million
- NPV @ 5%, After-Tax: $639 million
- IRR %, After-Tax: 18.3%
- Payback (y): 5.4

Table 22-8 shows the Phase 2 detailed financial model while Figure 22-3 shows the cost and revenue summary by Phase 2 project year.

Table 22-8: Phase 2 Detail Financial Model

			Total	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Mining Operations																						
ROM Ore (kton)			236,350	-	-	-	18,250	18,250	18,250	18,250	18,250	18,250	18,250	18,250	18,250	18,250	18,250	18,250	14,775	2,576	-	-
Gold Grade (oz/ton)			0.0121	-	-	-	0.0108	0.0112	0.0112	0.0106	0.0102	0.0104	0.0127	0.0111	0.0121	0.0120	0.0136	0.0128	0.0187	0.0176	-	-
Contained Gold (koz)			2,851	-	-	-	196	205	204	193	186	190	232	202	220	218	248	234	277	45	-	-
Mill Ore (kton)			16,169	-	-	-	1,058	1,259	1,480	1,217	723	1,256	1,662	1,022	916	1,364	1,273	493	1,922	524	-	-
Gold Grade (oz/ton)			0.0685	-	-	-	0.0644	0.0473	0.0515	0.0703	0.0462	0.0721	0.0649	0.0616	0.0559	0.0854	0.0929	0.0932	0.0825	0.0643	-	-
Contained Gold (koz)			1,108	-	-	-	68	60	76	86	33	91	108	63	51	117	118	46	159	34	-	-
Waste (kton)			641,245	-	-	-	43,830	43,676	44,238	53,694	54,808	53,307	53,284	59,179	59,449	58,744	60,354	42,516	11,989	2,178	-	-
Total Material Mined (kton)			893,764	-	-	-	63,138	63,186	63,968	73,161	73,781	72,812	73,196	78,450	78,615	78,358	79,877	61,258	28,686	5,278	-	-
Stockpile (kton)			1,710	-	-	-	145	18	-	61	370	-	-	256	128	-	4	83	-	645	-	-
Total Material Moved (kton)			895,473	-	-	-	63,283	63,204	63,968	73,222	74,151	72,812	73,196	78,706	78,743	78,358	79,881	61,341	28,686	5,923	-	-
Process Plant																						
ROM Ore (kton)			235,208	-	-	-	18,250	18,250	18,250	18,250	18,066	18,228	18,250	18,250	18,016	18,250	18,250	17,548	14,775	2,576	-	-
Gold Grade (oz/ton)			0.0119	-	-	-	0.0108	0.0112	0.0112	0.0106	0.0100	0.0104	0.0127	0.0111	0.0117	0.0120	0.0136	0.0116	0.0187	0.0176	-	-
Contained Gold (koz)			2,804	-	-	-	196	205	204	193	180	190	232	202	210	218	248	204	277	45	-	-
Gold Recovery (%)			74.0%	0.0%	0.0%	0.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%	67.0%			
Recovered Gold (koz)			2,095	-	-	-	132	137	137	129	121	127	155	136	141	146	166	137	185	95	86	65
Mill Ore (kton)			17,702	-	-	-	1,203	1,277	1,278	1,278	1,278	1,278	1,278	1,278	1,278	1,278	1,277	1,278	1,278	1,169	-	-
Gold Grade (oz/ton)			0.0665	-	-	-	0.0635	0.0474	0.0515	0.0695	0.0466	0.0714	0.0649	0.0622	0.0544	0.0854	0.0928	0.0650	0.0825	0.0743	-	-
Contained Gold (koz)			1,177	-	-	-	76	61	66	89	60	91	83	79	69	109	119	83	105	87	-	-
Gold Recovery (%)			94.0%	0.0%	0.0%	0.0%	94.0%	94.0%	94.0%	94.0%	94.0%	94.0%	94.0%	94.0%	94.0%	94.0%	94.0%	94.0%	94.0%	94.0%	0.0%	0.0%
Recovered Gold (koz)			1,108	-	-	-	72	57	62	84	56	86	78	75	65	103	112	78	99	82	-	-
Total Ore (ROM & Mill)			252,910	-	-	-	19,453	19,527	19,528	19,528	19,343	19,506	19,528	19,528	19,294	19,527	19,528	18,825	16,052	3,745	-	-
Gold Grade (oz/ton)			0.0157	-	-	-	0.0140	0.0136	0.0138	0.0144	0.0124	0.0144	0.0161	0.0144	0.0145	0.0168	0.0188	0.0152	0.0238	0.0353	-	-
Contained Gold (koz)			3,982	-	-	-	273	265	270	282	240	281	315	282	279	327	366	287	382	132	-	-
Gold Recovery (%)			80.5%	0.0%	0.0%	0.0%	74.6%	73.2%	73.6%	75.6%	73.7%	75.8%	74.1%	74.7%	73.8%	76.0%	75.8%	74.9%	74.5%	133.8%	0.0%	0.0%
Total Recovered Gold (koz)			3,203	-	-	-	203	194	199	213	177	213	233	210	206	249	278	215	285	177	86	65
Payable Metal																						
Payable Gold (koz)			3,187	-	-	-	202	193	198	212	176	212	232	209	205	248	276	214	283	176	86	64
Income Statement ($000)																						
Metal Prices																						
Gold ($/oz)			$1,500.00	$1,500.00	$1,500.00	$1,500.00	$1,500.00	$1,500.00	$1,500.00	$1,500.00	$1,500.00	$1,500.00	$1,500.00	$1,500.00	$1,500.00	$1,500.00	$1,500.00	$1,500.00	$1,500.00	$1,500.00	$1,500.00	$1,500.00
Revenues																						
Gold Revenue ($000)			$4,780,994	$0	$0	$0	$303,672	$289,766	$296,809	$317,665	$264,054	$317,838	$348,463	$313,988	$307,560	$371,552	$414,468	$320,531	$424,735	$264,227	$128,952	$96,714
Refining Charges			$1,785	$0	$0	$0	$113	$108	$111	$119	$99	$119	$130	$117	$115	$139	$155	$120	$159	$99	$48	$36
Transportation			$3,028	$0	$0	$0	$192	$184	$188	$201	$167	$201	$221	$199	$195	$235	$262	$203	$269	$167	$82	$61
Net Revenues			$4,776,182	$0	$0	$0	$303,366	$289,475	$296,511	$317,346	$263,788	$317,518	$348,113	$313,672	$307,250	$371,178	$414,051	$320,208	$424,307	$263,961	$128,822	$96,617
Operating Cost	**$/ton mined**	**$/ton ore**																				
Mine	$1.75	$6.20	$1,566,941	$0	$0	$0	$100,003	$118,476	$120,933	$128,005	$130,418	$123,540	$121,970	$134,403	$137,146	$124,005	$128,523	$115,557	$69,164	$14,797	$0	$0
Process Plant - Heap Leach		$1.44	$365,189	$0	$0	$0	$27,259	$27,689	$27,562	$26,984	$27,303	$26,884	$27,401	$27,248	$27,241	$26,843	$26,919	$26,357	$23,179	$8,144	$4,672	$3,504
Process Plant - CIL		$1.01	$254,575	$0	$0	$0	$17,622	$17,793	$17,932	$18,520	$17,988	$18,615	$18,135	$18,299	$18,032	$18,725	$18,660	$18,381	$18,210	$17,664	$0	$0
G&A		$0.65	$164,102	$0	$0	$0	$11,444	$11,452	$11,452	$11,452	$11,433	$11,450	$11,452	$11,452	$11,428	$11,452	$11,452	$11,379	$11,092	$9,819	$3,368	$2,526
Total Operating Cost (Minus Refining)		$9.30	$2,350,808	$0	$0	$0	$156,328	$175,410	$177,879	$184,961	$187,142	$180,488	$178,958	$191,402	$193,848	$181,025	$185,553	$171,674	$121,645	$50,423	$8,040	$6,030
Royalties																						
FNV			$126,569	$0	$0	$0	$8,039	$7,671	$7,858	$8,410	$6,990	$8,414	$9,225	$8,312	$8,142	$9,836	$10,972	$8,486	$11,244	$6,995	$3,414	$2,560
Conservation Fund			$575	$0	$0	$0	$0	$0	$57	$382	$132	$4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Huntington Tile			$78,303	$0	$0	$0	$0	$0	$0	$0	$93	$151	$197	$505	$1,569	$7,008	$18,145	$17,382	$28,102	$5,152	$0	$0
American Standard			$8,132	$0	$0	$0	$266	$2,019	$2,569	$1,894	$407	$977	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Salvage Value			-$2,500																-$2,500			
Reclamation/Closure			$22,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,500	$3,500	$15,000
Gross Margin			$2,192,294	$0	$0	$0	$138,732	$104,375	$108,149	$121,699	$69,023	$127,484	$159,732	$113,453	$103,691	$173,308	$199,380	$122,666	$265,816	$197,891	$113,868	$73,026
Depreciation			$642,495	$0	$84,942	$38,442	$189,290	$46,072	$39,674	$39,111	$35,208	$27,942	$27,345	$22,859	$18,374	$19,113	$14,864	$11,079	$9,835	$8,027	$6,125	$3,390
Operating Income after Depreciation			$1,549,799	$0	-$84,942	-$38,443	-$50,557	$58,302	$68,475	$82,588	$33,815	$99,542	$132,387	$90,594	$85,317	$154,196	$184,517	$111,587	$255,981	$189,864	$107,743	$69,636
Taxes			$270,196	$0	$0	$0	$0	$1,602	$1,887	$2,282	$917	$2,927	$11,773	$12,529	$11,791	$27,983	$35,183	$18,578	$54,481	$43,247	$25,573	$19,443

	Total	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Net Income after Taxes	$1,279,603	$0	-$84,942	-$38,443	-$50,557	$56,700	$66,588	$80,306	$32,898	$96,615	$120,615	$78,065	$73,526	$126,213	$149,333	$93,009	$201,500	$146,617	$82,171	$50,193
Cash Flow																				
Operating Income after Depreciation	$1,549,799	$0	-$84,942	-$38,443	-$50,557	$58,302	$68,475	$82,588	$33,815	$99,542	$132,387	$90,594	$85,317	$154,196	$184,517	$111,587	$255,981	$189,864	$107,743	$69,636
Add back Depreciation	$642,495	$0	$84,942	$38,442	$189,290	$46,072	$39,674	$39,111	$35,208	$27,942	$27,345	$22,859	$18,374	$19,113	$14,864	$11,079	$9,835	$8,027	$6,125	$3,390
Working Capital																				
Accounts Receivable (0 days)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Accounts Payable (30 days)	$0	$0	$0	$0	$12,849	$1,568	$203	$582	$179	-$547	-$126	$1,023	$201	-$1,054	$372	-$1,141	-$4,112	-$5,854	-$3,484	-$165
Working Capital	$0				-$15,500															$15,500
Total Working Capital	$0	$0	$0	$0	-$2,651	$1,568	$203	$582	$179	-$547	-$126	$1,023	$201	-$1,054	$372	-$1,141	-$4,112	-$5,854	-$3,484	$15,335
Capital Expenditures																				
Initial Capital																				
Mine	$195,522	$0	$108,978	$62,397	$24,146	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Process Plant	$299,546	$28,126	$203,512	$67,909	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sustaining Capital																				
Mine	$80,872	$0	$0	$0	$1,846	$8,131	$13,570	$16,469	$3,342	$650	$7,351	$12,831	$15,473	$236	$662	$236	$75	$0	$0	$0
Process Plant	$66,555	$0	$0	$0	$3,404	$0	$1,295	$26,965	$0	$0	$22,249	$0	$0	$12,641	$0	$0	$0	$0	$0	$0
Total Capital Expenditures	$642,495	$28,126	$312,490	$130,306	$29,396	$8,131	$14,865	$43,434	$3,342	$650	$29,601	$12,831	$15,473	$12,877	$662	$236	$75	$0	$0	$0
Cash Flow before Taxes	$1,549,799	-$28,126	-$312,490	-$130,306	$106,685	$97,812	$93,487	$78,846	$65,860	$126,286	$130,006	$101,645	$88,419	$159,377	$199,090	$121,290	$261,629	$192,037	$110,385	$88,361
Cumulative Cash Flow before Taxes		-$28,126	-$340,616	-$470,922	-$364,237	-$266,425	-$172,938	-$94,091	-$28,231	$98,055	$228,061	$329,707	$418,125	$577,503	$776,593	$897,883	$1,159,512	$1,351,548	$1,461,933	$1,550,294
Taxes	$270,196	$0	$0	$0	$0	$1,602	$1,887	$2,282	$917	$2,927	$11,773	$12,529	$11,791	$27,983	$35,183	$18,578	$54,481	$43,247	$25,573	$19,443
Cash Flow after Taxes	$1,279,603	-$28,126	-$312,490	-$130,306	$106,685	$96,210	$91,600	$76,565	$64,943	$123,359	$118,233	$89,116	$76,628	$131,394	$163,907	$102,712	$207,148	$148,790	$84,812	$68,918
Cumulative Cash Flow after Taxes		-$28,126	-$340,616	-$470,922	-$364,237	-$268,027	-$176,427	-$99,862	-$34,919	$88,440	$206,674	$295,790	$372,418	$503,812	$667,719	$770,431	$977,579	$1,126,369	$1,211,181	$1,280,099
Financial Indicators before Taxes																				
NPV @ 0%	**$1,549,799**																			
NPV @ 5%	**$783,721**																			
IRR	**18.9%**																			
Payback	**5.2**			1.0	1.0	1.0	1.0	1.0	0.2	-	-	-	-	-	-	-	-	-	-	-
Financial Indicators after Taxes																				
NPV @ 0%	**$1,279,603**																			
NPV @ 5%	**$638,627**																			
IRR	**17.5%**																			
Payback	**5.3**			1.0	1.0	1.0	1.0	1.0	0.3	-	-	-	-	-	-	-	-	-	-	-

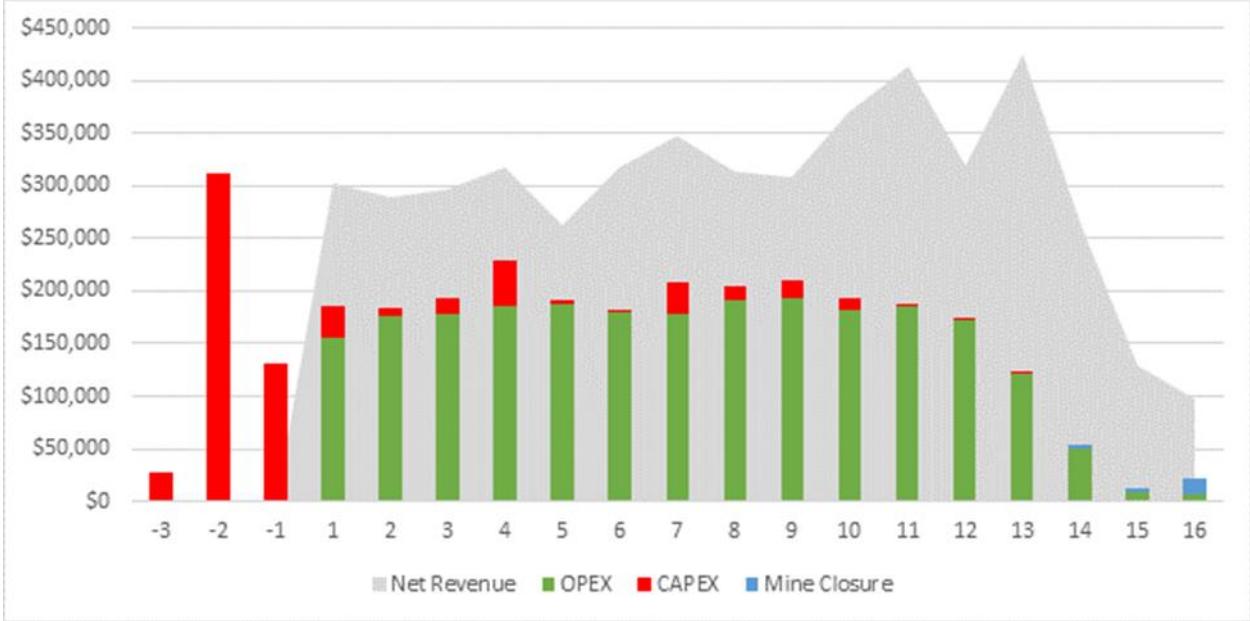


Figure 22-3: Phase 2 Cost and Revenue Summary

22.11.1 Sensitivity Analysis

The following tables illustrate the Base Case project economics and the sensitivity of the project to changes in the base case gold prices, operating costs, and capital costs. As is typical with precious metal projects, the Castle Mountain Project is most sensitive to gold prices, followed by operating cost and then initial capital costs. Presented in Table 22-9 to Table 22-13 are the sensitivities. Figure 22-4 shows the sensitivity analysis.

Table 22-9: Gold Price Sensitivity – After Taxes

Variance	Gold Price ($)	NPV @ 5% ($M)	IRR (%)	Payback (y)
-20%	1,200	143.3	7.9	10.3
-10%	1,350	393.9	12.9	6.9
0%	**1,500**	**638.6**	**17.5**	**5.3**
10%	1,650	874.6	21.7	3.9
20%	1,800	1,104.2	25.4	3.1
33%	2,000	1,408.8	30.1	2.5

Table 22-10: Operating Cost Sensitivity – After Taxes

Variance	NPV @ 5% ($M)	IRR (%)	Payback (y)
-20%	878.4	22.0	3.8
-10%	761.3	19.9	4.4
0%	**638.6**	**17.5**	**5.3**
10%	510.1	15.0	6.1
20%	378.4	12.4	7.4

Table 22-11: Initial Capital Sensitivity – After Taxes

Variance	NPV @ 5% ($M)	IRR (%)	Payback (y)
-20%	735.9	21.9	4.0
-10%	687.3	19.5	4.8
0%	**638.6**	**17.5**	**5.3**
10%	590.0	15.8	5.7
20%	541.3	14.3	6.1

Table 22-12: Cyanide Consumption Sensitivity – After Taxes

Variance	NPV @ 5% ($M)	IRR (%)	Payback (y)
-20%	654.8	17.8	5.2
-10%	646.7	17.7	5.2
0%	**638.6**	**17.5**	**5.3**
10%	630.5	17.3	5.3
20%	622.4	17.2	5.4

Table 22-13: Heap Leach Recovery Sensitivity – After Taxes

Variance	Recovery (%)	NPV @ 5% ($M)	IRR (%)	Payback (y)
-2.7%	72	556.4	16.1	5.6
-1.4%	73	597.5	16.8	5.5
0%	**74**	**638.6**	**17.5**	**5.3**
1.4%	75	679.8	18.2	5.1
2.7%	76	720.9	18.9	4.9

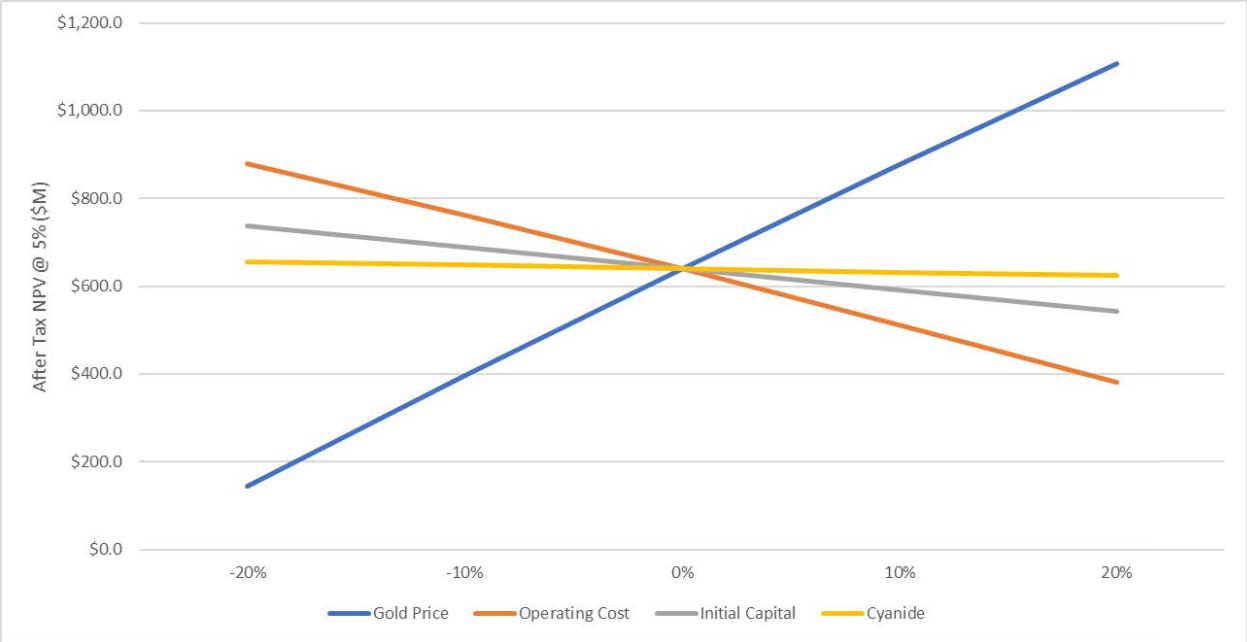


Figure 22-4: Sensitivity Analysis NPV @ 5%

23 ADJACENT PROPERTIES

There are no adjacent properties to the Project.

24 OTHER RELEVANT DATA AND INFORMATION

24.1 PROJECT IMPLEMENTATION

Project execution of the Castle Mountain Phase 2 expansion is expected to be completed in several stages including basic engineering or front-end engineering design (FEED) which are expected to progress in parallel with project permitting exercises. Further stages will include detailed engineering, project construction, commissioning, and project start-up and ramp-up.

There is expected to be some overlap between each stage; however, the near-term focus will be on permitting the project and optimization. The overall project timeline depends largely on attaining the discretionary operating permits from the co-lead agencies, the BLM and the County. The project permitting process and modifications to existing permits required for the Phase 2 project are discussed in Section 20.2. This permitting phase will be a main factor in the project timeline from the completion of the feasibility study to project completion and start of Operations. Phase 2 construction will not begin until the key operating permits are attained.

Considering the above, the Phase 2 expansion is anticipated to require an overall timeline of approximately 4 years from the effective date of this report to achieve full expanded operations. This timeline coincides with the completion of current operations' mining activity relating to JSLA backfill material and a requirement to move into fresh ore regions to sustain production.

24.1.1 Optimization and FEED

Throughout the course of completing the feasibility study, several areas have been identified that may provide environmental and economic benefits to the project or mitigate risk. A few key potential improvements will be studied to inform final project basis decisions prior to release of full-scale engineering activities. These studies will consist of specific evaluations of areas within the proposed process plant, alternative plant layouts and arrangements, reduction in overall project footprint, potential use of modularized equipment and structures etc. Additional testwork is planned to help inform these decisions.

Optimization work is expected to extend into a FEED program which will advance the feasibility study design to basic engineering. This will include development of long lead equipment specifications as well as receipt of detailed quotations, further engineering detailing, updates to cost estimates and implementation of project controls. During this stage, further development of important project infrastructure elements such as the utility transmission line and water sourcing will be undertaken. This stage is expected to be impacted to some extent by the permit application process which may evolve into additional engineering modifications. As the project timeline is refined, a detailed project execution plan (PEP) and project schedule will be developed. It is expected that during this stage the project organization structure will be developed and different project execution strategies will be reviewed. Further reviews by third parties will be incorporated.

The goal of this stage is to have a clear scope definition to start the detailed engineering stage and result in improved engineering timeline and deliverable quality. This stage is anticipated to continue for approximately 12 months and precedes full release of project engineering.

24.1.2 Basic and Detailed Engineering

The full project engineering scope of work begins with development of foundational deliverables such as project detailed design criteria, detailed project flow sheets, detailed piping and

instrumentation diagrams, equipment lists, long lead equipment procurement, PEP, detailed process description and control philosophy.

Once the project has been fully defined during this basic phase, updated project cost estimates will be developed to act as the final project control point as the project moves into stages requiring more substantial financial investment.

Detailed engineering will then commence for all disciplines with priority on early works packages which may be required to support the construction on site. Basic and Detailed Engineering for this project, including the heap leach and filtered tailings facility, are anticipated to take approximately 15 months.

24.1.3 Contract Development

As detailed engineering reaches a point of substantial advancement and project work packages become available, a detailed project contracting plan is developed, work packages assembled and requests for services from Contractors are begun. Selected project contractor(s) will be engaged to complete a constructability review and establish firm expectations and execution methods prior to mobilization into the construction phase. This stage is expected to be carried primarily over the course of 3-6 months.

24.1.4 Project Construction

Project construction is anticipated to continue for approximately 24 months based on 50-hour work weeks. This includes construction of new process facilities, heap leach Phase 2A, the initial starter cell for the filtered tailings facility, the truck shop and wash, process maintenance and warehousing building and all supporting infrastructure to operate the project. This construction timeframe also includes a duration for commissioning and ramp up of the plant over the last 6 months of construction with handover to the Owner's team.

Within the two-year construction period, care will be taken to schedule construction activities during optimized seasons and conditions to minimize things like construction water usage and to coincide best with on site operations.

Figure 24-1 shows a summary of the anticipated overall project schedule.

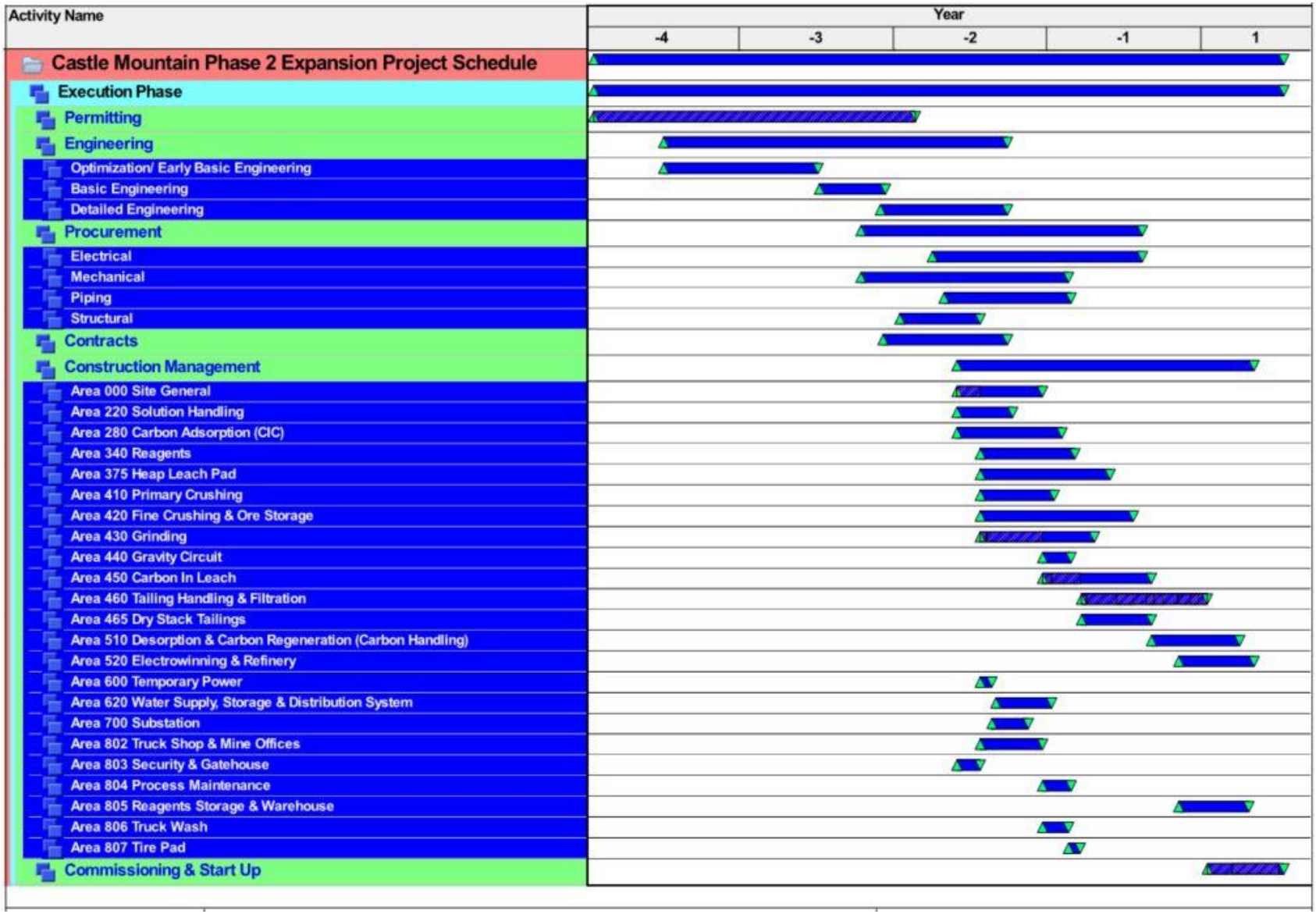


Figure 24-1: Anticipated Overall Project Schedule

25 INTERPRETATION AND CONCLUSIONS

25.1 CONCLUSIONS

This Technical Report provides a summary of study results and conclusions for each major element of investigation conducted. These include, but are not limited to, resource exploration, project metallurgy and interpretation, resource estimation, mine planning and design, process plant and infrastructure design and requirements, environmental status and mitigation, capital and operating costs, and economic analysis.

The feasibility study results provide a clear conclusion that the Castle Mountain Phase 2 Project is an economically viable project based on an evaluation and interpretation of the available data and work carried out in undertaking the study. The QPs have drawn the following principal conclusions:

25.1.1 General

The level of investigation for all elements of this study, as confirmed by all Technical Report QPs, is consistent and typical of a feasibility level study.

As of the effective date of this Technical Report, Equinox holds a 100% interest in the Castle Mountain Project.

25.1.2 Geology and Mineral Resource Estimate

The deposits within the Castle Mountain Project are part of a low sulfidation epithermal system characterized by gold mineralization commonly occurring with silica alteration and iron oxide minerals. Mineralization is controlled by first order porosity and permeability of the lithological units that form the host volcanic complex and structural zones which can provide the conduit for hydrothermal fluids that carry mineralization.

The Project has now combined Measured and Indicated mineral resources exclusive of mineral reserves that are amenable to open pit mining that total 82 Mton at 0.018 oz/ton gold for 1,470 koz contained gold. These mineral resources occur dominantly within the oxide portion of the ore body and include portions of transition and sulfide ore. The Measured mineral resources exclusive of mineral reserves that are amenable to open pit mining total 861,000 tons at 0.020 oz/ton gold for 17 koz contained gold. Indicated mineral resources exclusive of mineral reserves that are amenable to open pit mining that total 81 Mton at 0.018 oz/ton gold for 1,453 koz contained gold.

Contributions to the changes to the current mineral resources are predominantly due to the differences between criterion used for Mineral Resource classification which relies dominantly on drillhole spacing.

25.1.3 Mining and Mineral Reserve Estimate

The current LOM plan was developed based upon Proven and Probable Mineral Reserves of 284.3 Mton with a grade of 0.015 oz/ton at a cut-off grade of 0.005 oz/ton Au. The total waste mined will be 701.9 Mton. The strip ratio average is 2.47:1 waste:ore tons.

Mining for project expansion will be by Owner operated conventional diesel-powered truck and shovel operation. Current operations are focused on mining of previously backfilled material in

the JSLA pit while expanded operations will focus on expansion of current pits and new pit development.

25.1.4 Mineral Processing and Metallurgical Testing

Significant metallurgical testwork from 2015 to 2020 has been completed on both heap leach and mill material to establish the design criteria for the Phase 2 expansion. The testwork program completed provided the necessary data to define a process flowsheet and engineering parameters. This allowed for design and cost estimation of a conventional process plant for the feasibility study as well as defining the metal recoveries and operating consumables. Recovery methods proposed for the expansion consist of proven and well-known technologies in the industry.

After evaluating the column leach tests by feed size, ore zone, and lithology, the arithmetic average gold recovery was 81%, 80% and 80%, respectively. A weighted gold recovery based on ounces per lithology was calculated as 82%. The average lab recovery for Castle Mountain low grade ore was 80%.

To estimate the Castle Mountain gold recovery for the production heap leach from the lab data, operating and environmental conditions were considered. This includes ROM particle size distribution, permeability, effective leaching of the side slopes, etc. The ROM material for the Castle Mountain Project is predicted to have an F_{80} of 152 mm to 203 mm. When considering the ore size and other data, a lab to field deduction of 6% was applied to the average lab recovery of 80% for an expected LOM heap leach gold recovery of 74% after solution application is stopped. To account for the typical time impact in recovering gold from a large leach facility at closure, the expected gold recovery during LOM operations is considered to be 67% with a final recovery of 74% attained only after extracting residual gold values and reducing cyanide levels in the heap. This is expected approximately three years after mining has ceased.

For this Feasibility Study, gravity followed by gravity tail leach in a CIL circuit was selected for the process based on economics. An overall gold recovery of 94% is expected from mill grade ores processed through the mill after 24-hour hybrid leach/CIL retention time. The plant has been sized conservatively with 30 hours retention time in the leach/CIL tanks.

25.1.5 Project Infrastructure

The existing infrastructure including current operations has been integrated into the proposed designs to support the expansion operations to the greatest extent possible. Further Phase 2 infrastructure developments include a security gatehouse, expanded site fencing, on site access roads, truck fleet service facilities, and dedicated process storage and warehousing facilities.

A site wide water balance was developed considering multiple scenarios based on historic and current climatic conditions at site and in the surrounding areas. Resulting make-up water demands were evaluated and used to inform water supply requirements. Recently completed groundwater studies on and off site indicate a high likelihood that sufficient capacity for fresh water can be attained through a combination of on site and off-site sources.

Mill tailings were tested and analyzed, and it was concluded they are amenable to filtered stacking. To limit new land use on the property, it was determined that adequate capacity is available on the historic Viceroy heap leach pad and adjacent to the expanded heap leach facility

to serve the LOM requirement. This results in optimized footprint while minimizing new disturbance on the property.

Several options for power supply were studied in detail with each being determined to provide viable alternatives for power supply to the expanded operations. The selected basis for the feasibility study is connection to the grid via a new powerline serviced by NV Energy and SCE. Other alternatives including supplementing with renewable power, specifically solar, have been investigated and show potential opportunity.

25.1.6 Environmental Studies and Permitting

The Castle Mountain Mine is located on both public and private land and historically has been environmentally permitted by co-lead agencies, the County of San Bernardino at the state level, and the United States Bureau of Land Management (BLM) at the federal level. The current operation was issued a revised Mining CUP by the County in August 2019 while the BLM issued a Decision Record and FONSI in February 2020 approving the revised Mine and Reclamation Plan. These key permits along with others provide the authorization for current mine operations at the project site.

Significant resource monitoring and environmental analyses have been conducted and continue to be completed on site to assure compliance and environmental stewardship of the project site.

Mine expansion as considered in this feasibility study is expected to require new or updated environmental review (likely in the format of an EIS/EIR) as well as several new state and federal permits and amendments. Future amendments to the mine and reclamation plan to account for mine expansion are also expected and will include facility decommissioning, land recontouring, and revegetation.

25.1.7 Cost Estimates

Detailed capital and operating cost estimates have been developed including consideration for all direct and indirect costs associated with execution of the expansion project and required supporting infrastructure as well as sustaining costs, and reclamation and closure costs.

The cost estimate is based on preliminary engineering including 250 feasibility level design drawings covering all engineering disciplines, design criteria and detailed material take-offs. Mechanical and electrical equipment pricing was obtained for all major equipment (>$50,000) including 89% (or 140 items) through budgetary quotes. Bulk material pricing was estimated from recent projects budget quotes, local contractor budgetary review and actual pricing from Phase 1 construction. Mining equipment costs are based on quotes from major suppliers. Labor rates have been estimated using a weighted average of prevailing non-union shop wages from a published source (Davis-Bacon; 50%) and actual labor rates on site for Phase 1 construction (50%).

Project operating cost is based on a detailed build up of staffing requirements, reagent and fuel consumptions, mining activities, maintenance, and power demand. All major consumables have been specifically quoted with delivery to site.

The costs reflect a joint effort conducted by M3, NMS and specialist sub-consultants to adequately define project cost to a -10% to +15% accuracy level.

Analysis of the resulting economic parameters shows the expansion project to be economically viable.

25.2 RISKS

As with most projects at the feasibility stage, there are risks that could affect the economic potential or the continued viability of the project. There are several risks associated with external factors such as permitting, political, social, and metal prices which are generally considered inherent general risks to all mining projects. Throughout the development of the feasibility study, specific risks have been identified and mitigated through testing, analysis, and engineering practice. However, some risks remain and to a large degree there will always be risk associated with a mining project. Not all of these are listed here but a few key ones are described below.

In going forward it is expected that the project will develop a formal detailed Project Risk Register as well as conduct several risk assessments at various stages including Hazard and Operability Analysis (HAZOP). Risk mitigation will be a continual aspect that gets further refined through the next stages of project development.

25.2.1 Permitting

As described in detail in Section 20, there are significant regulatory hurdles and several different agencies involved. Time frames include time to prepare and submit environmental review documents, additional time for environmental studies, as well as multiple public review and comment periods. Key permits must be obtained in order that other non-discretionary permit processes can begin. There is a risk that the agencies will not meet reasonable time frames for permitting approvals. Equinox has developed good relationships with all permitting agencies through the recent permitting of the Phase 1 operations and continued dialogue through the next phase of work will mitigate permitting concerns.

25.2.2 Gold Recovery

The LOM gold recovery for heap leach grade ore is anticipated to be 67% and increasing to 74% after rinsing. It is based on column tests which have been completed using material finer than the predicted ROM with a top size of 432 mm (F_{80} of 152-203 mm). There are several factors within a heap that could affect performance. Gold recovery could be less than anticipated despite extensive column and bottle roll testwork that has been conducted on various crush sizes and on ROM; therefore, additional ROM testing on in-situ ore paired with 9.5 mm, 25 mm and 50 mm column tests is recommended.

25.2.3 Water Supply

The source of project make-up water is based on recent groundwater potential studies and small-scale pump testing which have indicated the high probability to service the project's demand needs from a combination of current and new on site as well as off-site wells (Lanfair Basin). Should further planned pump testing and groundwater modelling result in contrary results, alternative sources for water and/or adjustments to water demand will need to be investigated which could impact project economics.

25.2.4 Filtered Tailings

Mill tailings will be filtered and additionally allowed to dry before being systematically layered in place in a dry stack facility which is lined and will be abutted to the coarse ROM ore heap leach pad. The material has been geotechnically studied to ensure it will be structurally stable when placed. Filtered tailings is considered best available technology in terms of tailings placement. By abutting mill tailings with heap leach, residual cyanide solution is collected and recycled to the process.

Mill tailings have been shown through testwork to be readily amendable to detoxification and meeting recent USA EPA recommendations for the state of California for effluent cyanide concentration. Should lower levels of resulting cyanide be determined to be required to meet acceptable final residual levels within the lined facility, detox reagent consumptions and operating costs could be affected.

25.2.5 Geotechnical

During Viceroy operation, there were three significant wall failures. Geotechnical evaluation discovered that each failure was associated with weak clay altered materials and geological evaluation shows that the weak clay altered materials are within close vicinity of major mapped fault zones. Slope recommendations implemented in the mine plan include reduced slope angles within specified widths to mapped fault zones. Additional wall failures may occur again, but the risk is significantly mitigated based on lessons learned from previous operations.

25.3 OPPORTUNITIES

Throughout the feasibility study, opportunities for improvement of project economics were identified and investigated. Many of these opportunities have been incorporated into the study while others will be more fully examined in the next stage of project development. A few key ones are summarized here.

25.3.1 Supplemental Solar Power

The use of renewable energy has been investigated and the Castle Mountain site offers high potential for reducing reliance on conventional power generation. A solar plant has been examined in detail and provides an excellent opportunity to the Project to reduce GHG emission and lower reliance on electrical power provided by utilities.

The Project is situated in an area with substantial recent development of solar power generating plants and is well placed to utilize this as a renewable energy source on site to offset utility power supply costs. An analysis of solar power and its project economics has been prepared. This analysis focused on an 11.5 MW_{DC} photovoltaic solar power production plant, typically providing 10 MW_{AC} of power to the site and located on 42 acres at the northwestern corner of the current mine property. Figure 25-1 below shows the proposed location.

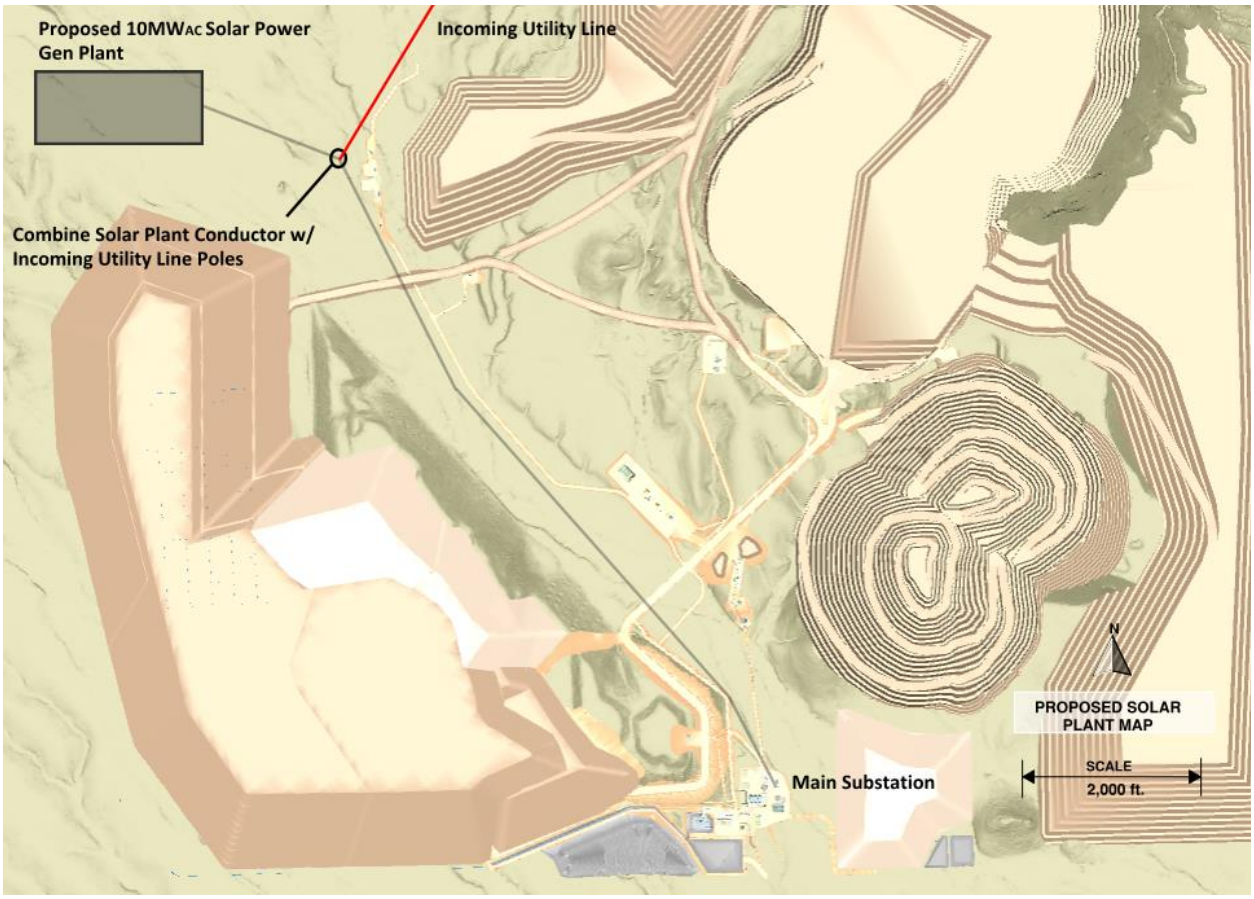


Figure 25-1: Proposed Solar Plant Map

The proposed solar power generating plant has shown to lower the energy cost for Castle Mountain if Castle Mountain subscribes to Net Metering. Net Metering is a program run by the California Public Utilities Commission providing customer-generators with credit or compensation for electricity generated by their renewable facilities to balance the costs of the renewable electrical generation facility. Net Metering is a direct incentive for solar power generation, and it has been indicated that Castle Mountain would likely qualify.

The proposed plant would generate approximately 40% of the typical expanded project demand load and reduce all-in average power costs from $0.103/kWh to $0.073 kWh. Initial capital of the 10 MW_{AC} is estimated at $12.8 million (including 15% contingency) with an operating cost of $140,000 annually resulting in a net power savings of $1.88 million annually, a simple payback of 6.8 years and an IRR of 12% when considering Net Metering.

Potential opportunity also exists for current operations on site in the potential addition of a pilot solar facility to offset or eliminate diesel power generation on site. Further studies to optimize are likely to be progressed throughout 2021.

25.3.2 Exploration

As resources are depleted throughout the current project life, exploration targets exist in the form of anomalous mineralized trends on East Ridge, East Flats, Egg Hill, Northwest Rim and Benson.

25.3.3 Plant and Infrastructure Design

There are several project and plant design aspects that offer opportunities to improve the project. These include reducing water usage and reagent consumption while there are others that may provide economic benefits through reduced equipment or footprint. This includes modularization of some equipment and selecting different types of similar equipment such as vertical carbon columns or alternative grinding mill or filter designs.

Grinding size sensitivity tests have indicated that coarser particle sizes show gold recovery by cyanide to be similar to the tests completed at 150 microns. Grinding to a coarser size would require both less power and smaller equipment.

Carbon loadings for the carbon columns are estimated to be 100 oz (Au + Ag) per tonne of carbon. Should current operations and further evaluation validate improved loadings, the daily amount of carbon movement may be able to be reduced.

Tailings have been shown to readily detoxify to low cyanide levels. There may be an opportunity to store tailings in an unlined facility which would allow for backfilling tailings into pits and co-mingling tailings with waste rock.

26 RECOMMENDATIONS

Based on the results from the study conducted, the following recommendations are made:

26.1 GENERAL

- The Castle Mountain Project Phase 2 expansion is a feasible project with good economics and should be progressed to the next stage which includes permitting along with optimization and front-end engineering ahead of detailed engineering.

26.2 ASSAY MANAGEMENT AND GEOLOGIC MODELING

- Implement a blind QA/QC program for ongoing monitoring of grade control and production sampling with control samples and duplicates analyzed at the mine laboratory.
- Implement in-pit bench mapping to inform short-range models in concert with grade control sampling.

26.3 MINERAL RESOURCE

- On-going grade control and reconciliation processes are recommended to measure the performance of the long-term model against production, to identify areas for improvement of the production cycle and to possibly refine the long-term model based on these results.
- Additional characterization of alteration and mineralization to better inform and constrain existing alteration and oxidation models is recommended.

26.4 MINING

- Continued optimization of phase development, pit waste backfill sequencing and blast patterns with respect to fragmentation for ROM leaching is recommended.

26.5 HEAP LEACH

- Observation of current operations to confirm design criteria such as saturation moisture percentage within the pad, performance of overliner gravel, evaporation losses etc.

26.6 METALLURGICAL AND PROCESS PLANT

- Conduct additional ROM testing on in-situ ore paired with 9.5 mm, 25 mm and 50 mm column tests to validate optimal size for heap leach.
- Conduct further mill grind size vs recovery with whole ore leach and gravity with gravity tails leach to validate optimal grind size.
- Further investigate potential clay impact on rheology and filtration characteristics. Specifically add East Ridge samples to confirm thickening and filtration criteria.
- Further investigate comparative leach/CIL tests to confirm effect of cyanide concentration on gold dissolution rates, final extraction, and reagent consumption.

- Head analyses on heap leach and mill composites from 2020 testwork indicated high levels of copper associated with andesite lithology. High solubility of the copper can impact the efficiency of carbon and the consumption of cyanide and detox reagents. The addition of copper and sulfur to the project mine plan is recommended.

- Undertake gravity recoverable gold (GRG) tests and modelling to determine optimum percentage of material to send to the gravity circuit. In addition, carry out intensive leach tests on gravity concentrate to confirm recovery and reagent consumption.

- Conduct further leach/CIL tests to validate reagent consumption.

- Gravity and tails leach testwork has not been done on the East Ridge ore zone which accounts for 17% of the LOM gold ounces to be processed. This testwork is recommended to be completed.

- Detoxification tests using oxygen are recommended to validate reagent consumption.

- Agitator testing to observe mixing performance and to determine design parameters with the variability expected in the solids density from different ore types for both CIL and Detox.

26.7 PROJECT INFRASTRUCTURE

- Update the Lanfair Valley hydrogeological model based upon recent well testing results and surface geophysical information.

- Install larger diameter wells in the Lanfair Valley and Ivanpah Valley to validate sustainable availability of make-up water. Each of the wells could eventually serve as production wells.

27 REFERENCES

Ausburn, K.E., 1991. Ore-petrogenesis of Tertiary volcanic-hosted epithermal gold mineralization at the Hart mining district, Castle Mountains, NE San Bernardino County, California, in Raines, G.L., Lisle, R.E., Schafer, R.W., and Wilkinson, W.H., eds., Geology and ore deposits of the Great Basin--Symposium proceedings: Reno, Geological Society of Nevada, v. 2, April 1990, p. 1147-1188.

Ausburn, K.E., 1995. Ore-petrogenesis of Tertiary volcanic-hosted epithermal gold mineralization at the Hart mining district, Castle Mountains, NE San Bernardino County, California. PhD. Thesis, University of North Carolina at Chapel Hill, 1995, 121 pp.

Barrett, T.J., 2016a. Castle Mountain Au Deposit (NewCastle Gold): Lithogeochemical and Lithological Features of the Volcanic Host Rock Sequence. Internal report for NewCastle Gold Ltd., December 25, 2016.

Barrett, T.J., 2016b. Castle Mountain Property (NewCastle Gold):Lithogeochemical Classification of Host Rocks and Assessment of Alteration Effects. Appendix I: Petrographic Observations. Internal report to NewCastle Gold Ltd., December 21, 2016.

BCSC, 2016. National Instrument 43-101 - Standards of Disclosure for Mineral Projects, Compiled by British Columbia Securities Commission to May 9, 2016, 23 pp.

Buesch, D.C. 1992, Field and chemical investigations of the Peach Springs Tuff, southeastern California, western Arizona, and southern Nevada. Ph.D. thesis, University of California–Santa Barbara, 196 p.

Call & Nicholas, Inc., 2020. Castle Mountain Geotechnical Feasibility Report. Prepared for Equinox Gold Corp. April 2020.

Capps, R.C. and Moore, J., 1997. Castle Mountains Geology and Gold Mineralization, San Bernardino County, California and Clark County, Nevada. Geological Survey of Nevada, Accompaniment to Map 108. 20 p.

Capps, R.C., and Moore, J., 1991. Geological Setting of Mid-Miocene Gold Deposits in the Castle Mountains, San Bernardino County, California and Clark County, Nevada. Geological Society of Nevada, Great Basin Symposium, v.2., p. 1195-1219.

Capps, R.C., and Moore, J., 1994. Mineralization and Alteration in the Castle Mountains, report prepared for Viceroy Gold Corp.

CIM, 2014, CIM Definition Standards - For Mineral Resources and Mineral Reserves. Prepared by the CIM Standing Committee on Reserve Definitions, Adopted by CIM Council on May 10, 2014. 9 pp.

CIM, 2019. Estimation of Mineral Resources & Mineral Reserves Best Practice Guidelines. Prepared by the Canadian Institute of Mining, Metallurgy and Petroleum's (CIM) Mineral Resources and Mineral Reserves Committee (CIM MRMR Committee) to update an earlier version that was accepted by CIM Council on November 23, 2003. Adopted by CIM Council on November 29, 2019. 75 pp. https://mrmr.cim.org/media/1129/cim-mrmr-bp-guidelines_2019.pdf

Cline, J.S., 2016. Petrographic and SEM Study of Gold and Alteration Minerals, Castle Mountain Mine, San Bernardino County, California. Prepared for NewCastle Gold Ltd. in January, 2016. 33 pp.

Clear Creek, 2020a. Groundwater Exploration Drilling Summary Report, Castle Mountain Mine, San Bernardino County, California. Submitted to Equinox Gold / Castle Mountain Venture. Prepared by Clear Creek Associates. Project #CC20.1009. Dated August 20, 2020.

Clear Creek, 2020b. Ivanpah Basin Groundwater Investigation, Summary Report, Castle Mountain Mine, San Bernardino County, California. Submitted to Equinox Gold / Castle Mountain Venture. Prepared by Clear Creek Associates. Project #CC20.1009. Dated August 31, 2020.

Crook, N., Baldyga, C., Poje, M., Cain, J. 2020. Geophysical Hydrogeological Characterization, Phase II Survey - Castle Mountain Venture. RPT-2020-020, Rev 0. Prepared by HydroGEOPHYSICS (HGI). Prepared for Castle Mountain Venture. Published July 2020.

Cyanco, 2020. Test Program to Evaluate Cyanide Destruction Options Using SO_2/Air & Peroxygen Based (Caro's Acid) Technologies For the treatment of effluents from the Castle Mountain Mine. April 2020.

Equinox Gold Corp., 2018. Castle Mountain Project Health & Safety Plan, Standard Operating Procedures, & Terminology Guidebook. Internal Document. December 18, 2018. Unpublished Document, 141 pp.

Faulds, J.E., Feuerbach, D.L., Miller, C.F., and Smith, E.I., 2001. Cenozoic evolution of the northern Colorado River extensional corridor, southern Nevada and northwestern Arizona. Utah Geological Association Publication 30 – Pacific Section of the American Association of Petroleum Geologists Publication GB78, p. 239-271.

Ferguson, C.A., McIntosh, W.C., and Miller, C.F., 2013. Silver Creek caldera – The tectonically dismembered source of the Peach Spring Tuff. Geology, v. 41, No. 1, p. 3-6.

FLSmidth Minerals Testing & Research Center, 2020. McClelland Laboratories, Inc. Comminution Suite – JKTech Drop Weight and SMC Testing®. Prepared for McClelland Laboratories, Inc. February 6, 2020.

G.I.S Land Services, 2015. Pacific Clay Deposits Nos. 1 through 3 Limited Title Review, San Bernardino County, California. Prepared for Castle Mountain Venture. Limited Title Review 2015-1-LTR. July 9, 2015. 37 p.

Geo-Logic Associates, 2018. Pre-Feasibility Water Supply Investigations, Castle Mountain Mine, 2017.A002, Internal Report prepared for NewCastle Gold. 114 p.

Geo-Logic Associates, 2020. Geotechnical Report Proposed Phase 2 Site Improvements Castle Mountain Project, San Bernardino County, California. Submitted to Equinox Gold. March 2020.

Glazner, A.F., Nielson, J.E., Howard, K.A., and Miller, D.M., 1986. Correlation of the Peach Springs Tuff, a large-volume ignimbrite sheet in California and Arizona: Geology, v. 14, p. 840–843.

Gresham Savage Nolan & Tilden, 2020. Supplemental Title Report/Update, Castle Mountain Project, San Bernardino County, California. Prepared for Castle Mountain Mining Company. March 10, 2020.

Hewett, D. F., 1956. Geology and mineral resources of the Ivanpah quadrangle, California and Nevada: U. S. Geol. Survey Prof. Paper 275, 172 pp.

Howard, K.A., John, B.E., Davis, G.A., Anderson, J.L., and Gans, P.B. 1994. A Guide to Miocene Extension and Magmatism in the Lower Colorado River Region, Nevada, Arizona, and California. U.S. Department of the Interior, U.S. Geological Survey Open File Report 94-246. A Guide for Field Trip 3 - Eighth International Conference on Geochronology, Cosmochronology, and Isotope Geology, May 31- June 4, 1994, 54 pp.

John, D.A., Hofstra, A.H., Fleck, R.J., Brummer, J.E. and Saderholm, E.C., 2003. Geologic setting and genesis of the Mule Canyon low-sulfidation epithermal gold-silver deposit, north-central Nevada. Economic Geology, v. 98, p. 425-463.

John, D.A., Vikre, P.G., du Bray, E.A., Blakely, R.J., Fey, D.L., Rockwell, B.W., Mauk, J.L., Anderson, E.D., and Graybeal, F.T., 2018. Descriptive models of epithermal gold-silver deposits. US Geological Survey Scientific Investigations Report 2010-5070-Q, 247 pp.

Kappes, Cassiday and Associates, (KCA) 2018a, Metallurgical Test Report, Gravity / CIL Test – High Grade Composites, 30 July 2018, 49p.

Kappes, Cassiday and Associates, (KCA) 2018b, Castle Mountain Project – Compacted Permeability Test Work, prepared for Castle Mountain Venture, 30 July 2018, 72p.

Kappes, Cassiday and Associates, (KCA) 2018c, Castle Mountain Project – Gravity Amenability Test Work, prepared for Castle Mountain Venture, 17 August 2018, 15p.

Kappes, Cassiday and Associates, (KCA) 2018d, Pre-Feasibility Study design and support documentation package, prepared for Equinox, August 2018.

Magee Geophysical Services LLC, 2014. Gravity Survey over the Castle Mountain Mine Area, San Bernardino, CA. Prepared for Castle Mountain Mining Company. December 2014. 13 pp.

McClelland Laboratories, Inc., (MLI) 2015a. Report on Heap Leach, Milling/Cyanidation and Gravity Concentration Testing – Castle Mountain Drill Core Composites, MLI Job No. 3878. Prepared for Castle Mountain Mining Company. June 2, 2015. 492 p.

McClelland Laboratories, Inc., (MLI) 2015b. Report on Heap Leach Cyanidation Testing – Castle Mountain ROM Bulk Samples, MLI Job No. 3878-CO#1. Prepared for Castle Mountain Mining Company. October 19, 2015. 45 p.

McClelland Laboratories, Inc., (MLI) 2018. Report on Whole Ore Agitated Cyanidation and Gravity Cyanidation Testing, MLI Job No. 4217. Prepared for Castle Mountain Mining Company. May 21, 2018.

McClelland Laboratories, Inc., (MLI) 2018a. Report on Heap Leach, Gravity Concentration and Agitated Cyanidation Testing – Castle Mountain Drill Core Composites, MLI Job No. 4210. Prepared for Castle Mountain Mining Company. May 21, 2018.

McClelland Laboratories, Inc., (MLI) 2018b. Report on Pilot Scale Heap Leach Cyanidation Testing – Castle Mountain JSLA Pit Samples, MLI Job No. 4214. Prepared for Castle Mountain Mining Company. May 14, 2018.

McClelland Laboratories, Inc., (MLI) 2020a. Report on Castle Mountain Phase II Metallurgical Testing, MLI Job No. 4505. Prepared for Equinox Gold Corp. June 19, 2020.

McClelland Laboratories, Inc., (MLI) 2020b. Addendum Report on Castle Mountain Phase II Metallurgical Testing, MLI Job No. 4505. Prepared for Equinox Gold Corp. November 13, 2020.

Michaelsen, J., 2013. Mojave Desert Region Physical Geography. Retrieved from website www.geog.ucsb.edu. October 11, 2013.

MINES Group, 2020. Memorandum to Gabriel Secrest. Castle Mountain Mine, Dry Stack Tailings Facility – Preliminary Engineering Evaluations. The MINES Group, Inc. Dated December 15, 2020.

Monecke, T., 2016. Volcanic Succession and Hydrothermal Alteration at the Castle Mountain Gold Project. Internal report commissioned by New Castle Gold. August 15, 2016, 25 pp.

Monecke, T., 2017. Petrographic Report - Castle Mountain Project, San Bernardino County, California. Internal report commissioned by New Castle Gold. April 15, 2017, 83 pp.

Nicholls, O.G., Tharalson, E., Cattalani, S., 2017. Castle Mountain Geologic Mapping Report: update. Internal report to Castle Mountain Venture. May 15, 2017.

Nielson, J.E., and Nakata, J.K., 1993. Tertiary stratigraphy and structure of the Piute Range, California and Nevada. In: Sherrod, D.R., and Nielson, J.E., eds., Tertiary stratigraphy of highly extended terranes, California, Arizona, and Nevada: U.S. Geological Survey Bulletin 2053, p. 51-53.

Nielson, J.E., Lux, D.R., Dalrymple, G.B., and Glazner, A.F., 1990. Age of the Peach Springs Tuff, southeastern California and western Arizona. Journal of Geophysical Research, v. 95, no. B1, p. 571-580.

Nielson, J.E., Turner, R.D., and Bedford, D.R., 1999. Geologic Map of the Hart Peak Quadrangle, California and Nevada: A Digital Database: U.S. Geological Survey Open-File Report 99-34.

Process Mineralogical Consulting Ltd. (PMC), 2020. In-Situ Gold Deportment Study of Column Leach Head and Residue from the Castle Mountain Deposit, Part A: Ore Belle. Prepared for Equinox Gold. July 30, 2020.

Process Mineralogical Consulting Ltd. (PMC), 2020. In-Situ Gold Deportment Study of Column Leach Head and Residue from the Castle Mountain Deposit, Part B: South Domes. Prepared for Equinox Gold. August 13, 2020.

Pocock Industrial, Inc., 2020. Flocculant Screening Gravity Sedimentation Pulp Rheology Pressure Filtration and Vacuum Filtration Studies Conducted For: McClelland Laboratories, Inc. MLI 4505. March – April 2020.

Pressacco, R., 2013. Technical Report on the Mineral Resource Estimate for Castle Mountain Project, San Bernardino County, California, USA. Unpublished Document Available on the SEDAR web site at www.SEDAR.com. 188 pp.

Resource Development Inc. (RDi), 2017. New Castle Leach Tests. May 2017-June 2017.

Rogers, Wayne, 2020. Castle Mountain – Drill & Blast. A presentation made by AMC Consultants. Dated 23 May 2020. Number 720012.

Sawyer, D.A., Fleck, R.J., Lanphere, M.A., Warre, R.G., Broxton, D.E. and Hudson, M.R., 1994. Episodic caldera volcanism in the Miocene southwestern Nevada volcanic field: Revised stratigraphic framework, 40Ar/39Ar geochronology, and implications for magmatism and extension. Bulletin of the Geological Society of America, v. 106, p. 1304-1318.

Scott et al., 2018. NI 43-101 Technical Report on the Preliminary Feasibility Study for the Castle Mountain Project. San Bernardino County, California, USA. Prepared for Equinox Gold Corp. Effective Date: July 16, 2018. Signature Date: August 28, 2018.

Shoemaker, R.S., 1988, Lesley Ann Deposit Metallurgy – Internal Report prepared for Viceroy Resource Corporation, November 3, 1988, 70p.

Sillitoe, R.H., and Hedenquist, J. W., 2003. Linkages between Volcanotectonic Settings, Ore Fluid Compositions, and Epithermal Mineral Deposits. Society of Economic Geologists, Special Publication, 10, 2003.

Simmons, S.F., Brown, K.L., and Tutolo, B.M. 2016. Hydrothermal Transport of Ag, Au, Cu, Pb, Te, Zn, and Other Metals and Metalloids in New Zealand Geothermal Systems: Spatial Patterns, Fluid-Mineral Equilibria, and Implications for Epithermal Mineralization. Economic Geology, v. 111, p. 589-618.

Simmons, S.F., White, N.C., and John, D., 2005b, Geological characteristics of epithermal precious and base metal deposits: Economic Geology 100th Anniversary Volume, p. 485–522.

Simmons, S.F., White, N.C., and John, D.A., 2005. Geological characteristics of epithermal precious and base metal deposits. Economic Geology, 100th Anniversary Volume, p. 485-522.

Spencer, J.E., 1985. Miocene low-angle normal faulting and dike emplacement, Homer Mountain and surrounding areas, southeastern California and southernmost Nevada: Geological Society of America Bulletin, v. 96, p. 1140-1155.

Steinert, 2020. KSS Test Work Report, Equinox Gold – Castle Mountain, Ore Sorting Test Work, Opportunity No. 15440. Document number TRE-15440-KSS-908-Equinox Gold. Revision 01. Dated February 7, 2020. Authors: I. Hamilton. Issued by STEINERT.

Temkin, T., 2012. NI 43-101 Report on the Castle Mountain Property, San Bernardino County, California, USA. Prepared for Telegraph Gold Inc. and Foxpoint Capital Corp.

Tharalson, E. 2017. Stratigraphy of the NewCastle Gold Castle Mountain property. Internal Report, August 2017.

Theodore, T.G. (ed.) 2007. Geology and Mineral Resources of the East Mojave National Scenic Area, San Bernardino County, California. U.S. Geological Survey Bulletin 2160, 265 pp.

Tucker, W. B., and Sampson, R. J., 1943. San Bernardino County, Valley View mine: California Div. Mines Rept. 39, p. 464.

U.S. Geological Survey, 2007. Geology and Mineral Resources of the East Mojave National Scenic Area, San Bernardino County, California. U.S. Geological Bulletin 2160. 2007. 274 p.

Wakefield, T. and Tschabrun, D., 2017. NI-43-101 Technical Report on the Castle Mountain Project, San Bernardino County, California, USA. Available on the SEDAR web site at www.SEDAR.com. 218 pp. Prepared for NewCastle Gold Ltd. 26 October 2017.

White, N.C., and Hedenquist, J.W., 1995. Epithermal gold deposits: styles, characteristics and exploration. Society of Economic Geologists Newsletter, 23, p. 9-13.

Wooden, J.L. and Miller, D.M. 1990. Chronologic and isotopic framework for Early Proterozoic crustal evolution in the eastern Mojave Desert region, SE California. Journal of Geophysical Research, v. 95, No. B12, p. 20, 133-20, 146.

Wright, J.L., 2015a. Castle Mountain Property Gravity Survey. Prepared for Castle Mountain Company by Wright Geophysics. January 9, 2015. 19 pp.

Wright, J.L., 2015b. Castle Mountain Property Gravity Survey, Phase 2. Prepared for Castle Mountain Company by Wright Geophysics. July 11, 2015. 23 p.

Wright, L.A., et al., 1953. Mines and mineral resources of San Bernardino County, California: California Journal of Mines and Geology, California Division of Mines (Report 49): 49(1-2): 51-52.

Young, R.A., and Brennan, W.J., 1974. The Peach Springs Tuff: Its bearing on structural evolution of the Colorado Plateau and development of Cenozoic drainage in Mojave County, Arizona. Geological Society of America, Bulletin, v. 85, p. 83-90.

Zonge International, 2015. Transient Electromagnetic Survey, Castle Mountain Mine, Groundwater Exploration Project, San Bernardino, California, Data Acquisition, Analysis and Interpretation. Prepared for Castle Mountain Mining Ltd. March 30, 2015. 41 pp.

APPENDIX A: FEASIBILITY STUDY CONTRIBUTORS AND PROFESSIONAL QUALIFICATIONS

CERTIFICATE OF QUALIFIED PERSON

Gabriel A. Secrest

I, Gabriel A. Secrest, P.E., do hereby certify that:

1. I am an Assistant Vice President of:

   M3 Engineering and Technology Corporation
   2051 W Sunset Rd.
   Tucson, AZ 85704

2. I graduated with a Bachelor of Science degree in Mechanical Engineering from the University of Arizona in 2006.
3. I am a Professional Engineer in good standing in Arizona (Cert. # 52776), Nevada (Cert. # 21989) and South Carolina (Cert. # 30039).
4. I have worked as an engineer and project manager for industrial and mining projects a total of 15 years. My experience includes detailed engineering projects, project management and execution, engineering management, construction planning and management and technical analysis and study for industrial and mineral processing projects. I have worked on scoping, pre-feasibility and feasibility level studies for mining projects within the United States and abroad.
5. I have read the definition of "Qualified Person" set out in National Instrument 43-101 ("NI 43-101") and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "Qualified Person" for the purposes of NI 43-101.
6. I am the principal author for the preparation of the technical report titled "Technical Report on the Castle Mountain Project Feasibility Study, San Bernardino County, California, USA" (the "Technical Report"), dated effective February 26, 2021, prepared for Equinox Gold Corp. ("Equinox Gold"); and am responsible for Sections 1.1, 1.2, 1.3, 1.4, 1.14, 1.15, 1.16, 1.17, 1.18.1, 1.18.5, 1.18.6, 1.18.7, 1.19, 2, 3, 4, 5, 13.8.5, 17.3.1, 18 (except for 18.5.3), 19, 20, 21 (except for 21.1.7, 21.1.9 and 21.2.2), 22, 23, 24, 25.1.1, 25.1.5, 25.1.6, 25.1.7, 25.2, 25.3.1, 25.3.3, 26.1, 26.5, 26.7, and 27.
7. I have not had prior involvement with the property that is the subject of the Technical Report.
8. As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.
9. I am independent of Equinox Gold and all their subsidiaries as defined in Section 1.5 of National Instrument 43-101.
10. I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form.
11. I consent to the filing of the Technical Report with any stock exchange and other regulatory authority and any publication by them, including electronic publication in the public company files on their websites accessible by the public, of the Technical Report.

Signed and dated this 15th day of March, 2021.



Signature of Qualified Person

Gabriel A. Secrest

Print Name of Qualified Person

CERTIFICATE OF QUALIFIED PERSON

This certificate applies to the technical report entitled: "Technical Report on the Castle Mountain Project Feasibility Study, San Bernardino County, California, USA" (the "Technical Report"), dated effective February 26, 2021, prepared for Equinox Gold Corp.

I, Laurie Tahija, MMSA-QP, Principal Consultant (Processing), do hereby certify that:

1. I am currently employed as Senior Vice President by M3 Engineering & Technology Corporation, 2051 W. Sunset Road, Ste. 101, Tucson, Arizona 85704, USA.
2. I am a graduate of Montana College of Mineral Science and Technology, in Butte, Montana and received a Bachelor of Science degree in Mineral Processing Engineering in 1981.
3. I am recognized as a Qualified Professional (QP) member (#01399QP) with special expertise in Metallurgy/Processing by the Mining and Metallurgical Society of America (MMSA).
4. I visited the Castle Mountain Gold property on November 19, 2020, specifically to review the Phase I processing plant which was not the subject of this Technical Report.
5. I have practiced mineral processing for 39 years. I have over twenty (20) years of plant operations and project management experience at a variety of mines including both precious metals and base metals. I have worked both in the United States (Nevada, Idaho, California) and overseas (Papua New Guinea, China, Chile, Mexico) at existing operations and at new operations during construction and startup. My operating experience in precious metals processing includes heap leaching, agitation leaching, gravity, flotation, Merrill-Crowe, and ADR (CIC & CIL). My operating experience in base metal processing includes copper heap leaching with SX/EW and zinc recovery using ion exchange, SX/EW, and casting. I have been responsible for process design for new plants and the retrofitting of existing operations. I have been involved in projects from construction to startup and continuing into operation. I have worked on scoping, pre-feasibility and feasibility studies for mining projects in the United States and Latin America, as well as worked on the design and construction phases of some of these projects.
6. I have read the definition of "qualified person" set out in National Instrument 43-101 Standards of Disclosure for Mineral Projects ("NI 43-101") and certify that by virtue of my education, affiliation with a professional association and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
7. I am independent of the issuer as defined by Section 1.5 of NI 43-101.
8. I accept professional responsibility for Sections 1.9, 1.13, 1.18.4, 13, 17 (except for 17.3.1), 25.1.4, and 26.6 of the Technical Report.
9. I have not had prior involvement with the property that is the subject of the Technical Report.
10. As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.
11. I have read NI 43-101 and Form 43-101F1. The sections of the Technical Report that I am responsible for have been prepared in compliance with that instrument and form.

Dated this 15th day of March, 2021.

(Signed) (Sealed)
Signature of Qualified Person

Laurie M. Tahija
Print Name of Qualified Person

CERTIFICATE OF QUALIFIED PERSON

Eleanor Black

I, Eleanor Black, P.Geo, do hereby certify that:

1. I am Partner, Senior Geologist of:

   Equity Exploration Consultants Ltd.
   1238-200 Granville Street
   Vancouver, BC, Canada, V6C 1S4

2. I graduated with a Bachelor of Science in Geology from the University of British Columbia in 2004.
3. I am a Professional Geologist, license #42632, in good standing with the Engineers and Geoscientists of British Columbia.
4. I have worked as geologist for a total of 16 years. I have sufficient relevant experience having been directly involved in managing exploration programs focused on identifying and delineating orogenic gold, porphyry, VMS, and other deposit types in British Columbia, Nunavut, Ontario and Yukon, Canada as well as Finland, Brazil, and the United States. I have read the definition of "Qualified Person" set out in National Instrument 43-101 ("NI 43-101") and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "Qualified Person" for the purposes of NI 43-101.
5. I am a contributing author for the preparation of the technical report titled "Technical Report on the Castle Mountain Project Feasibility Study, San Bernardino County, California, USA" (the "Technical Report"), dated effective February 26, 2021, prepared for Equinox Gold Corp. ("Equinox Gold"); and am responsible for Sections 1.5, 1.6, 1.7, 1.8, 6, 7, 8, 9, 10, 11, 12 (except for 12.4), 25.3.2, and 26.2. I visited the project site from August 13 -15, 2019.
6. I have not had prior involvement with the property that is the subject of the Technical Report.
7. As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.
8. I am independent of the issuer applying all of the tests in Section 1.5 of National Instrument 43-101.
9. I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in accordance with that instrument and form.
10. I consent to the filing of the Technical Report with any stock exchange and other regulatory authority and any publication by them, including electronic publication in the public company files on their websites accessible by the public, of the Technical Report.

Signed and dated this 15th day of March, 2021.

(Signed) (Sealed)
Signature of Qualified Person

Eleanor Black
Print Name of Qualified Person

CERTIFICATE OF QUALIFIED PERSON

Trevor Rabb

I, Trevor Rabb, P.Geo, do hereby certify that:

1. I am Partner, Resource Geologist of:

   Equity Exploration Consultants Ltd.
   1238-200 Granville Street
   Vancouver, BC,
   Canada, V6C 1S4

2. I graduated with a Bachelor of Science in Geology from Simon Fraser University in 2009.

3. I am a Professional Geologist, license #39599, in good standing with the Engineers and Geoscientists of British Columbia.

4. I have worked as geologist for a total of 11 years. I have sufficient relevant experience having been directly involved in managing exploration, practicing geostatistics and resource modelling and estimating resources. I have practiced as a geologist since 2009 and have worked managing exploration programs focused on identifying and delineating copper porphyry, VMS, orogenic gold, nickel and other deposits in British Columbia, Yukon, Ontario, Australia, and Brazil. I have specialized in geochemistry, geostatistics and resource modelling for six years on various underground and open pit base metal and gold deposits in Canada, the United States, Central and South America. I have practiced mineral resource estimation for four year on various underground and open pit base metal and gold deposits in Canada, the United States, Central and South America. I have read the definition of "Qualified Person" set out in National Instrument 43-101 ("NI 43-101") and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "Qualified Person" for the purposes of NI 43-101.

5. I am a contributing author for the preparation of the technical report titled "Technical Report on the Castle Mountain Project Feasibility Study, San Bernardino County, California, USA" (the "Technical Report"), dated effective February 26, 2021, prepared for Equinox Gold Corp. ("Equinox Gold"); and am responsible for Section 1.10, 1.18.2, 12.4, 14, 25.1.2, and 26.3. I visited the project site from August 13 -15, 2019.

6. I have not had prior involvement with the property that is the subject of the Technical Report.

7. As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

8. I am independent of the issuer applying all of the tests in Section 1.5 of National Instrument 43-101.

9. I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in accordance with that instrument and form.

10. I consent to the filing of the Technical Report with any stock exchange and other regulatory authority and any publication by them, including electronic publication in the public company files on their websites accessible by the public, of the Technical Report.

Signed and dated this 15th day of March, 2021.

(Signed) (Sealed)
Signature of Qualified Person

Trevor Rabb
Print Name of Qualified Person

CERTIFICATE OF QUALIFIED PERSON

John Nilsson, MSc., P.Eng.

I, John Nilsson, MSc., P.Eng., do hereby certify that:

1. I am a Professional Engineer, President of:

   Nilsson Mine Services Ltd.
   20263 Mountain Place
   Pitt Meadows, B.C.
   Canada

2. I graduated from Queen's University with a Bachelor of Science degree Geology in 1977 and subsequently a Master of Science degree through the Department of Mine Engineering in 1990.

3. I am a member in good standing of the Engineers & Geoscientists British Columbia (License #20697).

4. I have worked as a geologist and then a mining engineer for a total of 43 years on mining related precious and base metal projects in North America, Central America, South America, Africa, Europe and Asia.

5. I have read the definition of "Qualified Person" set out in National Instrument 43-101 ("NI 43-101") and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "Qualified Person" for the purposes of NI 43-101.

6. I am a contributing author for the preparation of the technical report titled "Technical Report on the Castle Mountain Project Feasibility Study, San Bernardino County, California, USA" (the "Technical Report"), dated effective February 26, 2021, prepared for Equinox Gold Corp., Castle Mountain Venture; and am responsible for Sections 1.11, 1.12, 1.18.3, 15, 16, 21.1.7, 21.1.9, 21.2.2, 25.1.3, and 26.4. I have not visited the project.

7. I have not had prior involvement with the property that is the subject of the Technical Report.

8. As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

9. I am independent of the issuer applying all of the tests in Section 1.5 of National Instrument 43-101.

10. I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form.

11. I consent to the filing of the Technical Report with any stock exchange and other regulatory authority and any publication by them, including electronic publication in the public company files on their websites accessible by the public, of the Technical Report.

Signed and dated this 15th day of March, 2021.

(Signed) (Sealed)
Signature of Qualified Person

John W. Nilsson, MSc., P.Eng
Print Name of Qualified Person

CERTIFICATE OF QUALIFIED PERSON

R. Douglas Bartlett

I, R. Douglas Bartlett, PG, CPG, do hereby certify that:

1. I am Principal Hydrogeologist of:

   Geologic Associates, Inc.
   6155 E. Indian School Rd., Suite 200
   Scottsdale, AZ 85251

2. I graduated with a Master of Science degree in Geology from Colorado State University.
3. I am a Professional Geologist and Certified Hydrogeologist in good standing in California (CA PG 8809, CA CHG 965). I am also a Certified Professional Geologist with the American Institute of Professional Geologists (CPG No. 8433).
4. I have worked as a geologist/hydrogeologist for a total of 43 years. My experience includes assessing groundwater supplies for mining properties in the southwestern U.S.
5. I have read the definition of "Qualified Person" set out in National Instrument 43-101 ("NI 43-101") and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "Qualified Person" for the purposes of NI 43-101.
6. I am a contributing author for the preparation of the technical report titled "Technical Report on the Castle Mountain Project Feasibility Study, San Bernardino County, California, USA" (the "Technical Report"), dated effective February 26, 2021, prepared for Equinox Gold Corp. ("Equinox Gold"); and am responsible for Section 18.5.3. I last visited the project site on April 28, 2020.
7. I have prior involvement with the property that is the subject of the Technical Report. I have overseen the design of a groundwater exploration program intended to define the groundwater resources in and around the mine property.
8. I have also evaluated groundwater resources in Ivanpah Valley, west of the mine and have assisted Equinox Gold in assessing the condition of existing production wells at the site.
9. As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.
10. I am independent of the issuer applying all of the tests in Section 1.5 of National Instrument 43-101.
11. I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form.
12. I consent to the filing of the Technical Report with any stock exchange and other regulatory authority and any publication by them, including electronic publication in the public company files on their websites accessible by the public, of the Technical Report.

Signed and dated this 15th day of March, 2021.

(Signed) (Sealed)
Signature of Qualified Person

R. Douglas Bartlett
Print Name of Qualified Person

EIR APPENDIX 9

Trip Generation Assessment
(Urban Crossroads 2025)

MEMORANDUM

URBAN | CROSSROADS



DATE: October 28, 2025
TO: Frank Amendola, Lilburn Corporation
FROM: Charlene So, Urban Crossroads
JOB NO: 15766-04 TG Memo

CASTLE MOUNTAIN MINE TRIP GENERATION ASSESSMENT

Urban Crossroads, Inc. is pleased to provide the following Trip Generation Assessment for the Castle Mountain Mine (CMM or Project), which is located in the Mojave Desert of eastern San Bernardino County, California, approximately 100 miles east of Barstow and approximately 70 miles south of Las Vegas, Nevada. This trip generation letter describes the proposed Project trip generation and follows the County's Transportation Impact Study Guidelines (**County Guidelines**) dated July 9, 2019. The following trip generation assessment will support the proposed 2023 Plan Amendment, as discussed below.

PROJECT OVERVIEW

It is our understanding that the Project is currently operating on 1,460 acres within the permitted 3,910 acre boundary. The site processes up to approximately 6 million tons of ore annually. Overburden is mined to approximately 16 million tons annually. The 2023 Plan Amendment is intended to maintain the current Project area boundary of 3,910 acres with no expansion to the current boundary. However, the disturbance area will increase from the current 1,460 acres with an additional disturbance area of 1,416 acres. This will result in an increase of ore mining with an additional 296 million tons, overburden stockpiling by an additional 196 million tons, and increase maximum rate of mining by an additional 58 million tons per year. All existing mine pits, overburden sites, and leach pad areas will expand, the mining rate will increase, and the schedule will be extended to allow additional time to complete the mining and reclamation activity. Phase II mining and ore processing schedule extension will extend to 2048, which is an increase of 18 years to the current mining schedule.

The site is served by a single access point along Walking Box Ranch Road (CMM Access) which goes through the Bureau of Land Management (BLM) and National Park Services (NPS) land. Exhibit 1 illustrates the total proposed mining and reclamation boundary.

Table 1 summarizes the total trips by vehicle type for the proposed Project. Highest bus/van activity occurs between 5:00-6:00 AM and 3:30-4:30 PM which aligns with the day shift. Phase II will include the implementation of 2 to 3 shifts over the 24-hour day whereas the existing site preliminary runs a day shift with a skeleton crew only through the night.

EXHIBIT 1: APPROVED AND PROPOSED MINING & RECLAMATION BOUNDARY

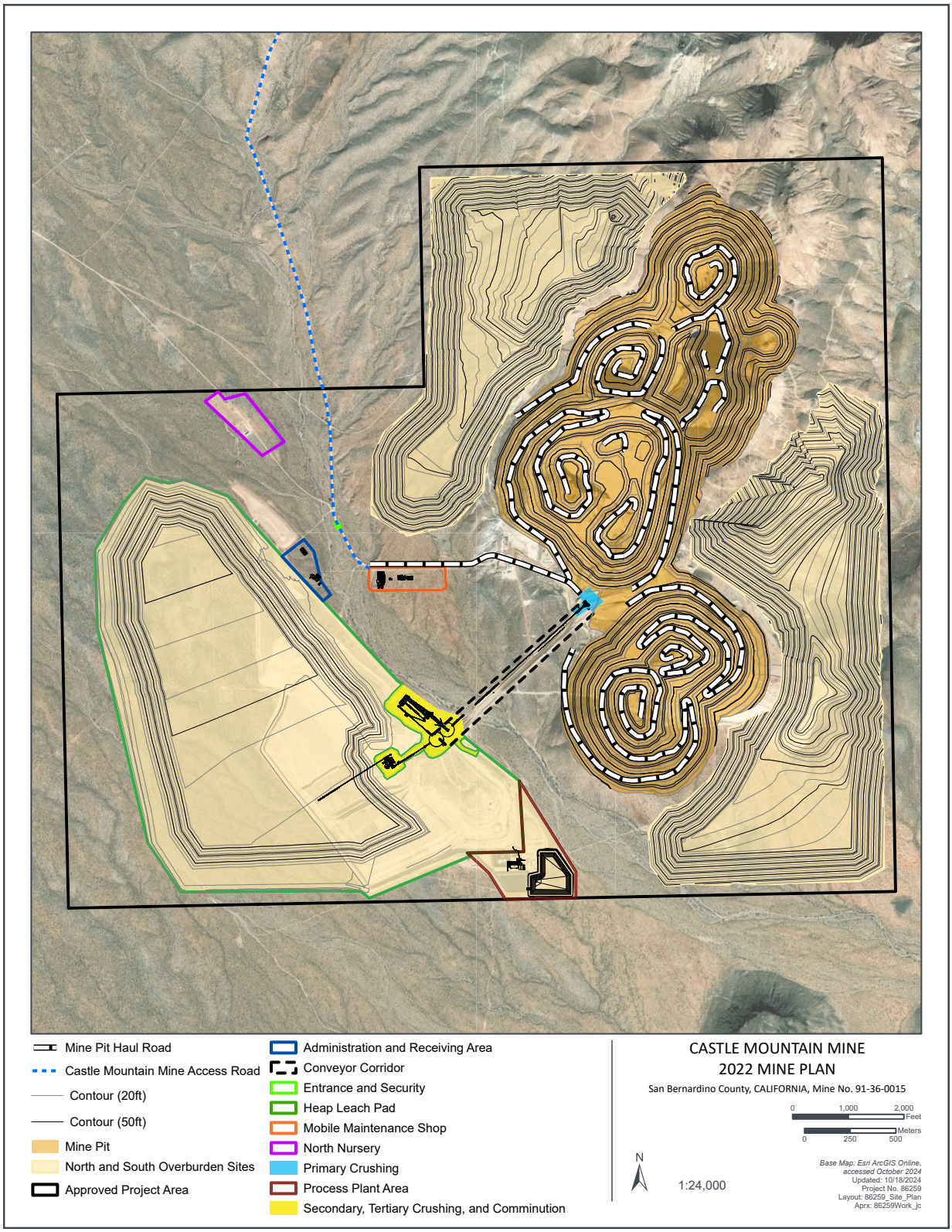


TABLE 1: SUMMARY OF VEHICLE TYPES FOR PROPOSED PROJECT

Fleet Type/Trip Type	Trip Rate	Two-Way Daily Trips
Employee Vehicles - Full Commute	30	60
Van/Buses[1]	5	10
Fuel Delivery Trucks	4	8
LNG Trucks	3	6
Product Delivery Trucks	1	2
Contractor/Reagent/Other Delivery Trucks	28	56

[1] Van/bus trips assume 35 passengers/bus or 175 employees based on buses. Employees would be bused in from Henderson, NV, Bullhead City/Laughlin, NV, and Las Vegas, NV.

TRIP GENERATION

Trip generation represents the amount of traffic, which is both attracted to, and produced by, a development. Determining traffic generation for a specific project is therefore based upon forecasting the amount of traffic that is expected to be both attracted to, and produced by, the specific land uses being proposed for a given development.

EXISTING MINING OPERATIONS

In an effort to understand the existing traffic associated with the current mining activities, traffic counts were collected at the driveway on March 12th through 14th, 2024 (Tuesday through Thursday). A detailed summary of the count data collected by day is shown in Attachment A. Table 2 summarizes the average existing trip generation based on the count data collected over the three consecutive days. The existing site currently generates an average of 100 two-way trips per day, with 2 trips during the AM peak hour and 5 trips during the PM peak hour. Trip generation for the existing use has been reflected in both actual vehicles and passenger car equivalent (PCE) in Table 2.

PCE factors were applied to the trip generation rates for heavy trucks (large 2-axles, 3-axles, 4+-axles). PCEs allow the typical "real-world" mix of vehicle types to be represented as a single, standardized unit, such as the passenger car, to be used for the purposes of capacity and level of service analyses. The PCE factors are consistent with the recommended PCE factors used for other projects within the County (1.5 for 2-axle trucks and 3.0 for 3 & 4+-axle trucks). The existing site currently generates an average of 125 two-way PCE trips per day, with 3 PCE trips during the AM peak hour and 6 PCE trips during the PM peak hour.

TABLE 2: EXISTING TRIP GENERATION

	AM Peak Hour			PM Peak Hour			
Existing Castle Mountain Mine	In	Out	Total	In	Out	Total	Daily
Actual Vehicles:							
Average 3-Day Trip Generation							
Passenger Cars:	0	1	1	2	2	4	83
2-axle Trucks:	1	0	1	0	1	1	6
3 & 4+-axle Trucks:	0	0	0	0	0	0	11
Total Truck Trips:	1	0	1	0	1	1	17
Average Total Existing Trips	**1**	**1**	**2**	**2**	**3**	**5**	**100**
Passenger Car Equivalent (PCE):							
Average 3-Day Trip Generation							
Passenger Cars:	0	1	1	2	2	4	83
2-axle Trucks (PCE = 1.5):	2	0	2	0	2	2	9
3 & 4+-axle Trucks (PCE = 3.0):	0	0	0	0	0	0	33
Total Trucks (PCE)	2	0	2	0	2	2	42
Average Total Project Trips (PCE)	**2**	**1**	**3**	**2**	**4**	**6**	**125**

PROPOSED PROJECT

Although the disturbance area would almost double on-site, the increased activity is not anticipated to have a doubling effect on the existing trip generation. There are 30 employee vehicles for a total of 60 two-way trips that are commuting by personal vehicle. The employee trips are anticipated to see a reduction as the Project is proposing vans/buses to bring in up to 175 employees onto the site daily via 5 vans/buses (assumes a capacity of 35 passengers per van/bus). As such, for the purposes of this trip generation assessment, the employee trips will conservatively remain unchanged, but will include an increase of 5 van/bus trips per day. AM and PM inbound and outbound trip generation has been derived based on a ratio of the existing and proposed daily trip generation changes.

Truck trips have been increased to 72 two-way trips per day consistent with the fuel delivery, liquified natural gas (LNG) trucks, product delivery, and contractor/reagent/other delivery trucks identified in Table 1. The proposed Project is anticipated to generate an average of 142 two-way trips per day, with 3 trips during the AM peak hour and 6 trips during the PM peak hour. As shown in Table 3, the Project is anticipated to generate an average of 292 two-way PCE trips per day, with 4 PCE trips during the AM peak hour and 7 PCE trips during the PM peak hour.

TABLE 3: PROPOSED PROJECT TRIP GENERATION

	AM Peak Hour			PM Peak Hour			
Proposed Trip Generation	In	Out	Total	In	Out	Total	Daily
Actual Vehicles:							
Passenger Cars:	0	1	1	2	2	4	60
2-axle Trucks:	2	0	2	0	2	2	10
3 & 4+-axle Trucks:[1]	0	0	0	0	0	0	72
Total Truck Trips:	2	0	2	0	2	2	82
Average Total Project Trips	**2**	**1**	**3**	**2**	**4**	**6**	**142**
Passenger Car Equivalent (PCE):							
Passenger Cars:	0	1	1	2	2	4	60
2-axle Trucks (PCE = 1.5):	3	0	3	0	3	3	16
3 & 4+-axle Trucks (PCE = 3.0):	0	0	0	0	0	0	216
Total Trucks (PCE)	3	0	3	0	3	3	232
Average Total Project Trips (PCE)	**3**	**1**	**4**	**2**	**5**	**7**	**292**

[1] Includes three liquified natural gas (LNG) delivery trucks for a total of six two-way trips.

FINDINGS

The traffic impact study area is to be defined in conformance with the requirements of the County's Guidelines, which state that the requirement to prepare a traffic study will be based upon, but not limited to, one or more of the following criteria:

- If a project generates 100 or more trips without consideration of pass-by trips during any peak hour.
- If a project is located within 300 feet of the intersection of two streets designated as Collector or higher in the County's General Plan or the Department's Master Plan or impacted intersection as determined by the Traffic Division.
- If this project creates safety or operational concerns.

The Project is anticipated to generate fewer than 100 peak hour trips during any peak hour and would therefore contribute fewer than 50 peak hour trips to any off-site study area intersection (both actual vehicle and in PCE). As such, additional traffic analysis beyond this trip generation assessment does not appear to be necessary.

If you have any questions, please contact me directly at cso@urbanxroads.com.

ATTACHMENT A: DRIVEWAY COUNTS

TABLE A-1: SUMMARY OF EXISTING TRIP GENERATION BY DAY

	AM Peak Hour			PM Peak Hour			
Land Use	In	Out	Total	In	Out	Total	Daily
Tuesday, March 12, 2024							
Passenger Cars:	1	0	1	2	1	3	82
2-axle Trucks:	2	0	2	0	1	1	8
3-axle Trucks:	0	1	1	0	0	0	2
4+-axle Trucks:	0	0	0	0	0	0	10
Total Trucks (Actual Vehicles)	2	1	3	0	1	1	20
Tuesday Total Project Trips	**3**	**1**	**4**	**2**	**2**	**4**	**102**
Wednesday, March 13, 2024							
Passenger Cars:	0	1	1	2	4	6	88
2-axle Trucks:	1	0	1	0	0	0	2
3-axle Trucks:	0	0	0	0	0	0	4
4+-axle Trucks:	0	0	0	0	0	0	6
Total Trucks (Actual Vehicles)	1	0	1	0	0	0	12
Wednesday Total Project Trips	**1**	**1**	**2**	**2**	**4**	**6**	**100**
Thursday, March 14, 2024							
Passenger Cars:	0	1	1	2	2	4	79
2-axle Trucks:	1	1	2	0	2	2	8
3-axle Trucks:	0	0	0	0	0	0	4
4+-axle Trucks:	1	0	1	0	0	0	8
Total Trucks (Actual Vehicles)	2	1	3	0	2	2	20
Thursday Total Project Trips	**2**	**2**	**4**	**2**	**4**	**6**	**99**

Counts Unlimited, Inc.

PO Box 1178
Corona, CA 92878
Phone: (951) 268-6268
email: counts@countsunlimited.com

County of San Bernardino
Castle Mountain Mine Entrance
B/ Hart Mine Road - New York Mountain Road
72 Hour Directional Classification Count

CSB001
Site Code: 051-24232

Northbound

Start Time	Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axl Double	5 Axle Double	>6 Axl Double	<6 Axl Multi	6 Axle Multi	>6 Axl Multi	Total
03/12/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:00	0	**2**	0	0	0	0	0	0	0	0	0	0	0	2
05:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:00	0	1	0	0	0	0	0	0	0	0	0	0	0	1
07:00	0	0	0	0	0	0	0	**1**	0	0	0	0	0	1
08:00	0	0	0	0	0	**1**	0	0	0	0	0	0	0	1
09:00	0	0	0	0	**1**	0	0	0	**1**	0	0	0	0	2
10:00	0	2	0	0	1	0	0	0	1	0	0	0	0	**4**
11:00	0	1	**1**	0	0	0	0	0	0	0	0	0	0	2
12 PM	0	**1**	2	0	**1**	0	0	0	0	0	0	0	0	4
13:00	0	0	2	0	0	0	0	0	0	0	0	0	**1**	3
14:00	0	1	**20**	0	0	0	0	0	0	0	0	0	0	**21**
15:00	0	1	5	0	0	0	0	0	**1**	0	0	0	0	7
16:00	0	1	0	0	1	0	0	0	0	0	0	0	0	2
17:00	0	1	1	0	0	0	0	0	0	0	0	0	0	2
18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	11	31	0	4	1	0	1	3	0	0	0	1	52
Percent	0.0%	21.2%	59.6%	0.0%	7.7%	1.9%	0.0%	1.9%	5.8%	0.0%	0.0%	0.0%	1.9%	
AM Peak		04:00	11:00		09:00	08:00		07:00	09:00					10:00
Vol.		2	1		1	1		1	1					4
PM Peak		12:00	14:00		12:00				15:00				13:00	14:00
Vol.		1	20		1				1				1	21

Counts Unlimited, Inc.

PO Box 1178
Corona, CA 92878
Phone: (951) 268-6268
email: counts@countsunlimited.com

County of San Bernardino
Castle Mountain Mine Entrance
B/ Hart Mine Road - New York Mountain Road
72 Hour Directional Classification Count

CSB001
Site Code: 051-24232

Northbound

Start Time	Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axl Double	5 Axle Double	>6 Axl Double	<6 Axl Multi	6 Axle Multi	>6 Axl Multi	Total
03/13/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:00	0	**1**	0	0	0	0	0	0	0	0	0	0	0	1
05:00	0	1	0	0	0	0	0	0	0	0	0	0	0	1
06:00	0	0	**2**	0	0	0	0	0	0	0	0	0	0	2
07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00	0	0	1	0	0	0	0	0	0	0	0	0	0	1
09:00	0	0	0	0	**1**	0	0	0	0	0	0	0	0	1
10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00	0	1	0	0	0	**1**	0	0	**1**	0	0	0	0	**3**
12 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00	0	1	5	**1**	0	**1**	0	0	0	0	0	0	**1**	9
14:00	0	**3**	**15**	0	0	0	0	0	0	0	0	0	0	**18**
15:00	0	2	7	0	0	0	0	0	0	0	0	0	0	9
16:00	0	0	4	0	0	0	0	0	0	0	0	0	0	4
17:00	0	1	0	0	0	0	0	0	0	0	0	0	0	1
18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:00	0	0	0	0	0	0	0	0	**1**	0	0	0	0	1
Total	0	10	34	1	1	2	0	0	2	0	0	0	1	51
Percent	0.0%	19.6%	66.7%	2.0%	2.0%	3.9%	0.0%	0.0%	3.9%	0.0%	0.0%	0.0%	2.0%	
AM Peak		04:00	06:00		09:00	11:00			11:00					11:00
Vol.		1	2		1	1			1					3
PM Peak		14:00	14:00	13:00		13:00			23:00				13:00	14:00
Vol.		3	15	1		1			1				1	18

Counts Unlimited, Inc.

PO Box 1178
Corona, CA 92878
Phone: (951) 268-6268
email: counts@countsunlimited.com

County of San Bernardino
Castle Mountain Mine Entrance
B/ Hart Mine Road - New York Mountain Road
72 Hour Directional Classification Count

CSB001
Site Code: 051-24232

Northbound

Start Time	Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axl Double	5 Axle Double	>6 Axl Double	<6 Axl Multi	6 Axle Multi	>6 Axl Multi	Total
03/14/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:00	0	**1**	0	0	0	0	0	0	0	0	0	0	0	1
05:00	0	1	1	0	0	0	0	0	**1**	0	0	0	0	3
06:00	0	0	0	0	0	**1**	0	0	0	0	0	0	0	1
07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00	0	0	1	0	**1**	0	0	0	0	0	0	0	0	2
09:00	0	0	0	0	1	0	0	0	0	0	0	0	0	1
10:00	0	0	**2**	0	0	0	0	0	1	0	0	0	0	3
11:00	0	1	2	0	0	0	0	0	1	0	0	0	0	**4**
12 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00	0	0	3	0	0	0	0	0	0	0	0	0	0	3
14:00	0	1	**16**	0	0	0	0	0	0	0	0	0	0	**17**
15:00	0	**2**	5	0	0	0	0	0	0	0	0	0	0	7
16:00	0	1	1	0	**2**	0	0	0	0	0	0	0	0	4
17:00	0	1	0	0	0	**1**	0	0	**1**	0	0	0	0	3
18:00	0	0	1	0	0	0	0	0	0	0	0	0	0	1
19:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	8	32	0	4	2	0	0	4	0	0	0	0	50
Percent	0.0%	16.0%	64.0%	0.0%	8.0%	4.0%	0.0%	0.0%	8.0%	0.0%	0.0%	0.0%	0.0%	
AM Peak		04:00	10:00		08:00	06:00			05:00					11:00
Vol.		1	2		1	1			1					4
PM Peak		15:00	14:00		16:00	17:00			17:00					14:00
Vol.		2	16		2	1			1					17
Grand Total	0	29	97	1	9	5	0	1	9	0	0	0	2	153
Percent	0.0%	19.0%	63.4%	0.7%	5.9%	3.3%	0.0%	0.7%	5.9%	0.0%	0.0%	0.0%	1.3%	

Counts Unlimited, Inc.

PO Box 1178
Corona, CA 92878
Phone: (951) 268-6268
email: counts@countsunlimited.com

County of San Bernardino
Castle Mountain Mine Entrance
B/ Hart Mine Road - New York Mountain Road
72 Hour Directional Classification Count

CSB001
Site Code: 051-24232

Southbound

Start Time	Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axl Double	5 Axle Double	>6 Axl Double	<6 Axl Multi	6 Axle Multi	>6 Axl Multi	Total
03/12/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00	0	0	1	0	0	0	0	0	0	0	0	0	0	1
03:00	0	1	3	0	0	0	0	0	0	0	0	0	0	4
04:00	0	**4**	**16**	0	0	0	0	0	0	0	0	0	0	**20**
05:00	0	1	3	0	0	0	0	0	0	0	0	0	0	4
06:00	0	1	1	0	0	0	0	**1**	0	0	0	0	0	3
07:00	0	1	0	0	1	0	0	0	**1**	0	0	0	0	3
08:00	0	1	0	0	**2**	0	0	0	0	0	0	0	0	3
09:00	0	0	2	0	0	**1**	0	0	1	0	0	0	0	4
10:00	0	0	0	0	1	0	0	0	0	0	0	0	**1**	2
11:00	0	0	1	0	0	0	0	0	0	0	0	0	0	1
12 PM	0	0	**1**	0	0	0	0	0	0	0	0	0	0	1
13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:00	0	0	0	0	0	0	0	0	**1**	0	0	0	0	1
15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:00	0	**2**	0	0	0	0	0	0	0	0	0	0	0	**2**
17:00	0	0	1	0	0	0	0	0	0	0	0	0	0	1
18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	11	29	0	4	1	0	1	3	0	0	0	1	50
Percent	0.0%	22.0%	58.0%	0.0%	8.0%	2.0%	0.0%	2.0%	6.0%	0.0%	0.0%	0.0%	2.0%	
AM Peak		04:00	04:00		08:00	09:00		06:00	07:00				10:00	04:00
Vol.		4	16		2	1		1	1				1	20
PM Peak		16:00	12:00						14:00					16:00
Vol.		2	1						1					2

Counts Unlimited, Inc.
PO Box 1178
Corona, CA 92878
Phone: (951) 268-6268
email: counts@countsunlimited.com

County of San Bernardino
Castle Mountain Mine Entrance
B/ Hart Mine Road - New York Mountain Road
72 Hour Directional Classification Count

CSB001
Site Code: 051-24232

Southbound

Start Time	Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axl Double	5 Axle Double	>6 Axl Double	<6 Axl Multi	6 Axle Multi	>6 Axl Multi	Total
03/13/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00	0	0	1	0	0	0	0	0	0	0	0	0	0	1
03:00	0	1	5	0	0	0	0	0	0	0	0	0	0	6
04:00	0	**5**	**16**	0	0	0	0	0	0	0	0	0	0	**21**
05:00	0	1	2	0	0	0	0	0	0	0	0	0	0	3
06:00	0	0	1	0	0	0	0	0	0	0	0	0	0	1
07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00	0	0	0	0	**1**	0	0	0	0	0	0	0	0	1
09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00	0	0	2	**1**	0	**1**	0	0	**1**	0	0	0	**1**	6
11:00	0	1	1	0	0	1	0	0	0	0	0	0	0	3
12 PM	0	**1**	0	0	0	0	0	0	**1**	0	0	0	0	**2**
13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:00	0	0	**2**	0	0	0	0	0	0	0	0	0	0	2
15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:00	0	1	1	0	0	0	0	0	0	0	0	0	0	2
17:00	0	0	1	0	0	0	0	0	0	0	0	0	0	1
18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	10	32	1	1	2	0	0	2	0	0	0	1	49
Percent	0.0%	20.4%	65.3%	2.0%	2.0%	4.1%	0.0%	0.0%	4.1%	0.0%	0.0%	0.0%	2.0%	
AM Peak		04:00	04:00	10:00	08:00	10:00			10:00				10:00	04:00
Vol.		5	16	1	1	1			1				1	21
PM Peak		12:00	14:00						12:00					12:00
Vol.		1	2						1					2

Counts Unlimited, Inc.

PO Box 1178
Corona, CA 92878
Phone: (951) 268-6268
email: counts@countsunlimited.com

County of San Bernardino
Castle Mountain Mine Entrance
B/ Hart Mine Road - New York Mountain Road
72 Hour Directional Classification Count

CSB001
Site Code: 051-24232

Southbound

Start Time	Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axl Double	5 Axle Double	>6 Axl Double	<6 Axl Multi	6 Axle Multi	>6 Axl Multi	Total
03/14/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00	0	0	1	0	0	0	0	0	0	0	0	0	0	1
03:00	0	2	4	0	0	0	0	0	0	0	0	0	0	6
04:00	0	**4**	**18**	0	0	**1**	0	0	**1**	0	0	0	0	**24**
05:00	0	1	1	0	0	0	0	0	0	0	0	0	0	2
06:00	0	0	1	0	**2**	0	0	0	0	0	0	0	0	3
07:00	0	0	1	0	1	1	0	0	1	0	0	0	0	4
08:00	0	0	0	0	1	0	0	0	1	0	0	0	0	2
09:00	0	0	0	0	0	0	0	0	1	0	0	0	0	1
10:00	0	0	2	0	0	0	0	0	0	0	0	0	0	2
11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00	0	0	**1**	0	0	0	0	0	0	0	0	0	0	1
14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:00	0	**2**	0	0	0	0	0	0	0	0	0	0	0	**2**
17:00	0	0	1	0	0	0	0	0	0	0	0	0	0	1
18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	9	30	0	4	2	0	0	4	0	0	0	0	49
Percent	0.0%	18.4%	61.2%	0.0%	8.2%	4.1%	0.0%	0.0%	8.2%	0.0%	0.0%	0.0%	0.0%	
AM Peak		04:00	04:00		06:00	04:00			04:00					04:00
Vol.		4	18		2	1			1					24
PM Peak		16:00	13:00											16:00
Vol.		2	1											2
Grand Total	0	30	91	1	9	5	0	1	9	0	0	0	2	148
Percent	0.0%	20.3%	61.5%	0.7%	6.1%	3.4%	0.0%	0.7%	6.1%	0.0%	0.0%	0.0%	1.4%	

Counts Unlimited, Inc.

PO Box 1178
Corona, CA 92878
Phone: (951) 268-6268
email: counts@countsunlimited.com

County of San Bernardino
Castle Mountain Mine Entrance
B/ Hart Mine Road - New York Mountain Road
72 Hour Directional Classification Count

CSB001
Site Code: 051-24232

Northbound, Southbound

Start Time	Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axl Double	5 Axle Double	>6 Axl Double	<6 Axl Multi	6 Axle Multi	>6 Axl Multi	Total
03/12/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00	0	0	1	0	0	0	0	0	0	0	0	0	0	1
03:00	0	1	3	0	0	0	0	0	0	0	0	0	0	4
04:00	0	**6**	**16**	0	0	0	0	0	0	0	0	0	0	**22**
05:00	0	1	3	0	0	0	0	0	0	0	0	0	0	4
06:00	0	2	1	0	0	0	0	**1**	0	0	0	0	0	4
07:00	0	1	0	0	1	0	0	1	1	0	0	0	0	4
08:00	0	1	0	0	**2**	**1**	0	0	0	0	0	0	0	4
09:00	0	0	2	0	1	1	0	0	**2**	0	0	0	0	6
10:00	0	2	0	0	2	0	0	0	1	0	0	0	**1**	6
11:00	0	1	2	0	0	0	0	0	0	0	0	0	0	3
12 PM	0	1	3	0	**1**	0	0	0	0	0	0	0	0	5
13:00	0	0	2	0	0	0	0	0	0	0	0	0	**1**	3
14:00	0	1	**20**	0	0	0	0	0	**1**	0	0	0	0	**22**
15:00	0	1	5	0	0	0	0	0	1	0	0	0	0	7
16:00	0	**3**	0	0	1	0	0	0	0	0	0	0	0	4
17:00	0	1	2	0	0	0	0	0	0	0	0	0	0	3
18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	22	60	0	8	2	0	2	6	0	0	0	2	102
Percent	0.0%	21.6%	58.8%	0.0%	7.8%	2.0%	0.0%	2.0%	5.9%	0.0%	0.0%	0.0%	2.0%	
AM Peak		04:00	04:00		08:00	08:00		06:00	09:00				10:00	04:00
Vol.		6	16		2	1		1	2				1	22
PM Peak		16:00	14:00		12:00				14:00				13:00	14:00
Vol.		3	20		1				1				1	22

Counts Unlimited, Inc.

PO Box 1178
Corona, CA 92878
Phone: (951) 268-6268
email: counts@countsunlimited.com

County of San Bernardino
Castle Mountain Mine Entrance
B/ Hart Mine Road - New York Mountain Road
72 Hour Directional Classification Count

CSB001
Site Code: 051-24232

Northbound, Southbound

Start Time	Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axl Double	5 Axle Double	>6 Axl Double	<6 Axl Multi	6 Axle Multi	>6 Axl Multi	Total
03/13/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00	0	0	1	0	0	0	0	0	0	0	0	0	0	1
03:00	0	1	5	0	0	0	0	0	0	0	0	0	0	6
04:00	0	**6**	**16**	0	0	0	0	0	0	0	0	0	0	**22**
05:00	0	2	2	0	0	0	0	0	0	0	0	0	0	4
06:00	0	0	3	0	0	0	0	0	0	0	0	0	0	3
07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00	0	0	1	0	**1**	0	0	0	0	0	0	0	0	2
09:00	0	0	0	0	1	0	0	0	0	0	0	0	0	1
10:00	0	0	2	**1**	0	1	0	0	**1**	0	0	0	**1**	6
11:00	0	2	1	0	0	**2**	0	0	1	0	0	0	0	6
12 PM	0	1	0	0	0	0	0	0	**1**	0	0	0	0	2
13:00	0	1	5	**1**	0	**1**	0	0	0	0	0	0	**1**	9
14:00	0	**3**	**17**	0	0	0	0	0	0	0	0	0	0	**20**
15:00	0	2	7	0	0	0	0	0	0	0	0	0	0	9
16:00	0	1	5	0	0	0	0	0	0	0	0	0	0	6
17:00	0	1	1	0	0	0	0	0	0	0	0	0	0	2
18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:00	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Total	0	20	66	2	2	4	0	0	4	0	0	0	2	100
Percent	0.0%	20.0%	66.0%	2.0%	2.0%	4.0%	0.0%	0.0%	4.0%	0.0%	0.0%	0.0%	2.0%	
AM Peak		04:00	04:00	10:00	08:00	11:00			10:00				10:00	04:00
Vol.		6	16	1	1	2			1				1	22
PM Peak		14:00	14:00	13:00		13:00			12:00				13:00	14:00
Vol.		3	17	1		1			1				1	20

Counts Unlimited, Inc.

PO Box 1178
Corona, CA 92878
Phone: (951) 268-6268
email: counts@countsunlimited.com

County of San Bernardino
Castle Mountain Mine Entrance
B/ Hart Mine Road - New York Mountain Road
72 Hour Directional Classification Count

CSB001
Site Code: 051-24232

Northbound, Southbound

Start Time	Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axl Double	5 Axle Double	>6 Axl Double	<6 Axl Multi	6 Axle Multi	>6 Axl Multi	Total
03/14/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00	0	0	1	0	0	0	0	0	0	0	0	0	0	1
03:00	0	2	4	0	0	0	0	0	0	0	0	0	0	6
04:00	0	**5**	**18**	0	0	**1**	0	0	**1**	0	0	0	0	**25**
05:00	0	2	2	0	0	0	0	0	1	0	0	0	0	5
06:00	0	0	1	0	**2**	1	0	0	0	0	0	0	0	4
07:00	0	0	1	0	1	1	0	0	1	0	0	0	0	4
08:00	0	0	1	0	2	0	0	0	1	0	0	0	0	4
09:00	0	0	0	0	1	0	0	0	1	0	0	0	0	2
10:00	0	0	4	0	0	0	0	0	1	0	0	0	0	5
11:00	0	1	2	0	0	0	0	0	1	0	0	0	0	4
12 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00	0	0	4	0	0	0	0	0	0	0	0	0	0	4
14:00	0	1	**16**	0	0	0	0	0	0	0	0	0	0	**17**
15:00	0	2	5	0	0	0	0	0	0	0	0	0	0	7
16:00	0	**3**	1	0	**2**	0	0	0	0	0	0	0	0	6
17:00	0	1	1	0	0	**1**	0	0	**1**	0	0	0	0	4
18:00	0	0	1	0	0	0	0	0	0	0	0	0	0	1
19:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	17	62	0	8	4	0	0	8	0	0	0	0	99
Percent	0.0%	17.2%	62.6%	0.0%	8.1%	4.0%	0.0%	0.0%	8.1%	0.0%	0.0%	0.0%	0.0%	
AM Peak		04:00	04:00		06:00	04:00			04:00					04:00
Vol.		5	18		2	1			1					25
PM Peak		16:00	14:00		16:00	17:00			17:00					14:00
Vol.		3	16		2	1			1					17
Grand Total	0	59	188	2	18	10	0	2	18	0	0	0	4	301
Percent	0.0%	19.6%	62.5%	0.7%	6.0%	3.3%	0.0%	0.7%	6.0%	0.0%	0.0%	0.0%	1.3%	

EIR APPENDIX 10

Phase II Noise Analysis Memorandum (Sespe Consulting 2022)

SESPE CONSULTING, INC.
A Trinity Consultants Company

374 Poli Street, Suite 200 • Ventura, CA 93001
Office: (805) 275-1515 • Fax: (805) 667-8104

MEMORANDUM

Date: August 21, 2024

To: Mr. Aren Hall – Environmental Manager
Castle Mountain Venture

From: Graham Stephens – Sespe Consulting, Inc.

CC: Brian Lindenlaub – WestLand Resources, Inc.
John Hecht, P.E. – Sespe Consulting, Inc.
Brian Anderson, P.G. – Sespe Consulting, Inc.

Re: Baseline/Phase II Noise Analysis
Castle Mountain Mine – San Bernardino County, California

This memorandum summarizes the results of noise monitoring conducted by Sespe Consulting, Inc. ("Sespe") and an analysis of the potential noise effects of future onsite operations at the Castle Mountain Mine site. The Castle Mountain Mine site (referred herein as the "Project site") is a gold mine operated by Equinox Gold Corp. ("Equinox")/Castle Mountain Venture (CMV) and has been conducting active (and idle) mine operations since 1991. The Project site is located in eastern San Bernardino County, California, and approximately 60 miles south of Las Vegas, Nevada. CMV is currently conducting mining operations, which were previously subject to multiple rounds of environmental reviews, including two separate Environmental Impact Statement/Environmental Impact Report (EIS/EIR) level reviews as well as many Environmental Assessments (EAs) conducted by the Bureau of Land Management (BLM). The most recent significant review was the Castle Mountain Mine Project Expansion, EIS/EIR that was certified in 1998 (SCH No. 95081031) by the lead agencies[1].

Phase II currently contemplates mining related activities within the currently approved Project boundary consisting of 3,910 acres, of which approximately 1,400 acres would likely be disturbed by the Phase II mine expansion (the "Project"). The Project is expected to include expansion of the existing excavation pit, heap leach facility, and overburden storage site, increased crushing and comminution equipment and processing rates, and related infrastructure. Figures 1 and 2 (Attachment A) show the proposed Phase II Project footprint boundary in relation to the Phase I footprint boundary. Also, see the terrain landform models presented in Figures 4A and 4B (Attachment A), which display approximate layouts of the existing Phase I and proposed Phase II operations, respectively.

This effort is designed to support expanded Phase II activities on private and BLM lands within the currently approved Project boundary, to facilitate state and federal agency review of the proposed expansion of the Castle

[1] San Bernardino County is the lead agency for CEQA and SMARA; the Bureau of Land Management is the lead agency for NEPA.

Mountain Mine and its potential effects related to noise. To accomplish this, Sespe monitored noise levels at the Project site continuously over two (2) consecutive days, beginning on Wednesday, August 4, 2021, and ending on Friday, August 6, 2021. Based on the results of the noise monitoring, Sespe has characterized the noise levels generated by the existing onsite Phase I operations (i.e., baseline), and estimated reference noise levels for specific Phase II operational areas/activities (e.g., excavation, haul truck transport, heap leach pad formation, processing plant, etc.). Phase II noise levels were also estimated using models of the anticipated final landforms and the specific locations and elevations of the expanded Phase II operational areas and equipment.

1.0 EXISTING PHYSICAL SETTING

The Project site is located in a remote area of the historic Hart Mining District, at the southern end of the Castle Mountains, in San Bernardino County, California. It is surrounded by undeveloped desert land, and there are no sensitive human receptors located within the Project vicinity; however, wilderness areas exist in and around the Project site which have potential to support wildlife species endemic to the region (e.g., birds, mammals, reptiles, etc.). Access to the Project site is provided by Walking Box Ranch Road, an approximately 18-mile, two-lane unpaved road connecting with Nevada State Route 164 (SR-164) to the north. This existing access road would continue to serve the Project site during Phase II operations. The closest airport/airstrip is the Searchlight Airport located approximately 15 miles to the northeast, and was observed to have no appreciable influence on the noise environment near the Project site. Currently, noise sources in the Project vicinity primarily include CMV's existing Phase I operations, as well as occasional aircraft flyovers and natural sounds (e.g., wind, birds chirping, etc.).

1.1 Noise Measurement Results

For this assessment, the existing setting would be described as noise associated with the ongoing Phase I operations, as well as non-Project sources, such as wind, overhead planes, and wildlife. To quantify the existing noise environment, and characterize the noise levels generated by Phase I industrial/mining activities, noise measurements were collected continuously at the Project site beginning on Wednesday, August 4, 2021, and ending on Friday, August 6, 2021. Specifically, two (2) consecutive, long-duration (24-hour) and nine (9) simultaneous short-duration (1-hour) noise measurements were collected in locations within and on the perimeter of the Project site/operational areas (see Figure 2, Attachment A). The measurements were obtained using two (2) Quest Technologies Soundpro SE/DL sound level meters programmed for "A-weighted" sound and "slow" response. The meters were calibrated prior to and following each measurement, and data were logged in 1-minute increments. A summary of the noise monitoring results, including 1-minute noise data logs for each day of monitoring, are included as Attachment B.

During the two (2) day monitoring period, normal Phase I operations were occurring at the Project site. The approximate measurement locations and the corresponding Phase I operational areas are shown on Figures 2 and 3 (Attachment A). Specifically, noise generated by the following Phase I operations were captured during the monitoring. Note that the proposed Phase II operations would generally involve similar activities and equipment (crushing and comminution plants would be added), and the same operating hours (i.e., up to 24-hours/day) as those currently approved for Phase I:

- Active open-pit mining/excavation using drilling, blasting, and conventional diesel-powered truck and shovel mining equipment;
- Loading of mined materials into haul trucks using hydraulic shovels and wheel loaders;

- Transporting of pit run material using haul trucks south to the heap leach pads;
- Formation of the heap leach pads using haul trucks, diesel-powered trucks and shovel mining equipment;
- Operation of a laboratory/gold processing plant, including an onsite diesel-fueled power generation plant;
- Movement of overburden throughout the site, and formation of overburden stockpiles;
- Light-duty vehicle movement/traffic throughout the Project site; and
- Ancillary operations (such as the administrative office, equipment refueling, and employee parking).

The short-duration (i.e., 1-hour) measurements were collected in locations near the current operational areas to most accurately detect the noise levels generated by the activities listed above at the reference distances measured. The long-duration (i.e., 24-hour) measurements (2 total) collected near the central portion of the Project site were used to both characterize specific operational activities (i.e., haul trucks) as well as a general baseline noise level attributable to the entirety of the Project Phase I operations. The long-duration measurement (as established at Location #1) was also placed adjacent to an existing wildlife drinker, and may therefore be utilized to estimate average noise levels experienced by wildlife occupying that area of the Project site (see Figures 2 and 3B, Attachment A). Specifically, during baseline monitoring, Sespe observed bighorn sheep (*Ovis canadensis*) in proximity to the active excavation/open pit mining operations (see Figures 2 and 3A, Attachment A).

Table 1 below summarizes the average (L_{avg}), maximum (L_{max}), and minimum (L_{min}) baseline noise levels measured at the Project site during the 2-day monitoring period. The details of the noise level measurements are presented in Attachment B.

Table 1 – Noise Monitoring Summary

Location	Duration	Average (L_{eq})	Maximum (L_{max})	Minimum (L_{min})	Noise Sources Captured
#1	24-Hours	53.2	86.7	31.9	Average Noise Levels (Background & Phase I Operations)
	24-Hours	50.5	83.9	32.1	
48-Hour Averages (dBA):		**52.1**	**85.5**	**32.0**	
#2	1-Hour	34.6	54.9	28.8	Background, Heap Leach Pad Formation
#3	1-Hour	35.3	53.8	30.3	Background, Misc. Light-Duty Vehicles
#4	1-Hour	64.1	80.0	34.0	Haul Truck Activity
#5	1-Hour	62.5	78.5	43.0	Heap Leach Pad Formation, Haul Truck Activity
#6	1-Hour	58.2	80.0	54.9	Gold Processing Plant, Power Generation
#7	1-Hour	46.1	63.1	29.5	Excavation
#8	1-Hour	59.6	67.3	53.6	Excavation, Haul Truck Activity
#9	1-Hour	63.1	87.4	50.8	Excavation, Haul Truck Activity, Misc. Mobile Equipment
#10	1-Hour	49.2	64.4	41.4	Excavation, Haul Truck Activity, Misc. Mobile Equipment

Note: Figures 2 and 3 (Attachment A) which display the monitoring locations described above, and the distance between the measurement location and the operational areas/equipment noise sources.

Using the long-duration measurement data, hourly average (L_{eq}) noise levels were plotted over the full 48-hour baseline monitoring period. These data provide a useful comparison of background noise levels (i.e., measured between the hours of 4:00 p.m. – 6:00 a.m., without significant industrial operations) with the Phase I operational noise levels (i.e., measured between the hours of 6:00 a.m. – 4:00 p.m., with active mining/hauling operations). Exhibit 1 below shows a chart of the hourly average noise levels throughout the entire monitoring period at Location #1, and Table 2 below summarizes the results.

On average, CMV's Phase I daytime mining operations elevated the noise levels measured at Location #1 (adjacent to the wildlife water source) by approximately +17 decibels (dBA). However, the Phase I noise level measured at Location #1 is similar to the noise levels one would expect to find in a typical residential environment (i.e., 55 dBA). For example, Chapter 83.01.080 (Noise) within the San Bernardino County – Development Code (San Bernardino County, 2014) has a daytime (7:00 a.m. – 10:00 p.m.) noise standard of 55 dBA for residential land uses (i.e., this is the maximum acceptable noise level an industrial/mining operation can generate at nearby residential areas).

The 48-hour measurement also reveals that Phase I operational noise levels are relatively consistent on an hourly and daily basis (i.e., trend lines were consistent from day to day). Future operations would generally involve the same industrial processes (e.g., equipment, mining/processing methods, etc.) as those measured at Location #1, with a few differences as summarized below:

- Current approved Phase I, and proposed Phase II operations, could occur up to 24-hours continuously during an operating day; however, during the noise monitoring period, operations were only occurring for 10 hours (6:00 a.m. – 4:00 p.m.).
- Phase II operations would involve the operations of a crushing plant and comminution plant/mill within the central portion of the Project site (refer to Figure 4B which shows the proposed locations of these plants). These operations did not occur during the noise monitoring period.

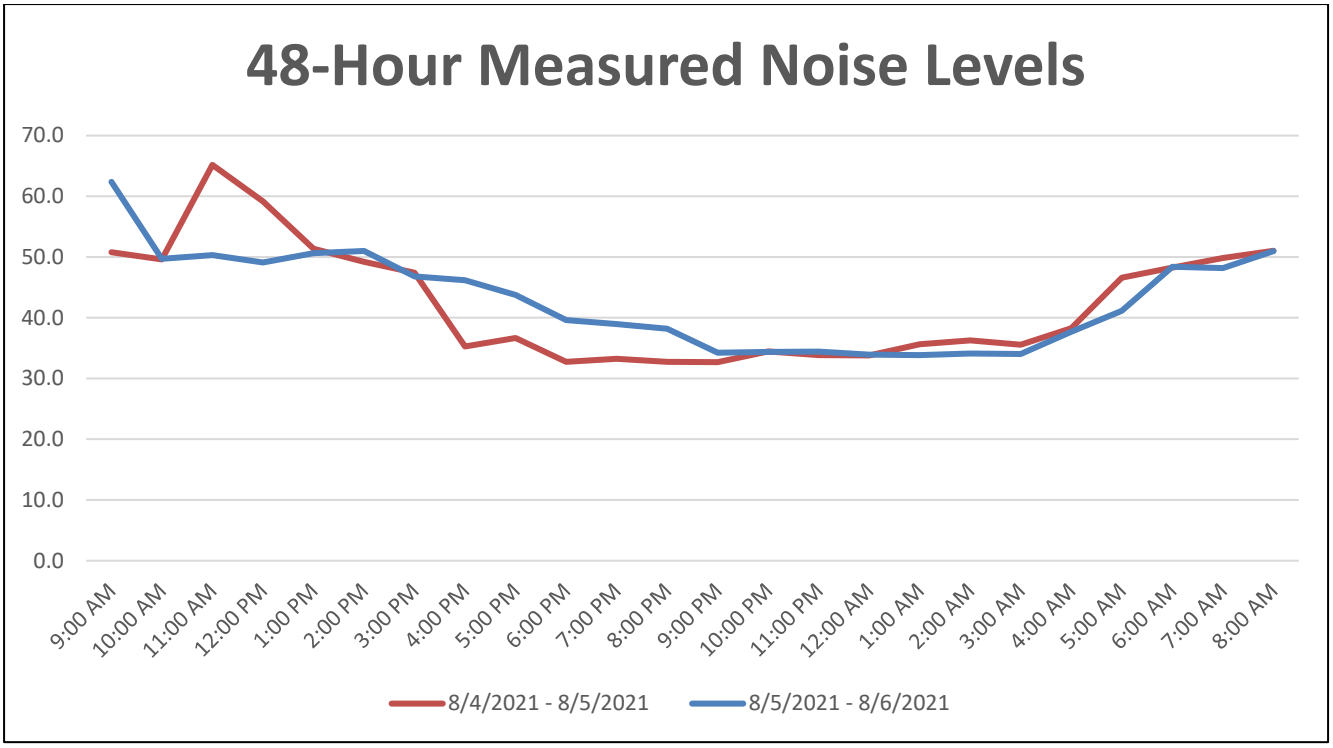
With the exception of the changes summarized above, Sespe would expect these operational noise levels to generally continue during Phase II operations.

Table 2 – Background vs. Operational 24-Hour Noise Level Comparison (Location #1)

Dates Measured	Background Noise Level (4:00 p.m. – 6:00 a.m.)	Operational Noise Level (6:00 a.m. – 4:00 p.m.)	Avg. Decibel Increase due to Phase I Operations (dBA)
8/4/2021 – 8/5/2021	38.1	56.9	+18.8
8/5/2021 – 8/6/2021	38.1	54.1	+16.0
Average (dBA):	**38.1**	**55.7**	**+17.6**

Note: Figure 3 (Attachment A) which displays the monitoring Location #1 described above.
Noise levels presented above are in terms of average equivalent sound level (L_{eq}), in decibels (dBA), over the time period shown.

Exhibit 1 – 48-Hour Noise Levels (8/4/2021 – 8/6/2021)



Note: Chart above shows the hourly average noise levels (L_{eq}) measured at monitoring Location #1 beginning at 8/4/2021 and ending on 8/6/2021. The vertical y-axis shows the measured hourly average noise level in decibels (dBA), while the x-axis shows the hour the measurement was collected. Per information provided by CMV staff, repair work conducted nearby Location #1 may have accounted for the slightly elevated noise levels measured between the hours of 10:00 a.m. – 12:00 p.m. on 8/4/2021.

1.2 Topographical/Surficial Considerations

As discussed above and shown on Figures 1 and 2 (Attachment A), as well as the terrain models shown on Figures 4A and 4B, the Project site is located at the southern end of the Castle Mountains, at elevations ranging from approximately 4,100- to 5,100-feet above mean seal level (amsl). Site topography generally slopes from the north/northeast to downward to the south/southwest. The current excavation/open-pit mining area is located near the hilltop on the north end of the Project site, while the heap leach pad/processing plant areas are located at a generally lower elevation to the south. The central portion of the Project site, where the existing administrative office/equipment fueling areas are located and where the long-duration measurements were collected adjacent to the wildlife drinker (i.e., Location #1), is a natural valley that generally represents the lowest elevation point on the Project site.

Topography attenuates noise by blocking the line-of-sight between a noise source and the receiver. This effect is demonstrated when comparing the hourly average noise levels (L_{eq}) measured at Locations #8 and #10. Both measurements were collected at similar distances from active excavation/open pit mining operations (approximately 900-feet away); however, Location #10 was partially shielded and did not have direct line-of-sight to the operating mining equipment (excavators, haul trucks, etc.). As such, the hourly average noise level measured at Location #10 (L_{eq} = 49.2 dBA) was approximately -10 decibels lower than the noise level measured at Location #8 (L_{eq} = 59.6 dBA). Sespe also qualitatively observed this effect when standing on the north/northeast

side of the Castle Mountain Range/ridgeline, as equipment noise was inaudible in the areas on the north/east side of the mountain ridge with no direct line-of-sight to Phase I operations.

Based on the information and exhibits presented in *Technical Report on the Castle Mountain Project Feasibility Study* (M3 Engineering, 2021), Phase II operations will change the Project site topography over space and time. Figure 4B (Attachment A) shows an approximate simulation of the final/fully developed Phase II landforms, including the modelled Phase II terrain, as well as the physical location and design of the proposed excavation pits and overburden storage areas in the northeast portion of the site, and the heap leach pad to the south. However, with respect to the topographic control on sound attenuation, the high Castle Mountain ridgeline to the north/northeast of the Project site, an important natural noise barrier, will remain during Phase II. Additionally, the Northwest and Southeast Waste Dump overburden storage piles will be expanded, and the ground surface raised by approximately 250-feet during Phase II. As such, these topographic features would be expected to attenuate Phase II noise levels at locations to the north and east of the operational areas.

The hill located between the current Phase I excavation area and the existing fueling area (see Figure 3A, Attachment A), currently partially attenuates noise generated by active excavation/mining equipment at points located further to the south. Per the Phase II simulated landforms shown in Figure 4B (Attachment A), this topographic feature (i.e., Big Chief Hill) would be completely removed due to the expansion of the JSLA excavation pit farther south. While removal of this hill has the potential to change the noise environment during Phase II, due to the large distance between the expanded Phase II excavation, and open space areas located farther south, this effect is expected to be de minimis (i.e., heap leach pad formation would remain dominant noise source). Specifically, due to its closer proximity, expansion of the existing Heap Leach Pad to the south and west is expected to result in a greater change to the noise environment, primarily in the areas immediately west and south of the Project site. Additionally, the significant expansion of the overburden storage piles would help replace any noise attenuation lost through the removal of the onsite hills within the Project site boundary, and ensure Phase II operational noise would continue to be contained within the Project footprint.

To predict Phase II noise levels associated with the Project, Sespe utilized the SoundPLAN Essential™ 5.0 computer noise propagation model software. With the measured source noise data (refer to Section 2.1 below) and the modeled Phase II final landforms (refer to Figures 4A and 4B in Attachment A), the SoundPLAN model generated noise contour maps for both the existing Phase I operations as well as the fully built-out Phase II facility. These maps provide a useful comparison for the noise assessment, showing how the proposed Phase II operations and changes to the onsite topography would potentially change the noise environment. See Section 2.2 below for additional discussion of the noise modeling results.

2.0 PHASE II NOISE CHARACTERIZATION

As described in *Technical Report on the Castle Mountain Project Feasibility Study* (M3 Engineering, 2021), CMV's proposed Phase II expansion will continue to utilize existing Phase I facilities to the greatest extent possible, and will use industrial mining methods, processes and equipment similar to those currently approved and being implemented at the Castle Mountain Mine. However, Phase II operations would increase the size and locations of certain facilities to meet the Project parameters. Specifically, the Phase II operations will include the following onsite changes:

- Continued mining within the existing approved excavation pits (JSLA, Jumbo, Oro Belle Pit, and South Extension pit);
- Extension of the existing overburden (see North Overburden and South Overburden sites) storage areas;
- Replacement of a portion of the existing haul road/trucks with a conveyor corridor;
- Operation of tertiary crushing plant and secondary crusher within the southcentral portion of the Project site (see Figure 4B);
- Operation of a comminution plant/mill within the southcentral portion of the Project site (see Figure 4B); and
- Expansion of the existing heap leach pad to the west.

The gold processing plant, including the existing plant structures/processes facilities, would generally remain unchanged during Phase II though capacity would expand and be consistent with the existing Phase I operations. Please see the landform/facility design simulations and associated model generated noise contour maps in Figures 4A and 4B (attachment A), which show the approximate locations of the existing Phase I (see Figure 4A) proposed Phase II (see Figure 4B) operational areas and infrastructure, respectively.

2.1 Noise Reference Levels

Reference noise levels for each type of operational area were estimated using the noise monitoring data collected onsite. Specifically, average noise levels (L_{eq}) at a reference distance of 50-feet were determined for the following operations: 1) Excavation/Open-Pit Mining; 2) Haul Road/Truck Activity; 3) Heap Leach Pad Formation; 4) Gold Processing Plant; 5) Overburden Storage/Pile Formation; 6) Crushing Plant; and 7) Comminution Plant (mill). Phase II operations would continue using similar equipment/processes. Therefore, these reference noise levels are appropriate to use for the noise analyses of Phase II operations.

Table 3 summarizes the operational reference noise levels measured at the Project site, normalized to a reference distance of 50-feet (i.e., distance from noise source to monitor location). Because overburden stockpiling/material movement was shuttered during the monitoring event, a reference noise level for the "Heap Leach Pad Formation" was utilized, as the nature of the activities and associated noise factors involve similar activities (i.e., material movement/pile formation) and equipment (e.g., haul trucks, dozers, etc.). Similarly, because the crushing and comminution plant were also not operational during the monitoring event, reference noise collected by Sespe in 2020 from comparable operation/facility in Otay Mesa, California was utilized (refer to Attachment C for additional details). Additionally, specification sheets and reference noise levels for the primary/tertiary crushing plant and secondary crushing plant were also provided by the plant manufacturer. Figure 3 (Attachment A) and Attachment C contain additional details.

Table 3 – Operational Reference Noise Levels (Phase I and II)

Operations Area	Equipment Noise Sources	Measurement Data Utilized	Noise Level (L_{eq}) @ 50-Feet (dBA)
Excavation/Open Pit Mining	Excavators, Loaders, Haul Trucks (loading)	Locations #7, #8 and #10	84.1
Haul Road/Trucks	Haul Trucks (transporting, lime dispensing)	Locations #1, #4 and #9	74.6
Heap Leach Pad Formation	Dozers, Scrapers, Haul Trucks (unloading)	Locations #2 and #5	88.2
Gold Processing Plant	Diesel Power Generators, Pumps/ Fans, Miscellaneous Equipment/ Vehicles	Location #6	71.1
Overburden Storage / Pile Formation	Haul Trucks (unloading), Dozers	Locations #2 and #5	88.2
Crushing/Comminution Plant(s)	Crushing/Process, Loaders, Haul Trucks (loading)	Previous Sespe noise Study/measurement data.	84.1
Primary/Tertiary Crushing Plant	Crushing/Process, Loaders, Haul Trucks (loading)	Manufacturers noise statement/specifications	85.6
Secondary Crushing Plant	Crushing/Process, Loaders, Haul Trucks (loading)	Manufacturers noise statement/specifications	75.6

Note: Figure 3 (Attachment A) and Attachment C for additional detail.

Using the reference noise levels above with the appropriate noise attenuation factor of minus 6 decibels (dB) per doubling of distance from the source (Caltrans, 2013), the noise level at other distances, such as the potential location for wildlife habitation, can be predicted. With the data presented in Table 3, a combination of source effects can be summed to predict sound levels at a specific location.

2.2 Phase I and II Noise Modeling Results

The operational reference noise levels summarized in Table 3 for both current (Phase I) and future (Phase II) activities were modelled using the SoundPLAN Essential 5.0 computer noise propagation model software. Specifically, noise contour maps were generated for both the existing Phase I operations (refer to Figure 4A, Attachment A) as well as the fully built-out Phase II facility (refer to Figure 4B, Attachment A). These maps provide approximations for how the proposed Project operations and related changes to the onsite topography would potentially affect the noise environment over the life of the Project. Source-receptor geometry, noise source data and terrain information (both real and modeled) were input into the model. SoundPLAN calculates noise levels based on the International Organization for Standardization's (ISO) "ISO 9613-2" standard for outdoor sound propagation from industrial sources.

Figures 4 (Attachment A) presents the modeled source-receptor geometry and noise contour maps for the existing Phase I operations (refer to Figure 4A) and future Phase II (refer to Figure 4B) Project activities, respectively. For context, the models show noise contour maps with identical decibel intervals (i.e., 45 dBA, 55 dBA, 65 dBA, etc.) to provide a useful comparison that approximates the Phase I and Phase II noise environment. Based upon the results of the SoundPLAN models and comparison of the noise contours for Phase I and Phase II, the following conclusions can be drawn:

- Generally, the peak offsite noise levels generated by Phase II operations would not change or increase compared to Phase I (i.e., peak noise levels would remain in the 70- to 80-decibel range), and may even

be reduced in areas to the north of the site due to the overburden piles providing increased noise shielding. However, the total noise footprint is expected to expand over time. This is evident in areas to the south/east (due to the extended excavation pits) and to the west/southwest (due to the extended and elevated heap leach pad).

- While peak (i.e., highest estimated hourly average) offsite noise levels are not expected to significantly increase (and may even decrease to the north of the site), the footprint of peak onsite noise levels within the Project site is expected to slightly expand. Per the SoundPLAN model results, this is primarily the case for the central/southern portion of the facility, near the proposed crushing/comminution plant, primary/tertiary crushing plant and secondary crushing plant (see the "blue" and "red" noise contour areas on Figure 4B, which covers a broader area in the central/southern portion of the facility in Phase II). However, note that during Phase II, much of the existing haul route would be replaced by a conveyor line, which would help reduce operational noise levels within this same area (see Figure 4B).
- Although excavation/open pit mining operations will extend to the north and east during Phase II, estimated noise levels in that area are not expected to significantly change (and may even decrease compared to current Phase I operations). This is due to the noise attenuation provided by the elevated ridgeline (immediately north of the excavation pits) that would remain throughout the life of the Project (see Figure 4B). This ridgeline has and will continue to serve as an important natural noise barrier by blocking line-of-sight to offsite wilderness areas located farther north and east (see the "orange" noise contour areas on Figure 4B, which indicates a lower estimate noise level).
- Similar to the natural ridgelines, the increase in overburden/waste rock piles to the northwest and southeast and steepening of the excavation pit walls (see Figure 4B) would also serve as valuable manmade sound barriers, and help to contain equipment noise within the footprint of the facility. It is also important to note that the overburden/waste rock piles are expected to be expanded early during the Phase II mining process (estimated within the first 6 to 22 years), which would ensure they provide significant attenuation into the future.
- Based upon the SoundPLAN models, design changes in the heap leach pad as part of the Project are expected to only slightly increase noise levels experienced by offsite receivers located to the west and southwest of the Project site. This is primarily due to the increase in total acreage and elevation of the heap leach pad(s), and the lack of natural terrain barriers in this area. While noise levels may increase, the SoundPLAN model results estimate these effects would be localized and limited to the areas immediately adjacent to the heap leach pad(s).
- Per the SoundPLAN model outputs, noise levels generated by onsite haul truck activity and the gold processing operations are not expected to significantly change or increase during Phase II operations; however, as discussed above, a portion of the existing haul route would be replaced by a conveyor system, which is expected to reduce total operational noise levels resulting from haul truck activity.

It's important to note that the SoundPLAN model results and noise contours presented in Figures 4A and 4B (Attachment A) represent broad approximations that conservatively assume all onsite industrial noise sources would be operating simultaneously at full capacity. In reality, Phase II operations would vary over the life of the Project, and therefore noise levels would also fluctuate depending upon the location and duration of specific onsite activities. Additionally, noise levels drop significantly as the distance between a source and receivers is increased. Therefore, due to the large size of the Project site and the large spatial distances between individual

operational areas, noise effects would generally be localized during Phase II. For example, excavation/open pit mining and heap leach pad formation operations occur in onsite locations separated by over 1.0 mile of distance, and therefore noise generated by these activities would not comingle. This phenomenon is somewhat obscured within the SoundPLAN model results and noise contour maps.

2.3 Vibration Reference Levels

Qualitative onsite observations found the existing vibration environment in the immediate vicinity of the Project site is extremely low. During field visits, Sespe staff experienced no ground movement during CMV's Phase I operations. Although blasting did not occur during this study, it is an authorized activity and will again become more common with Phase II expansion. Since blasting activities have been and will continue to be occasional (no more than 5 blasts per week) and very short in duration (about 1 second), they are not expected to have any significant effect on the noise or vibration environment in the Project area. Additionally, blasting will continue to occur during daytime hours only, and using the same methods and in the same manner as currently occurs onsite. Because the nature and design of onsite blasting activities would not change as a result of the Project, and because there are no sensitive receptors within the Project site vicinity, a detailed blasting vibration analysis has been excluded from this memorandum.

As described above, Phase II operations would not change the groundborne vibration environment. However, future evaluations may need to consider vibration levels and characteristics, such as those in relation to nearby wildlife receivers. Table 4 below summarizes applicable vibration source reference levels, in terms of peak particle velocity (PPV) in units of inches per second at a distance of 25-feet. These reference vibration levels were taken from both the Federal Transit Administration's (FTA) *Transit Noise and Vibration Impact Assessment* (FTA, 2006) and the California Department of Transportations' (Caltrans) *Transportation and Construction Vibration Guidance Manual* (Caltrans, 2020), and are commonly applied to mining/industrial operations. Please see Attachment C for applicable excerpts from the FTA's guidance document.

Table 4 – Equipment Reference Vibration Levels

Equipment	PPV (in/sec) @ 25-feet away
Large bulldozer	0.089
Caisson drilling	0.089
Loaded trucks	0.076
Jackhammer	0.035
Small bulldozer	0.003

Source: *Transit Noise and Vibration Impact Assessment* (FTA, 2006).

As observed during Sespe's field visit, the continued operation of the onsite mobile equipment summarized in Table 4 above is not expected to generate increased vibration levels compared to existing operations, or vibration levels at nearby human and wildlife receivers that would exceed thresholds of human annoyance or structural damage.

3.0 REGULATORY SETTING

The following section presents the results of this Phase II noise analysis and addresses consistency with the conclusions of past environmental noise and vibration assessments completed for the Project, specifically the 1997 EIS/EIR. Applicable County noise standards are also briefly discussed.

3.1 1997 EIS/EIR

As stated above, existing Project operations were previously subject to a detailed environmental review in an EIS/EIR certified in 1997 pursuant to the National Environmental Policy Act (NEPA)/California Environmental Quality Act (CEQA). A subsequent environmental review was completed in 2019/2020 as part of approval for minor modifications to the Project's Phase I mine and reclamation plans.

The 1997 EIS/EIR acknowledged that the removal, distribution, and processing of ore onsite had the potential to generate noise, specifically due to blasting/excavation in the mine pits, loading and movement of vehicles between the mine pits, overburden storage, and crushing/milling operations. The 1997 EIR/EIS also acknowledged that at that time, studies had shown that certain desert wildlife species may be sensitive to loud noises, and that noise generation can result in increased predation of certain animals by snakes and coyotes, reducing their onsite densities; however, as noted in the 1997 EIS/EIR, few studies on these subjects have yielded conclusive results.

The 1997 EIS/EIR determined that noise is attenuated by distance, atmospheric conditions, and topography; and consequently, the primary effects of project noise would be limited to the immediate source area. Because the 1997 EIS/EIR determined that the majority of noise effects were expected to be minimal within 0.25 mile and negligible within 1 mile of the site, no significant effects on wildlife in the area were expected as a result of noise. Therefore, impacts were found to be less than significant with no mitigation required.

Both the onsite noise monitoring and the SoundPLAN noise models/contour maps show that noise effects associated with Phase II operations would continue to remain localized (i.e., minimal within 0.25 miles), and negligible at wildlife receivers located over 1 mile from the Project site. For example, using the standard noise attenuation factor of minus 6 decibels (dB) per doubling of distance from the source (Caltrans, 2013), noise levels resulting from the heap leach pad formation operations (i.e., the loudest measured noise source measured onsite [88.2 decibels at 50-feet]) would be reduced to an approximate noise level of below 47 decibels (dBAs) at a distance of 1 mile. This estimate is also conservative, as this does not take into account intervening topography, ground surfaces, and other operational parameters that would further attenuate noise at distances of 0.25 to 1.0 miles. As such, at these distances, Project noise would be generally indistinguishable from background sources. Therefore, based upon the analysis presented above, the conclusions of the 1997 EIS/EIR would remain unchanged, and Phase II operations are not expected to result in any new noise or vibration impacts.

3.2 San Bernardino County Regulations

As discussed above, the Project site is located in unincorporated San Bernardino County, California. Therefore, San Bernardino County policies and regulations pertaining to noise and vibration would apply to Phase II operations. The *County of San Bernardino – Countywide Plan* (adopted 2020), specifically the Hazards Element, has a number of policies related to noise and vibration (San Bernardino County, 2020). The San Bernardino County Development Code (Title 8), specifically Chapters 83.01.080 (General Performance Standards, Noise) and 83.01.090 (General Performance Standards, Vibration), also contains provisions that regulate both mobile and stationary construction and industrial noise and vibration sources (San Bernardino County, 2014).

Sespe reviewed both the County's General Plan and Development Code, and the policies and regulations found therein do not apply to the Project. Specifically, the County's noise and vibration criteria only apply to human receptors, such as residential properties. The closest human receptor/residence is located about 5 miles south from the Project site, and therefore noise and vibration levels resulting from Phase II operations would be imperceptible at this closest receptor. There are no County noise requirements that address potential noise impacts to wildlife receptors. For this reason, the Project would be consistent with San Bernardino County regulations, and there would be no new impacts.

4.0 RESULTS & RECOMMENDATIONS

Based upon the results of the onsite noise monitoring and review of the proposed Phase II operations, Sespe makes the following conclusions and/or recommendations:

- Both existing Phase I and proposed Phase II onsite operations generate noise and vibration levels with no potential to adversely affect human receptors (i.e., residences, other noise-sensitive land uses, etc.). Due to the large distance between the Project site and the nearest receptor (closest residence located about 5 miles away), the Project would have no appreciable noise or vibration effect at this nearest receptor. For this reason, the Project would also be consistent with applicable San Bernardino County noise standards (e.g., General Plan, Development Code, etc.).

- Given the distances between onsite operational areas, Project noise effects would be localized. The Phase II noise levels, both measured and modeled in SoundPLAN, were generally representative of the closest onsite industrial activity. For example, while the noise measurements collected at Location #5 did have partial line-of-sight to multiple Phase I operational areas (i.e., excavation, haul route, processing plant, etc.), due to its close proximity to the heap leach pad, noise generated by equipment forming the heap leach pad dominated the environment.

  Although not anticipated or recommended within this memorandum, if potential noise controls (e.g., buffers, earthen barriers, etc.) are implemented in the future, these would be most effective when focused on singular operational areas/noise sources closest to the areas of potential concern. The effectiveness of noise barriers increases with decreasing distance to the source or receiver (i.e., the closer a barrier is to a specific source, the more attenuation can be achieved).

- Based on Sespe's discussion with Westland biologists about the current noise levels and interaction with animals onsite and our observations, as well as the information provided by CMV's onsite operations personnel when combined with the analysis presented in our report, it is our opinion that existing Phase I noise and vibration levels do not adversely affect wildlife species within the Project area. For instance, although a wildlife water source (i.e., drinker) is located within the central portion of the mine site (see Figures 2 and 3B, Attachment A), CMV reported that remote cameras often observe wildlife species utilizing this source within this area. This is important when considering that a second water source (drinker) was recently added at a more remote location north of the mine pits and away from human activity. The fact that wildlife still uses a water source surrounded by higher levels of human activity/industrial operations does support a conclusion of negligible impact to wildlife. Furthermore, during the baseline monitoring Sespe directly observed bighorn sheep (*Ovis canadensis*) in relatively close

proximity to Phase I active excavation/open pit mining operations, and the species appeared to be undisturbed by the nearby mining operations.

- Based upon the analysis presented above, the conclusions of the 1997 EIS/EIR would remain unchanged, and Phase II operations are not expected to result in any new noise or vibration impacts, with no new mitigation required. Noise levels resulting from Phase II operations would continue to remain localized within and immediately adjacent to the Project site footprint (i.e., minimal within 0.25 miles), and negligible at wildlife receivers located over 1 mile from the Project site.

ATTACHMENTS

A. Figures
B. Baseline Noise Measurement Data
C. Operational Source Noise Estimates/Calculations

5.0 REFERENCES

Caltrans. (2013). *Technical Noise Supplement to the Traffic Noise Analysis Protocol.* Sacramento, CA: California Department of Transportation. Retrieved from https://dot.ca.gov/-/media/dot-media/programs/environmental-analysis/documents/env/tens-sep2013-a11y.pdf

Caltrans. (2020). *Transportation and Construction Vibration Guidance Manual.* Sacramento, CA: California Department of Transportation. Retrieved from https://dot.ca.gov/-/media/dot-media/programs/environmental-analysis/documents/env/tcvgm-apr2020-a11y.pdf

FTA. (2006). *Transit Noise and Vibration Impact Assessment.* Office of Planning and Environment. Washington, DC: Federal Transit Administration. Retrieved from https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/FTA_Noise_and_Vibration_Manual.pdf

M3 Engineering. (2021). *Technical Report on the Castle Mountain Project Feasibility Study.* Tucson, AZ: M3 Engineering.

San Bernardino County. (2014). *2007 Development Code.* San Bernardino, CA: San Bernardino County. Retrieved from http://www.sbcounty.gov/Uploads/lus/DevelopmentCode/DCWebsite.pdf

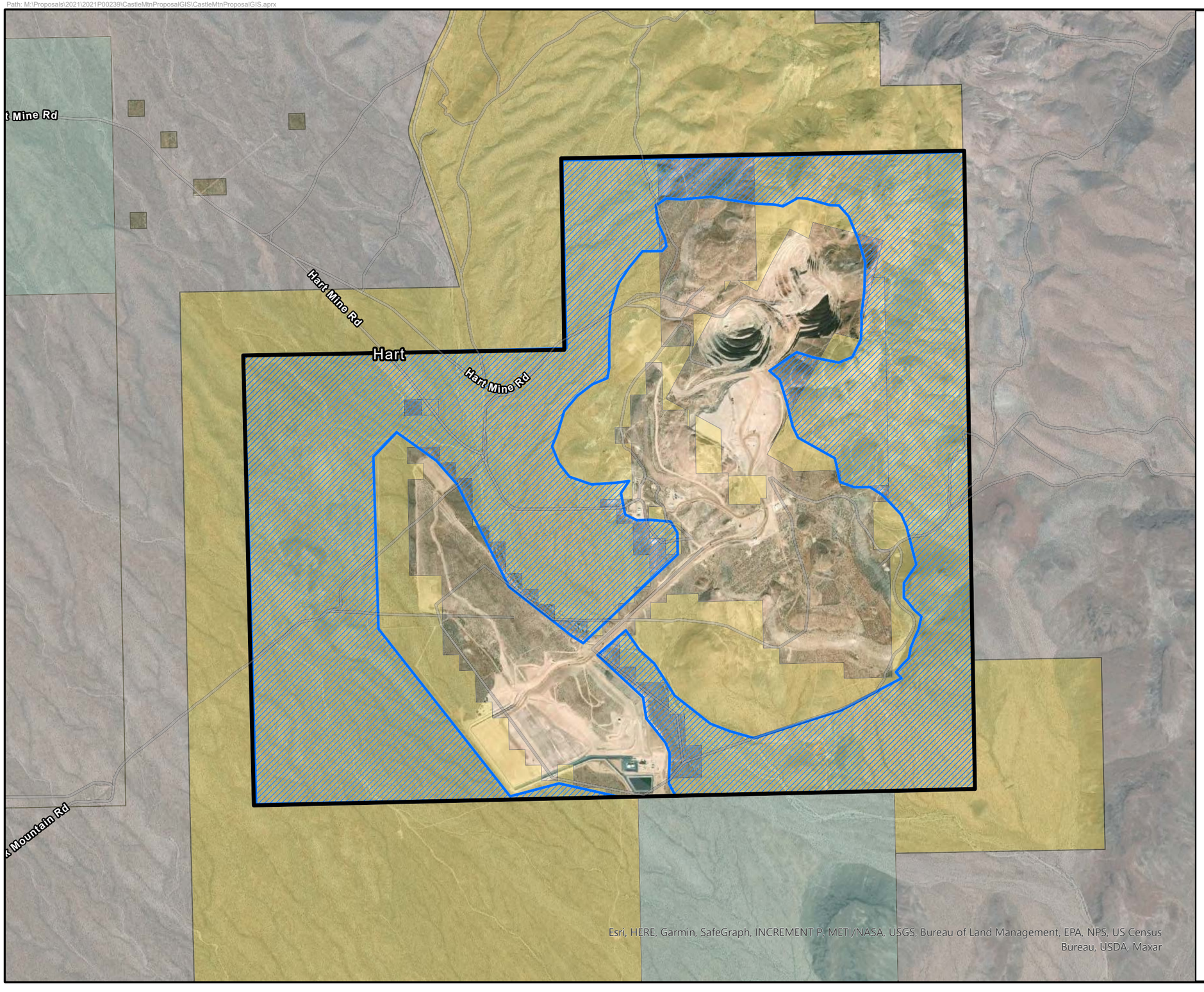
San Bernardino County. (2020). *San Bernardino County - Countywide General Plan.* San Bernardino, CA: San Bernardino County. Retrieved from https://cms.sbcounty.gov/lus/Planning/GeneralPlan.aspx

Attachment A

Figures

Path: M:\Proposals\2021\2021P00239\CastleMtnProposalGIS\CastleMtnProposalGIS.aprx

Date: 5/7/2021 User: towens



T14N, R17E, Portions of Sections 13, 14, and 22-27,
T14N, R18E, Portions of Sections 18, 19, and 30,
San Bernardino County, California,
Image Source: Maxar 9/29/2020

Legend

- 1997 EIS Boundary
- Phase 2 Expansion Area

Surface Management (BLM 2019)

- Bureau of Land Management (BLM)
- National Park Service (NPS)
- State Trust Land

N

0 1,000 2,000 Feet

0 300 600 Meters

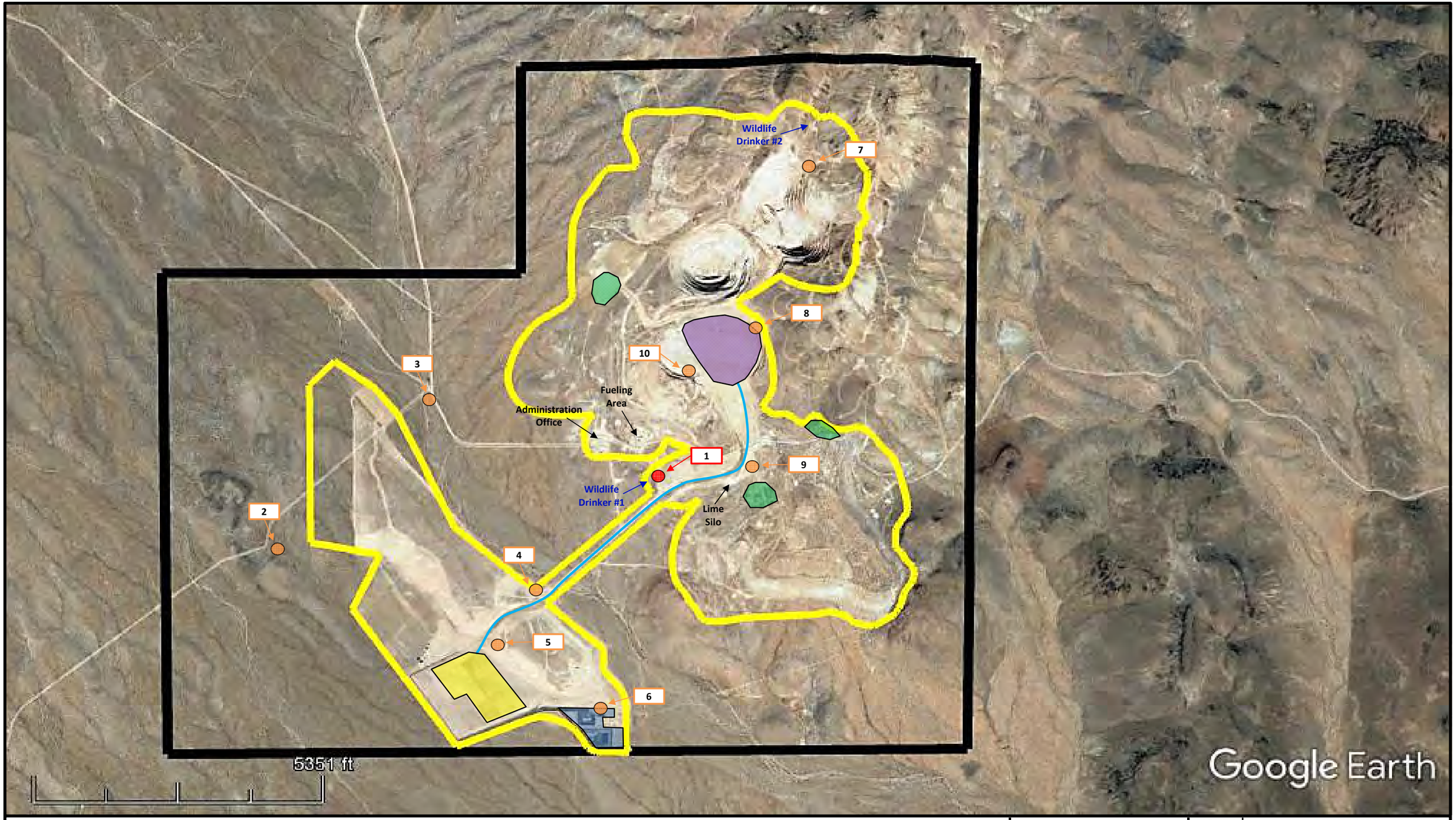
WestLand Resources

CASTLE MOUNTAIN VENTURE

Castle Mountain Project

PERMITTING SUPPORT

Figure 1



Google Earth (2021)

- 1997 EIS/EIR Project Boundary (approximate)
- 1998 Permitted Activity (Phase 1) Boundary (approximate)
- 48-Hour Noise Monitoring Location
- 1-Hour Noise Monitoring Location(s)

- **Primary Haul Road** (haul trucks)
- **Excavation/Open-Pit Mining Area** (excavators, loaders, haul trucks loading)
- **Heap Leach Pad Formation** (dozers, scrapers, haul trucks unloading)
- **Gold Processing Plant** (power generators, pumps/fans, misc. equipment)
- **Overburden Storage/Misc. Material Movement** (haul trucks unloading, dozers)

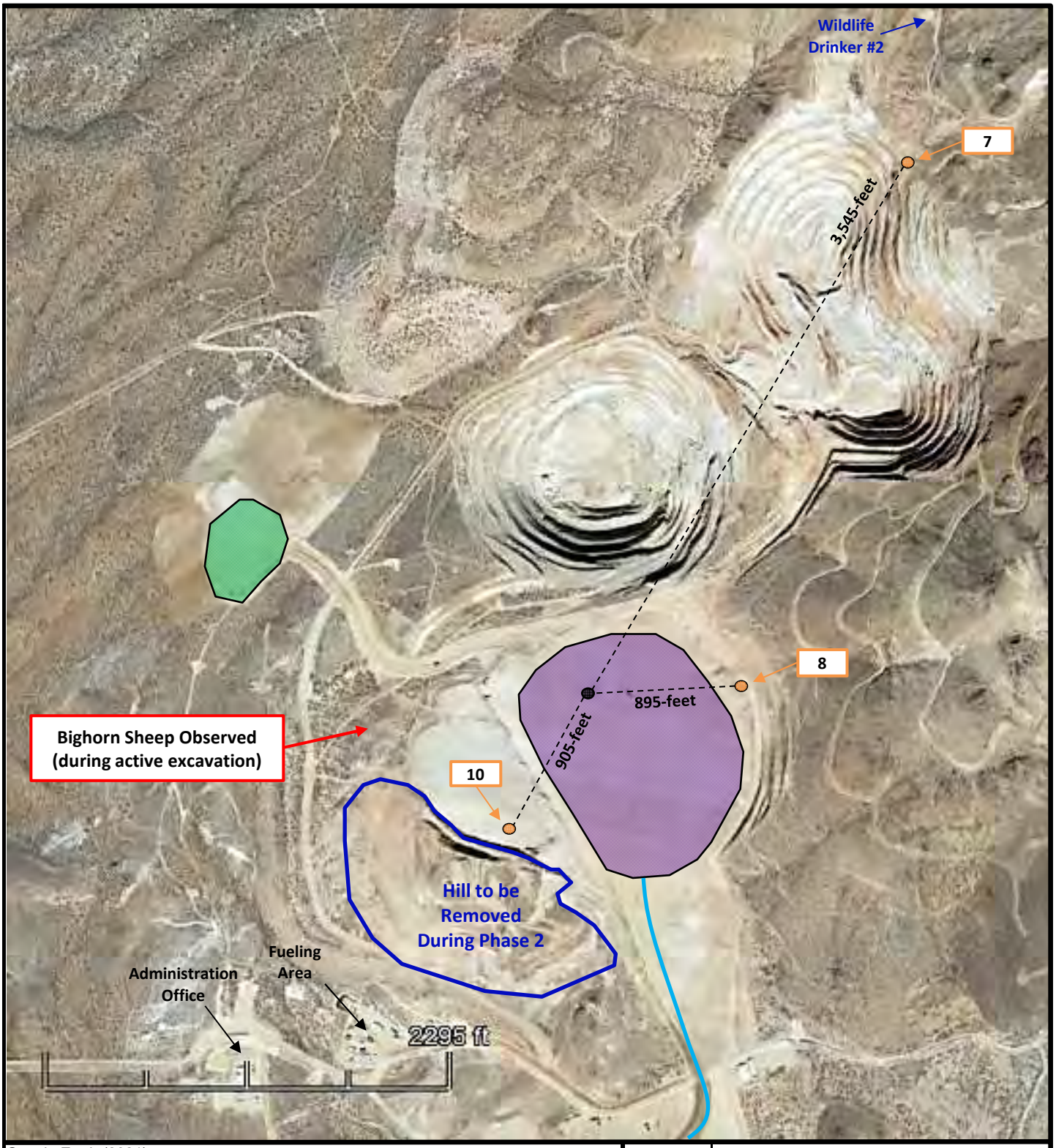
N

SESPE CONSULTING, INC.
A Trinity Consultants Company

FIGURE 2

BASELINE NOISE MONITORING
Castle Mountain Project
980 American Pacific Drive, Suite 102
Henderson, Nevada 89014

PROJECT #:	210509.0444	DATE:	9/8/21
SCALE:	See Above	DRAWN BY:	GPS



Google Earth (2021)

N

SESPE CONSULTING, INC.
A Trinity Consultants Company

Excavation/Open-Pit Mining Area (excavators, loaders, haul trucks loading)
Overburden Storage/Misc. Material Movement (haul trucks unloading, dozers)
Primary Haul Road (haul trucks)
Approximate Center of Noise Generating Operations
1-Hour Noise Monitoring Location(s)

FIGURE
3A

EXCAVATION/MINING AREA
Castle Mountain Project
980 American Pacific Drive, Suite 102
Henderson, Nevada 89014

PROJECT #:	210509.0444	DATE:	9/29/21
SCALE:	See Above	DRAWN BY:	GPS



Google Earth (2021)

Primary Haul Road (haul trucks)
48-Hour Noise Monitoring Location
1-Hour Noise Monitoring Location(s)

N

SESPE CONSULTING, INC.
A Trinity Consultants Company

FIGURE 3B	HAUL TRUCK ACTIVITY Castle Mountain Project 980 American Pacific Drive, Suite 102 Henderson, Nevada 89014		
PROJECT #:	210509.0444	DATE:	9/29/21
SCALE:	See Above	DRAWN BY:	GPS



Google Earth (2021)

- **Heap Leach Pad Formation** (dozers, scrapers, haul trucks unloading)
- **Gold Processing Plant** (power generators, pumps/fans, misc. equipment)
- **Primary Haul Road** (haul trucks)
- Approximate Center of Noise Generating Operations
- 1-Hour Noise Monitoring Location(s)

N

SESPE CONSULTING, INC.
A Trinity Consultants Company

FIGURE 3C	HEAP LEACH PAD FORMATION Castle Mountain Project 980 American Pacific Drive, Suite 102 Henderson, Nevada 89014		
PROJECT #:	210509.0444	DATE:	9/29/21
SCALE:	See Above	DRAWN BY:	GPS



Google Earth (2021)

Gold Processing Plant (power generators, pumps/fans, misc. equipment)

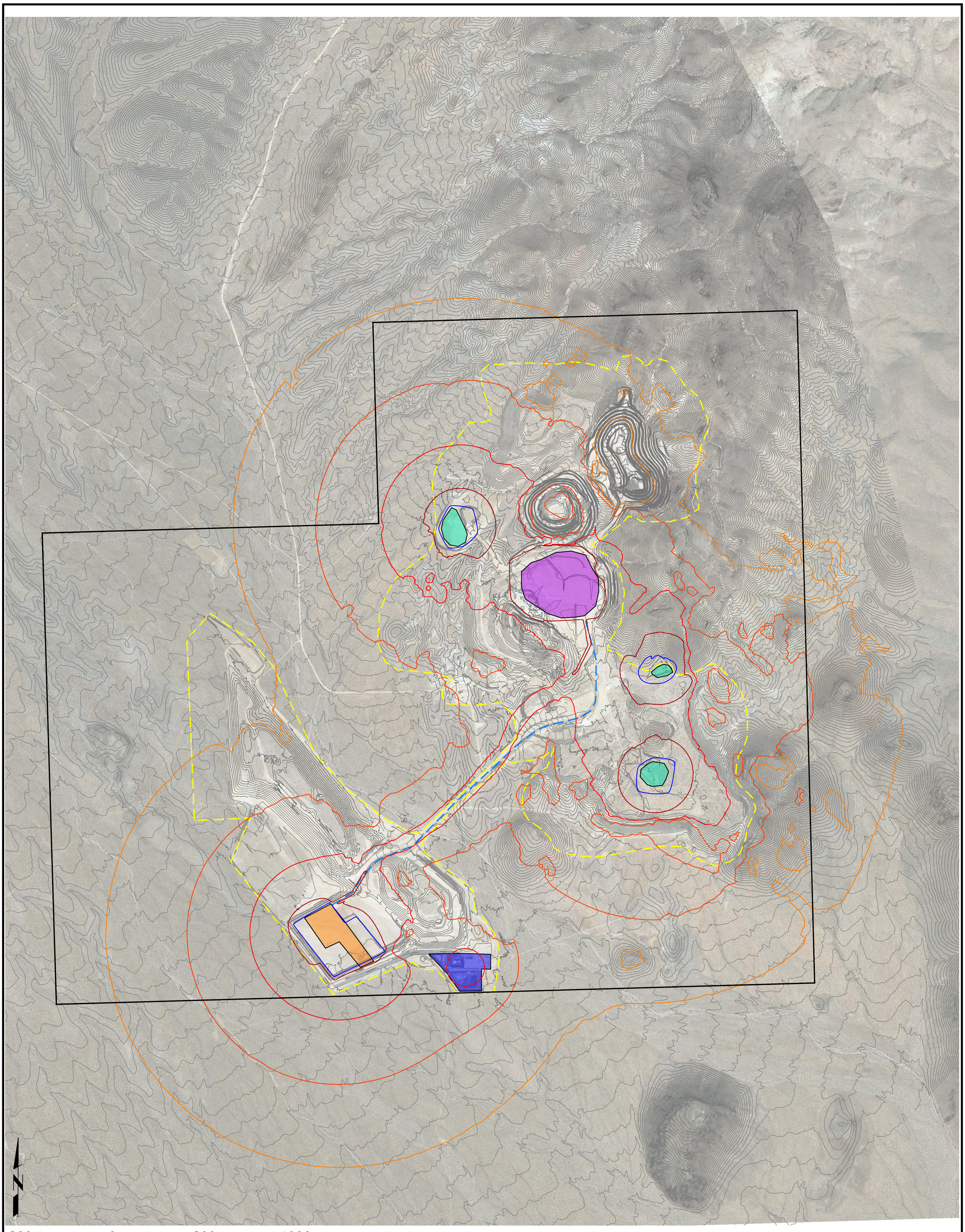
Approximate Center of Noise Generating Operations

1-Hour Noise Monitoring Location(s)

N

SESPE CONSULTING, INC.
A Trinity Consultants Company

FIGURE 3D	GOLD PROCESSING PLANT Castle Mountain Project 980 American Pacific Drive, Suite 102 Henderson, Nevada 89014		
PROJECT #:	210509.0444	DATE:	9/29/21
SCALE:	See Above	DRAWN BY:	GPS



LEGEND

- 45 dBA
- 55 dBA
- 65 dBA
- 75 dBA
- 85 dBA
- 1997 EIS/EIR PROJECT BOUNDARY (APPROXIMATE)
- 1988 PERMITTED ACTIVITY (PHASE 1) BOUNDARY (APPROXIMATE)
- PRIMARY HAUL ROAD
- HEAP LEACH PAD FORMATION
- GOLD PROCESSING PLANT
- EXCAVATION /OPEN PIT MINING AREA
- OVERBURDEN STORAGE/MISC. MATERIAL MOVEMENT

SESPE CONSULTING, INC.
A Trinity Consultants Company.
374 Poli Street, Suite 200 • Ventura, CA 93001
(805) 275-1515 • www.sespeconsulting.com

WESLAND

CASTLE MINE
EXISTING CONDITIONS

SCALE: HORIZ. AS SHOWN VERT. AS SHOWN	FIGURE NUMBER 4A
DRAWN BY: G. CAMUS	
CHECKED BY: GS	DATE: JANUARY 2022

800 0 800 1600

SCALE IN FEET

N

SESPE
CONSULTING, INC.
A Trinity Consultants Company.
374 Poli Street, Suite 200 • Ventura, CA 93001
(805) 275-1515 • www.sespeconsulting.com

WESLAND
CASTLE MINE
PROPOSED CONDITIONS

SCALE: HORIZ. AS SHOWN VERT. AS SHOWN	FIGURE NUMBER 4B
DRAWN BY: G. CAMUS	
CHECKED BY: GS	DATE: JANUARY 2022

Attachment B

Baseline Noise Measurement Data (8/4/2021 – 8/6/2021)

Baseline Noise Monitoring Summary

Baseline Noise - Average, Maximum & Minimum Equivalent Noise Levels (dBA)							
Location	**Duration**	**Date**	**Start**	**Stop**	**L_{eq} (Average)**	**L_{max} (Maximum)**	**L_{min} (Minimum)**
#1	24-Hours	8/4/2021	9:07 AM	---	53.2	86.7	31.9
		8/5/2021	---	9:07 AM			
	24-Hours	8/5/2021	9:13 AM	---	50.5	83.9	32.1
		8/6/2021	---	9:13 AM			
48-Hour Averages (dBA):					**52.1**	**85.5**	**32.0**
#2	1-Hour	8/4/2021	9:31 AM	10:31 AM	34.6	54.9	28.8
#3	1-Hour	8/4/2021	10:46 AM	11:46 AM	35.3	53.8	30.3
#4	1-Hour	8/4/2021	11:53 AM	12:53 PM	64.1	80	34
#5	1-Hour	8/4/2021	1:03 PM	2:03 PM	62.5	78.5	43
#6	1-Hour	8/4/2021	2:21 PM	3:21 PM	58.2	80	54.9
#7	1-Hour	8/5/2021	9:42 AM	10:42 AM	46.1	63.1	29.5
#8	1-Hour	8/5/2021	11:07 AM	12:07 PM	59.6	67.3	53.6
#9	1-Hour	8/5/2021	12:18 PM	1:18 PM	63.1	87.4	50.8
#10	1-Hour	8/5/2021	1:33 PM	2:33 PM	49.2	64.4	41.4

24-Hour vs. 1-Hour Noise Comparison											
Location	**Start**	**Stop**	**L_{eq} (Average)**			**L_{max} (Maximum)**			**L_{min} (Minimum)**		
			1-Hour	**24-Hour**	**Change**	**1-Hour**	**24-Hour**	**Change**	**1-Hour**	**24-Hour**	**Change**
#2	9:31 AM	10:31 AM	34.6	49.9	15.3	54.9	57.8	2.9	28.8	38.3	9.5
#3	10:46 AM	11:46 AM	35.3	65.2	29.9	53.8	70.9	17.1	30.3	52.1	21.8
#4	11:53 AM	12:53 PM	64.1	59.1	-5.0	80	66.3	-13.7	34	47.8	13.8
#5	1:03 PM	2:03 PM	62.5	51.3	-11.2	78.5	61.1	-17.4	43	38.3	-4.7
#6	2:21 PM	3:21 PM	58.2	47.3	-10.9	80	55.3	-24.7	54.9	36.4	-18.5
#7	9:42 AM	10:42 AM	46.1	48.8	2.7	63.1	57.7	-5.4	29.5	37.3	7.8
#8	11:07 AM	12:07 PM	59.6	49.6	-10.0	67.3	57.7	-9.6	53.6	39.1	-14.5
#9	12:18 PM	1:18 PM	63.1	50.0	-13.1	87.4	57.4	-30.0	50.8	40.7	-10.1
#10	1:33 PM	2:33 PM	49.2	50.8	1.6	64.4	58.4	-6.0	41.4	41.0	-0.4

48-Hour Hourly Noise Levels

Background vs. Operational Noise Comparison

Hourly Noise Level Summary (Average - L_{eq} dBA)				
Time Period	8/4/2021 - 8/5/2021		8/5/2021 - 8/6/2021	
	24-Hour	1-Hour	24-Hour	1-Hour
9:00 AM	50.8	34.6	62.4	46.1
10:00 AM	49.6		49.7	
11:00 AM	65.2	35.3	50.3	59.6
12:00 PM	59.1	64.1	49.1	63.1
1:00 PM	51.4	62.5	50.6	49.2
2:00 PM	49.2	58.2	51.0	
3:00 PM	47.4		46.8	
4:00 PM	35.3		46.2	
5:00 PM	36.7		43.7	
6:00 PM	32.7		39.6	
7:00 PM	33.2		38.9	
8:00 PM	32.7		38.2	
9:00 PM	32.7		34.2	
10:00 PM	34.4		34.4	
11:00 PM	33.8		34.4	
12:00 AM	33.8		33.9	
1:00 AM	35.6		33.8	
2:00 AM	36.3		34.1	
3:00 AM	35.6		34.0	
4:00 AM	38.3		37.7	
5:00 AM	46.6		41.2	
6:00 AM	48.3		48.4	
7:00 AM	49.8		48.2	
8:00 AM	51.0		51.0	

Background vs. Operational Noise Level Comparison (Average - L_{eq} dBA)			
Dates Measured	Avg. Background Noise Levels (4:00 p.m. - 6:00 a.m.)	Avg. Operational Noise Levels (6:00 a.m. - 4:00 p.m.)	Increase Due to Operations (dBA)
8/4/2021 - 8/5/2021	38.1	56.9	18.8
8/5/2021 - 8/6/2022	38.1	54.1	16.0
Statistical Average:	**38.1**	**55.7**	**17.6**

Serial Number	BGI040008	UNIT REV	R12N
Start Time	09:07:09 04-Aug-2021		
Run Length	24:00:00 5529600		

Microphone Information		
Description	Units	Value
Sensitivity	dB	29
Polarization	Volts	0
Meter Range	dB	110
Max Level	dB	140
Meas. Floor	dB	-20

Calibration Information			
Description		Units	Value
Pre-Cal	Level	dB	114
	Date		09:00:42 04-Aug-2021
Post-Cal	Level	dB	
	Date		
ReCert	Date		Unavailable

Configuration Information			
Description	Units	Meter 1	Meter 2
Integration Threshold	dB	OFF	OFF
Exchange Rate	dB	3	3
Criterion Level	dB	80	80
Upper Limit Level	dB	140	140
Projected Time	Hrs	24	24
Weighting		A	A
Time Response		SLOW	SLOW

Measurement	Units	Meter 1 Broadband	Meter 2 Broadband
Lavg	dB	53.2	53.1
Lmax	dB	86.7	86.6
Lmin	dB	31.9	31.9
Lpk	dB	106.1	106.1
TWA	dB	57.9	57.9
PTWA	dB	57.9	57.9
DOSE	%	0.62	0.62
PDOSE	%	0.62	0.62
SEL	dB	102.5	102.5
EXP	p2s	7	7

Measurement	Units	Value
LDN	dB	54.2
CNEL	dB	54.1
TAKTMAX (5sec)	dB	N/A
LC-A	dB	N/A

Exceedence	Units	Value
L01	dB	59.3
L08	dB	50.3
L25	dB	40.9
L50	dB	35.2

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
Study 1	0:01:00	0:01:00		45	55.1	34.8
Location #1	0:02:00	0:02:00		58.2	73.9	35.9
	0:03:00	0:03:00		40.1	54	35.7
	0:04:00	0:04:00		53.5	58.2	49
	0:05:00	0:05:00		51.6	56.8	39.3
	0:06:00	0:06:00		51.8	58.7	37.6
	0:07:00	0:07:00		52.4	56.7	46.6
	0:08:00	0:08:00		53.2	58.1	41.3
	0:09:00	0:09:00		39.8	43.1	36.5
	0:10:00	0:10:00		37.7	41.8	36.3
	0:11:00	0:11:00		39	46.5	34.7
	0:12:00	0:12:00		52.7	62	35.3
	0:13:00	0:13:00		42.5	53.8	36
	0:14:00	0:14:00		46.1	54	38.6
	0:15:00	0:15:00		54.9	61.9	48.1
	0:16:00	0:16:00		52.6	56.5	45.6
	0:17:00	0:17:00		43.4	50.4	36.2
	0:18:00	0:18:00		51.7	59.1	43
	0:19:00	0:19:00		49.7	53.9	44.6
	0:20:00	0:20:00		53.7	62.4	40.8
	0:21:00	0:21:00		54.1	64	41.2
	0:22:00	0:22:00		47.5	56.9	38.1
	0:23:00	0:23:00		50.8	58	38.6
	0:24:00	0:24:00		50.2	59.1	40.3
	0:25:00	0:25:00		51	59	38.8
	0:26:00	0:26:00		51.8	59.6	37.8
	0:27:00	0:27:00		49.2	56.4	39
	0:28:00	0:28:00		52.7	60.9	38.5
	0:29:00	0:29:00		41.4	47.8	36.7
	0:30:00	0:30:00		55.8	62.2	46.9
	0:31:00	0:31:00		48.6	53.7	41
	0:32:00	0:32:00		53.4	59.1	40.5
	0:33:00	0:33:00		44.9	53.1	38.2
	0:34:00	0:34:00		53.5	61.6	38.8
	0:35:00	0:35:00		48.5	58.4	37.1
	0:36:00	0:36:00		44.3	50.6	39.1
	0:37:00	0:37:00		50.9	57.7	38.5
	0:38:00	0:38:00		43.2	49.9	37.7
	0:39:00	0:39:00		50.6	58.2	39.5
	0:40:00	0:40:00		50.7	58.2	39.5
	0:41:00	0:41:00		42.2	49.4	34.5
	0:42:00	0:42:00		40.8	48.2	36
	0:43:00	0:43:00		53.2	62.2	36.5
	0:44:00	0:44:00		36.4	41.1	33.9
	0:45:00	0:45:00		40.1	48.2	34.4
	0:46:00	0:46:00		53.3	61.8	37.8
	0:47:00	0:47:00		51.6	59.8	38.4
	0:48:00	0:48:00		53.9	60	41.1
	0:49:00	0:49:00		49.7	56.7	39.2
	0:50:00	0:50:00		50.7	59.3	40
	0:51:00	0:51:00		43.6	50.1	35.8
	0:52:00	0:52:00		50.5	59.8	36
	0:53:00	0:53:00		50.6	59	38.4
	0:54:00	0:54:00		39.8	43.8	36.5
	0:55:00	0:55:00		48.2	58	37.3
	0:56:00	0:56:00		52.2	58.9	40.9
	0:57:00	0:57:00		39.8	46.2	34.5
	0:58:00	0:58:00		40.5	49.3	34.1
	0:59:00	0:59:00		40.8	50	34.6
	1:00:00	1:00:00		52.7	60.9	35.1
	1:01:00	1:01:00		39.1	49.2	35
	1:02:00	1:02:00		51.8	58.6	39.7
	1:03:00	1:03:00		54.9	60.3	42
	1:04:00	1:04:00		50	60	36
	1:05:00	1:05:00		50.6	59.8	35.9
	1:06:00	1:06:00		40.8	49.9	35.8
	1:07:00	1:07:00		43.7	51.7	33.9
	1:08:00	1:08:00		48.9	57.3	33.9
	1:09:00	1:09:00		41.9	50.7	36.3
	1:10:00	1:10:00		52	58.7	37.7
	1:11:00	1:11:00		39.4	44.1	34.3
	1:12:00	1:12:00		42.4	50.4	35.1
	1:13:00	1:13:00		53.4	61.4	36.9
	1:14:00	1:14:00		42.5	53.9	34
	1:15:00	1:15:00		41.9	48.4	35.1
	1:16:00	1:16:00		47.6	57.2	38
	1:17:00	1:17:00		46.2	56.9	36.5
	1:18:00	1:18:00		50.7	59.6	35.9
	1:19:00	1:19:00		52.2	60.9	38.9
	1:20:00	1:20:00		51.4	59.7	38.9
	1:21:00	1:21:00		50.4	59.1	37.3
	1:22:00	1:22:00		50.5	59	34.7

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
9:07:09 AM				
9:08:09 AM		31622.78	323593.66	3019.95
9:09:09 AM		660693.45	24547089.16	3890.45
9:10:09 AM		10232.93	251188.64	3715.35
9:11:09 AM		223872.11	660693.45	79432.82
9:12:09 AM		144543.98	478630.09	8511.38
9:13:09 AM		151356.12	741310.24	5754.40
9:14:09 AM		173780.08	467735.14	45708.82
9:15:09 AM		208929.61	645654.23	13489.63
9:16:09 AM		9549.93	20417.38	4466.84
9:17:09 AM		5888.44	15135.61	4265.80
9:18:09 AM		7943.28	44668.36	2951.21
9:19:09 AM		186208.71	1584893.19	3388.44
9:20:09 AM		17782.79	239883.29	3981.07
9:21:09 AM		40738.03	251188.64	7244.36
9:22:09 AM		309029.54	1548816.62	64565.42
9:23:09 AM		181970.09	446683.59	36307.81
9:24:09 AM		21877.62	109647.82	4168.69
9:25:09 AM		147910.84	812830.52	19952.62
9:26:09 AM		93325.43	245470.89	28840.32
9:27:09 AM		234422.88	1737800.83	12022.64
9:28:09 AM		257039.58	2511886.43	13182.57
9:29:09 AM		56234.13	489778.82	6456.54
9:30:09 AM		120226.44	630957.34	7244.36
9:31:09 AM	Location #2	104712.85	812830.52	10715.19
9:32:09 AM	Location #2	125892.54	794328.23	7585.78
9:33:09 AM	Location #2	151356.12	912010.84	6025.60
9:34:09 AM	Location #2	83176.38	436515.83	7943.28
9:35:09 AM	Location #2	186208.71	1230268.77	7079.46
9:36:09 AM	Location #2	13803.84	60255.96	4677.35
9:37:09 AM	Location #2	380189.40	1659586.91	48977.88
9:38:09 AM	Location #2	72443.60	234422.88	12589.25
9:39:09 AM	Location #2	218776.16	812830.52	11220.18
9:40:09 AM	Location #2	30902.95	204173.79	6606.93
9:41:09 AM	Location #2	223872.11	1445439.77	7585.78
9:42:09 AM	Location #2	70794.58	691830.97	5128.61
9:43:09 AM	Location #2	26915.35	114815.36	8128.31
9:44:09 AM	Location #2	123026.88	588843.66	7079.46
9:45:09 AM	Location #2	20892.96	97723.72	5888.44
9:46:09 AM	Location #2	114815.36	660693.45	8912.51
9:47:09 AM	Location #2	117489.76	660693.45	8912.51
9:48:09 AM	Location #2	16595.87	87096.36	2818.38
9:49:09 AM	Location #2	12022.64	66069.34	3981.07
9:50:09 AM	Location #2	208929.61	1659586.91	4466.84
9:51:09 AM	Location #2	4365.16	12882.50	2454.71
9:52:09 AM	Location #2	10232.93	66069.34	2754.23
9:53:09 AM	Location #2	213796.21	1513561.25	6025.60
9:54:09 AM	Location #2	144543.98	954992.59	6918.31
9:55:09 AM	Location #2	245470.89	1000000.00	12882.50
9:56:09 AM	Location #2	93325.43	467735.14	8317.64
9:57:09 AM	Location #2	117489.76	851138.04	10000.00
9:58:09 AM	Location #2	22908.68	102329.30	3801.89
9:59:09 AM	Location #2	112201.85	954992.59	3981.07
10:00:09 AM	Location #2	114815.36	794328.23	6918.31
10:01:09 AM	Location #2	9549.93	23988.33	4466.84
10:02:09 AM	Location #2	66069.34	630957.34	5370.32
10:03:09 AM	Location #2	165958.69	776247.12	12302.69
10:04:09 AM	Location #2	9549.93	41686.94	2818.38
10:05:09 AM	Location #2	11220.18	85113.80	2570.40
10:06:09 AM	Location #2	12022.64	100000.00	2884.03
10:07:09 AM	Location #2	186208.71	1230268.77	3235.94
10:08:09 AM	Location #2	8128.31	83176.38	3162.28
10:09:09 AM	Location #2	151356.12	724435.96	9332.54
10:10:09 AM	Location #2	309029.54	1071519.31	15848.93
10:11:09 AM	Location #2	100000.00	1000000.00	3981.07
10:12:09 AM	Location #2	114815.36	954992.59	3890.45
10:13:09 AM	Location #2	12022.64	97723.72	3801.89
10:14:09 AM	Location #2	23442.29	147910.84	2454.71
10:15:09 AM	Location #2	77624.71	537031.80	2454.71
10:16:09 AM	Location #2	15488.17	117489.76	4265.80
10:17:09 AM	Location #2	158489.32	741310.24	5888.44
10:18:09 AM	Location #2	8709.64	25703.96	2691.53
10:19:09 AM	Location #2	17378.01	109647.82	3235.94
10:20:09 AM	Location #2	218776.16	1380384.26	4897.79
10:21:09 AM	Location #2	17782.79	245470.89	2511.89
10:22:09 AM	Location #2	15488.17	69183.10	3235.94
10:23:09 AM	Location #2	57543.99	524807.46	6309.57
10:24:09 AM	Location #2	41686.94	489778.82	4466.84
10:25:09 AM	Location #2	117489.76	912010.84	3890.45
10:26:09 AM	Location #2	165958.69	1230268.77	7762.47
10:27:09 AM	Location #2	138038.43	933254.30	7762.47
10:28:09 AM	Location #2	109647.82	812830.52	5370.32
10:29:09 AM	Location #2	112201.85	794328.23	2951.21

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	1:23:00	1:23:00		46.4	55.7	40.1
	1:24:00	1:24:00		54.3	59.9	44.9
	1:25:00	1:25:00		51.6	58.8	40.4
	1:26:00	1:26:00		48.6	59.8	36.9
	1:27:00	1:27:00		51.6	60.8	39.9
	1:28:00	1:28:00		42.5	46.5	37.5
	1:29:00	1:29:00		43.6	49.5	36.3
	1:30:00	1:30:00		48.8	58.5	35.7
	1:31:00	1:31:00		41.9	50.1	38.4
	1:32:00	1:32:00		50.2	60	38.1
	1:33:00	1:33:00		48.1	56.3	35.1
	1:34:00	1:34:00		50.6	59.4	35.1
	1:35:00	1:35:00		42.4	47.1	38.1
	1:36:00	1:36:00		52	59.4	37.1
	1:37:00	1:37:00		50.1	58.6	37.9
	1:38:00	1:38:00		44.9	52.4	38.5
	1:39:00	1:39:00		53.3	60.1	43.9
	1:40:00	1:40:00		53.4	60.7	42.8
	1:41:00	1:41:00		41.9	49.1	36.3
	1:42:00	1:42:00		53.8	61.7	39.1
	1:43:00	1:43:00		48.2	57.2	37.7
	1:44:00	1:44:00		41.2	48.5	34.9
	1:45:00	1:45:00		36.9	40.8	34.6
	1:46:00	1:46:00		46	57	37.8
	1:47:00	1:47:00		53.3	60.7	39.5
	1:48:00	1:48:00		46.9	58.3	36.6
	1:49:00	1:49:00		52	59.1	41.5
	1:50:00	1:50:00		50.2	59.7	37.1
	1:51:00	1:51:00		52	58.9	39.8
	1:52:00	1:52:00		41	44.5	35.7
	1:53:00	1:53:00		41.3	46.7	35.1
	1:54:00	1:54:00		45.5	51.9	36.9
	1:55:00	1:55:00		50.9	59.4	38.1
	1:56:00	1:56:00		56.6	60.5	40.6
	1:57:00	1:57:00		57.9	64	50.9
	1:58:00	1:58:00		54.3	63	47.3
	1:59:00	1:59:00		54.1	58.4	47.6
	2:00:00	2:00:00		54.9	62.1	48.6
	2:01:00	2:01:00		62.6	68.7	52.2
	2:02:00	2:02:00		76.8	83.6	67
	2:03:00	2:03:00		81.5	86.7	65.8
	2:04:00	2:04:00		51.3	66.7	37.6
	2:05:00	2:05:00		52.8	62.5	39.5
	2:06:00	2:06:00		51.7	58.6	36.6
	2:07:00	2:07:00		49.6	55.5	41.9
	2:08:00	2:08:00		49.7	56.9	37
	2:09:00	2:09:00		43.4	49	38.3
	2:10:00	2:10:00		43.7	50.9	35.1
	2:11:00	2:11:00		47.5	58.1	34
	2:12:00	2:12:00		49.9	58.7	42.4
	2:13:00	2:13:00		43	51.5	35.4
	2:14:00	2:14:00		54.5	61.9	36.1
	2:15:00	2:15:00		45.1	51.4	35.1
	2:16:00	2:16:00		49.5	58.9	36
	2:17:00	2:17:00		52.1	59.3	37.5
	2:18:00	2:18:00		39.3	45	34.6
	2:19:00	2:19:00		41.7	48.7	36.5
	2:20:00	2:20:00		51.9	59.9	35.3
	2:21:00	2:21:00		46.4	53.6	35.3
	2:22:00	2:22:00		52.2	60.3	34.1
	2:23:00	2:23:00		36.4	42.9	33.7
	2:24:00	2:24:00		49.5	57.4	35.3
	2:25:00	2:25:00		35.6	39.9	34.2
	2:26:00	2:26:00		49.5	58.4	35.4
	2:27:00	2:27:00		41	47.4	35
	2:28:00	2:28:00		43.8	49.4	38
	2:29:00	2:29:00		49.4	57.1	38.8
	2:30:00	2:30:00		42.7	49.2	37.7
	2:31:00	2:31:00		51.3	59.5	36
	2:32:00	2:32:00		50.8	56.9	42.2
	2:33:00	2:33:00		53.1	61	36.7
	2:34:00	2:34:00		52.4	57.8	43.1
	2:35:00	2:35:00		51.3	58	43.7
	2:36:00	2:36:00		49.3	59.2	36.4
	2:37:00	2:37:00		41.8	46.6	38
	2:38:00	2:38:00		51.9	58.6	42.3
	2:39:00	2:39:00		44.7	52.3	39.2
	2:40:00	2:40:00		53.1	60.5	38.8
	2:41:00	2:41:00		36.6	40	34.6
	2:42:00	2:42:00		50.1	60.9	36
	2:43:00	2:43:00		53.9	60.9	42.9
	2:44:00	2:44:00		50	58.8	39.1
	2:45:00	2:45:00		41.5	53.3	34.9

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
10:30:09 AM	Location #2	43651.58	371535.23	10232.93
10:31:09 AM		269153.48	977237.22	30902.95
10:32:09 AM		144543.98	758577.58	10964.78
10:33:09 AM		72443.60	954992.59	4897.79
10:34:09 AM		144543.98	1202264.43	9772.37
10:35:09 AM		17782.79	44668.36	5623.41
10:36:09 AM		22908.68	89125.09	4265.80
10:37:09 AM		75857.76	707945.78	3715.35
10:38:09 AM		15488.17	102329.30	6918.31
10:39:09 AM		104712.85	1000000.00	6456.54
10:40:09 AM		64565.42	426579.52	3235.94
10:41:09 AM		114815.36	870963.59	3235.94
10:42:09 AM		17378.01	51286.14	6456.54
10:43:09 AM		158489.32	870963.59	5128.61
10:44:09 AM		102329.30	724435.96	6165.95
10:45:09 AM		30902.95	173780.08	7079.46
10:46:09 AM	Location #3	213796.21	1023292.99	24547.09
10:47:09 AM	Location #3	218776.16	1174897.55	19054.61
10:48:09 AM	Location #3	15488.17	81283.05	4265.80
10:49:09 AM	Location #3	239883.29	1479108.39	8128.31
10:50:09 AM	Location #3	66069.34	524807.46	5888.44
10:51:09 AM	Location #3	13182.57	70794.58	3090.30
10:52:09 AM	Location #3	4897.79	12022.64	2884.03
10:53:09 AM	Location #3	39810.72	501187.23	6025.60
10:54:09 AM	Location #3	213796.21	1174897.55	8912.51
10:55:09 AM	Location #3	48977.88	676082.98	4570.88
10:56:09 AM	Location #3	158489.32	812830.52	14125.38
10:57:09 AM	Location #3	104712.85	933254.30	5128.61
10:58:09 AM	Location #3	158489.32	776247.12	9549.93
10:59:09 AM	Location #3	12589.25	28183.83	3715.35
11:00:09 AM	Location #3	13489.63	46773.51	3235.94
11:01:09 AM	Location #3	35481.34	154881.66	4897.79
11:02:09 AM	Location #3	123026.88	870963.59	6456.54
11:03:09 AM	Location #3	457088.19	1122018.45	11481.54
11:04:09 AM	Location #3	616595.00	2511886.43	123026.88
11:05:09 AM	Location #3	269153.48	1995262.31	53703.18
11:06:09 AM	Location #3	257039.58	691830.97	57543.99
11:07:09 AM	Location #3	309029.54	1621810.10	72443.60
11:08:09 AM	Location #3	1819700.86	7413102.41	165958.69
11:09:09 AM	Location #3	47863009.23	229086765.28	5011872.34
11:10:09 AM	Location #3	141253754.46	467735141.29	3801893.96
11:11:09 AM	Location #3	134896.29	4677351.41	5754.40
11:12:09 AM	Location #3	190546.07	1778279.41	8912.51
11:13:09 AM	Location #3	147910.84	724435.96	4570.88
11:14:09 AM	Location #3	91201.08	354813.39	15488.17
11:15:09 AM	Location #3	93325.43	489778.82	5011.87
11:16:09 AM	Location #3	21877.62	79432.82	6760.83
11:17:09 AM	Location #3	23442.29	123026.88	3235.94
11:18:09 AM	Location #3	56234.13	645654.23	2511.89
11:19:09 AM	Location #3	97723.72	741310.24	17378.01
11:20:09 AM	Location #3	19952.62	141253.75	3467.37
11:21:09 AM	Location #3	281838.29	1548816.62	4073.80
11:22:09 AM	Location #3	32359.37	138038.43	3235.94
11:23:09 AM	Location #3	89125.09	776247.12	3981.07
11:24:09 AM	Location #3	162181.01	851138.04	5623.41
11:25:09 AM	Location #3	8511.38	31622.78	2884.03
11:26:09 AM	Location #3	14791.08	74131.02	4466.84
11:27:09 AM	Location #3	154881.66	977237.22	3388.44
11:28:09 AM	Location #3	43651.58	229086.77	3388.44
11:29:09 AM	Location #3	165958.69	1071519.31	2570.40
11:30:09 AM	Location #3	4365.16	19498.45	2344.23
11:31:09 AM	Location #3	89125.09	549540.87	3388.44
11:32:09 AM	Location #3	3630.78	9772.37	2630.27
11:33:09 AM	Location #3	89125.09	691830.97	3467.37
11:34:09 AM	Location #3	12589.25	54954.09	3162.28
11:35:09 AM	Location #3	23988.33	87096.36	6309.57
11:36:09 AM	Location #3	87096.36	512861.38	7585.78
11:37:09 AM	Location #3	18620.87	83176.38	5888.44
11:38:09 AM	Location #3	134896.29	891250.94	3981.07
11:39:09 AM	Location #3	120226.44	489778.82	16595.87
11:40:09 AM	Location #3	204173.79	1258925.41	4677.35
11:41:09 AM	Location #3	173780.08	602559.59	20417.38
11:42:09 AM	Location #3	134896.29	630957.34	23442.29
11:43:09 AM	Location #3	85113.80	831763.77	4365.16
11:44:09 AM	Location #3	15135.61	45708.82	6309.57
11:45:09 AM	Location #3	154881.66	724435.96	16982.44
11:46:09 AM		29512.09	169824.37	8317.64
11:47:09 AM		204173.79	1122018.45	7585.78
11:48:09 AM		4570.88	10000.00	2884.03
11:49:09 AM		102329.30	1230268.77	3981.07
11:50:09 AM		245470.89	1230268.77	19498.45
11:51:09 AM		100000.00	758577.58	8128.31
11:52:09 AM		14125.38	213796.21	3090.30

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	2:46:00	2:46:00		50.1	57.3	35.2
	2:47:00	2:47:00		46.3	54.2	38.7
	2:48:00	2:48:00		46.3	53.8	37.9
	2:49:00	2:49:00		51	58.4	40.2
	2:50:00	2:50:00		46.2	52.7	36.6
	2:51:00	2:51:00		49.6	57.3	38.2
	2:52:00	2:52:00		44.8	50.2	41.3
	2:53:00	2:53:00		46.4	51.5	38.9
	2:54:00	2:54:00		51	58.8	39.4
	2:55:00	2:55:00		44.9	50.5	42.8
	2:56:00	2:56:00		45.7	48.9	43.4
	2:57:00	2:57:00		54.1	59.7	42.8
	2:58:00	2:58:00		43.5	45.3	42.3
	2:59:00	2:59:00		56.9	61.4	44
	3:00:00	3:00:00		57.3	62	56.1
	3:01:00	3:01:00		64.6	73.5	56.4
	3:02:00	3:02:00		62.6	72.5	56.7
	3:03:00	3:03:00		73.2	78.7	57.1
	3:04:00	3:04:00		72.3	79.9	60.6
	3:05:00	3:05:00		60.5	67.9	50.1
	3:06:00	3:06:00		44.6	50.8	40.5
	3:07:00	3:07:00		41.9	45.3	39.8
	3:08:00	3:08:00		39.1	41.5	37.6
	3:09:00	3:09:00		40.7	44.8	37.4
	3:10:00	3:10:00		41.3	44.6	38.7
	3:11:00	3:11:00		50.3	57.4	42.6
	3:12:00	3:12:00		47.3	52.5	41.7
	3:13:00	3:13:00		44.5	48.3	40.6
	3:14:00	3:14:00		46.1	54	41.1
	3:15:00	3:15:00		47	54	42
	3:16:00	3:16:00		45.5	52.5	40.7
	3:17:00	3:17:00		42.6	46.1	39.6
	3:18:00	3:18:00		45.4	49.5	41.9
	3:19:00	3:19:00		50.6	60.1	36.6
	3:20:00	3:20:00		49.7	60.1	36.6
	3:21:00	3:21:00		40.5	47.1	37
	3:22:00	3:22:00		42.4	51	36.6
	3:23:00	3:23:00		53.4	62.1	38
	3:24:00	3:24:00		39.6	43.5	36.6
	3:25:00	3:25:00		47.9	56	38.1
	3:26:00	3:26:00		45.8	51.3	34.3
	3:27:00	3:27:00		37.2	41	34.2
	3:28:00	3:28:00		51.1	57.1	39.1
	3:29:00	3:29:00		52.8	61	39
	3:30:00	3:30:00		49.6	56.1	37.4
	3:31:00	3:31:00		47.5	55.3	38.4
	3:32:00	3:32:00		43.4	50.4	36.4
	3:33:00	3:33:00		53.5	60.6	41.8
	3:34:00	3:34:00		44.9	57.2	38.4
	3:35:00	3:35:00		50.7	59.4	43
	3:36:00	3:36:00		45.9	50.5	38.7
	3:37:00	3:37:00		48.2	53.8	41.3
	3:38:00	3:38:00		53	59.9	42.4
	3:39:00	3:39:00		57.3	69.1	38
	3:40:00	3:40:00		56	68.9	38.7
	3:41:00	3:41:00		44	51	36.6
	3:42:00	3:42:00		41.5	52.3	36
	3:43:00	3:43:00		48.5	57.1	35.5
	3:44:00	3:44:00		51.6	59.7	35.6
	3:45:00	3:45:00		47.5	55	35
	3:46:00	3:46:00		39.4	47.3	34.8
	3:47:00	3:47:00		52.9	61.3	38.7
	3:48:00	3:48:00		49.8	58	38.2
	3:49:00	3:49:00		36.8	39.4	34.9
	3:50:00	3:50:00		45.2	51.9	36.4
	3:51:00	3:51:00		46.6	52	37.2
	3:52:00	3:52:00		54.2	61.1	42.3
	3:53:00	3:53:00		51.9	60	40
	3:54:00	3:54:00		51.8	57.6	43
	3:55:00	3:55:00		38.8	43	34.9
	3:56:00	3:56:00		35.8	38.6	34.3
	3:57:00	3:57:00		50	58.1	37
	3:58:00	3:58:00		52.7	61.9	39.9
	3:59:00	3:59:00		48.7	56.6	41
	4:00:00	4:00:00		38.3	43.9	35.3
	4:01:00	4:01:00		53.5	61.4	40.3
	4:02:00	4:02:00		50.2	58.1	37
	4:03:00	4:03:00		36.3	39.1	34.4
	4:04:00	4:04:00		52	59.6	38.2
	4:05:00	4:05:00		51.1	57.4	41.3
	4:06:00	4:06:00		52.3	59.8	38.4
	4:07:00	4:07:00		46.8	55.3	36.4
	4:08:00	4:08:00		47.6	53.8	39.8

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
11:53:09 AM	Location #4	102329.30	537031.80	3311.31
11:54:09 AM	Location #4	42657.95	263026.80	7413.10
11:55:09 AM	Location #4	42657.95	239883.29	6165.95
11:56:09 AM	Location #4	125892.54	691830.97	10471.29
11:57:09 AM	Location #4	41686.94	186208.71	4570.88
11:58:09 AM	Location #4	91201.08	537031.80	6606.93
11:59:09 AM	Location #4	30199.52	104712.85	13489.63
12:00:09 PM	Location #4	43651.58	141253.75	7762.47
12:01:09 PM	Location #4	125892.54	758577.58	8709.64
12:02:09 PM	Location #4	30902.95	112201.85	19054.61
12:03:09 PM	Location #4	37153.52	77624.71	21877.62
12:04:09 PM	Location #4	257039.58	933254.30	19054.61
12:05:09 PM	Location #4	22387.21	33884.42	16982.44
12:06:09 PM	Location #4	489778.82	1380384.26	25118.86
12:07:09 PM	Location #4	537031.80	1584893.19	407380.28
12:08:09 PM	Location #4	2884031.50	22387211.39	436515.83
12:09:09 PM	Location #4	1819700.86	17782794.10	467735.14
12:10:09 PM	Location #4	20892961.31	74131024.13	512861.38
12:11:09 PM	Location #4	16982436.52	97723722.10	1148153.62
12:12:09 PM	Location #4	1122018.45	6165950.02	102329.30
12:13:09 PM	Location #4	28840.32	120226.44	11220.18
12:14:09 PM	Location #4	15488.17	33884.42	9549.93
12:15:09 PM	Location #4	8128.31	14125.38	5754.40
12:16:09 PM	Location #4	11748.98	30199.52	5495.41
12:17:09 PM	Location #4	13489.63	28840.32	7413.10
12:18:09 PM	Location #4	107151.93	549540.87	18197.01
12:19:09 PM	Location #4	53703.18	177827.94	14791.08
12:20:09 PM	Location #4	28183.83	67608.30	11481.54
12:21:09 PM	Location #4	40738.03	251188.64	12882.50
12:22:09 PM	Location #4	50118.72	251188.64	15848.93
12:23:09 PM	Location #4	35481.34	177827.94	11748.98
12:24:09 PM	Location #4	18197.01	40738.03	9120.11
12:25:09 PM	Location #4	34673.69	89125.09	15488.17
12:26:09 PM	Location #4	114815.36	1023292.99	4570.88
12:27:09 PM	Location #4	93325.43	1023292.99	4570.88
12:28:09 PM	Location #4	11220.18	51286.14	5011.87
12:29:09 PM	Location #4	17378.01	125892.54	4570.88
12:30:09 PM	Location #4	218776.16	1621810.10	6309.57
12:31:09 PM	Location #4	9120.11	22387.21	4570.88
12:32:09 PM	Location #4	61659.50	398107.17	6456.54
12:33:09 PM	Location #4	38018.94	134896.29	2691.53
12:34:09 PM	Location #4	5248.07	12589.25	2630.27
12:35:09 PM	Location #4	128824.96	512861.38	8128.31
12:36:09 PM	Location #4	190546.07	1258925.41	7943.28
12:37:09 PM	Location #4	91201.08	407380.28	5495.41
12:38:09 PM	Location #4	56234.13	338844.16	6918.31
12:39:09 PM	Location #4	21877.62	109647.82	4365.16
12:40:09 PM	Location #4	223872.11	1148153.62	15135.61
12:41:09 PM	Location #4	30902.95	524807.46	6918.31
12:42:09 PM	Location #4	117489.76	870963.59	19952.62
12:43:09 PM	Location #4	38904.51	112201.85	7413.10
12:44:09 PM	Location #4	66069.34	239883.29	13489.63
12:45:09 PM	Location #4	199526.23	977237.22	17378.01
12:46:09 PM	Location #4	537031.80	8128305.16	6309.57
12:47:09 PM	Location #4	398107.17	7762471.17	7413.10
12:48:09 PM	Location #4	25118.86	125892.54	4570.88
12:49:09 PM	Location #4	14125.38	169824.37	3981.07
12:50:09 PM	Location #4	70794.58	512861.38	3548.13
12:51:09 PM	Location #4	144543.98	933254.30	3630.78
12:52:09 PM	Location #4	56234.13	316227.77	3162.28
12:53:09 PM		8709.64	53703.18	3019.95
12:54:09 PM		194984.46	1348962.88	7413.10
12:55:09 PM		95499.26	630957.34	6606.93
12:56:09 PM		4786.30	8709.64	3090.30
12:57:09 PM		33113.11	154881.66	4365.16
12:58:09 PM		45708.82	158489.32	5248.07
12:59:09 PM		263026.80	1288249.55	16982.44
1:00:09 PM		154881.66	1000000.00	10000.00
1:01:09 PM		151356.12	575439.94	19952.62
1:02:09 PM		7585.78	19952.62	3090.30
1:03:09 PM	Location #5	3801.89	7244.36	2691.53
1:04:09 PM	Location #5	100000.00	645654.23	5011.87
1:05:09 PM	Location #5	186208.71	1548816.62	9772.37
1:06:09 PM	Location #5	74131.02	457088.19	12589.25
1:07:09 PM	Location #5	6760.83	24547.09	3388.44
1:08:09 PM	Location #5	223872.11	1380384.26	10715.19
1:09:09 PM	Location #5	104712.85	645654.23	5011.87
1:10:09 PM	Location #5	4265.80	8128.31	2754.23
1:11:09 PM	Location #5	158489.32	912010.84	6606.93
1:12:09 PM	Location #5	128824.96	549540.87	13489.63
1:13:09 PM	Location #5	169824.37	954992.59	6918.31
1:14:09 PM	Location #5	47863.01	338844.16	4365.16
1:15:09 PM	Location #5	57543.99	239883.29	9549.93

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	4:09:00	4:09:00		43.3	51.6	34.4
	4:10:00	4:10:00		48.3	56.7	34.3
	4:11:00	4:11:00		40.3	47.8	35.7
	4:12:00	4:12:00		50	58	39.2
	4:13:00	4:13:00		52.8	60	37.7
	4:14:00	4:14:00		49.6	57.7	37.4
	4:15:00	4:15:00		49.8	58.9	37.6
	4:16:00	4:16:00		50.5	59.2	35.8
	4:17:00	4:17:00		41.9	49	35.8
	4:18:00	4:18:00		38.6	45.8	34.7
	4:19:00	4:19:00		49.7	58.1	39
	4:20:00	4:20:00		53.5	60.3	37.7
	4:21:00	4:21:00		42.9	52.1	35.9
	4:22:00	4:22:00		39	43.1	35.6
	4:23:00	4:23:00		46	51.1	39.4
	4:24:00	4:24:00		51.2	56.9	42.9
	4:25:00	4:25:00		42.9	48.5	35.5
	4:26:00	4:26:00		49.3	58.9	37.4
	4:27:00	4:27:00		53.9	61.4	39.3
	4:28:00	4:28:00		50.3	58.8	38.3
	4:29:00	4:29:00		38	43.2	34.8
	4:30:00	4:30:00		52.9	60.5	38.6
	4:31:00	4:31:00		42.7	48.7	35.4
	4:32:00	4:32:00		36.3	42	34.5
	4:33:00	4:33:00		45.2	49.6	39.3
	4:34:00	4:34:00		52.9	62.2	40.8
	4:35:00	4:35:00		48.9	58	35.4
	4:36:00	4:36:00		37	40.7	34.5
	4:37:00	4:37:00		49.7	56.8	35.5
	4:38:00	4:38:00		63.7	74.4	40.8
	4:39:00	4:39:00		57.6	72.2	35.7
	4:40:00	4:40:00		49.1	57.6	36.7
	4:41:00	4:41:00		53.4	61.7	42.2
	4:42:00	4:42:00		46.4	54.3	40.7
	4:43:00	4:43:00		49.2	57	35.8
	4:44:00	4:44:00		52.2	60.3	41.4
	4:45:00	4:45:00		48.1	54.8	41.4
	4:46:00	4:46:00		52	60.2	42.2
	4:47:00	4:47:00		48.1	54.1	38.1
	4:48:00	4:48:00		42.8	48.6	37.9
	4:49:00	4:49:00		53.1	60.7	37.4
	4:50:00	4:50:00		51.2	57.6	42.5
	4:51:00	4:51:00		50.7	59.1	37.9
	4:52:00	4:52:00		45.4	56.3	34.1
	4:53:00	4:53:00		45.6	54.7	35
	4:54:00	4:54:00		48.8	57.9	34.9
	4:55:00	4:55:00		51.7	62	34.8
	4:56:00	4:56:00		46.6	55.3	36.4
	4:57:00	4:57:00		43.7	50.4	35.9
	4:58:00	4:58:00		53.7	62	36.6
	4:59:00	4:59:00		49.9	58.6	41.9
	5:00:00	5:00:00		47.1	58.2	35.8
	5:01:00	5:01:00		37.7	43.3	34.1
	5:02:00	5:02:00		46.6	51.9	38.2
	5:03:00	5:03:00		50.6	58.9	35.4
	5:04:00	5:04:00		51.7	61.8	34.4
	5:05:00	5:05:00		51.7	60.3	43.6
	5:06:00	5:06:00		44.3	50.5	35
	5:07:00	5:07:00		48.4	56.2	36.3
	5:08:00	5:08:00		34.9	39.6	33.4
	5:09:00	5:09:00		49.3	57.6	35
	5:10:00	5:10:00		52.3	60.9	39.6
	5:11:00	5:11:00		36.6	39.7	33.1
	5:12:00	5:12:00		50	60	37.9
	5:13:00	5:13:00		53.7	59.1	45.7
	5:14:00	5:14:00		49.4	57.9	34.7
	5:15:00	5:15:00		41.7	49.2	34.7
	5:16:00	5:16:00		40.8	48.5	35
	5:17:00	5:17:00		50.4	56.2	40.6
	5:18:00	5:18:00		49.1	57.1	39.4
	5:19:00	5:19:00		42.6	47.8	38.6
	5:20:00	5:20:00		53.1	59.7	44.2
	5:21:00	5:21:00		41	50.4	33.7
	5:22:00	5:22:00		50.4	58.1	34.7
	5:23:00	5:23:00		42.6	49.5	37.9
	5:24:00	5:24:00		53.8	60.5	38.6
	5:25:00	5:25:00		47.8	55.6	41.9
	5:26:00	5:26:00		51.6	58.7	39.9
	5:27:00	5:27:00		39.1	47.9	35.4
	5:28:00	5:28:00		53.5	59.9	38.1
	5:29:00	5:29:00		47.2	55.2	37.3
	5:30:00	5:30:00		38.8	41.6	34.4
	5:31:00	5:31:00		44.9	51.4	35.4

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
1:16:09 PM	Location #5	21379.62	144543.98	2754.23
1:17:09 PM	Location #5	67608.30	467735.14	2691.53
1:18:09 PM	Location #5	10715.19	60255.96	3715.35
1:19:09 PM	Location #5	100000.00	630957.34	8317.64
1:20:09 PM	Location #5	190546.07	1000000.00	5888.44
1:21:09 PM	Location #5	91201.08	588843.66	5495.41
1:22:09 PM	Location #5	95499.26	776247.12	5754.40
1:23:09 PM	Location #5	112201.85	831763.77	3801.89
1:24:09 PM	Location #5	15488.17	79432.82	3801.89
1:25:09 PM	Location #5	7244.36	38018.94	2951.21
1:26:09 PM	Location #5	93325.43	645654.23	7943.28
1:27:09 PM	Location #5	223872.11	1071519.31	5888.44
1:28:09 PM	Location #5	19498.45	162181.01	3890.45
1:29:09 PM	Location #5	7943.28	20417.38	3630.78
1:30:09 PM	Location #5	39810.72	128824.96	8709.64
1:31:09 PM	Location #5	131825.67	489778.82	19498.45
1:32:09 PM	Location #5	19498.45	70794.58	3548.13
1:33:09 PM	Location #5	85113.80	776247.12	5495.41
1:34:09 PM	Location #5	245470.89	1380384.26	8511.38
1:35:09 PM	Location #5	107151.93	758577.58	6760.83
1:36:09 PM	Location #5	6309.57	20892.96	3019.95
1:37:09 PM	Location #5	194984.46	1122018.45	7244.36
1:38:09 PM	Location #5	18620.87	74131.02	3467.37
1:39:09 PM	Location #5	4265.80	15848.93	2818.38
1:40:09 PM	Location #5	33113.11	91201.08	8511.38
1:41:09 PM	Location #5	194984.46	1659586.91	12022.64
1:42:09 PM	Location #5	77624.71	630957.34	3467.37
1:43:09 PM	Location #5	5011.87	11748.98	2818.38
1:44:09 PM	Location #5	93325.43	478630.09	3548.13
1:45:09 PM	Location #5	2344228.82	27542287.03	12022.64
1:46:09 PM	Location #5	575439.94	16595869.07	3715.35
1:47:09 PM	Location #5	81283.05	575439.94	4677.35
1:48:09 PM	Location #5	218776.16	1479108.39	16595.87
1:49:09 PM	Location #5	43651.58	269153.48	11748.98
1:50:09 PM	Location #5	83176.38	501187.23	3801.89
1:51:09 PM	Location #5	165958.69	1071519.31	13803.84
1:52:09 PM	Location #5	64565.42	301995.17	13803.84
1:53:09 PM	Location #5	158489.32	1047128.55	16595.87
1:54:09 PM	Location #5	64565.42	257039.58	6456.54
1:55:09 PM	Location #5	19054.61	72443.60	6165.95
1:56:09 PM	Location #5	204173.79	1174897.55	5495.41
1:57:09 PM	Location #5	131825.67	575439.94	17782.79
1:58:09 PM	Location #5	117489.76	812830.52	6165.95
1:59:09 PM	Location #5	34673.69	426579.52	2570.40
2:00:09 PM	Location #5	36307.81	295120.92	3162.28
2:01:09 PM	Location #5	75857.76	616595.00	3090.30
2:02:09 PM	Location #5	147910.84	1584893.19	3019.95
2:03:09 PM		45708.82	338844.16	4365.16
2:04:09 PM		23442.29	109647.82	3890.45
2:05:09 PM		234422.88	1584893.19	4570.88
2:06:09 PM		97723.72	724435.96	15488.17
2:07:09 PM		51286.14	660693.45	3801.89
2:08:09 PM		5888.44	21379.62	2570.40
2:09:09 PM		45708.82	154881.66	6606.93
2:10:09 PM		114815.36	776247.12	3467.37
2:11:09 PM		147910.84	1513561.25	2754.23
2:12:09 PM		147910.84	1071519.31	22908.68
2:13:09 PM		26915.35	112201.85	3162.28
2:14:09 PM		69183.10	416869.38	4265.80
2:15:09 PM		3090.30	9120.11	2187.76
2:16:09 PM		85113.80	575439.94	3162.28
2:17:09 PM		169824.37	1230268.77	9120.11
2:18:09 PM		4570.88	9332.54	2041.74
2:19:09 PM		100000.00	1000000.00	6165.95
2:20:09 PM		234422.88	812830.52	37153.52
2:21:09 PM	Location #6	87096.36	616595.00	2951.21
2:22:09 PM	Location #6	14791.08	83176.38	2951.21
2:23:09 PM	Location #6	12022.64	70794.58	3162.28
2:24:09 PM	Location #6	109647.82	416869.38	11481.54
2:25:09 PM	Location #6	81283.05	512861.38	8709.64
2:26:09 PM	Location #6	18197.01	60255.96	7244.36
2:27:09 PM	Location #6	204173.79	933254.30	26302.68
2:28:09 PM	Location #6	12589.25	109647.82	2344.23
2:29:09 PM	Location #6	109647.82	645654.23	2951.21
2:30:09 PM	Location #6	18197.01	89125.09	6165.95
2:31:09 PM	Location #6	239883.29	1122018.45	7244.36
2:32:09 PM	Location #6	60255.96	363078.05	15488.17
2:33:09 PM	Location #6	144543.98	741310.24	9772.37
2:34:09 PM	Location #6	8128.31	61659.50	3467.37
2:35:09 PM	Location #6	223872.11	977237.22	6456.54
2:36:09 PM	Location #6	52480.75	331131.12	5370.32
2:37:09 PM	Location #6	7585.78	14454.40	2754.23
2:38:09 PM	Location #6	30902.95	138038.43	3467.37

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	5:32:00	5:32:00		54	60.6	36.4
	5:33:00	5:33:00		39.2	47.7	34
	5:34:00	5:34:00		40.6	48.8	34.5
	5:35:00	5:35:00		38.2	41.9	34.7
	5:36:00	5:36:00		54.1	59.8	41.5
	5:37:00	5:37:00		48.9	59.7	40.9
	5:38:00	5:38:00		53	62.4	35.4
	5:39:00	5:39:00		49.7	57.5	35.9
	5:40:00	5:40:00		42.8	48.4	35.2
	5:41:00	5:41:00		47.9	57.6	33.9
	5:42:00	5:42:00		42.1	50.2	36.5
	5:43:00	5:43:00		46.5	55.8	35.6
	5:44:00	5:44:00		52.3	61.4	36.7
	5:45:00	5:45:00		46.5	56.5	34.2
	5:46:00	5:46:00		50.2	58.5	35.3
	5:47:00	5:47:00		50.2	59.5	37.6
	5:48:00	5:48:00		48.1	59.4	35.9
	5:49:00	5:49:00		48.1	58.3	33.2
	5:50:00	5:50:00		46.2	57.1	33.4
	5:51:00	5:51:00		45.5	56.4	33.6
	5:52:00	5:52:00		34	34.7	33.4
	5:53:00	5:53:00		34.3	35.2	33.5
	5:54:00	5:54:00		35.4	38.8	33.5
	5:55:00	5:55:00		33.8	35.5	33.2
	5:56:00	5:56:00		35.1	40	32.9
	5:57:00	5:57:00		34.7	37.7	33
	5:58:00	5:58:00		36.9	40.7	34.2
	5:59:00	5:59:00		33.8	37	32.9
	6:00:00	6:00:00		33.1	33.4	32.8
	6:01:00	6:01:00		33.1	33.4	32.7
	6:02:00	6:02:00		33.3	34.5	32.8
	6:03:00	6:03:00		34	36.5	33
	6:04:00	6:04:00		33.9	35.5	32.9
	6:05:00	6:05:00		33.2	35.9	32.5
	6:06:00	6:06:00		35	40	32.7
	6:07:00	6:07:00		35.4	43.5	32.8
	6:08:00	6:08:00		33.9	34.9	33.2
	6:09:00	6:09:00		34.4	35.6	33.6
	6:10:00	6:10:00		45.3	55.5	33.8
	6:11:00	6:11:00		40.8	46.5	34.5
	6:12:00	6:12:00		34.4	37.6	33
	6:13:00	6:13:00		34.5	35.6	33.8
	6:14:00	6:14:00		41.8	54	33.5
	6:15:00	6:15:00		37	43.5	33.2
	6:16:00	6:16:00		33.5	35.2	32.7
	6:17:00	6:17:00		39.9	48	33.2
	6:18:00	6:18:00		36.3	41.7	33.3
	6:19:00	6:19:00		36.9	43.8	33.7
	6:20:00	6:20:00		37.6	43.5	34.3
	6:21:00	6:21:00		34.7	36.9	33.3
	6:22:00	6:22:00		35.7	41.9	33.1
	6:23:00	6:23:00		61.3	76.4	41.2
	6:24:00	6:24:00		62.3	79.1	33.7
	6:25:00	6:25:00		34.4	37.2	33.2
	6:26:00	6:26:00		34.7	36.7	33.2
	6:27:00	6:27:00		35.8	38.1	34.5
	6:28:00	6:28:00		34.5	36.4	33.7
	6:29:00	6:29:00		35.4	42.1	33.6
	6:30:00	6:30:00		37.6	42.2	33.1
	6:31:00	6:31:00		33.7	36.3	32.8
	6:32:00	6:32:00		33.2	34.6	32.7
	6:33:00	6:33:00		33.4	34.3	32.8
	6:34:00	6:34:00		35.7	41.5	32.7
	6:35:00	6:35:00		37.6	43.4	34.3
	6:36:00	6:36:00		37.1	45.2	33.3
	6:37:00	6:37:00		34.8	36.9	33.6
	6:38:00	6:38:00		39.1	49.6	33.7
	6:39:00	6:39:00		36.4	43.5	34.1
	6:40:00	6:40:00		34	36.8	32.8
	6:41:00	6:41:00		36.4	40.6	32.9
	6:42:00	6:42:00		36.2	39.6	34.5
	6:43:00	6:43:00		37.3	41.4	34.6
	6:44:00	6:44:00		37	41.4	33.4
	6:45:00	6:45:00		33.7	34.6	32.8
	6:46:00	6:46:00		34.1	43.5	32.8
	6:47:00	6:47:00		33.1	33.9	32.7
	6:48:00	6:48:00		35.2	41.3	33
	6:49:00	6:49:00		37	42.7	33.3
	6:50:00	6:50:00		33.4	36.5	32.7
	6:51:00	6:51:00		37.5	45.3	33
	6:52:00	6:52:00		37.3	42.1	33.3
	6:53:00	6:53:00		34.1	37.8	33
	6:54:00	6:54:00		33.6	34.8	32.8

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
2:39:09 PM	Location #6	251188.64	1148153.62	4365.16
2:40:09 PM	Location #6	8317.64	58884.37	2511.89
2:41:09 PM	Location #6	11481.54	75857.76	2818.38
2:42:09 PM	Location #6	6606.93	15488.17	2951.21
2:43:09 PM	Location #6	257039.58	954992.59	14125.38
2:44:09 PM	Location #6	77624.71	933254.30	12302.69
2:45:09 PM	Location #6	199526.23	1737800.83	3467.37
2:46:09 PM	Location #6	93325.43	562341.33	3890.45
2:47:09 PM	Location #6	19054.61	69183.10	3311.31
2:48:09 PM	Location #6	61659.50	575439.94	2454.71
2:49:09 PM	Location #6	16218.10	104712.85	4466.84
2:50:09 PM	Location #6	44668.36	380189.40	3630.78
2:51:09 PM	Location #6	169824.37	1380384.26	4677.35
2:52:09 PM	Location #6	44668.36	446683.59	2630.27
2:53:09 PM	Location #6	104712.85	707945.78	3388.44
2:54:09 PM	Location #6	104712.85	891250.94	5754.40
2:55:09 PM	Location #6	64565.42	870963.59	3890.45
2:56:09 PM	Location #6	64565.42	676082.98	2089.30
2:57:09 PM	Location #6	41686.94	512861.38	2187.76
2:58:09 PM	Location #6	35481.34	436515.83	2290.87
2:59:09 PM	Location #6	2511.89	2951.21	2187.76
3:00:09 PM	Location #6	2691.53	3311.31	2238.72
3:01:09 PM	Location #6	3467.37	7585.78	2238.72
3:02:09 PM	Location #6	2398.83	3548.13	2089.30
3:03:09 PM	Location #6	3235.94	10000.00	1949.84
3:04:09 PM	Location #6	2951.21	5888.44	1995.26
3:05:09 PM	Location #6	4897.79	11748.98	2630.27
3:06:09 PM	Location #6	2398.83	5011.87	1949.84
3:07:09 PM	Location #6	2041.74	2187.76	1905.46
3:08:09 PM	Location #6	2041.74	2187.76	1862.09
3:09:09 PM	Location #6	2137.96	2818.38	1905.46
3:10:09 PM	Location #6	2511.89	4466.84	1995.26
3:11:09 PM	Location #6	2454.71	3548.13	1949.84
3:12:09 PM	Location #6	2089.30	3890.45	1778.28
3:13:09 PM	Location #6	3162.28	10000.00	1862.09
3:14:09 PM	Location #6	3467.37	22387.21	1905.46
3:15:09 PM	Location #6	2454.71	3090.30	2089.30
3:16:09 PM	Location #6	2754.23	3630.78	2290.87
3:17:09 PM	Location #6	33884.42	354813.39	2398.83
3:18:09 PM	Location #6	12022.64	44668.36	2818.38
3:19:09 PM	Location #6	2754.23	5754.40	1995.26
3:20:09 PM	Location #6	2818.38	3630.78	2398.83
3:21:09 PM		15135.61	251188.64	2238.72
3:22:09 PM		5011.87	22387.21	2089.30
3:23:09 PM		2238.72	3311.31	1862.09
3:24:09 PM		9772.37	63095.73	2089.30
3:25:09 PM		4265.80	14791.08	2137.96
3:26:09 PM		4897.79	23988.33	2344.23
3:27:09 PM		5754.40	22387.21	2691.53
3:28:09 PM		2951.21	4897.79	2137.96
3:29:09 PM		3715.35	15488.17	2041.74
3:30:09 PM		1348962.88	43651583.22	13182.57
3:31:09 PM		1698243.65	81283051.62	2344.23
3:32:09 PM		2754.23	5248.07	2089.30
3:33:09 PM		2951.21	4677.35	2089.30
3:34:09 PM		3801.89	6456.54	2818.38
3:35:09 PM		2818.38	4365.16	2344.23
3:36:09 PM		3467.37	16218.10	2290.87
3:37:09 PM		5754.40	16595.87	2041.74
3:38:09 PM		2344.23	4265.80	1905.46
3:39:09 PM		2089.30	2884.03	1862.09
3:40:09 PM		2187.76	2691.53	1905.46
3:41:09 PM		3715.35	14125.38	1862.09
3:42:09 PM		5754.40	21877.62	2691.53
3:43:09 PM		5128.61	33113.11	2137.96
3:44:09 PM		3019.95	4897.79	2290.87
3:45:09 PM		8128.31	91201.08	2344.23
3:46:09 PM		4365.16	22387.21	2570.40
3:47:09 PM		2511.89	4786.30	1905.46
3:48:09 PM		4365.16	11481.54	1949.84
3:49:09 PM		4168.69	9120.11	2818.38
3:50:09 PM		5370.32	13803.84	2884.03
3:51:09 PM		5011.87	13803.84	2187.76
3:52:09 PM		2344.23	2884.03	1905.46
3:53:09 PM		2570.40	22387.21	1905.46
3:54:09 PM		2041.74	2454.71	1862.09
3:55:09 PM		3311.31	13489.63	1995.26
3:56:09 PM		5011.87	18620.87	2137.96
3:57:09 PM		2187.76	4466.84	1862.09
3:58:09 PM		5623.41	33884.42	1995.26
3:59:09 PM		5370.32	16218.10	2137.96
4:00:09 PM		2570.40	6025.60	1995.26
4:01:09 PM		2290.87	3019.95	1905.46

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	6:55:00	6:55:00		37.6	43	33
	6:56:00	6:56:00		38.9	45	32.7
	6:57:00	6:57:00		35.3	40	33
	6:58:00	6:58:00		33.3	34.6	32.8
	6:59:00	6:59:00		33.5	36.6	32.6
	7:00:00	7:00:00		33.5	34.7	32.9
	7:01:00	7:01:00		34.4	39	32.6
	7:02:00	7:02:00		34.2	36.2	32.7
	7:03:00	7:03:00		33.5	35.6	32.9
	7:04:00	7:04:00		33.1	33.7	32.7
	7:05:00	7:05:00		32.9	34	32.5
	7:06:00	7:06:00		33	34.7	32.5
	7:07:00	7:07:00		33.8	36.6	32.5
	7:08:00	7:08:00		34.9	37.4	33.5
	7:09:00	7:09:00		34.3	38.6	32.8
	7:10:00	7:10:00		36.4	42.3	32.6
	7:11:00	7:11:00		36.6	41.7	33.2
	7:12:00	7:12:00		36.2	41	32.8
	7:13:00	7:13:00		38.8	46	32.6
	7:14:00	7:14:00		39.5	48.1	32.9
	7:15:00	7:15:00		33.4	35.4	32.5
	7:16:00	7:16:00		34.5	37.4	33.4
	7:17:00	7:17:00		35.8	42.8	32.7
	7:18:00	7:18:00		39.1	47.9	32.8
	7:19:00	7:19:00		33.1	35.4	32.6
	7:20:00	7:20:00		35.8	44	32.6
	7:21:00	7:21:00		35.7	40.5	32.7
	7:22:00	7:22:00		35.5	40.4	32.7
	7:23:00	7:23:00		36.8	41.6	33.3
	7:24:00	7:24:00		34.7	41.4	32.9
	7:25:00	7:25:00		32.8	33.4	32.3
	7:26:00	7:26:00		33	34.2	32.6
	7:27:00	7:27:00		33.1	33.4	32.8
	7:28:00	7:28:00		33.3	34	32.8
	7:29:00	7:29:00		33.8	35.8	32.6
	7:30:00	7:30:00		33.3	34.7	32.5
	7:31:00	7:31:00		36.1	44	33.4
	7:32:00	7:32:00		33.3	34.8	32.6
	7:33:00	7:33:00		41.9	48.2	33
	7:34:00	7:34:00		34.2	38.7	32.6
	7:35:00	7:35:00		33.3	34.9	32.8
	7:36:00	7:36:00		32.8	33.1	32.5
	7:37:00	7:37:00		32.6	32.9	32.2
	7:38:00	7:38:00		32.5	33	32.3
	7:39:00	7:39:00		32.8	33.2	32.5
	7:40:00	7:40:00		32.7	33.3	32.3
	7:41:00	7:41:00		33.2	35.3	32.5
	7:42:00	7:42:00		36.6	43	32.5
	7:43:00	7:43:00		36.2	42.5	32.8
	7:44:00	7:44:00		33.1	34.9	32.3
	7:45:00	7:45:00		34.2	36.9	32.7
	7:46:00	7:46:00		34.2	40.3	32.8
	7:47:00	7:47:00		33.1	36.2	32.4
	7:48:00	7:48:00		32.8	35.1	32.3
	7:49:00	7:49:00		35.1	39.1	32.8
	7:50:00	7:50:00		34.5	40.2	32.3
	7:51:00	7:51:00		35.8	41.1	32.8
	7:52:00	7:52:00		36.2	39.9	33.4
	7:53:00	7:53:00		33	35.8	32.3
	7:54:00	7:54:00		35.2	38.9	32.4
	7:55:00	7:55:00		37.2	42.5	33.3
	7:56:00	7:56:00		32.9	33.6	32.5
	7:57:00	7:57:00		33.1	34.5	32.4
	7:58:00	7:58:00		33.4	36.9	32.3
	7:59:00	7:59:00		33.9	39.7	32.4
	8:00:00	8:00:00		33.4	36.7	32.4
	8:01:00	8:01:00		33.3	35	32.5
	8:02:00	8:02:00		32.7	33	32.4
	8:03:00	8:03:00		34.9	40.9	32.7
	8:04:00	8:04:00		34.6	42.2	32.7
	8:05:00	8:05:00		35.7	42.8	32.6
	8:06:00	8:06:00		32.8	33.2	32.5
	8:07:00	8:07:00		32.7	33.3	32.4
	8:08:00	8:08:00		35.1	37.6	32.9
	8:09:00	8:09:00		33.6	35.1	32.9
	8:10:00	8:10:00		33	33.4	32.7
	8:11:00	8:11:00		35.1	42.8	32.7
	8:12:00	8:12:00		34.1	40.9	32.6
	8:13:00	8:13:00		32.9	34.4	32.4
	8:14:00	8:14:00		34.4	40.9	32.4
	8:15:00	8:15:00		37.5	43.4	33.6
	8:16:00	8:16:00		41.6	51.6	32.9
	8:17:00	8:17:00		36.1	43.2	32.7

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
4:02:09 PM		5754.40	19952.62	1995.26
4:03:09 PM		7762.47	31622.78	1862.09
4:04:09 PM		3388.44	10000.00	1995.26
4:05:09 PM		2137.96	2884.03	1905.46
4:06:09 PM		2238.72	4570.88	1819.70
4:07:09 PM		2238.72	2951.21	1949.84
4:08:09 PM		2754.23	7943.28	1819.70
4:09:09 PM		2630.27	4168.69	1862.09
4:10:09 PM		2238.72	3630.78	1949.84
4:11:09 PM		2041.74	2344.23	1862.09
4:12:09 PM		1949.84	2511.89	1778.28
4:13:09 PM		1995.26	2951.21	1778.28
4:14:09 PM		2398.83	4570.88	1778.28
4:15:09 PM		3090.30	5495.41	2238.72
4:16:09 PM		2691.53	7244.36	1905.46
4:17:09 PM		4365.16	16982.44	1819.70
4:18:09 PM		4570.88	14791.08	2089.30
4:19:09 PM		4168.69	12589.25	1905.46
4:20:09 PM		7585.78	39810.72	1819.70
4:21:09 PM		8912.51	64565.42	1949.84
4:22:09 PM		2187.76	3467.37	1778.28
4:23:09 PM		2818.38	5495.41	2187.76
4:24:09 PM		3801.89	19054.61	1862.09
4:25:09 PM		8128.31	61659.50	1905.46
4:26:09 PM		2041.74	3467.37	1819.70
4:27:09 PM		3801.89	25118.86	1819.70
4:28:09 PM		3715.35	11220.18	1862.09
4:29:09 PM		3548.13	10964.78	1862.09
4:30:09 PM		4786.30	14454.40	2137.96
4:31:09 PM		2951.21	13803.84	1949.84
4:32:09 PM		1905.46	2187.76	1698.24
4:33:09 PM		1995.26	2630.27	1819.70
4:34:09 PM		2041.74	2187.76	1905.46
4:35:09 PM		2137.96	2511.89	1905.46
4:36:09 PM		2398.83	3801.89	1819.70
4:37:09 PM		2137.96	2951.21	1778.28
4:38:09 PM		4073.80	25118.86	2187.76
4:39:09 PM		2137.96	3019.95	1819.70
4:40:09 PM		15488.17	66069.34	1995.26
4:41:09 PM		2630.27	7413.10	1819.70
4:42:09 PM		2137.96	3090.30	1905.46
4:43:09 PM		1905.46	2041.74	1778.28
4:44:09 PM		1819.70	1949.84	1659.59
4:45:09 PM		1778.28	1995.26	1698.24
4:46:09 PM		1905.46	2089.30	1778.28
4:47:09 PM		1862.09	2137.96	1698.24
4:48:09 PM		2089.30	3388.44	1778.28
4:49:09 PM		4570.88	19952.62	1778.28
4:50:09 PM		4168.69	17782.79	1905.46
4:51:09 PM		2041.74	3090.30	1698.24
4:52:09 PM		2630.27	4897.79	1862.09
4:53:09 PM		2630.27	10715.19	1905.46
4:54:09 PM		2041.74	4168.69	1737.80
4:55:09 PM		1905.46	3235.94	1698.24
4:56:09 PM		3235.94	8128.31	1905.46
4:57:09 PM		2818.38	10471.29	1698.24
4:58:09 PM		3801.89	12882.50	1905.46
4:59:09 PM		4168.69	9772.37	2187.76
5:00:09 PM		1995.26	3801.89	1698.24
5:01:09 PM		3311.31	7762.47	1737.80
5:02:09 PM		5248.07	17782.79	2137.96
5:03:09 PM		1949.84	2290.87	1778.28
5:04:09 PM		2041.74	2818.38	1737.80
5:05:09 PM		2187.76	4897.79	1698.24
5:06:09 PM		2454.71	9332.54	1737.80
5:07:09 PM		2187.76	4677.35	1737.80
5:08:09 PM		2137.96	3162.28	1778.28
5:09:09 PM		1862.09	1995.26	1737.80
5:10:09 PM		3090.30	12302.69	1862.09
5:11:09 PM		2884.03	16595.87	1862.09
5:12:09 PM		3715.35	19054.61	1819.70
5:13:09 PM		1905.46	2089.30	1778.28
5:14:09 PM		1862.09	2137.96	1737.80
5:15:09 PM		3235.94	5754.40	1949.84
5:16:09 PM		2290.87	3235.94	1949.84
5:17:09 PM		1995.26	2187.76	1862.09
5:18:09 PM		3235.94	19054.61	1862.09
5:19:09 PM		2570.40	12302.69	1819.70
5:20:09 PM		1949.84	2754.23	1737.80
5:21:09 PM		2754.23	12302.69	1737.80
5:22:09 PM		5623.41	21877.62	2290.87
5:23:09 PM		14454.40	144543.98	1949.84
5:24:09 PM		4073.80	20892.96	1862.09

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	8:18:00	8:18:00		33.5	35.1	32.7
	8:19:00	8:19:00		33.3	34.1	32.6
	8:20:00	8:20:00		32.8	34.8	32.4
	8:21:00	8:21:00		32.8	33.2	32.6
	8:22:00	8:22:00		32.7	33.5	32.3
	8:23:00	8:23:00		48	60.1	32.4
	8:24:00	8:24:00		42.8	57.4	32.2
	8:25:00	8:25:00		36.8	45	32
	8:26:00	8:26:00		36.3	41.9	32.9
	8:27:00	8:27:00		37.9	44.8	32.5
	8:28:00	8:28:00		38	47.1	32.9
	8:29:00	8:29:00		41.3	49.8	34.8
	8:30:00	8:30:00		40.2	46	34.5
	8:31:00	8:31:00		39.5	45.2	32.8
	8:32:00	8:32:00		32.7	33.6	32.3
	8:33:00	8:33:00		32.8	33.7	32.1
	8:34:00	8:34:00		32.4	32.7	31.9
	8:35:00	8:35:00		32.5	33.6	32.1
	8:36:00	8:36:00		32.5	33.7	32.1
	8:37:00	8:37:00		32.7	35.1	32.1
	8:38:00	8:38:00		32.8	34.3	32.2
	8:39:00	8:39:00		37.3	47.1	32.3
	8:40:00	8:40:00		38.1	47.1	32.4
	8:41:00	8:41:00		34	38.6	32.1
	8:42:00	8:42:00		33.7	35.7	32.2
	8:43:00	8:43:00		33.1	36.2	32.1
	8:44:00	8:44:00		32.9	37.7	32.2
	8:45:00	8:45:00		32.8	35	31.9
	8:46:00	8:46:00		32.9	37.5	31.9
	8:47:00	8:47:00		33.6	36.1	31.9
	8:48:00	8:48:00		34.4	38.6	32.7
	8:49:00	8:49:00		32.4	32.8	32
	8:50:00	8:50:00		33.7	39.2	32.1
	8:51:00	8:51:00		33.4	37.7	32.1
	8:52:00	8:52:00		34.1	38.1	32.8
	8:53:00	8:53:00		32.5	33.2	32
	8:54:00	8:54:00		32.3	32.7	32
	8:55:00	8:55:00		32.2	32.5	32
	8:56:00	8:56:00		32.3	32.5	32
	8:57:00	8:57:00		32.3	32.6	32
	8:58:00	8:58:00		32.6	33.5	32
	8:59:00	8:59:00		32.3	32.5	32
	9:00:00	9:00:00		32.6	33.6	32.1
	9:01:00	9:01:00		33	34	32.5
	9:02:00	9:02:00		32.4	32.8	32
	9:03:00	9:03:00		32.4	32.7	32
	9:04:00	9:04:00		32.5	33.2	32.1
	9:05:00	9:05:00		32.4	33	32.1
	9:06:00	9:06:00		33.7	35.4	32.1
	9:07:00	9:07:00		35	37.5	33.4
	9:08:00	9:08:00		32.8	34.6	32.1
	9:09:00	9:09:00		32.3	32.8	32
	9:10:00	9:10:00		34.5	36.4	32.8
	9:11:00	9:11:00		32.8	33.6	32.4
	9:12:00	9:12:00		32.5	32.8	32.2
	9:13:00	9:13:00		32.3	32.6	31.9
	9:14:00	9:14:00		32.4	33.6	32
	9:15:00	9:15:00		32.4	32.7	32.1
	9:16:00	9:16:00		32.7	33.7	32.3
	9:17:00	9:17:00		32.7	33	32.4
	9:18:00	9:18:00		32.7	33.1	32.2
	9:19:00	9:19:00		32.5	32.9	32.2
	9:20:00	9:20:00		33	33.8	32.3
	9:21:00	9:21:00		32.7	33.5	32.3
	9:22:00	9:22:00		32.6	33	32.3
	9:23:00	9:23:00		33.5	39.6	32.3
	9:24:00	9:24:00		32.6	33.2	32.3
	9:25:00	9:25:00		32.5	33	32.1
	9:26:00	9:26:00		32.4	32.8	32.2
	9:27:00	9:27:00		32.5	33.8	32.1
	9:28:00	9:28:00		32.5	32.9	32.1
	9:29:00	9:29:00		32.6	33.9	32.2
	9:30:00	9:30:00		35.4	40.2	33.1
	9:31:00	9:31:00		33.1	35.3	32.3
	9:32:00	9:32:00		32.5	33.9	32.1
	9:33:00	9:33:00		32.4	33.2	32.2
	9:34:00	9:34:00		32.4	33.3	32
	9:35:00	9:35:00		32.2	33	31.9
	9:36:00	9:36:00		32.5	33.7	32
	9:37:00	9:37:00		32.6	33.8	32.1
	9:38:00	9:38:00		32.4	32.9	32.1
	9:39:00	9:39:00		32.6	33.2	32.1
	9:40:00	9:40:00		32.5	33.2	32.1

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
5:25:09 PM		2238.72	3235.94	1862.09
5:26:09 PM		2137.96	2570.40	1819.70
5:27:09 PM		1905.46	3019.95	1737.80
5:28:09 PM		1905.46	2089.30	1819.70
5:29:09 PM		1862.09	2238.72	1698.24
5:30:09 PM		63095.73	1023292.99	1737.80
5:31:09 PM		19054.61	549540.87	1659.59
5:32:09 PM		4786.30	31622.78	1584.89
5:33:09 PM		4265.80	15488.17	1949.84
5:34:09 PM		6165.95	30199.52	1778.28
5:35:09 PM		6309.57	51286.14	1949.84
5:36:09 PM		13489.63	95499.26	3019.95
5:37:09 PM		10471.29	39810.72	2818.38
5:38:09 PM		8912.51	33113.11	1905.46
5:39:09 PM		1862.09	2290.87	1698.24
5:40:09 PM		1905.46	2344.23	1621.81
5:41:09 PM		1737.80	1862.09	1548.82
5:42:09 PM		1778.28	2290.87	1621.81
5:43:09 PM		1778.28	2344.23	1621.81
5:44:09 PM		1862.09	3235.94	1621.81
5:45:09 PM		1905.46	2691.53	1659.59
5:46:09 PM		5370.32	51286.14	1698.24
5:47:09 PM		6456.54	51286.14	1737.80
5:48:09 PM		2511.89	7244.36	1621.81
5:49:09 PM		2344.23	3715.35	1659.59
5:50:09 PM		2041.74	4168.69	1621.81
5:51:09 PM		1949.84	5888.44	1659.59
5:52:09 PM		1905.46	3162.28	1548.82
5:53:09 PM		1949.84	5623.41	1548.82
5:54:09 PM		2290.87	4073.80	1548.82
5:55:09 PM		2754.23	7244.36	1862.09
5:56:09 PM		1737.80	1905.46	1584.89
5:57:09 PM		2344.23	8317.64	1621.81
5:58:09 PM		2187.76	5888.44	1621.81
5:59:09 PM		2570.40	6456.54	1905.46
6:00:09 PM		1778.28	2089.30	1584.89
6:01:09 PM		1698.24	1862.09	1584.89
6:02:09 PM		1659.59	1778.28	1584.89
6:03:09 PM		1698.24	1778.28	1584.89
6:04:09 PM		1698.24	1819.70	1584.89
6:05:09 PM		1819.70	2238.72	1584.89
6:06:09 PM		1698.24	1778.28	1584.89
6:07:09 PM		1819.70	2290.87	1621.81
6:08:09 PM		1995.26	2511.89	1778.28
6:09:09 PM		1737.80	1905.46	1584.89
6:10:09 PM		1737.80	1862.09	1584.89
6:11:09 PM		1778.28	2089.30	1621.81
6:12:09 PM		1737.80	1995.26	1621.81
6:13:09 PM		2344.23	3467.37	1621.81
6:14:09 PM		3162.28	5623.41	2187.76
6:15:09 PM		1905.46	2884.03	1621.81
6:16:09 PM		1698.24	1905.46	1584.89
6:17:09 PM		2818.38	4365.16	1905.46
6:18:09 PM		1905.46	2290.87	1737.80
6:19:09 PM		1778.28	1905.46	1659.59
6:20:09 PM		1698.24	1819.70	1548.82
6:21:09 PM		1737.80	2290.87	1584.89
6:22:09 PM		1737.80	1862.09	1621.81
6:23:09 PM		1862.09	2344.23	1698.24
6:24:09 PM		1862.09	1995.26	1737.80
6:25:09 PM		1862.09	2041.74	1659.59
6:26:09 PM		1778.28	1949.84	1659.59
6:27:09 PM		1995.26	2398.83	1698.24
6:28:09 PM		1862.09	2238.72	1698.24
6:29:09 PM		1819.70	1995.26	1698.24
6:30:09 PM		2238.72	9120.11	1698.24
6:31:09 PM		1819.70	2089.30	1698.24
6:32:09 PM		1778.28	1995.26	1621.81
6:33:09 PM		1737.80	1905.46	1659.59
6:34:09 PM		1778.28	2398.83	1621.81
6:35:09 PM		1778.28	1949.84	1621.81
6:36:09 PM		1819.70	2454.71	1659.59
6:37:09 PM		3467.37	10471.29	2041.74
6:38:09 PM		2041.74	3388.44	1698.24
6:39:09 PM		1778.28	2454.71	1621.81
6:40:09 PM		1737.80	2089.30	1659.59
6:41:09 PM		1737.80	2137.96	1584.89
6:42:09 PM		1659.59	1995.26	1548.82
6:43:09 PM		1778.28	2344.23	1584.89
6:44:09 PM		1819.70	2398.83	1621.81
6:45:09 PM		1737.80	1949.84	1621.81
6:46:09 PM		1819.70	2089.30	1621.81
6:47:09 PM		1778.28	2089.30	1621.81

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	9:41:00	9:41:00		32.5	33	32.1
	9:42:00	9:42:00		32.7	33	32.3
	9:43:00	9:43:00		32.5	32.8	32.2
	9:44:00	9:44:00		32.5	32.8	32.2
	9:45:00	9:45:00		32.3	32.6	32
	9:46:00	9:46:00		32.4	32.7	32.1
	9:47:00	9:47:00		32.5	32.9	32.2
	9:48:00	9:48:00		32.4	33	32
	9:49:00	9:49:00		33.8	37.1	32.6
	9:50:00	9:50:00		32.5	32.8	32.2
	9:51:00	9:51:00		32.5	33.1	32.1
	9:52:00	9:52:00		32.5	33.1	32.1
	9:53:00	9:53:00		35.3	38.7	32.1
	9:54:00	9:54:00		34.4	38.4	32.5
	9:55:00	9:55:00		32.6	33.2	32.2
	9:56:00	9:56:00		34.1	40	32.3
	9:57:00	9:57:00		33.9	36.4	32.6
	9:58:00	9:58:00		32.5	33	32.2
	9:59:00	9:59:00		32.9	34.5	32.3
	10:00:00	10:00:00		32.6	33.8	32.1
	10:01:00	10:01:00		32.6	33.9	32.1
	10:02:00	10:02:00		32.2	32.5	31.9
	10:03:00	10:03:00		32.3	32.5	32
	10:04:00	10:04:00		32.3	32.6	32
	10:05:00	10:05:00		32.4	32.9	32.1
	10:06:00	10:06:00		32.4	32.8	32
	10:07:00	10:07:00		32.3	32.6	32
	10:08:00	10:08:00		32.3	32.6	32
	10:09:00	10:09:00		32.2	32.5	31.9
	10:10:00	10:10:00		32.9	33.6	32
	10:11:00	10:11:00		32.5	33.6	32
	10:12:00	10:12:00		32.3	32.7	32
	10:13:00	10:13:00		32.4	33.5	32
	10:14:00	10:14:00		32.5	33.7	32
	10:15:00	10:15:00		32.6	33.9	32.2
	10:16:00	10:16:00		32.7	34.3	32.1
	10:17:00	10:17:00		32.7	34.5	32
	10:18:00	10:18:00		32.7	34.7	32.1
	10:19:00	10:19:00		33.3	35.4	32.7
	10:20:00	10:20:00		33.2	35.1	32.5
	10:21:00	10:21:00		32.6	33.4	32.2
	10:22:00	10:22:00		32.3	32.5	32
	10:23:00	10:23:00		32.5	34.5	31.9
	10:24:00	10:24:00		32.3	32.6	31.9
	10:25:00	10:25:00		32.4	32.8	32.1
	10:26:00	10:26:00		32.3	32.8	31.9
	10:27:00	10:27:00		37.6	45.7	32
	10:28:00	10:28:00		39.7	45.8	33
	10:29:00	10:29:00		33.2	36.1	32.3
	10:30:00	10:30:00		32.7	34.2	32
	10:31:00	10:31:00		32.9	35.7	32.2
	10:32:00	10:32:00		32.3	33.4	32
	10:33:00	10:33:00		32.3	33.4	31.9
	10:34:00	10:34:00		32.4	34.1	31.9
	10:35:00	10:35:00		34	35	32.9
	10:36:00	10:36:00		32.8	34.1	32.1
	10:37:00	10:37:00		32.7	33.9	32
	10:38:00	10:38:00		32.7	33.6	32.3
	10:39:00	10:39:00		32.5	33.4	32
	10:40:00	10:40:00		32.7	34.2	32.1
	10:41:00	10:41:00		32.7	33.8	32.1
	10:42:00	10:42:00		33.3	37.4	32.3
	10:43:00	10:43:00		33.3	37.8	32
	10:44:00	10:44:00		32.7	36.8	32
	10:45:00	10:45:00		32.6	33.8	32.2
	10:46:00	10:46:00		33.1	35.1	32.4
	10:47:00	10:47:00		33.7	37.8	32.2
	10:48:00	10:48:00		33.3	38.8	32.2
	10:49:00	10:49:00		32.4	33.3	32.1
	10:50:00	10:50:00		33	35.6	32
	10:51:00	10:51:00		32.7	35.6	32.1
	10:52:00	10:52:00		32.6	34.3	32
	10:53:00	10:53:00		32.6	33.7	32.1
	10:54:00	10:54:00		32.5	34.1	32
	10:55:00	10:55:00		32.7	34.2	32.2
	10:56:00	10:56:00		33.1	36.2	32.2
	10:57:00	10:57:00		32.4	32.7	32.1
	10:58:00	10:58:00		32.7	33.3	32.3
	10:59:00	10:59:00		32.8	33.7	32.3
	11:00:00	11:00:00		32.6	32.9	32.3
	11:01:00	11:01:00		32.7	32.9	32.2
	11:02:00	11:02:00		32.4	32.7	32
	11:03:00	11:03:00		32.5	34.1	32

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
6:48:09 PM		1778.28	1995.26	1621.81
6:49:09 PM		1862.09	1995.26	1698.24
6:50:09 PM		1778.28	1905.46	1659.59
6:51:09 PM		1778.28	1905.46	1659.59
6:52:09 PM		1698.24	1819.70	1584.89
6:53:09 PM		1737.80	1862.09	1621.81
6:54:09 PM		1778.28	1949.84	1659.59
6:55:09 PM		1737.80	1995.26	1584.89
6:56:09 PM		2398.83	5128.61	1819.70
6:57:09 PM		1778.28	1905.46	1659.59
6:58:09 PM		1778.28	2041.74	1621.81
6:59:09 PM		1778.28	2041.74	1621.81
7:00:09 PM		3388.44	7413.10	1621.81
7:01:09 PM		2754.23	6918.31	1778.28
7:02:09 PM		1819.70	2089.30	1659.59
7:03:09 PM		2570.40	10000.00	1698.24
7:04:09 PM		2454.71	4365.16	1819.70
7:05:09 PM		1778.28	1995.26	1659.59
7:06:09 PM		1949.84	2818.38	1698.24
7:07:09 PM		1819.70	2398.83	1621.81
7:08:09 PM		1819.70	2454.71	1621.81
7:09:09 PM		1659.59	1778.28	1548.82
7:10:09 PM		1698.24	1778.28	1584.89
7:11:09 PM		1698.24	1819.70	1584.89
7:12:09 PM		1737.80	1949.84	1621.81
7:13:09 PM		1737.80	1905.46	1584.89
7:14:09 PM		1698.24	1819.70	1584.89
7:15:09 PM		1698.24	1819.70	1584.89
7:16:09 PM		1659.59	1778.28	1548.82
7:17:09 PM		1949.84	2290.87	1584.89
7:18:09 PM		1778.28	2290.87	1584.89
7:19:09 PM		1698.24	1862.09	1584.89
7:20:09 PM		1737.80	2238.72	1584.89
7:21:09 PM		1778.28	2344.23	1584.89
7:22:09 PM		1819.70	2454.71	1659.59
7:23:09 PM		1862.09	2691.53	1621.81
7:24:09 PM		1862.09	2818.38	1584.89
7:25:09 PM		1862.09	2951.21	1621.81
7:26:09 PM		2137.96	3467.37	1862.09
7:27:09 PM		2089.30	3235.94	1778.28
7:28:09 PM		1819.70	2187.76	1659.59
7:29:09 PM		1698.24	1778.28	1584.89
7:30:09 PM		1778.28	2818.38	1548.82
7:31:09 PM		1698.24	1819.70	1548.82
7:32:09 PM		1737.80	1905.46	1621.81
7:33:09 PM		1698.24	1905.46	1548.82
7:34:09 PM		5754.40	37153.52	1584.89
7:35:09 PM		9332.54	38018.94	1995.26
7:36:09 PM		2089.30	4073.80	1698.24
7:37:09 PM		1862.09	2630.27	1584.89
7:38:09 PM		1949.84	3715.35	1659.59
7:39:09 PM		1698.24	2187.76	1584.89
7:40:09 PM		1698.24	2187.76	1548.82
7:41:09 PM		1737.80	2570.40	1548.82
7:42:09 PM		2511.89	3162.28	1949.84
7:43:09 PM		1905.46	2570.40	1621.81
7:44:09 PM		1862.09	2454.71	1584.89
7:45:09 PM		1862.09	2290.87	1698.24
7:46:09 PM		1778.28	2187.76	1584.89
7:47:09 PM		1862.09	2630.27	1621.81
7:48:09 PM		1862.09	2398.83	1621.81
7:49:09 PM		2137.96	5495.41	1698.24
7:50:09 PM		2137.96	6025.60	1584.89
7:51:09 PM		1862.09	4786.30	1584.89
7:52:09 PM		1819.70	2398.83	1659.59
7:53:09 PM		2041.74	3235.94	1737.80
7:54:09 PM		2344.23	6025.60	1659.59
7:55:09 PM		2137.96	7585.78	1659.59
7:56:09 PM		1737.80	2137.96	1621.81
7:57:09 PM		1995.26	3630.78	1584.89
7:58:09 PM		1862.09	3630.78	1621.81
7:59:09 PM		1819.70	2691.53	1584.89
8:00:09 PM		1819.70	2344.23	1621.81
8:01:09 PM		1778.28	2570.40	1584.89
8:02:09 PM		1862.09	2630.27	1659.59
8:03:09 PM		2041.74	4168.69	1659.59
8:04:09 PM		1737.80	1862.09	1621.81
8:05:09 PM		1862.09	2137.96	1698.24
8:06:09 PM		1905.46	2344.23	1698.24
8:07:09 PM		1819.70	1949.84	1698.24
8:08:09 PM		1862.09	1949.84	1659.59
8:09:09 PM		1737.80	1862.09	1584.89
8:10:09 PM		1778.28	2570.40	1584.89

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	11:04:00	11:04:00		34.5	36.8	32.8
	11:05:00	11:05:00		32.6	33.6	32.1
	11:06:00	11:06:00		32.3	32.6	32.1
	11:07:00	11:07:00		32.3	33.2	31.9
	11:08:00	11:08:00		32.4	32.8	32
	11:09:00	11:09:00		32.4	32.8	32
	11:10:00	11:10:00		32.3	33	32
	11:11:00	11:11:00		33.5	36.3	32.3
	11:12:00	11:12:00		32.4	33.1	32
	11:13:00	11:13:00		34.9	38.9	32.3
	11:14:00	11:14:00		33	35.4	32.1
	11:15:00	11:15:00		32.4	32.7	32.1
	11:16:00	11:16:00		32.3	32.5	32
	11:17:00	11:17:00		32.5	34	32.1
	11:18:00	11:18:00		32.3	32.5	32
	11:19:00	11:19:00		32.3	32.6	32
	11:20:00	11:20:00		33	34.4	32
	11:21:00	11:21:00		33.4	35	32.5
	11:22:00	11:22:00		32.8	33.2	32.3
	11:23:00	11:23:00		32.8	35.4	32.1
	11:24:00	11:24:00		33.3	35	32.4
	11:25:00	11:25:00		33.8	36.1	32.4
	11:26:00	11:26:00		33.7	35.4	32.5
	11:27:00	11:27:00		32.6	33.9	32.2
	11:28:00	11:28:00		32.7	35	32
	11:29:00	11:29:00		32.5	33	32.2
	11:30:00	11:30:00		32.6	34.4	32
	11:31:00	11:31:00		32.5	33.1	32.1
	11:32:00	11:32:00		32.3	33	32
	11:33:00	11:33:00		32.4	32.8	31.9
	11:34:00	11:34:00		32.3	32.7	32
	11:35:00	11:35:00		32.4	32.7	32
	11:36:00	11:36:00		33	34.9	32
	11:37:00	11:37:00		33.5	35.4	32.3
	11:38:00	11:38:00		32.6	33.5	32.3
	11:39:00	11:39:00		32.4	32.8	32.1
	11:40:00	11:40:00		32.4	33.2	32.1
	11:41:00	11:41:00		32.4	32.7	32
	11:42:00	11:42:00		32.4	32.7	32
	11:43:00	11:43:00		32.4	32.7	32.2
	11:44:00	11:44:00		32.5	33.3	32.2
	11:45:00	11:45:00		32.3	32.6	32
	11:46:00	11:46:00		32.5	32.8	32.2
	11:47:00	11:47:00		32.5	32.8	32.2
	11:48:00	11:48:00		32.5	32.9	32.2
	11:49:00	11:49:00		32.8	33.6	32.3
	11:50:00	11:50:00		32.6	33.1	32.3
	11:51:00	11:51:00		32.5	32.7	32.1
	11:52:00	11:52:00		32.5	32.7	32.3
	11:53:00	11:53:00		32.4	32.8	32
	11:54:00	11:54:00		32.5	32.9	32.1
	11:55:00	11:55:00		32.5	33.1	32.1
	11:56:00	11:56:00		32.4	32.9	32
	11:57:00	11:57:00		32.5	36.6	32
	11:58:00	11:58:00		32.4	32.6	32.1
	11:59:00	11:59:00		32.5	32.7	32.1
	12:00:00	12:00:00		32.4	32.8	32.1
	12:01:00	12:01:00		32.5	32.8	32.2
	12:02:00	12:02:00		32.4	32.6	32.1
	12:03:00	12:03:00		32.2	32.6	31.9
	12:04:00	12:04:00		32.4	32.9	32.1
	12:05:00	12:05:00		33.6	36.2	32.2
	12:06:00	12:06:00		32.7	34.7	32.2
	12:07:00	12:07:00		32.4	33.1	32.1
	12:08:00	12:08:00		33.7	36.3	32
	12:09:00	12:09:00		33.5	35.6	32.3
	12:10:00	12:10:00		32.4	33	32.2
	12:11:00	12:11:00		32.8	33.3	32.3
	12:12:00	12:12:00		32.6	33.1	32.2
	12:13:00	12:13:00		32.5	32.8	32.1
	12:14:00	12:14:00		32.6	33.2	32.2
	12:15:00	12:15:00		32.3	32.6	32.1
	12:16:00	12:16:00		32.5	33.1	32.1
	12:17:00	12:17:00		32.8	34.1	32.1
	12:18:00	12:18:00		32.8	33.2	32.4
	12:19:00	12:19:00		32.3	32.9	31.9
	12:20:00	12:20:00		32.8	33.8	32.2
	12:21:00	12:21:00		32.6	34.1	32.3
	12:22:00	12:22:00		32.3	32.6	32
	12:23:00	12:23:00		32.3	32.7	32
	12:24:00	12:24:00		32.4	34	31.9
	12:25:00	12:25:00		32.5	33.4	32.1
	12:26:00	12:26:00		32.4	32.7	32.1

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
8:11:09 PM		2818.38	4786.30	1905.46
8:12:09 PM		1819.70	2290.87	1621.81
8:13:09 PM		1698.24	1819.70	1621.81
8:14:09 PM		1698.24	2089.30	1548.82
8:15:09 PM		1737.80	1905.46	1584.89
8:16:09 PM		1737.80	1905.46	1584.89
8:17:09 PM		1698.24	1995.26	1584.89
8:18:09 PM		2238.72	4265.80	1698.24
8:19:09 PM		1737.80	2041.74	1584.89
8:20:09 PM		3090.30	7762.47	1698.24
8:21:09 PM		1995.26	3467.37	1621.81
8:22:09 PM		1737.80	1862.09	1621.81
8:23:09 PM		1698.24	1778.28	1584.89
8:24:09 PM		1778.28	2511.89	1621.81
8:25:09 PM		1698.24	1778.28	1584.89
8:26:09 PM		1698.24	1819.70	1584.89
8:27:09 PM		1995.26	2754.23	1584.89
8:28:09 PM		2187.76	3162.28	1778.28
8:29:09 PM		1905.46	2089.30	1698.24
8:30:09 PM		1905.46	3467.37	1621.81
8:31:09 PM		2137.96	3162.28	1737.80
8:32:09 PM		2398.83	4073.80	1737.80
8:33:09 PM		2344.23	3467.37	1778.28
8:34:09 PM		1819.70	2454.71	1659.59
8:35:09 PM		1862.09	3162.28	1584.89
8:36:09 PM		1778.28	1995.26	1659.59
8:37:09 PM		1819.70	2754.23	1584.89
8:38:09 PM		1778.28	2041.74	1621.81
8:39:09 PM		1698.24	1995.26	1584.89
8:40:09 PM		1737.80	1905.46	1548.82
8:41:09 PM		1698.24	1862.09	1584.89
8:42:09 PM		1737.80	1862.09	1584.89
8:43:09 PM		1995.26	3090.30	1584.89
8:44:09 PM		2238.72	3467.37	1698.24
8:45:09 PM		1819.70	2238.72	1698.24
8:46:09 PM		1737.80	1905.46	1621.81
8:47:09 PM		1737.80	2089.30	1621.81
8:48:09 PM		1737.80	1862.09	1584.89
8:49:09 PM		1737.80	1862.09	1584.89
8:50:09 PM		1737.80	1862.09	1659.59
8:51:09 PM		1778.28	2137.96	1659.59
8:52:09 PM		1698.24	1819.70	1584.89
8:53:09 PM		1778.28	1905.46	1659.59
8:54:09 PM		1778.28	1905.46	1659.59
8:55:09 PM		1778.28	1949.84	1659.59
8:56:09 PM		1905.46	2290.87	1698.24
8:57:09 PM		1819.70	2041.74	1698.24
8:58:09 PM		1778.28	1862.09	1621.81
8:59:09 PM		1778.28	1862.09	1698.24
9:00:09 PM		1737.80	1905.46	1584.89
9:01:09 PM		1778.28	1949.84	1621.81
9:02:09 PM		1778.28	2041.74	1621.81
9:03:09 PM		1737.80	1949.84	1584.89
9:04:09 PM		1778.28	4570.88	1584.89
9:05:09 PM		1737.80	1819.70	1621.81
9:06:09 PM		1778.28	1862.09	1621.81
9:07:09 PM		1737.80	1905.46	1621.81
9:08:09 PM		1778.28	1905.46	1659.59
9:09:09 PM		1737.80	1819.70	1621.81
9:10:09 PM		1659.59	1819.70	1548.82
9:11:09 PM		1737.80	1949.84	1621.81
9:12:09 PM		2290.87	4168.69	1659.59
9:13:09 PM		1862.09	2951.21	1659.59
9:14:09 PM		1737.80	2041.74	1621.81
9:15:09 PM		2344.23	4265.80	1584.89
9:16:09 PM		2238.72	3630.78	1698.24
9:17:09 PM		1737.80	1995.26	1659.59
9:18:09 PM		1905.46	2137.96	1698.24
9:19:09 PM		1819.70	2041.74	1659.59
9:20:09 PM		1778.28	1905.46	1621.81
9:21:09 PM		1819.70	2089.30	1659.59
9:22:09 PM		1698.24	1819.70	1621.81
9:23:09 PM		1778.28	2041.74	1621.81
9:24:09 PM		1905.46	2570.40	1621.81
9:25:09 PM		1905.46	2089.30	1737.80
9:26:09 PM		1698.24	1949.84	1548.82
9:27:09 PM		1905.46	2398.83	1659.59
9:28:09 PM		1819.70	2570.40	1698.24
9:29:09 PM		1698.24	1819.70	1584.89
9:30:09 PM		1698.24	1862.09	1584.89
9:31:09 PM		1737.80	2511.89	1548.82
9:32:09 PM		1778.28	2187.76	1621.81
9:33:09 PM		1737.80	1862.09	1621.81

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	12:27:00	12:27:00		32.4	32.7	32.2
	12:28:00	12:28:00		32.4	32.7	32.1
	12:29:00	12:29:00		32.6	33.9	32.1
	12:30:00	12:30:00		32.8	33.9	32.1
	12:31:00	12:31:00		32.5	33	32.2
	12:32:00	12:32:00		32.7	33.3	32.3
	12:33:00	12:33:00		32.5	32.9	32.1
	12:34:00	12:34:00		32.5	32.8	32.2
	12:35:00	12:35:00		33.8	36.2	32.2
	12:36:00	12:36:00		34.1	36.5	32.5
	12:37:00	12:37:00		32.5	33.1	32.2
	12:38:00	12:38:00		32.6	33.1	32.2
	12:39:00	12:39:00		32.7	33.1	32.4
	12:40:00	12:40:00		32.6	32.9	32.2
	12:41:00	12:41:00		32.5	32.8	32.2
	12:42:00	12:42:00		32.6	32.9	32.2
	12:43:00	12:43:00		34.4	37.5	32.5
	12:44:00	12:44:00		33.1	35.1	32.3
	12:45:00	12:45:00		32.7	33.1	32.3
	12:46:00	12:46:00		32.9	34.4	32.3
	12:47:00	12:47:00		32.4	32.8	32
	12:48:00	12:48:00		32.3	32.6	32
	12:49:00	12:49:00		32.5	32.8	32.2
	12:50:00	12:50:00		32.5	32.9	32.1
	12:51:00	12:51:00		32.5	32.8	32.2
	12:52:00	12:52:00		32.7	33	32.4
	12:53:00	12:53:00		32.7	33.5	32.3
	12:54:00	12:54:00		32.5	32.7	32.2
	12:55:00	12:55:00		32.5	33.1	32.2
	12:56:00	12:56:00		32.6	32.9	32.2
	12:57:00	12:57:00		32.4	32.7	32.2
	12:58:00	12:58:00		32.5	32.7	32.3
	12:59:00	12:59:00		32.3	32.9	32
	13:00:00	13:00:00		32.4	32.7	32.1
	13:01:00	13:01:00		32.4	32.7	32.1
	13:02:00	13:02:00		32.6	32.8	32.3
	13:03:00	13:03:00		32.6	32.9	32.3
	13:04:00	13:04:00		32.6	32.9	32.3
	13:05:00	13:05:00		33.8	38.4	32.3
	13:06:00	13:06:00		34.5	38.8	32.6
	13:07:00	13:07:00		33.2	35.5	32.4
	13:08:00	13:08:00		33.6	35.9	32.6
	13:09:00	13:09:00		32.9	33.7	32.4
	13:10:00	13:10:00		32.6	33.2	32.3
	13:11:00	13:11:00		32.5	32.9	32.2
	13:12:00	13:12:00		32.5	32.9	32.2
	13:13:00	13:13:00		32.6	33	32.2
	13:14:00	13:14:00		32.6	32.9	32.3
	13:15:00	13:15:00		32.9	33.4	32.4
	13:16:00	13:16:00		34.3	40.1	33.2
	13:17:00	13:17:00		35.3	38.5	33.6
	13:18:00	13:18:00		35.7	40.2	33.7
	13:19:00	13:19:00		34	34.9	33.4
	13:20:00	13:20:00		34	34.8	33.5
	13:21:00	13:21:00		34.7	37	33.5
	13:22:00	13:22:00		34.1	35.7	33.1
	13:23:00	13:23:00		34.8	37.1	33.4
	13:24:00	13:24:00		35.5	37.1	34.2
	13:25:00	13:25:00		34.9	36.4	34.1
	13:26:00	13:26:00		34.9	36.3	33.8
	13:27:00	13:27:00		34.7	35.5	34
	13:28:00	13:28:00		34.9	36.1	34.1
	13:29:00	13:29:00		36	36.8	34.9
	13:30:00	13:30:00		36.1	37.8	34.6
	13:31:00	13:31:00		36.9	38.1	35.2
	13:32:00	13:32:00		34.6	36.4	34
	13:33:00	13:33:00		34.3	35.5	33.7
	13:34:00	13:34:00		34.3	35.6	33.5
	13:35:00	13:35:00		33.9	34.4	33.5
	13:36:00	13:36:00		33.7	34.1	33.3
	13:37:00	13:37:00		33.7	34.4	33.1
	13:38:00	13:38:00		33.8	34.4	33.3
	13:39:00	13:39:00		34	34.6	33.5
	13:40:00	13:40:00		34.2	34.6	33.7
	13:41:00	13:41:00		34.1	35	33.7
	13:42:00	13:42:00		34.5	35.1	34
	13:43:00	13:43:00		34.4	35.3	33.8
	13:44:00	13:44:00		34.9	36	33.8
	13:45:00	13:45:00		36.2	37.9	35.1
	13:46:00	13:46:00		36.3	37.4	35.2
	13:47:00	13:47:00		36.3	37.2	35.5
	13:48:00	13:48:00		36.9	38.1	36
	13:49:00	13:49:00		35.9	37.8	35.1

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
9:34:09 PM		1737.80	1862.09	1659.59
9:35:09 PM		1737.80	1862.09	1621.81
9:36:09 PM		1819.70	2454.71	1621.81
9:37:09 PM		1905.46	2454.71	1621.81
9:38:09 PM		1778.28	1995.26	1659.59
9:39:09 PM		1862.09	2137.96	1698.24
9:40:09 PM		1778.28	1949.84	1621.81
9:41:09 PM		1778.28	1905.46	1659.59
9:42:09 PM		2398.83	4168.69	1659.59
9:43:09 PM		2570.40	4466.84	1778.28
9:44:09 PM		1778.28	2041.74	1659.59
9:45:09 PM		1819.70	2041.74	1659.59
9:46:09 PM		1862.09	2041.74	1737.80
9:47:09 PM		1819.70	1949.84	1659.59
9:48:09 PM		1778.28	1905.46	1659.59
9:49:09 PM		1819.70	1949.84	1659.59
9:50:09 PM		2754.23	5623.41	1778.28
9:51:09 PM		2041.74	3235.94	1698.24
9:52:09 PM		1862.09	2041.74	1698.24
9:53:09 PM		1949.84	2754.23	1698.24
9:54:09 PM		1737.80	1905.46	1584.89
9:55:09 PM		1698.24	1819.70	1584.89
9:56:09 PM		1778.28	1905.46	1659.59
9:57:09 PM		1778.28	1949.84	1621.81
9:58:09 PM		1778.28	1905.46	1659.59
9:59:09 PM		1862.09	1995.26	1737.80
10:00:09 PM		1862.09	2238.72	1698.24
10:01:09 PM		1778.28	1862.09	1659.59
10:02:09 PM		1778.28	2041.74	1659.59
10:03:09 PM		1819.70	1949.84	1659.59
10:04:09 PM		1737.80	1862.09	1659.59
10:05:09 PM		1778.28	1862.09	1698.24
10:06:09 PM		1698.24	1949.84	1584.89
10:07:09 PM		1737.80	1862.09	1621.81
10:08:09 PM		1737.80	1862.09	1621.81
10:09:09 PM		1819.70	1905.46	1698.24
10:10:09 PM		1819.70	1949.84	1698.24
10:11:09 PM		1819.70	1949.84	1698.24
10:12:09 PM		2398.83	6918.31	1698.24
10:13:09 PM		2818.38	7585.78	1819.70
10:14:09 PM		2089.30	3548.13	1737.80
10:15:09 PM		2290.87	3890.45	1819.70
10:16:09 PM		1949.84	2344.23	1737.80
10:17:09 PM		1819.70	2089.30	1698.24
10:18:09 PM		1778.28	1949.84	1659.59
10:19:09 PM		1778.28	1949.84	1659.59
10:20:09 PM		1819.70	1995.26	1659.59
10:21:09 PM		1819.70	1949.84	1698.24
10:22:09 PM		1949.84	2187.76	1737.80
10:23:09 PM		2691.53	10232.93	2089.30
10:24:09 PM		3388.44	7079.46	2290.87
10:25:09 PM		3715.35	10471.29	2344.23
10:26:09 PM		2511.89	3090.30	2187.76
10:27:09 PM		2511.89	3019.95	2238.72
10:28:09 PM		2951.21	5011.87	2238.72
10:29:09 PM		2570.40	3715.35	2041.74
10:30:09 PM		3019.95	5128.61	2187.76
10:31:09 PM		3548.13	5128.61	2630.27
10:32:09 PM		3090.30	4365.16	2570.40
10:33:09 PM		3090.30	4265.80	2398.83
10:34:09 PM		2951.21	3548.13	2511.89
10:35:09 PM		3090.30	4073.80	2570.40
10:36:09 PM		3981.07	4786.30	3090.30
10:37:09 PM		4073.80	6025.60	2884.03
10:38:09 PM		4897.79	6456.54	3311.31
10:39:09 PM		2884.03	4365.16	2511.89
10:40:09 PM		2691.53	3548.13	2344.23
10:41:09 PM		2691.53	3630.78	2238.72
10:42:09 PM		2454.71	2754.23	2238.72
10:43:09 PM		2344.23	2570.40	2137.96
10:44:09 PM		2344.23	2754.23	2041.74
10:45:09 PM		2398.83	2754.23	2137.96
10:46:09 PM		2511.89	2884.03	2238.72
10:47:09 PM		2630.27	2884.03	2344.23
10:48:09 PM		2570.40	3162.28	2344.23
10:49:09 PM		2818.38	3235.94	2511.89
10:50:09 PM		2754.23	3388.44	2398.83
10:51:09 PM		3090.30	3981.07	2398.83
10:52:09 PM		4168.69	6165.95	3235.94
10:53:09 PM		4265.80	5495.41	3311.31
10:54:09 PM		4265.80	5248.07	3548.13
10:55:09 PM		4897.79	6456.54	3981.07
10:56:09 PM		3890.45	6025.60	3235.94

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	13:50:00	13:50:00		35.5	36.4	34.7
	13:51:00	13:51:00		37.7	40.5	35.6
	13:52:00	13:52:00		37.5	40.9	35.9
	13:53:00	13:53:00		36.1	36.9	35.1
	13:54:00	13:54:00		35.8	36.8	35
	13:55:00	13:55:00		36.3	37.8	34.8
	13:56:00	13:56:00		36.1	37.6	34.5
	13:57:00	13:57:00		35.6	36.5	34.9
	13:58:00	13:58:00		36.1	37.2	35
	13:59:00	13:59:00		35	37.9	33.7
	14:00:00	14:00:00		34.4	35.5	33.8
	14:01:00	14:01:00		35.9	37.3	34.7
	14:02:00	14:02:00		35.4	37.2	34
	14:03:00	14:03:00		34.6	35.5	33.9
	14:04:00	14:04:00		33.9	34.8	33.3
	14:05:00	14:05:00		34.1	34.7	33.3
	14:06:00	14:06:00		34.1	35.3	33.5
	14:07:00	14:07:00		33.9	34.4	33.3
	14:08:00	14:08:00		33.8	34.1	33.4
	14:09:00	14:09:00		33.6	34.5	33
	14:10:00	14:10:00		33.4	33.8	33
	14:11:00	14:11:00		33.5	34.1	33.1
	14:12:00	14:12:00		33.3	33.7	32.9
	14:13:00	14:13:00		33.2	33.6	32.8
	14:14:00	14:14:00		33.1	33.4	32.7
	14:15:00	14:15:00		33.1	33.6	32.7
	14:16:00	14:16:00		33.4	33.8	32.7
	14:17:00	14:17:00		33.1	33.7	32.8
	14:18:00	14:18:00		33.1	33.9	32.6
	14:19:00	14:19:00		33	33.5	32.5
	14:20:00	14:20:00		33	33.4	32.7
	14:21:00	14:21:00		33.1	33.5	32.7
	14:22:00	14:22:00		33.2	33.8	32.8
	14:23:00	14:23:00		33.1	33.4	32.7
	14:24:00	14:24:00		33.2	33.6	32.8
	14:25:00	14:25:00		33.1	33.9	32.8
	14:26:00	14:26:00		33.7	34.5	32.8
	14:27:00	14:27:00		33.2	34	32.7
	14:28:00	14:28:00		32.8	33.2	32.3
	14:29:00	14:29:00		33.3	34.1	32.6
	14:30:00	14:30:00		33.1	33.7	32.4
	14:31:00	14:31:00		32.8	33.2	32.5
	14:32:00	14:32:00		32.7	33.2	32.4
	14:33:00	14:33:00		32.8	33.3	32.5
	14:34:00	14:34:00		33.1	33.6	32.5
	14:35:00	14:35:00		33.2	33.7	32.7
	14:36:00	14:36:00		33.2	34.2	32.7
	14:37:00	14:37:00		32.9	34.2	32.5
	14:38:00	14:38:00		32.9	33.2	32.5
	14:39:00	14:39:00		33.1	33.5	32.7
	14:40:00	14:40:00		33.5	34.2	33
	14:41:00	14:41:00		33.8	34.5	33.3
	14:42:00	14:42:00		33.7	34.2	33.1
	14:43:00	14:43:00		33.3	34	33
	14:44:00	14:44:00		33.5	34.1	33
	14:45:00	14:45:00		33.2	33.5	32.7
	14:46:00	14:46:00		33.3	34	32.8
	14:47:00	14:47:00		33.9	34.5	33.4
	14:48:00	14:48:00		33.4	34	32.9
	14:49:00	14:49:00		32.9	33.2	32.5
	14:50:00	14:50:00		33	33.3	32.7
	14:51:00	14:51:00		33.3	33.8	32.9
	14:52:00	14:52:00		33.5	33.9	32.9
	14:53:00	14:53:00		33.3	33.6	32.9
	14:54:00	14:54:00		33.5	34.1	33
	14:55:00	14:55:00		33.7	34.1	33.3
	14:56:00	14:56:00		33.3	33.8	33
	14:57:00	14:57:00		33.4	33.8	33
	14:58:00	14:58:00		33.6	33.9	33
	14:59:00	14:59:00		33.5	33.9	33
	15:00:00	15:00:00		33.9	34.3	33.3
	15:01:00	15:01:00		33.7	34.2	33.3
	15:02:00	15:02:00		33.5	34.2	32.9
	15:03:00	15:03:00		33.6	34	33.2
	15:04:00	15:04:00		33.8	34.3	33.3
	15:05:00	15:05:00		33.6	34.3	33.2
	15:06:00	15:06:00		33.6	33.9	33.3
	15:07:00	15:07:00		33.5	34	33.1
	15:08:00	15:08:00		33.4	33.8	33
	15:09:00	15:09:00		33.3	33.8	32.8
	15:10:00	15:10:00		33.3	33.7	33
	15:11:00	15:11:00		33.6	34	33.1
	15:12:00	15:12:00		33.5	33.9	33.1

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
10:57:09 PM		3548.13	4365.16	2951.21
10:58:09 PM		5888.44	11220.18	3630.78
10:59:09 PM		5623.41	12302.69	3890.45
11:00:09 PM		4073.80	4897.79	3235.94
11:01:09 PM		3801.89	4786.30	3162.28
11:02:09 PM		4265.80	6025.60	3019.95
11:03:09 PM		4073.80	5754.40	2818.38
11:04:09 PM		3630.78	4466.84	3090.30
11:05:09 PM		4073.80	5248.07	3162.28
11:06:09 PM		3162.28	6165.95	2344.23
11:07:09 PM		2754.23	3548.13	2398.83
11:08:09 PM		3890.45	5370.32	2951.21
11:09:09 PM		3467.37	5248.07	2511.89
11:10:09 PM		2884.03	3548.13	2454.71
11:11:09 PM		2454.71	3019.95	2137.96
11:12:09 PM		2570.40	2951.21	2137.96
11:13:09 PM		2570.40	3388.44	2238.72
11:14:09 PM		2454.71	2754.23	2137.96
11:15:09 PM		2398.83	2570.40	2187.76
11:16:09 PM		2290.87	2818.38	1995.26
11:17:09 PM		2187.76	2398.83	1995.26
11:18:09 PM		2238.72	2570.40	2041.74
11:19:09 PM		2137.96	2344.23	1949.84
11:20:09 PM		2089.30	2290.87	1905.46
11:21:09 PM		2041.74	2187.76	1862.09
11:22:09 PM		2041.74	2290.87	1862.09
11:23:09 PM		2187.76	2398.83	1862.09
11:24:09 PM		2041.74	2344.23	1905.46
11:25:09 PM		2041.74	2454.71	1819.70
11:26:09 PM		1995.26	2238.72	1778.28
11:27:09 PM		1995.26	2187.76	1862.09
11:28:09 PM		2041.74	2238.72	1862.09
11:29:09 PM		2089.30	2398.83	1905.46
11:30:09 PM		2041.74	2187.76	1862.09
11:31:09 PM		2089.30	2290.87	1905.46
11:32:09 PM		2041.74	2454.71	1905.46
11:33:09 PM		2344.23	2818.38	1905.46
11:34:09 PM		2089.30	2511.89	1862.09
11:35:09 PM		1905.46	2089.30	1698.24
11:36:09 PM		2137.96	2570.40	1819.70
11:37:09 PM		2041.74	2344.23	1737.80
11:38:09 PM		1905.46	2089.30	1778.28
11:39:09 PM		1862.09	2089.30	1737.80
11:40:09 PM		1905.46	2137.96	1778.28
11:41:09 PM		2041.74	2290.87	1778.28
11:42:09 PM		2089.30	2344.23	1862.09
11:43:09 PM		2089.30	2630.27	1862.09
11:44:09 PM		1949.84	2630.27	1778.28
11:45:09 PM		1949.84	2089.30	1778.28
11:46:09 PM		2041.74	2238.72	1862.09
11:47:09 PM		2238.72	2630.27	1995.26
11:48:09 PM		2398.83	2818.38	2137.96
11:49:09 PM		2344.23	2630.27	2041.74
11:50:09 PM		2137.96	2511.89	1995.26
11:51:09 PM		2238.72	2570.40	1995.26
11:52:09 PM		2089.30	2238.72	1862.09
11:53:09 PM		2137.96	2511.89	1905.46
11:54:09 PM		2454.71	2818.38	2187.76
11:55:09 PM		2187.76	2511.89	1949.84
11:56:09 PM		1949.84	2089.30	1778.28
11:57:09 PM		1995.26	2137.96	1862.09
11:58:09 PM		2137.96	2398.83	1949.84
11:59:09 PM		2238.72	2454.71	1949.84
12:00:09 AM		2137.96	2290.87	1949.84
12:01:09 AM		2238.72	2570.40	1995.26
12:02:09 AM		2344.23	2570.40	2137.96
12:03:09 AM		2137.96	2398.83	1995.26
12:04:09 AM		2187.76	2398.83	1995.26
12:05:09 AM		2290.87	2454.71	1995.26
12:06:09 AM		2238.72	2454.71	1995.26
12:07:09 AM		2454.71	2691.53	2137.96
12:08:09 AM		2344.23	2630.27	2137.96
12:09:09 AM		2238.72	2630.27	1949.84
12:10:09 AM		2290.87	2511.89	2089.30
12:11:09 AM		2398.83	2691.53	2137.96
12:12:09 AM		2290.87	2691.53	2089.30
12:13:09 AM		2290.87	2454.71	2137.96
12:14:09 AM		2238.72	2511.89	2041.74
12:15:09 AM		2187.76	2398.83	1995.26
12:16:09 AM		2137.96	2398.83	1905.46
12:17:09 AM		2137.96	2344.23	1995.26
12:18:09 AM		2290.87	2511.89	2041.74
12:19:09 AM		2238.72	2454.71	2041.74

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	15:13:00	15:13:00		33.6	34.1	33.1
	15:14:00	15:14:00		33.6	35.4	33.1
	15:15:00	15:15:00		33.4	33.8	32.9
	15:16:00	15:16:00		33.3	33.8	33
	15:17:00	15:17:00		33.4	33.7	32.9
	15:18:00	15:18:00		33.4	33.7	33
	15:19:00	15:19:00		33.5	34.1	33.1
	15:20:00	15:20:00		33.8	34.3	33.3
	15:21:00	15:21:00		33.6	34.1	33.2
	15:22:00	15:22:00		33.4	33.9	33
	15:23:00	15:23:00		33.4	33.9	33
	15:24:00	15:24:00		33.5	33.8	33
	15:25:00	15:25:00		33.5	34	32.9
	15:26:00	15:26:00		33.6	34	33.2
	15:27:00	15:27:00		33.8	34.1	33.4
	15:28:00	15:28:00		33.8	34.3	33.3
	15:29:00	15:29:00		34.1	34.5	33.8
	15:30:00	15:30:00		34.2	34.6	33.7
	15:31:00	15:31:00		34.2	35.2	33.6
	15:32:00	15:32:00		33.7	34.2	33.3
	15:33:00	15:33:00		33.8	34.2	33.4
	15:34:00	15:34:00		33.5	33.9	33.1
	15:35:00	15:35:00		33.7	34	33.2
	15:36:00	15:36:00		33.7	34.3	33.1
	15:37:00	15:37:00		34	34.8	33.4
	15:38:00	15:38:00		34.1	35.3	33.2
	15:39:00	15:39:00		34.2	35.3	33.2
	15:40:00	15:40:00		34.3	35.9	33.4
	15:41:00	15:41:00		33.5	34.2	32.9
	15:42:00	15:42:00		34	34.9	32.9
	15:43:00	15:43:00		33.9	34.9	33.1
	15:44:00	15:44:00		34.2	34.7	33.6
	15:45:00	15:45:00		34	36.8	33.5
	15:46:00	15:46:00		35.5	37.1	34.2
	15:47:00	15:47:00		35	36.7	33.3
	15:48:00	15:48:00		34.4	36.5	33.3
	15:49:00	15:49:00		34.1	35.1	33.3
	15:50:00	15:50:00		34.5	35.8	33.3
	15:51:00	15:51:00		34.3	36.9	33.2
	15:52:00	15:52:00		33.7	35.1	32.8
	15:53:00	15:53:00		33.6	34.7	33
	15:54:00	15:54:00		34.3	39.4	32.8
	15:55:00	15:55:00		35.5	40.9	33.2
	15:56:00	15:56:00		35.4	39.6	33
	15:57:00	15:57:00		38	45.6	33.4
	15:58:00	15:58:00		35.6	40	33.1
	15:59:00	15:59:00		34.7	38.8	33
	16:00:00	16:00:00		36.8	45	33.4
	16:01:00	16:01:00		38.4	44.3	34.4
	16:02:00	16:02:00		37.6	41.9	33.5
	16:03:00	16:03:00		37.9	46.1	33.9
	16:04:00	16:04:00		37.9	47.5	33.1
	16:05:00	16:05:00		37.8	44.3	32.7
	16:06:00	16:06:00		34	39.8	32.6
	16:07:00	16:07:00		34.1	38	32.7
	16:08:00	16:08:00		37.1	43.3	32.8
	16:09:00	16:09:00		35.8	42.4	33.3
	16:10:00	16:10:00		35.3	38.9	33.5
	16:11:00	16:11:00		34.2	37.9	33.2
	16:12:00	16:12:00		36.3	43.5	33.2
	16:13:00	16:13:00		34.1	38.3	33
	16:14:00	16:14:00		36.2	45.4	33.1
	16:15:00	16:15:00		35.4	41.1	33
	16:16:00	16:16:00		35	38	32.9
	16:17:00	16:17:00		35	39.6	33.1
	16:18:00	16:18:00		34	37.3	33
	16:19:00	16:19:00		34.8	38.6	32.9
	16:20:00	16:20:00		34.9	40.1	33.2
	16:21:00	16:21:00		34.8	38.5	33.2
	16:22:00	16:22:00		33.8	35.5	33.1
	16:23:00	16:23:00		33.7	36.2	32.8
	16:24:00	16:24:00		34.2	38	33
	16:25:00	16:25:00		34.4	36.7	33.1
	16:26:00	16:26:00		33.5	34.7	32.7
	16:27:00	16:27:00		34.3	36.3	33.5
	16:28:00	16:28:00		34.3	35.8	33.2
	16:29:00	16:29:00		36.7	45.9	33.5
	16:30:00	16:30:00		34.1	38.1	33.2
	16:31:00	16:31:00		33.9	34.9	33.1
	16:32:00	16:32:00		34.4	38.9	33.1
	16:33:00	16:33:00		35.5	43.2	33.1
	16:34:00	16:34:00		37.5	45.7	33.1
	16:35:00	16:35:00		35	39.4	33.1

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
12:20:09 AM		2290.87	2570.40	2041.74
12:21:09 AM		2290.87	3467.37	2041.74
12:22:09 AM		2187.76	2398.83	1949.84
12:23:09 AM		2137.96	2398.83	1995.26
12:24:09 AM		2187.76	2344.23	1949.84
12:25:09 AM		2187.76	2344.23	1995.26
12:26:09 AM		2238.72	2570.40	2041.74
12:27:09 AM		2398.83	2691.53	2137.96
12:28:09 AM		2290.87	2570.40	2089.30
12:29:09 AM		2187.76	2454.71	1995.26
12:30:09 AM		2187.76	2454.71	1995.26
12:31:09 AM		2238.72	2398.83	1995.26
12:32:09 AM		2238.72	2511.89	1949.84
12:33:09 AM		2290.87	2511.89	2089.30
12:34:09 AM		2398.83	2570.40	2187.76
12:35:09 AM		2398.83	2691.53	2137.96
12:36:09 AM		2570.40	2818.38	2398.83
12:37:09 AM		2630.27	2884.03	2344.23
12:38:09 AM		2630.27	3311.31	2290.87
12:39:09 AM		2344.23	2630.27	2137.96
12:40:09 AM		2398.83	2630.27	2187.76
12:41:09 AM		2238.72	2454.71	2041.74
12:42:09 AM		2344.23	2511.89	2089.30
12:43:09 AM		2344.23	2691.53	2041.74
12:44:09 AM		2511.89	3019.95	2187.76
12:45:09 AM		2570.40	3388.44	2089.30
12:46:09 AM		2630.27	3388.44	2089.30
12:47:09 AM		2691.53	3890.45	2187.76
12:48:09 AM		2238.72	2630.27	1949.84
12:49:09 AM		2511.89	3090.30	1949.84
12:50:09 AM		2454.71	3090.30	2041.74
12:51:09 AM		2630.27	2951.21	2290.87
12:52:09 AM		2511.89	4786.30	2238.72
12:53:09 AM		3548.13	5128.61	2630.27
12:54:09 AM		3162.28	4677.35	2137.96
12:55:09 AM		2754.23	4466.84	2137.96
12:56:09 AM		2570.40	3235.94	2137.96
12:57:09 AM		2818.38	3801.89	2137.96
12:58:09 AM		2691.53	4897.79	2089.30
12:59:09 AM		2344.23	3235.94	1905.46
1:00:09 AM		2290.87	2951.21	1995.26
1:01:09 AM		2691.53	8709.64	1905.46
1:02:09 AM		3548.13	12302.69	2089.30
1:03:09 AM		3467.37	9120.11	1995.26
1:04:09 AM		6309.57	36307.81	2187.76
1:05:09 AM		3630.78	10000.00	2041.74
1:06:09 AM		2951.21	7585.78	1995.26
1:07:09 AM		4786.30	31622.78	2187.76
1:08:09 AM		6918.31	26915.35	2754.23
1:09:09 AM		5754.40	15488.17	2238.72
1:10:09 AM		6165.95	40738.03	2454.71
1:11:09 AM		6165.95	56234.13	2041.74
1:12:09 AM		6025.60	26915.35	1862.09
1:13:09 AM		2511.89	9549.93	1819.70
1:14:09 AM		2570.40	6309.57	1862.09
1:15:09 AM		5128.61	21379.62	1905.46
1:16:09 AM		3801.89	17378.01	2137.96
1:17:09 AM		3388.44	7762.47	2238.72
1:18:09 AM		2630.27	6165.95	2089.30
1:19:09 AM		4265.80	22387.21	2089.30
1:20:09 AM		2570.40	6760.83	1995.26
1:21:09 AM		4168.69	34673.69	2041.74
1:22:09 AM		3467.37	12882.50	1995.26
1:23:09 AM		3162.28	6309.57	1949.84
1:24:09 AM		3162.28	9120.11	2041.74
1:25:09 AM		2511.89	5370.32	1995.26
1:26:09 AM		3019.95	7244.36	1949.84
1:27:09 AM		3090.30	10232.93	2089.30
1:28:09 AM		3019.95	7079.46	2089.30
1:29:09 AM		2398.83	3548.13	2041.74
1:30:09 AM		2344.23	4168.69	1905.46
1:31:09 AM		2630.27	6309.57	1995.26
1:32:09 AM		2754.23	4677.35	2041.74
1:33:09 AM		2238.72	2951.21	1862.09
1:34:09 AM		2691.53	4265.80	2238.72
1:35:09 AM		2691.53	3801.89	2089.30
1:36:09 AM		4677.35	38904.51	2238.72
1:37:09 AM		2570.40	6456.54	2089.30
1:38:09 AM		2454.71	3090.30	2041.74
1:39:09 AM		2754.23	7762.47	2041.74
1:40:09 AM		3548.13	20892.96	2041.74
1:41:09 AM		5623.41	37153.52	2041.74
1:42:09 AM		3162.28	8709.64	2041.74

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	16:36:00	16:36:00		35.7	40.4	33
	16:37:00	16:37:00		35.6	41.4	32.8
	16:38:00	16:38:00		34.8	39	33.1
	16:39:00	16:39:00		35.4	40.2	33.2
	16:40:00	16:40:00		37	45.2	33.2
	16:41:00	16:41:00		34.3	37.6	33
	16:42:00	16:42:00		33.8	35.6	32.8
	16:43:00	16:43:00		35.1	39.3	33.1
	16:44:00	16:44:00		35.2	39.6	33.2
	16:45:00	16:45:00		35.4	41.5	33.1
	16:46:00	16:46:00		37.5	42.6	33.5
	16:47:00	16:47:00		34.4	38.4	33
	16:48:00	16:48:00		38.6	45.6	33.2
	16:49:00	16:49:00		34.2	37.4	32.9
	16:50:00	16:50:00		37.5	43.3	33.7
	16:51:00	16:51:00		34.4	39	33.1
	16:52:00	16:52:00		34.4	38.2	33.4
	16:53:00	16:53:00		36.6	42.7	33.5
	16:54:00	16:54:00		37	43.4	33.3
	16:55:00	16:55:00		34.7	38.1	33.2
	16:56:00	16:56:00		36.4	42.4	33.6
	16:57:00	16:57:00		37.6	45.7	33
	16:58:00	16:58:00		35.4	41.5	33
	16:59:00	16:59:00		36.8	44.3	33.1
	17:00:00	17:00:00		37.1	44.7	33.4
	17:01:00	17:01:00		36.6	42.4	33.1
	17:02:00	17:02:00		38.3	42.9	33.3
	17:03:00	17:03:00		39.9	46.2	34
	17:04:00	17:04:00		35.5	40.8	33.2
	17:05:00	17:05:00		37.5	46.8	33
	17:06:00	17:06:00		36.9	44.3	33.2
	17:07:00	17:07:00		35.5	40.7	32.9
	17:08:00	17:08:00		35.7	41.8	32.8
	17:09:00	17:09:00		34.1	36.6	33.3
	17:10:00	17:10:00		35.1	41.3	33.3
	17:11:00	17:11:00		35.1	41.5	33.4
	17:12:00	17:12:00		35	38.1	33.4
	17:13:00	17:13:00		34.5	40	33.3
	17:14:00	17:14:00		37.5	45.5	33.4
	17:15:00	17:15:00		36.4	42.4	33.5
	17:16:00	17:16:00		37.8	46.4	33.4
	17:17:00	17:17:00		41.4	48.1	34.2
	17:18:00	17:18:00		37.1	43.8	33.1
	17:19:00	17:19:00		36	41.4	33.4
	17:20:00	17:20:00		37.4	43.2	33.6
	17:21:00	17:21:00		37.3	43.4	33.6
	17:22:00	17:22:00		34.3	36.5	32.9
	17:23:00	17:23:00		39.7	44.6	34.2
	17:24:00	17:24:00		35.8	41.9	33.2
	17:25:00	17:25:00		35.7	41.5	33
	17:26:00	17:26:00		35.6	42.4	33
	17:27:00	17:27:00		35.5	41.9	33
	17:28:00	17:28:00		33.9	35.5	33.1
	17:29:00	17:29:00		34	36.2	32.9
	17:30:00	17:30:00		33.8	35.4	32.9
	17:31:00	17:31:00		33.5	34.5	32.8
	17:32:00	17:32:00		33.6	34.7	32.9
	17:33:00	17:33:00		33.7	35	32.8
	17:34:00	17:34:00		33.7	35.5	32.9
	17:35:00	17:35:00		33.8	35	33.1
	17:36:00	17:36:00		34.2	35.8	33.2
	17:37:00	17:37:00		34.4	36.6	33.2
	17:38:00	17:38:00		34.4	36.7	33.1
	17:39:00	17:39:00		34.9	39.8	33.4
	17:40:00	17:40:00		36.2	40.3	33.6
	17:41:00	17:41:00		36.5	41.8	33.5
	17:42:00	17:42:00		35.7	40.8	33.5
	17:43:00	17:43:00		35	40.9	33.2
	17:44:00	17:44:00		35.4	40	33.6
	17:45:00	17:45:00		37.4	43.7	33.4
	17:46:00	17:46:00		35.1	40.1	33.2
	17:47:00	17:47:00		37.6	43.5	33.6
	17:48:00	17:48:00		37.1	42.8	33.2
	17:49:00	17:49:00		36.3	43.2	33.6
	17:50:00	17:50:00		35.9	39.5	33.1
	17:51:00	17:51:00		34.9	40.7	32.8
	17:52:00	17:52:00		35.5	40.5	32.8
	17:53:00	17:53:00		35.9	42	33
	17:54:00	17:54:00		35.7	42.4	33.1
	17:55:00	17:55:00		33.6	35	32.9
	17:56:00	17:56:00		34.8	38.9	33.2
	17:57:00	17:57:00		33.6	34.5	33
	17:58:00	17:58:00		34.3	38.3	32.9

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
1:43:09 AM		3715.35	10964.78	1995.26
1:44:09 AM		3630.78	13803.84	1905.46
1:45:09 AM		3019.95	7943.28	2041.74
1:46:09 AM		3467.37	10471.29	2089.30
1:47:09 AM		5011.87	33113.11	2089.30
1:48:09 AM		2691.53	5754.40	1995.26
1:49:09 AM		2398.83	3630.78	1905.46
1:50:09 AM		3235.94	8511.38	2041.74
1:51:09 AM		3311.31	9120.11	2089.30
1:52:09 AM		3467.37	14125.38	2041.74
1:53:09 AM		5623.41	18197.01	2238.72
1:54:09 AM		2754.23	6918.31	1995.26
1:55:09 AM		7244.36	36307.81	2089.30
1:56:09 AM		2630.27	5495.41	1949.84
1:57:09 AM		5623.41	21379.62	2344.23
1:58:09 AM		2754.23	7943.28	2041.74
1:59:09 AM		2754.23	6606.93	2187.76
2:00:09 AM		4570.88	18620.87	2238.72
2:01:09 AM		5011.87	21877.62	2137.96
2:02:09 AM		2951.21	6456.54	2089.30
2:03:09 AM		4365.16	17378.01	2290.87
2:04:09 AM		5754.40	37153.52	1995.26
2:05:09 AM		3467.37	14125.38	1995.26
2:06:09 AM		4786.30	26915.35	2041.74
2:07:09 AM		5128.61	29512.09	2187.76
2:08:09 AM		4570.88	17378.01	2041.74
2:09:09 AM		6760.83	19498.45	2137.96
2:10:09 AM		9772.37	41686.94	2511.89
2:11:09 AM		3548.13	12022.64	2089.30
2:12:09 AM		5623.41	47863.01	1995.26
2:13:09 AM		4897.79	26915.35	2089.30
2:14:09 AM		3548.13	11748.98	1949.84
2:15:09 AM		3715.35	15135.61	1905.46
2:16:09 AM		2570.40	4570.88	2137.96
2:17:09 AM		3235.94	13489.63	2137.96
2:18:09 AM		3235.94	14125.38	2187.76
2:19:09 AM		3162.28	6456.54	2187.76
2:20:09 AM		2818.38	10000.00	2137.96
2:21:09 AM		5623.41	35481.34	2187.76
2:22:09 AM		4365.16	17378.01	2238.72
2:23:09 AM		6025.60	43651.58	2187.76
2:24:09 AM		13803.84	64565.42	2630.27
2:25:09 AM		5128.61	23988.33	2041.74
2:26:09 AM		3981.07	13803.84	2187.76
2:27:09 AM		5495.41	20892.96	2290.87
2:28:09 AM		5370.32	21877.62	2290.87
2:29:09 AM		2691.53	4466.84	1949.84
2:30:09 AM		9332.54	28840.32	2630.27
2:31:09 AM		3801.89	15488.17	2089.30
2:32:09 AM		3715.35	14125.38	1995.26
2:33:09 AM		3630.78	17378.01	1995.26
2:34:09 AM		3548.13	15488.17	1995.26
2:35:09 AM		2454.71	3548.13	2041.74
2:36:09 AM		2511.89	4168.69	1949.84
2:37:09 AM		2398.83	3467.37	1949.84
2:38:09 AM		2238.72	2818.38	1905.46
2:39:09 AM		2290.87	2951.21	1949.84
2:40:09 AM		2344.23	3162.28	1905.46
2:41:09 AM		2344.23	3548.13	1949.84
2:42:09 AM		2398.83	3162.28	2041.74
2:43:09 AM		2630.27	3801.89	2089.30
2:44:09 AM		2754.23	4570.88	2089.30
2:45:09 AM		2754.23	4677.35	2041.74
2:46:09 AM		3090.30	9549.93	2187.76
2:47:09 AM		4168.69	10715.19	2290.87
2:48:09 AM		4466.84	15135.61	2238.72
2:49:09 AM		3715.35	12022.64	2238.72
2:50:09 AM		3162.28	12302.69	2089.30
2:51:09 AM		3467.37	10000.00	2290.87
2:52:09 AM		5495.41	23442.29	2187.76
2:53:09 AM		3235.94	10232.93	2089.30
2:54:09 AM		5754.40	22387.21	2290.87
2:55:09 AM		5128.61	19054.61	2089.30
2:56:09 AM		4265.80	20892.96	2290.87
2:57:09 AM		3890.45	8912.51	2041.74
2:58:09 AM		3090.30	11748.98	1905.46
2:59:09 AM		3548.13	11220.18	1905.46
3:00:09 AM		3890.45	15848.93	1995.26
3:01:09 AM		3715.35	17378.01	2041.74
3:02:09 AM		2290.87	3162.28	1949.84
3:03:09 AM		3019.95	7762.47	2089.30
3:04:09 AM		2290.87	2818.38	1995.26
3:05:09 AM		2691.53	6760.83	1949.84

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	17:59:00	17:59:00		33.7	35.7	32.9
	18:00:00	18:00:00		36.1	44.5	33.4
	18:01:00	18:01:00		35.5	41.7	33.2
	18:02:00	18:02:00		34.6	37.8	33.3
	18:03:00	18:03:00		35.6	43.1	33.1
	18:04:00	18:04:00		34.5	38.3	33
	18:05:00	18:05:00		34.8	39.9	32.9
	18:06:00	18:06:00		34.7	39.4	32.9
	18:07:00	18:07:00		33.7	34.9	33
	18:08:00	18:08:00		36.8	42	33.2
	18:09:00	18:09:00		34.7	38.6	33
	18:10:00	18:10:00		35.2	41.1	32.9
	18:11:00	18:11:00		35.9	43	33.3
	18:12:00	18:12:00		35.9	41.6	33.2
	18:13:00	18:13:00		35.6	41.1	33.2
	18:14:00	18:14:00		34.3	39.2	33
	18:15:00	18:15:00		35	39.2	33.1
	18:16:00	18:16:00		37.5	44.8	33.6
	18:17:00	18:17:00		34.3	38	33.1
	18:18:00	18:18:00		34.4	36.5	33.4
	18:19:00	18:19:00		34.4	37	33.2
	18:20:00	18:20:00		34.7	38.4	32.9
	18:21:00	18:21:00		33.6	34.9	32.8
	18:22:00	18:22:00		33.7	36.6	32.9
	18:23:00	18:23:00		33.7	34.9	33
	18:24:00	18:24:00		33.3	34.4	32.7
	18:25:00	18:25:00		33.9	35.8	32.8
	18:26:00	18:26:00		35.5	42.6	33.6
	18:27:00	18:27:00		35.9	44.5	33.2
	18:28:00	18:28:00		34.7	38.7	33.1
	18:29:00	18:29:00		34.6	38.8	33.1
	18:30:00	18:30:00		36.4	41.7	34.2
	18:31:00	18:31:00		38.5	46.7	33.6
	18:32:00	18:32:00		35.6	39.3	33.3
	18:33:00	18:33:00		35.8	43.5	33.1
	18:34:00	18:34:00		37	45.2	33.2
	18:35:00	18:35:00		36.5	41.3	33.1
	18:36:00	18:36:00		35.4	41.7	33
	18:37:00	18:37:00		35.6	40.6	33.3
	18:38:00	18:38:00		34.3	38.3	32.9
	18:39:00	18:39:00		35.4	38.5	33.5
	18:40:00	18:40:00		35.3	40.2	33.3
	18:41:00	18:41:00		34.2	38	33
	18:42:00	18:42:00		35.8	40.3	33.2
	18:43:00	18:43:00		34.8	37.8	33.3
	18:44:00	18:44:00		38.1	45.6	33.2
	18:45:00	18:45:00		36.3	40.5	33.4
	18:46:00	18:46:00		35.9	40.6	33.5
	18:47:00	18:47:00		37.8	47.8	33.3
	18:48:00	18:48:00		35.9	40.4	33.4
	18:49:00	18:49:00		36	41.8	33.9
	18:50:00	18:50:00		37	44.3	33.3
	18:51:00	18:51:00		38.3	44.1	33.6
	18:52:00	18:52:00		37.8	41.6	34.3
	18:53:00	18:53:00		37.6	42.2	33
	18:54:00	18:54:00		34.4	39.5	33
	18:55:00	18:55:00		34.5	37.2	33.2
	18:56:00	18:56:00		35.3	39.6	33.3
	18:57:00	18:57:00		34.3	36.6	32.9
	18:58:00	18:58:00		33.6	34.9	33
	18:59:00	18:59:00		35.2	40.5	33.2
	19:00:00	19:00:00		34.1	38.5	33.1
	19:01:00	19:01:00		34.7	40.5	32.9
	19:02:00	19:02:00		35.6	40.9	33.1
	19:03:00	19:03:00		35.2	39.8	33.2
	19:04:00	19:04:00		34.6	36.9	33.1
	19:05:00	19:05:00		33.7	36.3	33
	19:06:00	19:06:00		34.4	38.8	33
	19:07:00	19:07:00		33.8	34.6	33.1
	19:08:00	19:08:00		34.2	37.5	33.2
	19:09:00	19:09:00		34.1	35.2	33
	19:10:00	19:10:00		33.9	36.5	33
	19:11:00	19:11:00		34.7	38.1	33.2
	19:12:00	19:12:00		34.6	39.5	33.3
	19:13:00	19:13:00		35	38.7	33.2
	19:14:00	19:14:00		36.1	39.4	33.4
	19:15:00	19:15:00		37.7	41.8	33.6
	19:16:00	19:16:00		36.1	40.6	33
	19:17:00	19:17:00		34.7	38	33.1
	19:18:00	19:18:00		36.8	41.5	34.3
	19:19:00	19:19:00		35.7	41.5	33.6
	19:20:00	19:20:00		35.7	38.6	34.1
	19:21:00	19:21:00		36.9	43.7	33.9

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
3:06:09 AM		2344.23	3715.35	1949.84
3:07:09 AM		4073.80	28183.83	2187.76
3:08:09 AM		3548.13	14791.08	2089.30
3:09:09 AM		2884.03	6025.60	2137.96
3:10:09 AM		3630.78	20417.38	2041.74
3:11:09 AM		2818.38	6760.83	1995.26
3:12:09 AM		3019.95	9772.37	1949.84
3:13:09 AM		2951.21	8709.64	1949.84
3:14:09 AM		2344.23	3090.30	1995.26
3:15:09 AM		4786.30	15848.93	2089.30
3:16:09 AM		2951.21	7244.36	1995.26
3:17:09 AM		3311.31	12882.50	1949.84
3:18:09 AM		3890.45	19952.62	2137.96
3:19:09 AM		3890.45	14454.40	2089.30
3:20:09 AM		3630.78	12882.50	2089.30
3:21:09 AM		2691.53	8317.64	1995.26
3:22:09 AM		3162.28	8317.64	2041.74
3:23:09 AM		5623.41	30199.52	2290.87
3:24:09 AM		2691.53	6309.57	2041.74
3:25:09 AM		2754.23	4466.84	2187.76
3:26:09 AM		2754.23	5011.87	2089.30
3:27:09 AM		2951.21	6918.31	1949.84
3:28:09 AM		2290.87	3090.30	1905.46
3:29:09 AM		2344.23	4570.88	1949.84
3:30:09 AM		2344.23	3090.30	1995.26
3:31:09 AM		2137.96	2754.23	1862.09
3:32:09 AM		2454.71	3801.89	1905.46
3:33:09 AM		3548.13	18197.01	2290.87
3:34:09 AM		3890.45	28183.83	2089.30
3:35:09 AM		2951.21	7413.10	2041.74
3:36:09 AM		2884.03	7585.78	2041.74
3:37:09 AM		4365.16	14791.08	2630.27
3:38:09 AM		7079.46	46773.51	2290.87
3:39:09 AM		3630.78	8511.38	2137.96
3:40:09 AM		3801.89	22387.21	2041.74
3:41:09 AM		5011.87	33113.11	2089.30
3:42:09 AM		4466.84	13489.63	2041.74
3:43:09 AM		3467.37	14791.08	1995.26
3:44:09 AM		3630.78	11481.54	2137.96
3:45:09 AM		2691.53	6760.83	1949.84
3:46:09 AM		3467.37	7079.46	2238.72
3:47:09 AM		3388.44	10471.29	2137.96
3:48:09 AM		2630.27	6309.57	1995.26
3:49:09 AM		3801.89	10715.19	2089.30
3:50:09 AM		3019.95	6025.60	2137.96
3:51:09 AM		6456.54	36307.81	2089.30
3:52:09 AM		4265.80	11220.18	2187.76
3:53:09 AM		3890.45	11481.54	2238.72
3:54:09 AM		6025.60	60255.96	2137.96
3:55:09 AM		3890.45	10964.78	2187.76
3:56:09 AM		3981.07	15135.61	2454.71
3:57:09 AM		5011.87	26915.35	2137.96
3:58:09 AM		6760.83	25703.96	2290.87
3:59:09 AM		6025.60	14454.40	2691.53
4:00:09 AM		5754.40	16595.87	1995.26
4:01:09 AM		2754.23	8912.51	1995.26
4:02:09 AM		2818.38	5248.07	2089.30
4:03:09 AM		3388.44	9120.11	2137.96
4:04:09 AM		2691.53	4570.88	1949.84
4:05:09 AM		2290.87	3090.30	1995.26
4:06:09 AM		3311.31	11220.18	2089.30
4:07:09 AM		2570.40	7079.46	2041.74
4:08:09 AM		2951.21	11220.18	1949.84
4:09:09 AM		3630.78	12302.69	2041.74
4:10:09 AM		3311.31	9549.93	2089.30
4:11:09 AM		2884.03	4897.79	2041.74
4:12:09 AM		2344.23	4265.80	1995.26
4:13:09 AM		2754.23	7585.78	1995.26
4:14:09 AM		2398.83	2884.03	2041.74
4:15:09 AM		2630.27	5623.41	2089.30
4:16:09 AM		2570.40	3311.31	1995.26
4:17:09 AM		2454.71	4466.84	1995.26
4:18:09 AM		2951.21	6456.54	2089.30
4:19:09 AM		2884.03	8912.51	2137.96
4:20:09 AM		3162.28	7413.10	2089.30
4:21:09 AM		4073.80	8709.64	2187.76
4:22:09 AM		5888.44	15135.61	2290.87
4:23:09 AM		4073.80	11481.54	1995.26
4:24:09 AM		2951.21	6309.57	2041.74
4:25:09 AM		4786.30	14125.38	2691.53
4:26:09 AM		3715.35	14125.38	2290.87
4:27:09 AM		3715.35	7244.36	2570.40
4:28:09 AM		4897.79	23442.29	2454.71

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	19:22:00	19:22:00		39.3	44.4	34.4
	19:23:00	19:23:00		39.2	45.6	34
	19:24:00	19:24:00		34.6	36	33.8
	19:25:00	19:25:00		37.3	44.2	34
	19:26:00	19:26:00		35.9	39.2	34.2
	19:27:00	19:27:00		37.2	42.4	34.3
	19:28:00	19:28:00		37.9	41.6	35
	19:29:00	19:29:00		36.2	40.3	34.1
	19:30:00	19:30:00		36.3	39.1	34.8
	19:31:00	19:31:00		36.4	42.5	34.5
	19:32:00	19:32:00		37.1	41.6	34.5
	19:33:00	19:33:00		35.9	39.6	34.3
	19:34:00	19:34:00		40.3	44.2	34.9
	19:35:00	19:35:00		38.7	48	34
	19:36:00	19:36:00		34.7	37.1	33.4
	19:37:00	19:37:00		34.7	38.8	33.5
	19:38:00	19:38:00		34.6	37.3	33.6
	19:39:00	19:39:00		34.6	36.2	33.7
	19:40:00	19:40:00		35.5	39.8	33.7
	19:41:00	19:41:00		49.2	64.1	34.4
	19:42:00	19:42:00		48.8	63.9	34.6
	19:43:00	19:43:00		36.6	39.1	34.9
	19:44:00	19:44:00		35.9	39.3	34.4
	19:45:00	19:45:00		35.9	38.7	34.3
	19:46:00	19:46:00		35.9	41.4	34.7
	19:47:00	19:47:00		37.5	42.9	34.8
	19:48:00	19:48:00		38.6	43.1	35.1
	19:49:00	19:49:00		37.7	42	35.3
	19:50:00	19:50:00		38.1	43.2	34.9
	19:51:00	19:51:00		37.6	43.3	34.7
	19:52:00	19:52:00		36.2	39.6	34.5
	19:53:00	19:53:00		35.3	39.1	34.2
	19:54:00	19:54:00		35.1	36.5	34
	19:55:00	19:55:00		35.7	38.1	34.6
	19:56:00	19:56:00		37.7	44.1	34.6
	19:57:00	19:57:00		35.9	37.6	34.7
	19:58:00	19:58:00		36.2	39.5	34.1
	19:59:00	19:59:00		35.7	39.4	34.4
	20:00:00	20:00:00		37.5	39.5	35.2
	20:01:00	20:01:00		36.5	41.3	34.2
	20:02:00	20:02:00		36.4	39.9	34.5
	20:03:00	20:03:00		43.9	52.5	36.9
	20:04:00	20:04:00		38.9	43.7	35.7
	20:05:00	20:05:00		59	67.5	36
	20:06:00	20:06:00		39.7	49.5	34.6
	20:07:00	20:07:00		36.8	44.3	34.2
	20:08:00	20:08:00		43.8	53.1	35.2
	20:09:00	20:09:00		47.2	57.7	36.2
	20:10:00	20:10:00		38.9	44.1	34.7
	20:11:00	20:11:00		37.5	44	34.4
	20:12:00	20:12:00		35.9	40.6	34.3
	20:13:00	20:13:00		36.8	40.9	34.1
	20:14:00	20:14:00		36.2	39.5	34.4
	20:15:00	20:15:00		36.2	38.7	34.6
	20:16:00	20:16:00		40.1	45.6	35.2
	20:17:00	20:17:00		37.4	41.2	35.4
	20:18:00	20:18:00		36.5	39	35.3
	20:19:00	20:19:00		38.4	48	35.4
	20:20:00	20:20:00		38.2	41.5	35.8
	20:21:00	20:21:00		37.1	42.6	34.3
	20:22:00	20:22:00		36.2	41.4	34
	20:23:00	20:23:00		35.4	38.1	34
	20:24:00	20:24:00		35.1	36.9	34.2
	20:25:00	20:25:00		39.8	46.2	35.2
	20:26:00	20:26:00		61.8	71.6	39.4
	20:27:00	20:27:00		37	41.5	34.4
	20:28:00	20:28:00		37.6	45	34
	20:29:00	20:29:00		37.5	43.8	34.1
	20:30:00	20:30:00		39	45.1	34.8
	20:31:00	20:31:00		39.9	43.7	36.2
	20:32:00	20:32:00		38.5	42.6	35.5
	20:33:00	20:33:00		38.1	44.1	34.3
	20:34:00	20:34:00		36.8	41.4	34.4
	20:35:00	20:35:00		39.3	47.1	34.9
	20:36:00	20:36:00		36.1	39.1	34
	20:37:00	20:37:00		40.9	45.3	37.8
	20:38:00	20:38:00		38.9	48.2	34.8
	20:39:00	20:39:00		36.4	43.1	34.2
	20:40:00	20:40:00		37.7	42.6	34.2
	20:41:00	20:41:00		37	42.2	34
	20:42:00	20:42:00		38.4	45.2	34.4
	20:43:00	20:43:00		37.3	43.3	34.4
	20:44:00	20:44:00		42.1	48.7	34.7

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
4:29:09 AM		8511.38	27542.29	2754.23
4:30:09 AM		8317.64	36307.81	2511.89
4:31:09 AM		2884.03	3981.07	2398.83
4:32:09 AM		5370.32	26302.68	2511.89
4:33:09 AM		3890.45	8317.64	2630.27
4:34:09 AM		5248.07	17378.01	2691.53
4:35:09 AM		6165.95	14454.40	3162.28
4:36:09 AM		4168.69	10715.19	2570.40
4:37:09 AM		4265.80	8128.31	3019.95
4:38:09 AM		4365.16	17782.79	2818.38
4:39:09 AM		5128.61	14454.40	2818.38
4:40:09 AM		3890.45	9120.11	2691.53
4:41:09 AM		10715.19	26302.68	3090.30
4:42:09 AM		7413.10	63095.73	2511.89
4:43:09 AM		2951.21	5128.61	2187.76
4:44:09 AM		2951.21	7585.78	2238.72
4:45:09 AM		2884.03	5370.32	2290.87
4:46:09 AM		2884.03	4168.69	2344.23
4:47:09 AM		3548.13	9549.93	2344.23
4:48:09 AM		83176.38	2570395.78	2754.23
4:49:09 AM		75857.76	2454708.92	2884.03
4:50:09 AM		4570.88	8128.31	3090.30
4:51:09 AM		3890.45	8511.38	2754.23
4:52:09 AM		3890.45	7413.10	2691.53
4:53:09 AM		3890.45	13803.84	2951.21
4:54:09 AM		5623.41	19498.45	3019.95
4:55:09 AM		7244.36	20417.38	3235.94
4:56:09 AM		5888.44	15848.93	3388.44
4:57:09 AM		6456.54	20892.96	3090.30
4:58:09 AM		5754.40	21379.62	2951.21
4:59:09 AM		4168.69	9120.11	2818.38
5:00:09 AM		3388.44	8128.31	2630.27
5:01:09 AM		3235.94	4466.84	2511.89
5:02:09 AM		3715.35	6456.54	2884.03
5:03:09 AM		5888.44	25703.96	2884.03
5:04:09 AM		3890.45	5754.40	2951.21
5:05:09 AM		4168.69	8912.51	2570.40
5:06:09 AM		3715.35	8709.64	2754.23
5:07:09 AM		5623.41	8912.51	3311.31
5:08:09 AM		4466.84	13489.63	2630.27
5:09:09 AM		4365.16	9772.37	2818.38
5:10:09 AM		24547.09	177827.94	4897.79
5:11:09 AM		7762.47	23442.29	3715.35
5:12:09 AM		794328.23	5623413.25	3981.07
5:13:09 AM		9332.54	89125.09	2884.03
5:14:09 AM		4786.30	26915.35	2630.27
5:15:09 AM		23988.33	204173.79	3311.31
5:16:09 AM		52480.75	588843.66	4168.69
5:17:09 AM		7762.47	25703.96	2951.21
5:18:09 AM		5623.41	25118.86	2754.23
5:19:09 AM		3890.45	11481.54	2691.53
5:20:09 AM		4786.30	12302.69	2570.40
5:21:09 AM		4168.69	8912.51	2754.23
5:22:09 AM		4168.69	7413.10	2884.03
5:23:09 AM		10232.93	36307.81	3311.31
5:24:09 AM		5495.41	13182.57	3467.37
5:25:09 AM		4466.84	7943.28	3388.44
5:26:09 AM		6918.31	63095.73	3467.37
5:27:09 AM		6606.93	14125.38	3801.89
5:28:09 AM		5128.61	18197.01	2691.53
5:29:09 AM		4168.69	13803.84	2511.89
5:30:09 AM		3467.37	6456.54	2511.89
5:31:09 AM		3235.94	4897.79	2630.27
5:32:09 AM		9549.93	41686.94	3311.31
5:33:09 AM		1513561.25	14454397.71	8709.64
5:34:09 AM		5011.87	14125.38	2754.23
5:35:09 AM		5754.40	31622.78	2511.89
5:36:09 AM		5623.41	23988.33	2570.40
5:37:09 AM		7943.28	32359.37	3019.95
5:38:09 AM		9772.37	23442.29	4168.69
5:39:09 AM		7079.46	18197.01	3548.13
5:40:09 AM		6456.54	25703.96	2691.53
5:41:09 AM		4786.30	13803.84	2754.23
5:42:09 AM		8511.38	51286.14	3090.30
5:43:09 AM		4073.80	8128.31	2511.89
5:44:09 AM		12302.69	33884.42	6025.60
5:45:09 AM		7762.47	66069.34	3019.95
5:46:09 AM		4365.16	20417.38	2630.27
5:47:09 AM		5888.44	18197.01	2630.27
5:48:09 AM		5011.87	16595.87	2511.89
5:49:09 AM		6918.31	33113.11	2754.23
5:50:09 AM		5370.32	21379.62	2754.23
5:51:09 AM		16218.10	74131.02	2951.21

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	20:45:00	20:45:00		35.3	37.5	33.9
	20:46:00	20:46:00		36.2	42.1	33.9
	20:47:00	20:47:00		37.7	47.8	33.8
	20:48:00	20:48:00		37.4	44.5	34
	20:49:00	20:49:00		37.1	41.5	34.1
	20:50:00	20:50:00		35.4	39.5	33.9
	20:51:00	20:51:00		38.5	45.5	34.7
	20:52:00	20:52:00		39.1	43.6	35.7
	20:53:00	20:53:00		35.9	39.3	34
	20:54:00	20:54:00		40.5	48.1	34.2
	20:55:00	20:55:00		39.1	48	34.7
	20:56:00	20:56:00		36.5	39.1	34.9
	20:57:00	20:57:00		38.8	42.1	35
	20:58:00	20:58:00		37.5	45.6	35.1
	20:59:00	20:59:00		37.9	41.1	35.3
	21:00:00	21:00:00		37.8	45.7	35.1
	21:01:00	21:01:00		38.5	46	35.4
	21:02:00	21:02:00		40.6	46.8	36.7
	21:03:00	21:03:00		40.8	46	37.7
	21:04:00	21:04:00		40	44.2	37.1
	21:05:00	21:05:00		42.4	49	38.2
	21:06:00	21:06:00		39.1	43.8	36.1
	21:07:00	21:07:00		44.4	51.1	38.7
	21:08:00	21:08:00		44.1	50.1	40.3
	21:09:00	21:09:00		41.9	45.1	39
	21:10:00	21:10:00		42.6	48.4	38.3
	21:11:00	21:11:00		40.9	44.3	38.7
	21:12:00	21:12:00		50.1	58.7	38.9
	21:13:00	21:13:00		49.4	58.5	38.9
	21:14:00	21:14:00		41.4	43.9	39.2
	21:15:00	21:15:00		52	59.2	41.1
	21:16:00	21:16:00		50.8	58.7	40.9
	21:17:00	21:17:00		49.5	57.8	40.5
	21:18:00	21:18:00		41.9	49.9	37.8
	21:19:00	21:19:00		52	60.6	40.1
	21:20:00	21:20:00		50.1	58.8	38.5
	21:21:00	21:21:00		48.7	54.8	38.7
	21:22:00	21:22:00		50.5	58.9	40.2
	21:23:00	21:23:00		52.1	61.3	38.5
	21:24:00	21:24:00		43	49.6	39.3
	21:25:00	21:25:00		55	62	42
	21:26:00	21:26:00		49	57.3	41.8
	21:27:00	21:27:00		50.6	58.8	40.2
	21:28:00	21:28:00		42.9	48.2	39.3
	21:29:00	21:29:00		45.2	50.7	38.8
	21:30:00	21:30:00		51.6	59.9	40.4
	21:31:00	21:31:00		50	59.5	39.7
	21:32:00	21:32:00		49	58.7	39.2
	21:33:00	21:33:00		47.4	55.1	38.9
	21:34:00	21:34:00		49.3	57	38.7
	21:35:00	21:35:00		40.8	47.4	37.9
	21:36:00	21:36:00		51.9	60.1	40.8
	21:37:00	21:37:00		41	43.9	38.8
	21:38:00	21:38:00		49.5	57.4	39.5
	21:39:00	21:39:00		45.6	51.4	40.3
	21:40:00	21:40:00		53.3	61.8	40.4
	21:41:00	21:41:00		49.6	58.7	38.3
	21:42:00	21:42:00		49.3	56.9	38.8
	21:43:00	21:43:00		50.4	57.9	40.6
	21:44:00	21:44:00		39.1	42.8	37.3
	21:45:00	21:45:00		49.8	59.6	38.7
	21:46:00	21:46:00		52.3	61.5	38.4
	21:47:00	21:47:00		44.7	52.2	36.6
	21:48:00	21:48:00		50.5	59.1	37.4
	21:49:00	21:49:00		41.7	53.2	36.2
	21:50:00	21:50:00		48.8	56.2	39.2
	21:51:00	21:51:00		52.2	59.8	41.1
	21:52:00	21:52:00		49.3	57.5	37.5
	21:53:00	21:53:00		43.3	49	38.1
	21:54:00	21:54:00		51.4	60.3	37.1
	21:55:00	21:55:00		51.2	58.6	38.1
	21:56:00	21:56:00		50.7	58.3	36.9
	21:57:00	21:57:00		51.9	58.4	40.1
	21:58:00	21:58:00		49.5	59.7	39.8
	21:59:00	21:59:00		44.1	48.4	39.3
	22:00:00	22:00:00		52.1	60.2	38.2
	22:01:00	22:01:00		53.9	61	42.1
	22:02:00	22:02:00		50	61.4	40.4
	22:03:00	22:03:00		51.5	58.9	43.1
	22:04:00	22:04:00		48.2	57.3	38.6
	22:05:00	22:05:00		46.5	55	40.1
	22:06:00	22:06:00		54.5	61.1	45.9
	22:07:00	22:07:00		47.4	57.2	36.1

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
5:52:09 AM		3388.44	5623.41	2454.71
5:53:09 AM		4168.69	16218.10	2454.71
5:54:09 AM		5888.44	60255.96	2398.83
5:55:09 AM		5495.41	28183.83	2511.89
5:56:09 AM		5128.61	14125.38	2570.40
5:57:09 AM		3467.37	8912.51	2454.71
5:58:09 AM		7079.46	35481.34	2951.21
5:59:09 AM		8128.31	22908.68	3715.35
6:00:09 AM		3890.45	8511.38	2511.89
6:01:09 AM		11220.18	64565.42	2630.27
6:02:09 AM		8128.31	63095.73	2951.21
6:03:09 AM		4466.84	8128.31	3090.30
6:04:09 AM		7585.78	16218.10	3162.28
6:05:09 AM		5623.41	36307.81	3235.94
6:06:09 AM		6165.95	12882.50	3388.44
6:07:09 AM		6025.60	37153.52	3235.94
6:08:09 AM		7079.46	39810.72	3467.37
6:09:09 AM		11481.54	47863.01	4677.35
6:10:09 AM		12022.64	39810.72	5888.44
6:11:09 AM		10000.00	26302.68	5128.61
6:12:09 AM		17378.01	79432.82	6606.93
6:13:09 AM		8128.31	23988.33	4073.80
6:14:09 AM		27542.29	128824.96	7413.10
6:15:09 AM		25703.96	102329.30	10715.19
6:16:09 AM		15488.17	32359.37	7943.28
6:17:09 AM		18197.01	69183.10	6760.83
6:18:09 AM		12302.69	26915.35	7413.10
6:19:09 AM		102329.30	741310.24	7762.47
6:20:09 AM		87096.36	707945.78	7762.47
6:21:09 AM		13803.84	24547.09	8317.64
6:22:09 AM		158489.32	831763.77	12882.50
6:23:09 AM		120226.44	741310.24	12302.69
6:24:09 AM		89125.09	602559.59	11220.18
6:25:09 AM		15488.17	97723.72	6025.60
6:26:09 AM		158489.32	1148153.62	10232.93
6:27:09 AM		102329.30	758577.58	7079.46
6:28:09 AM		74131.02	301995.17	7413.10
6:29:09 AM		112201.85	776247.12	10471.29
6:30:09 AM		162181.01	1348962.88	7079.46
6:31:09 AM		19952.62	91201.08	8511.38
6:32:09 AM		316227.77	1584893.19	15848.93
6:33:09 AM		79432.82	537031.80	15135.61
6:34:09 AM		114815.36	758577.58	10471.29
6:35:09 AM		19498.45	66069.34	8511.38
6:36:09 AM		33113.11	117489.76	7585.78
6:37:09 AM		144543.98	977237.22	10964.78
6:38:09 AM		100000.00	891250.94	9332.54
6:39:09 AM		79432.82	741310.24	8317.64
6:40:09 AM		54954.09	323593.66	7762.47
6:41:09 AM		85113.80	501187.23	7413.10
6:42:09 AM		12022.64	54954.09	6165.95
6:43:09 AM		154881.66	1023292.99	12022.64
6:44:09 AM		12589.25	24547.09	7585.78
6:45:09 AM		89125.09	549540.87	8912.51
6:46:09 AM		36307.81	138038.43	10715.19
6:47:09 AM		213796.21	1513561.25	10964.78
6:48:09 AM		91201.08	741310.24	6760.83
6:49:09 AM		85113.80	489778.82	7585.78
6:50:09 AM		109647.82	616595.00	11481.54
6:51:09 AM		8128.31	19054.61	5370.32
6:52:09 AM		95499.26	912010.84	7413.10
6:53:09 AM		169824.37	1412537.54	6918.31
6:54:09 AM		29512.09	165958.69	4570.88
6:55:09 AM		112201.85	812830.52	5495.41
6:56:09 AM		14791.08	208929.61	4168.69
6:57:09 AM		75857.76	416869.38	8317.64
6:58:09 AM		165958.69	954992.59	12882.50
6:59:09 AM		85113.80	562341.33	5623.41
7:00:09 AM		21379.62	79432.82	6456.54
7:01:09 AM		138038.43	1071519.31	5128.61
7:02:09 AM		131825.67	724435.96	6456.54
7:03:09 AM		117489.76	676082.98	4897.79
7:04:09 AM		154881.66	691830.97	10232.93
7:05:09 AM		89125.09	933254.30	9549.93
7:06:09 AM		25703.96	69183.10	8511.38
7:07:09 AM		162181.01	1047128.55	6606.93
7:08:09 AM		245470.89	1258925.41	16218.10
7:09:09 AM		100000.00	1380384.26	10964.78
7:10:09 AM		141253.75	776247.12	20417.38
7:11:09 AM		66069.34	537031.80	7244.36
7:12:09 AM		44668.36	316227.77	10232.93
7:13:09 AM		281838.29	1288249.55	38904.51
7:14:09 AM		54954.09	524807.46	4073.80

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	22:08:00	22:08:00		49.8	58.3	37.2
	22:09:00	22:09:00		48	56	36.7
	22:10:00	22:10:00		53.7	59.9	38.9
	22:11:00	22:11:00		48.3	58.4	39.9
	22:12:00	22:12:00		52.3	59	38.2
	22:13:00	22:13:00		41.1	50.3	37
	22:14:00	22:14:00		44.6	52	37.1
	22:15:00	22:15:00		51.7	60.2	37.9
	22:16:00	22:16:00		41.5	47.5	38.4
	22:17:00	22:17:00		42.1	48.8	36.6
	22:18:00	22:18:00		51.1	59.8	38.1
	22:19:00	22:19:00		51.7	58.8	40.4
	22:20:00	22:20:00		44.1	52.6	36.1
	22:21:00	22:21:00		52	60.8	35.9
	22:22:00	22:22:00		48.8	56.8	40.2
	22:23:00	22:23:00		49.5	59.1	35.8
	22:24:00	22:24:00		40.6	45.6	36
	22:25:00	22:25:00		53.9	61.9	38.1
	22:26:00	22:26:00		48.6	57.1	36.2
	22:27:00	22:27:00		38.5	46.1	34.4
	22:28:00	22:28:00		45.1	50	38.5
	22:29:00	22:29:00		54	62	40.7
	22:30:00	22:30:00		41.5	47.5	37.5
	22:31:00	22:31:00		50.2	58.8	35.2
	22:32:00	22:32:00		42.9	49.4	36.8
	22:33:00	22:33:00		40	47.5	34.7
	22:34:00	22:34:00		38.3	42.3	35.6
	22:35:00	22:35:00		54.9	61.1	39.8
	22:36:00	22:36:00		37.3	40.7	35.2
	22:37:00	22:37:00		50	58.6	36.3
	22:38:00	22:38:00		49.2	57.8	38.9
	22:39:00	22:39:00		46.9	59.6	39
	22:40:00	22:40:00		51.9	60.4	37.4
	22:41:00	22:41:00		44.3	52.7	38.6
	22:42:00	22:42:00		52.6	58.6	44.1
	22:43:00	22:43:00		44.3	56.9	36.8
	22:44:00	22:44:00		48.2	58.3	38
	22:45:00	22:45:00		52.3	60.5	36.6
	22:46:00	22:46:00		39.9	46.9	35.8
	22:47:00	22:47:00		50.8	60.4	36
	22:48:00	22:48:00		41.3	45.6	37
	22:49:00	22:49:00		54.7	62.2	42.5
	22:50:00	22:50:00		41.5	46.4	38.6
	22:51:00	22:51:00		48.9	57.9	37.9
	22:52:00	22:52:00		45.1	51.2	40
	22:53:00	22:53:00		49	58.3	40.5
	22:54:00	22:54:00		40.8	44	38.3
	22:55:00	22:55:00		53.6	60.5	38.9
	22:56:00	22:56:00		44.6	52.2	39.3
	22:57:00	22:57:00		43.8	49.5	38
	22:58:00	22:58:00		49.6	57.9	39.6
	22:59:00	22:59:00		47.4	53	40.2
	23:00:00	23:00:00		51.3	59.5	39.4
	23:01:00	23:01:00		41.8	47.8	36.3
	23:02:00	23:02:00		50.9	60.8	37.7
	23:03:00	23:03:00		48.9	58.5	37.2
	23:04:00	23:04:00		50.3	56.1	41.5
	23:05:00	23:05:00		53.8	62.6	39.2
	23:06:00	23:06:00		49.7	59.8	36.1
	23:07:00	23:07:00		48.1	58.3	36.2
	23:08:00	23:08:00		47.4	56.3	36.2
	23:09:00	23:09:00		48.2	56.9	37.7
	23:10:00	23:10:00		48.6	57	35
	23:11:00	23:11:00		51.5	60.3	35.5
	23:12:00	23:12:00		39.9	47.6	34.3
	23:13:00	23:13:00		42.9	50.2	34.2
	23:14:00	23:14:00		48.4	56	36.1
	23:15:00	23:15:00		44.4	51.1	37.6
	23:16:00	23:16:00		42.1	48.7	36.5
	23:17:00	23:17:00		51.6	61.1	37.1
	23:18:00	23:18:00		48.6	57.3	37.3
	23:19:00	23:19:00		50	60	37.8
	23:20:00	23:20:00		50.6	58.8	38.1
	23:21:00	23:21:00		44.1	53.1	36.6
	23:22:00	23:22:00		52.9	62.5	43.1
	23:23:00	23:23:00		49.2	59.3	37
	23:24:00	23:24:00		42.1	48.3	37
	23:25:00	23:25:00		49.5	58.7	36.6
	23:26:00	23:26:00		46.6	53.3	38.6
	23:27:00	23:27:00		52.6	59	43.8
	23:28:00	23:28:00		53.5	69.9	40
	23:29:00	23:29:00		49.2	57.5	38.5
	23:30:00	23:30:00		40.3	45	36.7

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
7:15:09 AM		95499.26	676082.98	5248.07
7:16:09 AM		63095.73	398107.17	4677.35
7:17:09 AM		234422.88	977237.22	7762.47
7:18:09 AM		67608.30	691830.97	9772.37
7:19:09 AM		169824.37	794328.23	6606.93
7:20:09 AM		12882.50	107151.93	5011.87
7:21:09 AM		28840.32	158489.32	5128.61
7:22:09 AM		147910.84	1047128.55	6165.95
7:23:09 AM		14125.38	56234.13	6918.31
7:24:09 AM		16218.10	75857.76	4570.88
7:25:09 AM		128824.96	954992.59	6456.54
7:26:09 AM		147910.84	758577.58	10964.78
7:27:09 AM		25703.96	181970.09	4073.80
7:28:09 AM		158489.32	1202264.43	3890.45
7:29:09 AM		75857.76	478630.09	10471.29
7:30:09 AM		89125.09	812830.52	3801.89
7:31:09 AM		11481.54	36307.81	3981.07
7:32:09 AM		245470.89	1548816.62	6456.54
7:33:09 AM		72443.60	512861.38	4168.69
7:34:09 AM		7079.46	40738.03	2754.23
7:35:09 AM		32359.37	100000.00	7079.46
7:36:09 AM		251188.64	1584893.19	11748.98
7:37:09 AM		14125.38	56234.13	5623.41
7:38:09 AM		104712.85	758577.58	3311.31
7:39:09 AM		19498.45	87096.36	4786.30
7:40:09 AM		10000.00	56234.13	2951.21
7:41:09 AM		6760.83	16982.44	3630.78
7:42:09 AM		309029.54	1288249.55	9549.93
7:43:09 AM		5370.32	11748.98	3311.31
7:44:09 AM		100000.00	724435.96	4265.80
7:45:09 AM		83176.38	602559.59	7762.47
7:46:09 AM		48977.88	912010.84	7943.28
7:47:09 AM		154881.66	1096478.20	5495.41
7:48:09 AM		26915.35	186208.71	7244.36
7:49:09 AM		181970.09	724435.96	25703.96
7:50:09 AM		26915.35	489778.82	4786.30
7:51:09 AM		66069.34	676082.98	6309.57
7:52:09 AM		169824.37	1122018.45	4570.88
7:53:09 AM		9772.37	48977.88	3801.89
7:54:09 AM		120226.44	1096478.20	3981.07
7:55:09 AM		13489.63	36307.81	5011.87
7:56:09 AM		295120.92	1659586.91	17782.79
7:57:09 AM		14125.38	43651.58	7244.36
7:58:09 AM		77624.71	616595.00	6165.95
7:59:09 AM		32359.37	131825.67	10000.00
8:00:09 AM		79432.82	676082.98	11220.18
8:01:09 AM		12022.64	25118.86	6760.83
8:02:09 AM		229086.77	1122018.45	7762.47
8:03:09 AM		28840.32	165958.69	8511.38
8:04:09 AM		23988.33	89125.09	6309.57
8:05:09 AM		91201.08	616595.00	9120.11
8:06:09 AM		54954.09	199526.23	10471.29
8:07:09 AM		134896.29	891250.94	8709.64
8:08:09 AM		15135.61	60255.96	4265.80
8:09:09 AM		123026.88	1202264.43	5888.44
8:10:09 AM		77624.71	707945.78	5248.07
8:11:09 AM		107151.93	407380.28	14125.38
8:12:09 AM		239883.29	1819700.86	8317.64
8:13:09 AM		93325.43	954992.59	4073.80
8:14:09 AM		64565.42	676082.98	4168.69
8:15:09 AM		54954.09	426579.52	4168.69
8:16:09 AM		66069.34	489778.82	5888.44
8:17:09 AM		72443.60	501187.23	3162.28
8:18:09 AM		141253.75	1071519.31	3548.13
8:19:09 AM		9772.37	57543.99	2691.53
8:20:09 AM		19498.45	104712.85	2630.27
8:21:09 AM		69183.10	398107.17	4073.80
8:22:09 AM		27542.29	128824.96	5754.40
8:23:09 AM		16218.10	74131.02	4466.84
8:24:09 AM		144543.98	1288249.55	5128.61
8:25:09 AM		72443.60	537031.80	5370.32
8:26:09 AM		100000.00	1000000.00	6025.60
8:27:09 AM		114815.36	758577.58	6456.54
8:28:09 AM		25703.96	204173.79	4570.88
8:29:09 AM		194984.46	1778279.41	20417.38
8:30:09 AM		83176.38	851138.04	5011.87
8:31:09 AM		16218.10	67608.30	5011.87
8:32:09 AM		89125.09	741310.24	4570.88
8:33:09 AM		45708.82	213796.21	7244.36
8:34:09 AM		181970.09	794328.23	23988.33
8:35:09 AM		223872.11	9772372.21	10000.00
8:36:09 AM		83176.38	562341.33	7079.46
8:37:09 AM		10715.19	31622.78	4677.35

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	23:31:00	23:31:00		49.7	59.1	36.8
	23:32:00	23:32:00		49.9	61.1	37
	23:33:00	23:33:00		49.5	60.2	36.4
	23:34:00	23:34:00		40.5	46.6	36
	23:35:00	23:35:00		50.4	60.4	38.2
	23:36:00	23:36:00		49.8	58.9	38.4
	23:37:00	23:37:00		40.9	46	36.5
	23:38:00	23:38:00		49	58.6	37.9
	23:39:00	23:39:00		47.2	53.4	38
	23:40:00	23:40:00		49.5	59.2	37
	23:41:00	23:41:00		50.6	61.2	38.3
	23:42:00	23:42:00		42	49.8	35.8
	23:43:00	23:43:00		64.4	73.1	40
	23:44:00	23:44:00		51	59.8	41.5
	23:45:00	23:45:00		48.9	56	39.1
	23:46:00	23:46:00		48.8	59.4	36.1
	23:47:00	23:47:00		46.2	57.8	36.2
	23:48:00	23:48:00		47.5	57.9	36.1
	23:49:00	23:49:00		50.3	60.7	37.3
	23:50:00	23:50:00		50.5	58.6	39.5
	23:51:00	23:51:00		44.8	52.1	37.8
	23:52:00	23:52:00		50.4	58.5	40.4
	23:53:00	23:53:00		42.9	48.4	39
	23:54:00	23:54:00		51.4	57.5	39.5
	23:55:00	23:55:00		39.1	44.1	35.1
	23:56:00	23:56:00		41.8	50.4	37.6
	23:57:00	23:57:00		52.6	63.2	37.1
	23:58:00	23:58:00		51.5	62.6	37.1
	23:59:00	23:59:00		48.1	53.6	40.6
	24:00:00	24:00:00		48.4	55.3	42.4

Time	1-Hour Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
8:38:09 AM		93325.43	812830.52	4786.30
8:39:09 AM		97723.72	1288249.55	5011.87
8:40:09 AM		89125.09	1047128.55	4365.16
8:41:09 AM		11220.18	45708.82	3981.07
8:42:09 AM		109647.82	1096478.20	6606.93
8:43:09 AM		95499.26	776247.12	6918.31
8:44:09 AM		12302.69	39810.72	4466.84
8:45:09 AM		79432.82	724435.96	6165.95
8:46:09 AM		52480.75	218776.16	6309.57
8:47:09 AM		89125.09	831763.77	5011.87
8:48:09 AM		114815.36	1318256.74	6760.83
8:49:09 AM		15848.93	95499.26	3801.89
8:50:09 AM		2754228.70	20417379.45	10000.00
8:51:09 AM		125892.54	954992.59	14125.38
8:52:09 AM		77624.71	398107.17	8128.31
8:53:09 AM		75857.76	870963.59	4073.80
8:54:09 AM		41686.94	602559.59	4168.69
8:55:09 AM		56234.13	616595.00	4073.80
8:56:09 AM		107151.93	1174897.55	5370.32
8:57:09 AM		112201.85	724435.96	8912.51
8:58:09 AM		30199.52	162181.01	6025.60
8:59:09 AM		109647.82	707945.78	10964.78
9:00:09 AM		19498.45	69183.10	7943.28
9:01:09 AM		138038.43	562341.33	8912.51
9:02:09 AM		8128.31	25703.96	3235.94
9:03:09 AM		15135.61	109647.82	5754.40
9:04:09 AM		181970.09	2089296.13	5128.61
9:05:09 AM		141253.75	1819700.86	5128.61
9:06:09 AM		64565.42	229086.77	11481.54
9:07:09 AM		69183.10	338844.16	17378.01

24-Hour (Study #2) - Summary

Location #1

Serial Number	BGI040008	UNIT REV	R12N
Start Time	09:13:20 05-Aug-2021		
Run Length	24:00:00 5529600		

Microphone Information		
Description	Units	Value
Sensitivity	dB	29
Polarization	Volts	0
Meter Range	dB	110
Max Level	dB	140
Meas. Floor	dB	-20

Calibration Information			
Description		Units	Value
Pre-Cal	Level	dB	114.1
	Date		09:12:09 05-Aug-2021
Post-Cal	Level	dB	
	Date		
ReCert	Date		Unavailable

Configuration Information			
Description	Units	Meter 1	Meter 2
Integration Threshold	dB	OFF	OFF
Exchange Rate	dB	3	3
Criterion Level	dB	80	80
Upper Limit Level	dB	140	140
Projected Time	Hrs	24	24
Weighting		A	A
Time Response		SLOW	SLOW

Measurement	Units	Meter 1 Broadband	Meter 2 Broadband
Lavg	dB	50.5	50.5
Lmax	dB	83.9	83.8
Lmin	dB	32.1	32.1
Lpk	dB	98.4	98.4
TWA	dB	55.3	55.2
PTWA	dB	55.3	55.2
DOSE	%	0.34	0.33
PDOSE	%	0.34	0.33
SEL	dB	99.9	99.8
EXP	p2s	4	4

Measurement	Units	Value
LDN	dB	51.8
CNEL	dB	51.8
TAKTMAX (5sec)	dB	N/A
LC-A	dB	N/A

Exceedence	Units	Value
L01	dB	58.7
L08	dB	50.9
L25	dB	43.1
L50	dB	36.4

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
Study #2	0:01:00	0:01:00		44.3	57.3	36.2
Location #1	0:02:00	0:02:00		57	71.7	38.8
	0:03:00	0:03:00		51.6	60.2	37.8
	0:04:00	0:04:00		51	62.9	36.1
	0:05:00	0:05:00		48.8	56.9	36.5
	0:06:00	0:06:00		43.6	53.4	35.7
	0:07:00	0:07:00		45.3	54.2	35.8
	0:08:00	0:08:00		48.7	58.9	38
	0:09:00	0:09:00		50.6	59.1	37.9
	0:10:00	0:10:00		50	57.5	38.4
	0:11:00	0:11:00		43.8	49.2	37.6
	0:12:00	0:12:00		48.9	58.7	36.5
	0:13:00	0:13:00		52.6	61.3	37.5
	0:14:00	0:14:00		40.1	48.7	35.6
	0:15:00	0:15:00		50.8	59.1	37.6
	0:16:00	0:16:00		43.2	55.5	35.9
	0:17:00	0:17:00		48.1	57.5	38.8
	0:18:00	0:18:00		51	58.9	39.3
	0:19:00	0:19:00		47.4	53.5	38
	0:20:00	0:20:00		42.9	52.8	36.5
	0:21:00	0:21:00		42.6	48.7	37.1
	0:22:00	0:22:00		48.6	57.3	37.8
	0:23:00	0:23:00		51.8	62.4	38.9
	0:24:00	0:24:00		50	60	38
	0:25:00	0:25:00		46.5	54.5	37.7
	0:26:00	0:26:00		48.2	56.1	37
	0:27:00	0:27:00		44.7	50.1	37.2
	0:28:00	0:28:00		52.2	60.9	38.6
	0:29:00	0:29:00		49.2	60.1	35.5
	0:30:00	0:30:00		47.2	57.2	36.1
	0:31:00	0:31:00		49.6	58.6	38
	0:32:00	0:32:00		45.8	58.5	34.7
	0:33:00	0:33:00		39.9	44.5	35.9
	0:34:00	0:34:00		50.8	60	39.8
	0:35:00	0:35:00		47.3	55.8	35.6
	0:36:00	0:36:00		42.4	48.9	35.5
	0:37:00	0:37:00		49	56.6	36.9
	0:38:00	0:38:00		52	63	36.6
	0:39:00	0:39:00		46.8	54.5	36.1
	0:40:00	0:40:00		45.7	58.9	36
	0:41:00	0:41:00		52.7	60.9	37.7
	0:42:00	0:42:00		49.5	59.2	37.1
	0:43:00	0:43:00		49	59.7	35.7
	0:44:00	0:44:00		53	62.8	39
	0:45:00	0:45:00		39.2	44.3	35.9
	0:46:00	0:46:00		53.5	60.9	38.5
	0:47:00	0:47:00		43.9	57.1	34.1
	0:48:00	0:48:00		46.7	56	34.7
	0:49:00	0:49:00		43.6	49.3	37.1
	0:50:00	0:50:00		49.8	57.6	36.7
	0:51:00	0:51:00		49	58.6	37.1
	0:52:00	0:52:00		44.1	52.7	36
	0:53:00	0:53:00		51.7	62.5	38.3
	0:54:00	0:54:00		48.6	58.6	37.8
	0:55:00	0:55:00		46.1	53.6	35.7
	0:56:00	0:56:00		47.8	56.4	37
	0:57:00	0:57:00		51.4	60.1	38.2
	0:58:00	0:58:00		45	50.7	37.2
	0:59:00	0:59:00		51.5	61.3	36.1
	1:00:00	1:00:00		42	49.2	36
	1:01:00	1:01:00		52	59.2	40.4
	1:02:00	1:02:00		44.8	52.3	35.1
	1:03:00	1:03:00		47.6	56.6	36.9
	1:04:00	1:04:00		44.5	47.8	38.7
	1:05:00	1:05:00		53	60.2	38.8
	1:06:00	1:06:00		46.8	53.5	37
	1:07:00	1:07:00		50	59.8	37.3
	1:08:00	1:08:00		52.1	60.9	40.1
	1:09:00	1:09:00		40.5	47.5	35.7
	1:10:00	1:10:00		47.9	55.5	36.5
	1:11:00	1:11:00		40.1	44.1	36.3
	1:12:00	1:12:00		47.5	55.1	37.7
	1:13:00	1:13:00		53.4	60.3	41.6
	1:14:00	1:14:00		41.5	49.2	36.1
	1:15:00	1:15:00		39.2	44.3	35.1
	1:16:00	1:16:00		51.2	60	37
	1:17:00	1:17:00		47.8	57.8	35.8
	1:18:00	1:18:00		45.7	54.1	36
	1:19:00	1:19:00		47.1	56.4	36.3
	1:20:00	1:20:00		41.1	46.4	36.8
	1:21:00	1:21:00		48.5	58.4	35.9
	1:22:00	1:22:00		48.4	52.6	39.5

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
9:13:20 AM				
9:14:20 AM		26915.35	537031.80	4168.69
9:15:20 AM		501187.23	14791083.88	7585.78
9:16:20 AM		144543.98	1047128.55	6025.60
9:17:20 AM		125892.54	1949844.60	4073.80
9:18:20 AM		75857.76	489778.82	4466.84
9:19:20 AM		22908.68	218776.16	3715.35
9:20:20 AM		33884.42	263026.80	3801.89
9:21:20 AM		74131.02	776247.12	6309.57
9:22:20 AM		114815.36	812830.52	6165.95
9:23:20 AM		100000.00	562341.33	6918.31
9:24:20 AM		23988.33	83176.38	5754.40
9:25:20 AM		77624.71	741310.24	4466.84
9:26:20 AM		181970.09	1348962.88	5623.41
9:27:20 AM		10232.93	74131.02	3630.78
9:28:20 AM		120226.44	812830.52	5754.40
9:29:20 AM		20892.96	354813.39	3890.45
9:30:20 AM		64565.42	562341.33	7585.78
9:31:20 AM		125892.54	776247.12	8511.38
9:32:20 AM		54954.09	223872.11	6309.57
9:33:20 AM		19498.45	190546.07	4466.84
9:34:20 AM		18197.01	74131.02	5128.61
9:35:20 AM		72443.60	537031.80	6025.60
9:36:20 AM		151356.12	1737800.83	7762.47
9:37:20 AM		100000.00	1000000.00	6309.57
9:38:20 AM		44668.36	281838.29	5888.44
9:39:20 AM		66069.34	407380.28	5011.87
9:40:20 AM		29512.09	102329.30	5248.07
9:41:20 AM		165958.69	1230268.77	7244.36
9:42:20 AM	Location #7	83176.38	1023292.99	3548.13
9:43:20 AM	Location #7	52480.75	524807.46	4073.80
9:44:20 AM	Location #7	91201.08	724435.96	6309.57
9:45:20 AM	Location #7	38018.94	707945.78	2951.21
9:46:20 AM	Location #7	9772.37	28183.83	3890.45
9:47:20 AM	Location #7	120226.44	1000000.00	9549.93
9:48:20 AM	Location #7	53703.18	380189.40	3630.78
9:49:20 AM	Location #7	17378.01	77624.71	3548.13
9:50:20 AM	Location #7	79432.82	457088.19	4897.79
9:51:20 AM	Location #7	158489.32	1995262.31	4570.88
9:52:20 AM	Location #7	47863.01	281838.29	4073.80
9:53:20 AM	Location #7	37153.52	776247.12	3981.07
9:54:20 AM	Location #7	186208.71	1230268.77	5888.44
9:55:20 AM	Location #7	89125.09	831763.77	5128.61
9:56:20 AM	Location #7	79432.82	933254.30	3715.35
9:57:20 AM	Location #7	199526.23	1905460.72	7943.28
9:58:20 AM	Location #7	8317.64	26915.35	3890.45
9:59:20 AM	Location #7	223872.11	1230268.77	7079.46
10:00:20 AM	Location #7	24547.09	512861.38	2570.40
10:01:20 AM	Location #7	46773.51	398107.17	2951.21
10:02:20 AM	Location #7	22908.68	85113.80	5128.61
10:03:20 AM	Location #7	95499.26	575439.94	4677.35
10:04:20 AM	Location #7	79432.82	724435.96	5128.61
10:05:20 AM	Location #7	25703.96	186208.71	3981.07
10:06:20 AM	Location #7	147910.84	1778279.41	6760.83
10:07:20 AM	Location #7	72443.60	724435.96	6025.60
10:08:20 AM	Location #7	40738.03	229086.77	3715.35
10:09:20 AM	Location #7	60255.96	436515.83	5011.87
10:10:20 AM	Location #7	138038.43	1023292.99	6606.93
10:11:20 AM	Location #7	31622.78	117489.76	5248.07
10:12:20 AM	Location #7	141253.75	1348962.88	4073.80
10:13:20 AM	Location #7	15848.93	83176.38	3981.07
10:14:20 AM	Location #7	158489.32	831763.77	10964.78
10:15:20 AM	Location #7	30199.52	169824.37	3235.94
10:16:20 AM	Location #7	57543.99	457088.19	4897.79
10:17:20 AM	Location #7	28183.83	60255.96	7413.10
10:18:20 AM	Location #7	199526.23	1047128.55	7585.78
10:19:20 AM	Location #7	47863.01	223872.11	5011.87
10:20:20 AM	Location #7	100000.00	954992.59	5370.32
10:21:20 AM	Location #7	162181.01	1230268.77	10232.93
10:22:20 AM	Location #7	11220.18	56234.13	3715.35
10:23:20 AM	Location #7	61659.50	354813.39	4466.84
10:24:20 AM	Location #7	10232.93	25703.96	4265.80
10:25:20 AM	Location #7	56234.13	323593.66	5888.44
10:26:20 AM	Location #7	218776.16	1071519.31	14454.40
10:27:20 AM	Location #7	14125.38	83176.38	4073.80
10:28:20 AM	Location #7	8317.64	26915.35	3235.94
10:29:20 AM	Location #7	131825.67	1000000.00	5011.87
10:30:20 AM	Location #7	60255.96	602559.59	3801.89
10:31:20 AM	Location #7	37153.52	257039.58	3981.07
10:32:20 AM	Location #7	51286.14	436515.83	4265.80
10:33:20 AM	Location #7	12882.50	43651.58	4786.30
10:34:20 AM	Location #7	70794.58	691830.97	3890.45
10:35:20 AM	Location #7	69183.10	181970.09	8912.51

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	1:23:00	1:23:00		51.1	59.2	37.7
	1:24:00	1:24:00		51.4	59.8	37.7
	1:25:00	1:25:00		43.4	49	37.9
	1:26:00	1:26:00		36.8	41.8	34.3
	1:27:00	1:27:00		51.2	57.6	37.8
	1:28:00	1:28:00		44.2	48.9	41.1
	1:29:00	1:29:00		50	59.2	38.1
	1:30:00	1:30:00		53.1	61.7	37.9
	1:31:00	1:31:00		48.4	58.2	38
	1:32:00	1:32:00		43.1	49.6	38.3
	1:33:00	1:33:00		46.8	56	36.1
	1:34:00	1:34:00		49.5	58.7	37.6
	1:35:00	1:35:00		49.1	59.8	38.7
	1:36:00	1:36:00		40.7	46.1	35.5
	1:37:00	1:37:00		49.9	60.4	36.1
	1:38:00	1:38:00		53.8	64.2	42.5
	1:39:00	1:39:00		60.2	69.6	44.9
	1:40:00	1:40:00		42.9	49.5	36.1
	1:41:00	1:41:00		47.9	56	36.2
	1:42:00	1:42:00		52.2	58.7	38.8
	1:43:00	1:43:00		41.7	51.7	35.1
	1:44:00	1:44:00		49.7	59.6	36.3
	1:45:00	1:45:00		37.1	40.7	34.8
	1:46:00	1:46:00		54.1	63.3	40.1
	1:47:00	1:47:00		53	58.5	39.3
	1:48:00	1:48:00		60	68.5	40.7
	1:49:00	1:49:00		43.3	48	36.1
	1:50:00	1:50:00		39.9	45.5	34.6
	1:51:00	1:51:00		42.7	50.9	34.8
	1:52:00	1:52:00		36.1	37.6	34.7
	1:53:00	1:53:00		51.5	59.8	37.3
	1:54:00	1:54:00		52.5	63	41.6
	1:55:00	1:55:00		49.8	57.1	42
	1:56:00	1:56:00		46.4	55	41
	1:57:00	1:57:00		51.3	56.6	39.7
	1:58:00	1:58:00		51.6	60.7	37.9
	1:59:00	1:59:00		42	47.3	37
	2:00:00	2:00:00		46.5	52.6	37.8
	2:01:00	2:01:00		48.5	57.7	38.5
	2:02:00	2:02:00		53.7	60	43
	2:03:00	2:03:00		50.8	58.6	42.2
	2:04:00	2:04:00		40.3	45.8	35.3
	2:05:00	2:05:00		51.4	59	38.9
	2:06:00	2:06:00		50.1	59	36.1
	2:07:00	2:07:00		50.9	59	36.5
	2:08:00	2:08:00		45.6	55.4	35.4
	2:09:00	2:09:00		52.2	60	38.6
	2:10:00	2:10:00		44	50.1	39.6
	2:11:00	2:11:00		49.9	57.8	40.5
	2:12:00	2:12:00		53.7	59.7	38.9
	2:13:00	2:13:00		38.5	45.5	34.7
	2:14:00	2:14:00		46.1	53.2	36.8
	2:15:00	2:15:00		41.8	48.5	36.1
	2:16:00	2:16:00		53.2	61.2	36.2
	2:17:00	2:17:00		51.5	58.1	44
	2:18:00	2:18:00		50	59.8	40.2
	2:19:00	2:19:00		51.7	59.6	41.4
	2:20:00	2:20:00		42.9	50.4	37.7
	2:21:00	2:21:00		52.5	60.5	41.1
	2:22:00	2:22:00		48.3	56.7	37.3
	2:23:00	2:23:00		46.9	51.7	37.9
	2:24:00	2:24:00		53.9	63.7	42.7
	2:25:00	2:25:00		48.1	57.5	37
	2:26:00	2:26:00		49.6	58.4	38.2
	2:27:00	2:27:00		40.1	51.3	33.7
	2:28:00	2:28:00		36.7	42.2	33.8
	2:29:00	2:29:00		50.1	58.4	38.5
	2:30:00	2:30:00		36.3	39.2	34
	2:31:00	2:31:00		36.5	39.5	34.7
	2:32:00	2:32:00		51.4	59.8	38.8
	2:33:00	2:33:00		46.3	53.1	35
	2:34:00	2:34:00		37	40.1	34.9
	2:35:00	2:35:00		50.4	57.6	36.9
	2:36:00	2:36:00		44.8	53.6	36.1
	2:37:00	2:37:00		50.1	58.5	38.4
	2:38:00	2:38:00		45.1	50.6	40.1
	2:39:00	2:39:00		53.8	63.2	43.1
	2:40:00	2:40:00		52.6	59.5	43
	2:41:00	2:41:00		42.2	50.2	37.2
	2:42:00	2:42:00		52.6	58.6	40.6
	2:43:00	2:43:00		50.2	58.8	35.8
	2:44:00	2:44:00		49.8	57.6	35.6
	2:45:00	2:45:00		49.7	57.5	38.2

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
10:36:20 AM	Location #7	128824.96	831763.77	5888.44
10:37:20 AM	Location #7	138038.43	954992.59	5888.44
10:38:20 AM	Location #7	21877.62	79432.82	6165.95
10:39:20 AM	Location #7	4786.30	15135.61	2691.53
10:40:20 AM	Location #7	131825.67	575439.94	6025.60
10:41:20 AM	Location #7	26302.68	77624.71	12882.50
10:42:20 AM		100000.00	831763.77	6456.54
10:43:20 AM		204173.79	1479108.39	6165.95
10:44:20 AM		69183.10	660693.45	6309.57
10:45:20 AM		20417.38	91201.08	6760.83
10:46:20 AM		47863.01	398107.17	4073.80
10:47:20 AM		89125.09	741310.24	5754.40
10:48:20 AM		81283.05	954992.59	7413.10
10:49:20 AM		11748.98	40738.03	3548.13
10:50:20 AM		97723.72	1096478.20	4073.80
10:51:20 AM		239883.29	2630267.99	17782.79
10:52:20 AM		1047128.55	9120108.39	30902.95
10:53:20 AM		19498.45	89125.09	4073.80
10:54:20 AM		61659.50	398107.17	4168.69
10:55:20 AM		165958.69	741310.24	7585.78
10:56:20 AM		14791.08	147910.84	3235.94
10:57:20 AM		93325.43	912010.84	4265.80
10:58:20 AM		5128.61	11748.98	3019.95
10:59:20 AM		257039.58	2137962.09	10232.93
11:00:20 AM		199526.23	707945.78	8511.38
11:01:20 AM		1000000.00	7079457.84	11748.98
11:02:20 AM		21379.62	63095.73	4073.80
11:03:20 AM		9772.37	35481.34	2884.03
11:04:20 AM		18620.87	123026.88	3019.95
11:05:20 AM		4073.80	5754.40	2951.21
11:06:20 AM		141253.75	954992.59	5370.32
11:07:20 AM	Location #8	177827.94	1995262.31	14454.40
11:08:20 AM	Location #8	95499.26	512861.38	15848.93
11:09:20 AM	Location #8	43651.58	316227.77	12589.25
11:10:20 AM	Location #8	134896.29	457088.19	9332.54
11:11:20 AM	Location #8	144543.98	1174897.55	6165.95
11:12:20 AM	Location #8	15848.93	53703.18	5011.87
11:13:20 AM	Location #8	44668.36	181970.09	6025.60
11:14:20 AM	Location #8	70794.58	588843.66	7079.46
11:15:20 AM	Location #8	234422.88	1000000.00	19952.62
11:16:20 AM	Location #8	120226.44	724435.96	16595.87
11:17:20 AM	Location #8	10715.19	38018.94	3388.44
11:18:20 AM	Location #8	138038.43	794328.23	7762.47
11:19:20 AM	Location #8	102329.30	794328.23	4073.80
11:20:20 AM	Location #8	123026.88	794328.23	4466.84
11:21:20 AM	Location #8	36307.81	346736.85	3467.37
11:22:20 AM	Location #8	165958.69	1000000.00	7244.36
11:23:20 AM	Location #8	25118.86	102329.30	9120.11
11:24:20 AM	Location #8	97723.72	602559.59	11220.18
11:25:20 AM	Location #8	234422.88	933254.30	7762.47
11:26:20 AM	Location #8	7079.46	35481.34	2951.21
11:27:20 AM	Location #8	40738.03	208929.61	4786.30
11:28:20 AM	Location #8	15135.61	70794.58	4073.80
11:29:20 AM	Location #8	208929.61	1318256.74	4168.69
11:30:20 AM	Location #8	141253.75	645654.23	25118.86
11:31:20 AM	Location #8	100000.00	954992.59	10471.29
11:32:20 AM	Location #8	147910.84	912010.84	13803.84
11:33:20 AM	Location #8	19498.45	109647.82	5888.44
11:34:20 AM	Location #8	177827.94	1122018.45	12882.50
11:35:20 AM	Location #8	67608.30	467735.14	5370.32
11:36:20 AM	Location #8	48977.88	147910.84	6165.95
11:37:20 AM	Location #8	245470.89	2344228.82	18620.87
11:38:20 AM	Location #8	64565.42	562341.33	5011.87
11:39:20 AM	Location #8	91201.08	691830.97	6606.93
11:40:20 AM	Location #8	10232.93	134896.29	2344.23
11:41:20 AM	Location #8	4677.35	16595.87	2398.83
11:42:20 AM	Location #8	102329.30	691830.97	7079.46
11:43:20 AM	Location #8	4265.80	8317.64	2511.89
11:44:20 AM	Location #8	4466.84	8912.51	2951.21
11:45:20 AM	Location #8	138038.43	954992.59	7585.78
11:46:20 AM	Location #8	42657.95	204173.79	3162.28
11:47:20 AM	Location #8	5011.87	10232.93	3090.30
11:48:20 AM	Location #8	109647.82	575439.94	4897.79
11:49:20 AM	Location #8	30199.52	229086.77	4073.80
11:50:20 AM	Location #8	102329.30	707945.78	6918.31
11:51:20 AM	Location #8	32359.37	114815.36	10232.93
11:52:20 AM	Location #8	239883.29	2089296.13	20417.38
11:53:20 AM	Location #8	181970.09	891250.94	19952.62
11:54:20 AM	Location #8	16595.87	104712.85	5248.07
11:55:20 AM	Location #8	181970.09	724435.96	11481.54
11:56:20 AM	Location #8	104712.85	758577.58	3801.89
11:57:20 AM	Location #8	95499.26	575439.94	3630.78
11:58:20 AM	Location #8	93325.43	562341.33	6606.93

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	2:46:00	2:46:00		51.9	62.3	38.5
	2:47:00	2:47:00		51.2	60.1	39.7
	2:48:00	2:48:00		48.9	57	39
	2:49:00	2:49:00		39.8	45.8	36.7
	2:50:00	2:50:00		45.9	52.5	38.5
	2:51:00	2:51:00		44	48.8	40.7
	2:52:00	2:52:00		50.5	57.8	38.7
	2:53:00	2:53:00		42.4	48.7	38
	2:54:00	2:54:00		51.9	59.4	41.1
	2:55:00	2:55:00		49.2	57.1	42.2
	2:56:00	2:56:00		52.3	60.7	39.1
	2:57:00	2:57:00		51.3	60.3	39.3
	2:58:00	2:58:00		50.6	58.4	41
	2:59:00	2:59:00		41.9	45.9	38.7
	3:00:00	3:00:00		48.9	56.6	40.4
	3:01:00	3:01:00		42.4	44.7	39.9
	3:02:00	3:02:00		44	51	39.3
	3:03:00	3:03:00		41.4	44.4	38
	3:04:00	3:04:00		46.6	58.4	38.9
	3:05:00	3:05:00		48	57.7	39.7
	3:06:00	3:06:00		43.1	49.6	39.1
	3:07:00	3:07:00		44.2	46.6	40.9
	3:08:00	3:08:00		49.5	57.3	41.4
	3:09:00	3:09:00		43.4	46.8	40.5
	3:10:00	3:10:00		45.9	50.1	37.9
	3:11:00	3:11:00		45.4	56.2	40.1
	3:12:00	3:12:00		47.6	56.4	37.9
	3:13:00	3:13:00		49.3	57.8	37.8
	3:14:00	3:14:00		46.8	51.1	40.2
	3:15:00	3:15:00		42	46.8	38.9
	3:16:00	3:16:00		47.9	56.9	39.1
	3:17:00	3:17:00		50.3	58.4	40.8
	3:18:00	3:18:00		47.7	53.4	38.6
	3:19:00	3:19:00		41.5	45	37.8
	3:20:00	3:20:00		43.8	53.8	38
	3:21:00	3:21:00		53.8	59.9	42.5
	3:22:00	3:22:00		53.4	59.1	39.6
	3:23:00	3:23:00		44.7	52.2	39
	3:24:00	3:24:00		54.5	62.1	43.3
	3:25:00	3:25:00		52.5	58.1	43.8
	3:26:00	3:26:00		49.9	56.6	37.1
	3:27:00	3:27:00		41.9	51	35.2
	3:28:00	3:28:00		41.8	47.3	36.6
	3:29:00	3:29:00		39.6	47.2	34.9
	3:30:00	3:30:00		50.7	57.6	42
	3:31:00	3:31:00		52.2	59	43.9
	3:32:00	3:32:00		54	60.1	43.4
	3:33:00	3:33:00		52	61.4	42.1
	3:34:00	3:34:00		48.4	57.3	41.7
	3:35:00	3:35:00		45.3	54.1	37.3
	3:36:00	3:36:00		49.8	59.2	38.1
	3:37:00	3:37:00		49.8	57.7	41.2
	3:38:00	3:38:00		44	54.3	36.5
	3:39:00	3:39:00		52.1	58.6	39.7
	3:40:00	3:40:00		51.4	60	39.5
	3:41:00	3:41:00		44.2	51.2	36.2
	3:42:00	3:42:00		50.4	57.3	39.7
	3:43:00	3:43:00		50	56.7	39.9
	3:44:00	3:44:00		49.8	57.3	37.9
	3:45:00	3:45:00		41.3	49.5	36.2
	3:46:00	3:46:00		49.6	56.1	41.6
	3:47:00	3:47:00		52	59.8	40.5
	3:48:00	3:48:00		52	61	42
	3:49:00	3:49:00		49.5	58.2	43.3
	3:50:00	3:50:00		49.6	59.8	37.9
	3:51:00	3:51:00		51.1	58.5	41.7
	3:52:00	3:52:00		50.8	55.8	43.9
	3:53:00	3:53:00		54.5	60.4	43.9
	3:54:00	3:54:00		52.1	60.7	41.5
	3:55:00	3:55:00		48.7	56.1	39.4
	3:56:00	3:56:00		53.9	58.9	45.3
	3:57:00	3:57:00		51.7	59.3	42.6
	3:58:00	3:58:00		49.9	56.3	37.7
	3:59:00	3:59:00		40.1	44.7	36.1
	4:00:00	4:00:00		47.5	51.7	38.8
	4:01:00	4:01:00		53.4	60.7	44.1
	4:02:00	4:02:00		42.4	47.3	36.4
	4:03:00	4:03:00		54	61.7	44.4
	4:04:00	4:04:00		48.8	56.6	35.7
	4:05:00	4:05:00		34.9	36.8	33.8
	4:06:00	4:06:00		50.8	60.7	35.1
	4:07:00	4:07:00		52.2	59	40.6
	4:08:00	4:08:00		41.6	51.4	34.7

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
11:59:20 AM	Location #8	154881.66	1698243.65	7079.46
12:00:20 PM	Location #8	131825.67	1023292.99	9332.54
12:01:20 PM	Location #8	77624.71	501187.23	7943.28
12:02:20 PM	Location #8	9549.93	38018.94	4677.35
12:03:20 PM	Location #8	38904.51	177827.94	7079.46
12:04:20 PM	Location #8	25118.86	75857.76	11748.98
12:05:20 PM	Location #8	112201.85	602559.59	7413.10
12:06:20 PM	Location #8	17378.01	74131.02	6309.57
12:07:20 PM		154881.66	870963.59	12882.50
12:08:20 PM		83176.38	512861.38	16595.87
12:09:20 PM		169824.37	1174897.55	8128.31
12:10:20 PM		134896.29	1071519.31	8511.38
12:11:20 PM		114815.36	691830.97	12589.25
12:12:20 PM		15488.17	38904.51	7413.10
12:13:20 PM		77624.71	457088.19	10964.78
12:14:20 PM		17378.01	29512.09	9772.37
12:15:20 PM		25118.86	125892.54	8511.38
12:16:20 PM		13803.84	27542.29	6309.57
12:17:20 PM		45708.82	691830.97	7762.47
12:18:20 PM	Location #9	63095.73	588843.66	9332.54
12:19:20 PM	Location #9	20417.38	91201.08	8128.31
12:20:20 PM	Location #9	26302.68	45708.82	12302.69
12:21:20 PM	Location #9	89125.09	537031.80	13803.84
12:22:20 PM	Location #9	21877.62	47863.01	11220.18
12:23:20 PM	Location #9	38904.51	102329.30	6165.95
12:24:20 PM	Location #9	34673.69	416869.38	10232.93
12:25:20 PM	Location #9	57543.99	436515.83	6165.95
12:26:20 PM	Location #9	85113.80	602559.59	6025.60
12:27:20 PM	Location #9	47863.01	128824.96	10471.29
12:28:20 PM	Location #9	15848.93	47863.01	7762.47
12:29:20 PM	Location #9	61659.50	489778.82	8128.31
12:30:20 PM	Location #9	107151.93	691830.97	12022.64
12:31:20 PM	Location #9	58884.37	218776.16	7244.36
12:32:20 PM	Location #9	14125.38	31622.78	6025.60
12:33:20 PM	Location #9	23988.33	239883.29	6309.57
12:34:20 PM	Location #9	239883.29	977237.22	17782.79
12:35:20 PM	Location #9	218776.16	812830.52	9120.11
12:36:20 PM	Location #9	29512.09	165958.69	7943.28
12:37:20 PM	Location #9	281838.29	1621810.10	21379.62
12:38:20 PM	Location #9	177827.94	645654.23	23988.33
12:39:20 PM	Location #9	97723.72	457088.19	5128.61
12:40:20 PM	Location #9	15488.17	125892.54	3311.31
12:41:20 PM	Location #9	15135.61	53703.18	4570.88
12:42:20 PM	Location #9	9120.11	52480.75	3090.30
12:43:20 PM	Location #9	117489.76	575439.94	15848.93
12:44:20 PM	Location #9	165958.69	794328.23	24547.09
12:45:20 PM	Location #9	251188.64	1023292.99	21877.62
12:46:20 PM	Location #9	158489.32	1380384.26	16218.10
12:47:20 PM	Location #9	69183.10	537031.80	14791.08
12:48:20 PM	Location #9	33884.42	257039.58	5370.32
12:49:20 PM	Location #9	95499.26	831763.77	6456.54
12:50:20 PM	Location #9	95499.26	588843.66	13182.57
12:51:20 PM	Location #9	25118.86	269153.48	4466.84
12:52:20 PM	Location #9	162181.01	724435.96	9332.54
12:53:20 PM	Location #9	138038.43	1000000.00	8912.51
12:54:20 PM	Location #9	26302.68	131825.67	4168.69
12:55:20 PM	Location #9	109647.82	537031.80	9332.54
12:56:20 PM	Location #9	100000.00	467735.14	9772.37
12:57:20 PM	Location #9	95499.26	537031.80	6165.95
12:58:20 PM	Location #9	13489.63	89125.09	4168.69
12:59:20 PM	Location #9	91201.08	407380.28	14454.40
1:00:20 PM	Location #9	158489.32	954992.59	11220.18
1:01:20 PM	Location #9	158489.32	1258925.41	15848.93
1:02:20 PM	Location #9	89125.09	660693.45	21379.62
1:03:20 PM	Location #9	91201.08	954992.59	6165.95
1:04:20 PM	Location #9	128824.96	707945.78	14791.08
1:05:20 PM	Location #9	120226.44	380189.40	24547.09
1:06:20 PM	Location #9	281838.29	1096478.20	24547.09
1:07:20 PM	Location #9	162181.01	1174897.55	14125.38
1:08:20 PM	Location #9	74131.02	407380.28	8709.64
1:09:20 PM	Location #9	245470.89	776247.12	33884.42
1:10:20 PM	Location #9	147910.84	851138.04	18197.01
1:11:20 PM	Location #9	97723.72	426579.52	5888.44
1:12:20 PM	Location #9	10232.93	29512.09	4073.80
1:13:20 PM	Location #9	56234.13	147910.84	7585.78
1:14:20 PM	Location #9	218776.16	1174897.55	25703.96
1:15:20 PM	Location #9	17378.01	53703.18	4365.16
1:16:20 PM	Location #9	251188.64	1479108.39	27542.29
1:17:20 PM	Location #9	75857.76	457088.19	3715.35
1:18:20 PM		3090.30	4786.30	2398.83
1:19:20 PM		120226.44	1174897.55	3235.94
1:20:20 PM		165958.69	794328.23	11481.54
1:21:20 PM		14454.40	138038.43	2951.21

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	4:09:00	4:09:00		37	42.2	34.6
	4:10:00	4:10:00		49.4	55.5	38
	4:11:00	4:11:00		49.2	57.9	38
	4:12:00	4:12:00		50	58	38.2
	4:13:00	4:13:00		47	53.1	39
	4:14:00	4:14:00		50.2	57.5	38.5
	4:15:00	4:15:00		51.1	58.7	41.7
	4:16:00	4:16:00		44.1	49.7	39.7
	4:17:00	4:17:00		51.5	58.4	42.1
	4:18:00	4:18:00		55	63.3	44.3
	4:19:00	4:19:00		52.4	58.6	45.6
	4:20:00	4:20:00		51.5	58.7	41.4
	4:21:00	4:21:00		53.1	59.9	43.6
	4:22:00	4:22:00		51.4	58.2	39.5
	4:23:00	4:23:00		48.9	55.7	39.1
	4:24:00	4:24:00		44.9	50.2	37.6
	4:25:00	4:25:00		52.5	60.2	39.5
	4:26:00	4:26:00		51	59.2	38.9
	4:27:00	4:27:00		42.3	48	35.5
	4:28:00	4:28:00		38.5	42.6	35.4
	4:29:00	4:29:00		51.4	58.5	39.4
	4:30:00	4:30:00		39.7	44	36.1
	4:31:00	4:31:00		52.1	59.5	39.5
	4:32:00	4:32:00		46.4	52.4	41.6
	4:33:00	4:33:00		51.9	61	41.5
	4:34:00	4:34:00		52	59.6	41.7
	4:35:00	4:35:00		50.7	57.9	42.1
	4:36:00	4:36:00		44.2	49.8	38.4
	4:37:00	4:37:00		52.4	59.7	41.6
	4:38:00	4:38:00		44.3	50.3	39.4
	4:39:00	4:39:00		52.7	59.5	38.5
	4:40:00	4:40:00		52.6	58.8	37.8
	4:41:00	4:41:00		54	59.8	42.9
	4:42:00	4:42:00		50.1	58.6	36.1
	4:43:00	4:43:00		37.6	44.5	34.6
	4:44:00	4:44:00		49.5	59.6	37.4
	4:45:00	4:45:00		53.7	63.4	36.4
	4:46:00	4:46:00		44.8	51	38.5
	4:47:00	4:47:00		46.9	50.5	39.9
	4:48:00	4:48:00		53	61.7	39.5
	4:49:00	4:49:00		52.2	61.6	42.1
	4:50:00	4:50:00		53.6	64.3	38.7
	4:51:00	4:51:00		50.6	59	39.3
	4:52:00	4:52:00		48	54.1	44.1
	4:53:00	4:53:00		50.5	57.5	42.7
	4:54:00	4:54:00		54	60	42.9
	4:55:00	4:55:00		54.8	59.4	49.3
	4:56:00	4:56:00		48	54.2	41
	4:57:00	4:57:00		49	55.9	39.6
	4:58:00	4:58:00		52.7	59.9	43.8
	4:59:00	4:59:00		50.1	59.9	38.3
	5:00:00	5:00:00		46.5	55.1	37.9
	5:01:00	5:01:00		47.8	52.4	40.6
	5:02:00	5:02:00		54.8	60.7	42.7
	5:03:00	5:03:00		43.9	51.8	36.4
	5:04:00	5:04:00		49.8	61.6	35.7
	5:05:00	5:05:00		52	60.6	45
	5:06:00	5:06:00		51.1	57.5	37.7
	5:07:00	5:07:00		49.7	58	36.5
	5:08:00	5:08:00		45.5	50.7	39.7
	5:09:00	5:09:00		54.5	59.3	43.3
	5:10:00	5:10:00		52	59.4	39.3
	5:11:00	5:11:00		46.6	54.2	41.1
	5:12:00	5:12:00		50.3	57.6	43.4
	5:13:00	5:13:00		51.7	57.6	43.5
	5:14:00	5:14:00		43.4	48	39.2
	5:15:00	5:15:00		49.8	57.7	40.9
	5:16:00	5:16:00		52.4	59.1	43.6
	5:17:00	5:17:00		44.9	56	37.8
	5:18:00	5:18:00		49.4	58.5	37.7
	5:19:00	5:19:00		51.9	60.7	39.1
	5:20:00	5:20:00		46.9	55.9	38.3
	5:21:00	5:21:00		55.6	66.6	41.7
	5:22:00	5:22:00		52.7	60.9	41.9
	5:23:00	5:23:00		51.5	59.4	39.7
	5:24:00	5:24:00		50.1	55.9	39.2
	5:25:00	5:25:00		48.8	57.1	34.1
	5:26:00	5:26:00		42.8	51.5	33.9
	5:27:00	5:27:00		45.2	50.9	38.8
	5:28:00	5:28:00		51.6	59.7	40.5
	5:29:00	5:29:00		53.8	59.6	41.9
	5:30:00	5:30:00		47.7	55.3	39.5
	5:31:00	5:31:00		50.3	61	36.9

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
1:22:20 PM		5011.87	16595.87	2884.03
1:23:20 PM		87096.36	354813.39	6309.57
1:24:20 PM		83176.38	616595.00	6309.57
1:25:20 PM		100000.00	630957.34	6606.93
1:26:20 PM		50118.72	204173.79	7943.28
1:27:20 PM		104712.85	562341.33	7079.46
1:28:20 PM		128824.96	741310.24	14791.08
1:29:20 PM		25703.96	93325.43	9332.54
1:30:20 PM		141253.75	691830.97	16218.10
1:31:20 PM		316227.77	2137962.09	26915.35
1:32:20 PM		173780.08	724435.96	36307.81
1:33:20 PM	Location #10	141253.75	741310.24	13803.84
1:34:20 PM	Location #10	204173.79	977237.22	22908.68
1:35:20 PM	Location #10	138038.43	660693.45	8912.51
1:36:20 PM	Location #10	77624.71	371535.23	8128.31
1:37:20 PM	Location #10	30902.95	104712.85	5754.40
1:38:20 PM	Location #10	177827.94	1047128.55	8912.51
1:39:20 PM	Location #10	125892.54	831763.77	7762.47
1:40:20 PM	Location #10	16982.44	63095.73	3548.13
1:41:20 PM	Location #10	7079.46	18197.01	3467.37
1:42:20 PM	Location #10	138038.43	707945.78	8709.64
1:43:20 PM	Location #10	9332.54	25118.86	4073.80
1:44:20 PM	Location #10	162181.01	891250.94	8912.51
1:45:20 PM	Location #10	43651.58	173780.08	14454.40
1:46:20 PM	Location #10	154881.66	1258925.41	14125.38
1:47:20 PM	Location #10	158489.32	912010.84	14791.08
1:48:20 PM	Location #10	117489.76	616595.00	16218.10
1:49:20 PM	Location #10	26302.68	95499.26	6918.31
1:50:20 PM	Location #10	173780.08	933254.30	14454.40
1:51:20 PM	Location #10	26915.35	107151.93	8709.64
1:52:20 PM	Location #10	186208.71	891250.94	7079.46
1:53:20 PM	Location #10	181970.09	758577.58	6025.60
1:54:20 PM	Location #10	251188.64	954992.59	19498.45
1:55:20 PM	Location #10	102329.30	724435.96	4073.80
1:56:20 PM	Location #10	5754.40	28183.83	2884.03
1:57:20 PM	Location #10	89125.09	912010.84	5495.41
1:58:20 PM	Location #10	234422.88	2187761.62	4365.16
1:59:20 PM	Location #10	30199.52	125892.54	7079.46
2:00:20 PM	Location #10	48977.88	112201.85	9772.37
2:01:20 PM	Location #10	199526.23	1479108.39	8912.51
2:02:20 PM	Location #10	165958.69	1445439.77	16218.10
2:03:20 PM	Location #10	229086.77	2691534.80	7413.10
2:04:20 PM	Location #10	114815.36	794328.23	8511.38
2:05:20 PM	Location #10	63095.73	257039.58	25703.96
2:06:20 PM	Location #10	112201.85	562341.33	18620.87
2:07:20 PM	Location #10	251188.64	1000000.00	19498.45
2:08:20 PM	Location #10	301995.17	870963.59	85113.80
2:09:20 PM	Location #10	63095.73	263026.80	12589.25
2:10:20 PM	Location #10	79432.82	389045.14	9120.11
2:11:20 PM	Location #10	186208.71	977237.22	23988.33
2:12:20 PM	Location #10	102329.30	977237.22	6760.83
2:13:20 PM	Location #10	44668.36	323593.66	6165.95
2:14:20 PM	Location #10	60255.96	173780.08	11481.54
2:15:20 PM	Location #10	301995.17	1174897.55	18620.87
2:16:20 PM	Location #10	24547.09	151356.12	4365.16
2:17:20 PM	Location #10	95499.26	1445439.77	3715.35
2:18:20 PM	Location #10	158489.32	1148153.62	31622.78
2:19:20 PM	Location #10	128824.96	562341.33	5888.44
2:20:20 PM	Location #10	93325.43	630957.34	4466.84
2:21:20 PM	Location #10	35481.34	117489.76	9332.54
2:22:20 PM	Location #10	281838.29	851138.04	21379.62
2:23:20 PM	Location #10	158489.32	870963.59	8511.38
2:24:20 PM	Location #10	45708.82	263026.80	12882.50
2:25:20 PM	Location #10	107151.93	575439.94	21877.62
2:26:20 PM	Location #10	147910.84	575439.94	22387.21
2:27:20 PM	Location #10	21877.62	63095.73	8317.64
2:28:20 PM	Location #10	95499.26	588843.66	12302.69
2:29:20 PM	Location #10	173780.08	812830.52	22908.68
2:30:20 PM	Location #10	30902.95	398107.17	6025.60
2:31:20 PM	Location #10	87096.36	707945.78	5888.44
2:32:20 PM	Location #10	154881.66	1174897.55	8128.31
2:33:20 PM		48977.88	389045.14	6760.83
2:34:20 PM		363078.05	4570881.90	14791.08
2:35:20 PM		186208.71	1230268.77	15488.17
2:36:20 PM		141253.75	870963.59	9332.54
2:37:20 PM		102329.30	389045.14	8317.64
2:38:20 PM		75857.76	512861.38	2570.40
2:39:20 PM		19054.61	141253.75	2454.71
2:40:20 PM		33113.11	123026.88	7585.78
2:41:20 PM		144543.98	933254.30	11220.18
2:42:20 PM		239883.29	912010.84	15488.17
2:43:20 PM		58884.37	338844.16	8912.51
2:44:20 PM		107151.93	1258925.41	4897.79

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	5:32:00	5:32:00		46.2	49.9	38.3
	5:33:00	5:33:00		54.2	60.7	40.7
	5:34:00	5:34:00		53.5	62.4	43.2
	5:35:00	5:35:00		50.7	60.6	40.7
	5:36:00	5:36:00		52.8	58.8	43.6
	5:37:00	5:37:00		46.9	53.8	40.2
	5:38:00	5:38:00		51.9	59.1	42.9
	5:39:00	5:39:00		54.3	58.6	42.4
	5:40:00	5:40:00		46.6	54.9	36
	5:41:00	5:41:00		38	43.9	35
	5:42:00	5:42:00		50.9	60	36.1
	5:43:00	5:43:00		48.3	55.4	38.1
	5:44:00	5:44:00		49.4	58.4	35.1
	5:45:00	5:45:00		52.5	61.5	35.3
	5:46:00	5:46:00		45.2	57.2	33.1
	5:47:00	5:47:00		34.3	37.5	33.1
	5:48:00	5:48:00		34.1	37.1	32.8
	5:49:00	5:49:00		34.9	39.6	32.9
	5:50:00	5:50:00		36.5	43	32.9
	5:51:00	5:51:00		38.6	44.5	33
	5:52:00	5:52:00		35.7	40	33.7
	5:53:00	5:53:00		34.6	37.3	33.3
	5:54:00	5:54:00		37.1	39.9	35
	5:55:00	5:55:00		34.7	40	33.2
	5:56:00	5:56:00		45.4	55.3	33.3
	5:57:00	5:57:00		46.4	54.2	34.4
	5:58:00	5:58:00		46.7	53.7	34.4
	5:59:00	5:59:00		34.2	36.6	32.9
	6:00:00	6:00:00		36.2	39.9	33.1
	6:01:00	6:01:00		36.3	41	33.7
	6:02:00	6:02:00		35.8	44.7	33.1
	6:03:00	6:03:00		37.6	45.6	33.1
	6:04:00	6:04:00		42.2	53.6	34.5
	6:05:00	6:05:00		48.5	54.5	37.9
	6:06:00	6:06:00		42.8	56.3	32.8
	6:07:00	6:07:00		42.5	52.2	33.1
	6:08:00	6:08:00		42.8	49.4	33.6
	6:09:00	6:09:00		47	54.6	38.7
	6:10:00	6:10:00		43.1	48.2	34.4
	6:11:00	6:11:00		44.2	50	36.1
	6:12:00	6:12:00		41	50.8	33.3
	6:13:00	6:13:00		43.5	50.3	36.1
	6:14:00	6:14:00		41.4	49.5	33.7
	6:15:00	6:15:00		55.1	64.8	43.5
	6:16:00	6:16:00		52.2	61.1	36.2
	6:17:00	6:17:00		49.6	57	37.6
	6:18:00	6:18:00		46.7	54.3	35.6
	6:19:00	6:19:00		48	59.3	34
	6:20:00	6:20:00		37.9	43.8	33.6
	6:21:00	6:21:00		46	55.1	33.7
	6:22:00	6:22:00		56.3	69.9	39.4
	6:23:00	6:23:00		44.9	52.7	34
	6:24:00	6:24:00		48.6	59.5	33.8
	6:25:00	6:25:00		36.7	43.7	33
	6:26:00	6:26:00		39	46.9	33.9
	6:27:00	6:27:00		39.8	45.4	33.4
	6:28:00	6:28:00		44.1	52.4	36.3
	6:29:00	6:29:00		40.4	47.1	34.3
	6:30:00	6:30:00		41.8	50.8	33.5
	6:31:00	6:31:00		39.3	44.6	33.2
	6:32:00	6:32:00		40.7	49.6	33
	6:33:00	6:33:00		48.3	59.1	34.5
	6:34:00	6:34:00		37.2	43.9	33.6
	6:35:00	6:35:00		47.3	56.5	35.8
	6:36:00	6:36:00		46.9	57.7	34.3
	6:37:00	6:37:00		45.2	55.1	36.8
	6:38:00	6:38:00		37.5	42.4	34.5
	6:39:00	6:39:00		40.2	46.4	34.6
	6:40:00	6:40:00		43.4	51.6	32.7
	6:41:00	6:41:00		47.2	55.9	36.1
	6:42:00	6:42:00		52.3	63.7	35.5
	6:43:00	6:43:00		51.1	56.2	41.3
	6:44:00	6:44:00		53.4	60.4	38.6
	6:45:00	6:45:00		52.9	62.5	38.2
	6:46:00	6:46:00		45.6	56.9	34.1
	6:47:00	6:47:00		46.8	56.1	34
	6:48:00	6:48:00		42	49.7	34.2
	6:49:00	6:49:00		38.9	48.5	33.7
	6:50:00	6:50:00		46.2	52.3	36.8
	6:51:00	6:51:00		42.9	50.9	33.4
	6:52:00	6:52:00		43	51.5	33.8
	6:53:00	6:53:00		34.3	36.7	32.5
	6:54:00	6:54:00		34.2	36.9	32.8

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
2:45:20 PM		41686.94	97723.72	6760.83
2:46:20 PM		263026.80	1174897.55	11748.98
2:47:20 PM		223872.11	1737800.83	20892.96
2:48:20 PM		117489.76	1148153.62	11748.98
2:49:20 PM		190546.07	758577.58	22908.68
2:50:20 PM		48977.88	239883.29	10471.29
2:51:20 PM		154881.66	812830.52	19498.45
2:52:20 PM		269153.48	724435.96	17378.01
2:53:20 PM		45708.82	309029.54	3981.07
2:54:20 PM		6309.57	24547.09	3162.28
2:55:20 PM		123026.88	1000000.00	4073.80
2:56:20 PM		67608.30	346736.85	6456.54
2:57:20 PM		87096.36	691830.97	3235.94
2:58:20 PM		177827.94	1412537.54	3388.44
2:59:20 PM		33113.11	524807.46	2041.74
3:00:20 PM		2691.53	5623.41	2041.74
3:01:20 PM		2570.40	5128.61	1905.46
3:02:20 PM		3090.30	9120.11	1949.84
3:03:20 PM		4466.84	19952.62	1949.84
3:04:20 PM		7244.36	28183.83	1995.26
3:05:20 PM		3715.35	10000.00	2344.23
3:06:20 PM		2884.03	5370.32	2137.96
3:07:20 PM		5128.61	9772.37	3162.28
3:08:20 PM		2951.21	10000.00	2089.30
3:09:20 PM		34673.69	338844.16	2137.96
3:10:20 PM		43651.58	263026.80	2754.23
3:11:20 PM		46773.51	234422.88	2754.23
3:12:20 PM		2630.27	4570.88	1949.84
3:13:20 PM		4168.69	9772.37	2041.74
3:14:20 PM		4265.80	12589.25	2344.23
3:15:20 PM		3801.89	29512.09	2041.74
3:16:20 PM		5754.40	36307.81	2041.74
3:17:20 PM		16595.87	229086.77	2818.38
3:18:20 PM		70794.58	281838.29	6165.95
3:19:20 PM		19054.61	426579.52	1905.46
3:20:20 PM		17782.79	165958.69	2041.74
3:21:20 PM		19054.61	87096.36	2290.87
3:22:20 PM		50118.72	288403.15	7413.10
3:23:20 PM		20417.38	66069.34	2754.23
3:24:20 PM		26302.68	100000.00	4073.80
3:25:20 PM		12589.25	120226.44	2137.96
3:26:20 PM		22387.21	107151.93	4073.80
3:27:20 PM		13803.84	89125.09	2344.23
3:28:20 PM		323593.66	3019951.72	22387.21
3:29:20 PM		165958.69	1288249.55	4168.69
3:30:20 PM		91201.08	501187.23	5754.40
3:31:20 PM		46773.51	269153.48	3630.78
3:32:20 PM		63095.73	851138.04	2511.89
3:33:20 PM		6165.95	23988.33	2290.87
3:34:20 PM		39810.72	323593.66	2344.23
3:35:20 PM		426579.52	9772372.21	8709.64
3:36:20 PM		30902.95	186208.71	2511.89
3:37:20 PM		72443.60	891250.94	2398.83
3:38:20 PM		4677.35	23442.29	1995.26
3:39:20 PM		7943.28	48977.88	2454.71
3:40:20 PM		9549.93	34673.69	2187.76
3:41:20 PM		25703.96	173780.08	4265.80
3:42:20 PM		10964.78	51286.14	2691.53
3:43:20 PM		15135.61	120226.44	2238.72
3:44:20 PM		8511.38	28840.32	2089.30
3:45:20 PM		11748.98	91201.08	1995.26
3:46:20 PM		67608.30	812830.52	2818.38
3:47:20 PM		5248.07	24547.09	2290.87
3:48:20 PM		53703.18	446683.59	3801.89
3:49:20 PM		48977.88	588843.66	2691.53
3:50:20 PM		33113.11	323593.66	4786.30
3:51:20 PM		5623.41	17378.01	2818.38
3:52:20 PM		10471.29	43651.58	2884.03
3:53:20 PM		21877.62	144543.98	1862.09
3:54:20 PM		52480.75	389045.14	4073.80
3:55:20 PM		169824.37	2344228.82	3548.13
3:56:20 PM		128824.96	416869.38	13489.63
3:57:20 PM		218776.16	1096478.20	7244.36
3:58:20 PM		194984.46	1778279.41	6606.93
3:59:20 PM		36307.81	489778.82	2570.40
4:00:20 PM		47863.01	407380.28	2511.89
4:01:20 PM		15848.93	93325.43	2630.27
4:02:20 PM		7762.47	70794.58	2344.23
4:03:20 PM		41686.94	169824.37	4786.30
4:04:20 PM		19498.45	123026.88	2187.76
4:05:20 PM		19952.62	141253.75	2398.83
4:06:20 PM		2691.53	4677.35	1778.28
4:07:20 PM		2630.27	4897.79	1905.46

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	6:55:00	6:55:00		35.7	40.4	32.9
	6:56:00	6:56:00		36.4	42	32.9
	6:57:00	6:57:00		41.6	51.8	33.1
	6:58:00	6:58:00		46.3	53	33.6
	6:59:00	6:59:00		56.3	63.1	39.5
	7:00:00	7:00:00		52.6	60.3	38.8
	7:01:00	7:01:00		41.8	48.8	33.3
	7:02:00	7:02:00		49.6	58.3	34.6
	7:03:00	7:03:00		45.6	52.3	34.2
	7:04:00	7:04:00		42.4	52.1	33.7
	7:05:00	7:05:00		50.4	57.9	41.3
	7:06:00	7:06:00		48.8	57.3	38.1
	7:07:00	7:07:00		39.8	47.7	33.7
	7:08:00	7:08:00		48.3	55.8	38.8
	7:09:00	7:09:00		45.4	51.4	37.1
	7:10:00	7:10:00		38.7	47.5	32.8
	7:11:00	7:11:00		33.8	37.8	32.6
	7:12:00	7:12:00		44.8	58.1	32.7
	7:13:00	7:13:00		43.4	51.6	33.8
	7:14:00	7:14:00		52.3	61.5	34.7
	7:15:00	7:15:00		46.2	56.8	34.5
	7:16:00	7:16:00		45.3	51.7	34.8
	7:17:00	7:17:00		51.1	59.7	37.6
	7:18:00	7:18:00		47.4	53.7	38.7
	7:19:00	7:19:00		48	59.4	33
	7:20:00	7:20:00		37.5	43.5	32.5
	7:21:00	7:21:00		34.2	37.5	32.5
	7:22:00	7:22:00		34.3	38.9	32.5
	7:23:00	7:23:00		39.9	51	32.7
	7:24:00	7:24:00		43	48.4	33.5
	7:25:00	7:25:00		47.8	55	34.4
	7:26:00	7:26:00		46.1	53.1	34
	7:27:00	7:27:00		42.4	51.2	34.7
	7:28:00	7:28:00		44.5	53.5	34
	7:29:00	7:29:00		42.6	51.4	34.2
	7:30:00	7:30:00		44.4	52.9	34.9
	7:31:00	7:31:00		43.3	52.8	34.3
	7:32:00	7:32:00		41.2	49.2	35
	7:33:00	7:33:00		37.2	42.6	32.8
	7:34:00	7:34:00		33	34.3	32.4
	7:35:00	7:35:00		33.1	34.4	32.3
	7:36:00	7:36:00		33.4	37.3	32.1
	7:37:00	7:37:00		34.7	37.7	32.8
	7:38:00	7:38:00		34.2	39.1	32.6
	7:39:00	7:39:00		46.8	57.5	33.3
	7:40:00	7:40:00		51.4	58	39.2
	7:41:00	7:41:00		45.7	54.4	34.2
	7:42:00	7:42:00		44.9	50.7	35.8
	7:43:00	7:43:00		41.7	45.7	36.8
	7:44:00	7:44:00		45.5	54.8	35.3
	7:45:00	7:45:00		47.2	55.9	34
	7:46:00	7:46:00		35.3	44.6	32.5
	7:47:00	7:47:00		42.5	51.3	33.7
	7:48:00	7:48:00		43.9	51.2	35
	7:49:00	7:49:00		38.3	45.8	32.8
	7:50:00	7:50:00		47.7	58.2	33
	7:51:00	7:51:00		39.6	47.1	34.9
	7:52:00	7:52:00		39.3	45.4	33
	7:53:00	7:53:00		42.7	48.9	34.8
	7:54:00	7:54:00		35.3	40.1	32.7
	7:55:00	7:55:00		34.1	42.7	32.7
	7:56:00	7:56:00		39.3	48	33.2
	7:57:00	7:57:00		34.3	39.6	32.5
	7:58:00	7:58:00		33.8	37	32.1
	7:59:00	7:59:00		34.3	38.8	32.5
	8:00:00	8:00:00		34.8	37.8	33.3
	8:01:00	8:01:00		45.5	51.9	34
	8:02:00	8:02:00		40.8	49	34.8
	8:03:00	8:03:00		48.1	57.8	35.3
	8:04:00	8:04:00		46.5	54.1	34.4
	8:05:00	8:05:00		39.5	49.3	32.5
	8:06:00	8:06:00		38.3	46	32.8
	8:07:00	8:07:00		37.3	42.7	33
	8:08:00	8:08:00		35.4	41.6	32.8
	8:09:00	8:09:00		38.1	44.5	33
	8:10:00	8:10:00		38.5	48.4	32.8
	8:11:00	8:11:00		37.6	44.5	33
	8:12:00	8:12:00		43.5	50.8	35
	8:13:00	8:13:00		47.8	56	34.4
	8:14:00	8:14:00		41.5	48.9	33.4
	8:15:00	8:15:00		42.6	51.2	33.5
	8:16:00	8:16:00		43.1	50.6	36.1
	8:17:00	8:17:00		47.8	51.6	40.1

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
4:08:20 PM		3715.35	10964.78	1949.84
4:09:20 PM		4365.16	15848.93	1949.84
4:10:20 PM		14454.40	151356.12	2041.74
4:11:20 PM		42657.95	199526.23	2290.87
4:12:20 PM		426579.52	2041737.94	8912.51
4:13:20 PM		181970.09	1071519.31	7585.78
4:14:20 PM		15135.61	75857.76	2137.96
4:15:20 PM		91201.08	676082.98	2884.03
4:16:20 PM		36307.81	169824.37	2630.27
4:17:20 PM		17378.01	162181.01	2344.23
4:18:20 PM		109647.82	616595.00	13489.63
4:19:20 PM		75857.76	537031.80	6456.54
4:20:20 PM		9549.93	58884.37	2344.23
4:21:20 PM		67608.30	380189.40	7585.78
4:22:20 PM		34673.69	138038.43	5128.61
4:23:20 PM		7413.10	56234.13	1905.46
4:24:20 PM		2398.83	6025.60	1819.70
4:25:20 PM		30199.52	645654.23	1862.09
4:26:20 PM		21877.62	144543.98	2398.83
4:27:20 PM		169824.37	1412537.54	2951.21
4:28:20 PM		41686.94	478630.09	2818.38
4:29:20 PM		33884.42	147910.84	3019.95
4:30:20 PM		128824.96	933254.30	5754.40
4:31:20 PM		54954.09	234422.88	7413.10
4:32:20 PM		63095.73	870963.59	1995.26
4:33:20 PM		5623.41	22387.21	1778.28
4:34:20 PM		2630.27	5623.41	1778.28
4:35:20 PM		2691.53	7762.47	1778.28
4:36:20 PM		9772.37	125892.54	1862.09
4:37:20 PM		19952.62	69183.10	2238.72
4:38:20 PM		60255.96	316227.77	2754.23
4:39:20 PM		40738.03	204173.79	2511.89
4:40:20 PM		17378.01	131825.67	2951.21
4:41:20 PM		28183.83	223872.11	2511.89
4:42:20 PM		18197.01	138038.43	2630.27
4:43:20 PM		27542.29	194984.46	3090.30
4:44:20 PM		21379.62	190546.07	2691.53
4:45:20 PM		13182.57	83176.38	3162.28
4:46:20 PM		5248.07	18197.01	1905.46
4:47:20 PM		1995.26	2691.53	1737.80
4:48:20 PM		2041.74	2754.23	1698.24
4:49:20 PM		2187.76	5370.32	1621.81
4:50:20 PM		2951.21	5888.44	1905.46
4:51:20 PM		2630.27	8128.31	1819.70
4:52:20 PM		47863.01	562341.33	2137.96
4:53:20 PM		138038.43	630957.34	8317.64
4:54:20 PM		37153.52	275422.87	2630.27
4:55:20 PM		30902.95	117489.76	3801.89
4:56:20 PM		14791.08	37153.52	4786.30
4:57:20 PM		35481.34	301995.17	3388.44
4:58:20 PM		52480.75	389045.14	2511.89
4:59:20 PM		3388.44	28840.32	1778.28
5:00:20 PM		17782.79	134896.29	2344.23
5:01:20 PM		24547.09	131825.67	3162.28
5:02:20 PM		6760.83	38018.94	1905.46
5:03:20 PM		58884.37	660693.45	1995.26
5:04:20 PM		9120.11	51286.14	3090.30
5:05:20 PM		8511.38	34673.69	1995.26
5:06:20 PM		18620.87	77624.71	3019.95
5:07:20 PM		3388.44	10232.93	1862.09
5:08:20 PM		2570.40	18620.87	1862.09
5:09:20 PM		8511.38	63095.73	2089.30
5:10:20 PM		2691.53	9120.11	1778.28
5:11:20 PM		2398.83	5011.87	1621.81
5:12:20 PM		2691.53	7585.78	1778.28
5:13:20 PM		3019.95	6025.60	2137.96
5:14:20 PM		35481.34	154881.66	2511.89
5:15:20 PM		12022.64	79432.82	3019.95
5:16:20 PM		64565.42	602559.59	3388.44
5:17:20 PM		44668.36	257039.58	2754.23
5:18:20 PM		8912.51	85113.80	1778.28
5:19:20 PM		6760.83	39810.72	1905.46
5:20:20 PM		5370.32	18620.87	1995.26
5:21:20 PM		3467.37	14454.40	1905.46
5:22:20 PM		6456.54	28183.83	1995.26
5:23:20 PM		7079.46	69183.10	1905.46
5:24:20 PM		5754.40	28183.83	1995.26
5:25:20 PM		22387.21	120226.44	3162.28
5:26:20 PM		60255.96	398107.17	2754.23
5:27:20 PM		14125.38	77624.71	2187.76
5:28:20 PM		18197.01	131825.67	2238.72
5:29:20 PM		20417.38	114815.36	4073.80
5:30:20 PM		60255.96	144543.98	10232.93

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	8:18:00	8:18:00		45.6	53.2	33.6
	8:19:00	8:19:00		38.8	43.5	33.2
	8:20:00	8:20:00		49.4	56.1	36.1
	8:21:00	8:21:00		47.3	59.1	39
	8:22:00	8:22:00		49.7	58.6	37.3
	8:23:00	8:23:00		45.7	54.1	34.5
	8:24:00	8:24:00		40.3	46.7	33.3
	8:25:00	8:25:00		38.8	45.2	33
	8:26:00	8:26:00		35.7	41.2	32.2
	8:27:00	8:27:00		36.2	42.4	32.8
	8:28:00	8:28:00		44.6	53.4	32.6
	8:29:00	8:29:00		44.6	53.3	36.2
	8:30:00	8:30:00		48.4	56.5	34.8
	8:31:00	8:31:00		42.1	51.3	33.6
	8:32:00	8:32:00		33.9	36.4	32.8
	8:33:00	8:33:00		43.3	52.1	33.5
	8:34:00	8:34:00		50.4	58.2	34.5
	8:35:00	8:35:00		50.4	57.3	34.3
	8:36:00	8:36:00		42.5	51.9	33.6
	8:37:00	8:37:00		43.6	52.5	34
	8:38:00	8:38:00		43.5	53.5	33.5
	8:39:00	8:39:00		40.7	48.9	33.1
	8:40:00	8:40:00		37.4	42.2	32.7
	8:41:00	8:41:00		34.7	38.3	32.9
	8:42:00	8:42:00		36.1	42.6	33.3
	8:43:00	8:43:00		43.9	50.9	33.4
	8:44:00	8:44:00		40.1	49.1	32.9
	8:45:00	8:45:00		33.7	37.3	32.5
	8:46:00	8:46:00		36.9	42.2	33.2
	8:47:00	8:47:00		34.2	38.5	32.7
	8:48:00	8:48:00		33.6	36.3	32.6
	8:49:00	8:49:00		33.4	37.7	32.3
	8:50:00	8:50:00		34.1	36.5	32.6
	8:51:00	8:51:00		41.9	48.2	33.1
	8:52:00	8:52:00		46.2	53	37
	8:53:00	8:53:00		45.8	52.3	35.6
	8:54:00	8:54:00		45	54	36.5
	8:55:00	8:55:00		40.8	49.3	33.2
	8:56:00	8:56:00		38.9	44.5	34
	8:57:00	8:57:00		41.7	51.4	35
	8:58:00	8:58:00		39.5	46.7	33.5
	8:59:00	8:59:00		41.8	48.7	33.8
	9:00:00	9:00:00		45.2	50.4	36.8
	9:01:00	9:01:00		41.3	50	34.5
	9:02:00	9:02:00		42.3	49	34.9
	9:03:00	9:03:00		44.8	52	33.8
	9:04:00	9:04:00		39.6	45.4	33.7
	9:05:00	9:05:00		38.9	47.9	32.7
	9:06:00	9:06:00		37.7	45	33.1
	9:07:00	9:07:00		37.8	44.1	33.6
	9:08:00	9:08:00		35	42.6	32.5
	9:09:00	9:09:00		33.6	37.8	32.5
	9:10:00	9:10:00		34.2	38.9	32.4
	9:11:00	9:11:00		35.2	40.8	32.7
	9:12:00	9:12:00		36.6	42.6	32.8
	9:13:00	9:13:00		37.4	44.6	33.1
	9:14:00	9:14:00		35.4	40.4	32.8
	9:15:00	9:15:00		34.5	40.6	32.7
	9:16:00	9:16:00		34.4	37	32.7
	9:17:00	9:17:00		38	45.4	33.2
	9:18:00	9:18:00		36.5	42.1	33.1
	9:19:00	9:19:00		36.5	42.3	33
	9:20:00	9:20:00		36.6	42.4	32.7
	9:21:00	9:21:00		41.3	49.5	34.2
	9:22:00	9:22:00		38.1	46.2	32.5
	9:23:00	9:23:00		35.4	41.7	32.9
	9:24:00	9:24:00		43	49	34.7
	9:25:00	9:25:00		38.3	48.4	33.1
	9:26:00	9:26:00		40.3	48.5	34.2
	9:27:00	9:27:00		34.8	38.4	32.5
	9:28:00	9:28:00		33.5	35.9	32.5
	9:29:00	9:29:00		33.2	38.8	32.4
	9:30:00	9:30:00		34.5	39.2	32.5
	9:31:00	9:31:00		33.2	34.7	32.5
	9:32:00	9:32:00		33.8	37.9	32.7
	9:33:00	9:33:00		33.5	36.8	32.6
	9:34:00	9:34:00		34.1	38.3	32.7
	9:35:00	9:35:00		44	52.7	34.3
	9:36:00	9:36:00		39.2	47.7	32.9
	9:37:00	9:37:00		39.3	48.5	32.9
	9:38:00	9:38:00		34.2	39.6	32.5
	9:39:00	9:39:00		40.4	52	32.7
	9:40:00	9:40:00		36.1	43.7	32.6

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
5:31:20 PM		36307.81	208929.61	2290.87
5:32:20 PM		7585.78	22387.21	2089.30
5:33:20 PM		87096.36	407380.28	4073.80
5:34:20 PM		53703.18	812830.52	7943.28
5:35:20 PM		93325.43	724435.96	5370.32
5:36:20 PM		37153.52	257039.58	2818.38
5:37:20 PM		10715.19	46773.51	2137.96
5:38:20 PM		7585.78	33113.11	1995.26
5:39:20 PM		3715.35	13182.57	1659.59
5:40:20 PM		4168.69	17378.01	1905.46
5:41:20 PM		28840.32	218776.16	1819.70
5:42:20 PM		28840.32	213796.21	4168.69
5:43:20 PM		69183.10	446683.59	3019.95
5:44:20 PM		16218.10	134896.29	2290.87
5:45:20 PM		2454.71	4365.16	1905.46
5:46:20 PM		21379.62	162181.01	2238.72
5:47:20 PM		109647.82	660693.45	2818.38
5:48:20 PM		109647.82	537031.80	2691.53
5:49:20 PM		17782.79	154881.66	2290.87
5:50:20 PM		22908.68	177827.94	2511.89
5:51:20 PM		22387.21	223872.11	2238.72
5:52:20 PM		11748.98	77624.71	2041.74
5:53:20 PM		5495.41	16595.87	1862.09
5:54:20 PM		2951.21	6760.83	1949.84
5:55:20 PM		4073.80	18197.01	2137.96
5:56:20 PM		24547.09	123026.88	2187.76
5:57:20 PM		10232.93	81283.05	1949.84
5:58:20 PM		2344.23	5370.32	1778.28
5:59:20 PM		4897.79	16595.87	2089.30
6:00:20 PM		2630.27	7079.46	1862.09
6:01:20 PM		2290.87	4265.80	1819.70
6:02:20 PM		2187.76	5888.44	1698.24
6:03:20 PM		2570.40	4466.84	1819.70
6:04:20 PM		15488.17	66069.34	2041.74
6:05:20 PM		41686.94	199526.23	5011.87
6:06:20 PM		38018.94	169824.37	3630.78
6:07:20 PM		31622.78	251188.64	4466.84
6:08:20 PM		12022.64	85113.80	2089.30
6:09:20 PM		7762.47	28183.83	2511.89
6:10:20 PM		14791.08	138038.43	3162.28
6:11:20 PM		8912.51	46773.51	2238.72
6:12:20 PM		15135.61	74131.02	2398.83
6:13:20 PM		33113.11	109647.82	4786.30
6:14:20 PM		13489.63	100000.00	2818.38
6:15:20 PM		16982.44	79432.82	3090.30
6:16:20 PM		30199.52	158489.32	2398.83
6:17:20 PM		9120.11	34673.69	2344.23
6:18:20 PM		7762.47	61659.50	1862.09
6:19:20 PM		5888.44	31622.78	2041.74
6:20:20 PM		6025.60	25703.96	2290.87
6:21:20 PM		3162.28	18197.01	1778.28
6:22:20 PM		2290.87	6025.60	1778.28
6:23:20 PM		2630.27	7762.47	1737.80
6:24:20 PM		3311.31	12022.64	1862.09
6:25:20 PM		4570.88	18197.01	1905.46
6:26:20 PM		5495.41	28840.32	2041.74
6:27:20 PM		3467.37	10964.78	1905.46
6:28:20 PM		2818.38	11481.54	1862.09
6:29:20 PM		2754.23	5011.87	1862.09
6:30:20 PM		6309.57	34673.69	2089.30
6:31:20 PM		4466.84	16218.10	2041.74
6:32:20 PM		4466.84	16982.44	1995.26
6:33:20 PM		4570.88	17378.01	1862.09
6:34:20 PM		13489.63	89125.09	2630.27
6:35:20 PM		6456.54	41686.94	1778.28
6:36:20 PM		3467.37	14791.08	1949.84
6:37:20 PM		19952.62	79432.82	2951.21
6:38:20 PM		6760.83	69183.10	2041.74
6:39:20 PM		10715.19	70794.58	2630.27
6:40:20 PM		3019.95	6918.31	1778.28
6:41:20 PM		2238.72	3890.45	1778.28
6:42:20 PM		2089.30	7585.78	1737.80
6:43:20 PM		2818.38	8317.64	1778.28
6:44:20 PM		2089.30	2951.21	1778.28
6:45:20 PM		2398.83	6165.95	1862.09
6:46:20 PM		2238.72	4786.30	1819.70
6:47:20 PM		2570.40	6760.83	1862.09
6:48:20 PM		25118.86	186208.71	2691.53
6:49:20 PM		8317.64	58884.37	1949.84
6:50:20 PM		8511.38	70794.58	1949.84
6:51:20 PM		2630.27	9120.11	1778.28
6:52:20 PM		10964.78	158489.32	1862.09
6:53:20 PM		4073.80	23442.29	1819.70

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	9:41:00	9:41:00		38.8	45.2	33.3
	9:42:00	9:42:00		37.1	43.4	32.9
	9:43:00	9:43:00		41.3	50.4	32.8
	9:44:00	9:44:00		37.8	43.8	32.5
	9:45:00	9:45:00		38.3	46.6	32.3
	9:46:00	9:46:00		35.1	39.4	32.6
	9:47:00	9:47:00		39.6	46.9	32.7
	9:48:00	9:48:00		37.1	42.1	33.4
	9:49:00	9:49:00		37.6	45.5	32.8
	9:50:00	9:50:00		37.2	45.1	33.1
	9:51:00	9:51:00		34.1	37.8	32.5
	9:52:00	9:52:00		35.5	40.3	33.1
	9:53:00	9:53:00		34.3	38.9	32.8
	9:54:00	9:54:00		33.3	34.9	32.5
	9:55:00	9:55:00		33.6	37	32.5
	9:56:00	9:56:00		35.4	41.6	32.8
	9:57:00	9:57:00		36.9	44.3	32.6
	9:58:00	9:58:00		35.1	42.7	32.6
	9:59:00	9:59:00		37.5	43.3	32.7
	10:00:00	10:00:00		33.7	36.4	32.4
	10:01:00	10:01:00		36.6	42.3	32.6
	10:02:00	10:02:00		40	47.4	32.7
	10:03:00	10:03:00		37.7	48	32.6
	10:04:00	10:04:00		37.1	45.2	32.4
	10:05:00	10:05:00		38.2	47	32.7
	10:06:00	10:06:00		36.3	44.4	32.5
	10:07:00	10:07:00		35.5	42.5	32.6
	10:08:00	10:08:00		42.9	53.1	33.1
	10:09:00	10:09:00		36.9	42.1	33.3
	10:10:00	10:10:00		40.8	47.9	33.2
	10:11:00	10:11:00		36.7	44.3	33.4
	10:12:00	10:12:00		33.7	35.4	33
	10:13:00	10:13:00		37.1	44	32.8
	10:14:00	10:14:00		39.2	46.3	33.7
	10:15:00	10:15:00		36.9	44.5	32.7
	10:16:00	10:16:00		33.8	37.4	32.7
	10:17:00	10:17:00		33.7	35.8	32.9
	10:18:00	10:18:00		34.8	39.6	32.9
	10:19:00	10:19:00		36.9	40.6	33.4
	10:20:00	10:20:00		33.7	36.9	32.7
	10:21:00	10:21:00		36.1	41.6	32.8
	10:22:00	10:22:00		34.5	39	32.9
	10:23:00	10:23:00		39.3	45.2	33.1
	10:24:00	10:24:00		37.6	43.4	33.1
	10:25:00	10:25:00		37.3	42.9	33.1
	10:26:00	10:26:00		40.2	50.2	34.3
	10:27:00	10:27:00		39.5	46.3	33.6
	10:28:00	10:28:00		41.5	49.7	33.5
	10:29:00	10:29:00		39.3	46.5	33.7
	10:30:00	10:30:00		39.8	47	33.3
	10:31:00	10:31:00		38.8	45.9	32.7
	10:32:00	10:32:00		35.6	39.9	32.7
	10:33:00	10:33:00		34.5	39.4	32.8
	10:34:00	10:34:00		45.1	56.4	33.7
	10:35:00	10:35:00		41.9	48.7	33.2
	10:36:00	10:36:00		37.5	42.1	33.3
	10:37:00	10:37:00		34.2	36.5	33
	10:38:00	10:38:00		34.8	38.9	33.1
	10:39:00	10:39:00		39.3	46.8	33
	10:40:00	10:40:00		49.6	55.8	34
	10:41:00	10:41:00		41.5	49	34.5
	10:42:00	10:42:00		39.7	46.5	34.5
	10:43:00	10:43:00		39.6	45.2	33.5
	10:44:00	10:44:00		37.7	43.7	33.4
	10:45:00	10:45:00		35	42.9	33.3
	10:46:00	10:46:00		35.6	40.4	33.1
	10:47:00	10:47:00		35.9	41.4	33
	10:48:00	10:48:00		35.3	38.6	33
	10:49:00	10:49:00		35.2	39.4	33.5
	10:50:00	10:50:00		34.3	37.1	32.8
	10:51:00	10:51:00		40.6	47.8	33.5
	10:52:00	10:52:00		36.8	42.8	33.2
	10:53:00	10:53:00		38.4	48.8	33.1
	10:54:00	10:54:00		39.9	46.8	33.7
	10:55:00	10:55:00		34	35.5	32.9
	10:56:00	10:56:00		35.9	42.4	32.7
	10:57:00	10:57:00		40.3	49.5	32.9
	10:58:00	10:58:00		42.9	54.1	33.1
	10:59:00	10:59:00		42.3	48.4	34.5
	11:00:00	11:00:00		36.8	41.7	33.2
	11:01:00	11:01:00		34.1	37.2	33
	11:02:00	11:02:00		34.6	39.8	32.9
	11:03:00	11:03:00		35.1	41	33

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
6:54:20 PM		7585.78	33113.11	2137.96
6:55:20 PM		5128.61	21877.62	1949.84
6:56:20 PM		13489.63	109647.82	1905.46
6:57:20 PM		6025.60	23988.33	1778.28
6:58:20 PM		6760.83	45708.82	1698.24
6:59:20 PM		3235.94	8709.64	1819.70
7:00:20 PM		9120.11	48977.88	1862.09
7:01:20 PM		5128.61	16218.10	2187.76
7:02:20 PM		5754.40	35481.34	1905.46
7:03:20 PM		5248.07	32359.37	2041.74
7:04:20 PM		2570.40	6025.60	1778.28
7:05:20 PM		3548.13	10715.19	2041.74
7:06:20 PM		2691.53	7762.47	1905.46
7:07:20 PM		2137.96	3090.30	1778.28
7:08:20 PM		2290.87	5011.87	1778.28
7:09:20 PM		3467.37	14454.40	1905.46
7:10:20 PM		4897.79	26915.35	1819.70
7:11:20 PM		3235.94	18620.87	1819.70
7:12:20 PM		5623.41	21379.62	1862.09
7:13:20 PM		2344.23	4365.16	1737.80
7:14:20 PM		4570.88	16982.44	1819.70
7:15:20 PM		10000.00	54954.09	1862.09
7:16:20 PM		5888.44	63095.73	1819.70
7:17:20 PM		5128.61	33113.11	1737.80
7:18:20 PM		6606.93	50118.72	1862.09
7:19:20 PM		4265.80	27542.29	1778.28
7:20:20 PM		3548.13	17782.79	1819.70
7:21:20 PM		19498.45	204173.79	2041.74
7:22:20 PM		4897.79	16218.10	2137.96
7:23:20 PM		12022.64	61659.50	2089.30
7:24:20 PM		4677.35	26915.35	2187.76
7:25:20 PM		2344.23	3467.37	1995.26
7:26:20 PM		5128.61	25118.86	1905.46
7:27:20 PM		8317.64	42657.95	2344.23
7:28:20 PM		4897.79	28183.83	1862.09
7:29:20 PM		2398.83	5495.41	1862.09
7:30:20 PM		2344.23	3801.89	1949.84
7:31:20 PM		3019.95	9120.11	1949.84
7:32:20 PM		4897.79	11481.54	2187.76
7:33:20 PM		2344.23	4897.79	1862.09
7:34:20 PM		4073.80	14454.40	1905.46
7:35:20 PM		2818.38	7943.28	1949.84
7:36:20 PM		8511.38	33113.11	2041.74
7:37:20 PM		5754.40	21877.62	2041.74
7:38:20 PM		5370.32	19498.45	2041.74
7:39:20 PM		10471.29	104712.85	2691.53
7:40:20 PM		8912.51	42657.95	2290.87
7:41:20 PM		14125.38	93325.43	2238.72
7:42:20 PM		8511.38	44668.36	2344.23
7:43:20 PM		9549.93	50118.72	2137.96
7:44:20 PM		7585.78	38904.51	1862.09
7:45:20 PM		3630.78	9772.37	1862.09
7:46:20 PM		2818.38	8709.64	1905.46
7:47:20 PM		32359.37	436515.83	2344.23
7:48:20 PM		15488.17	74131.02	2089.30
7:49:20 PM		5623.41	16218.10	2137.96
7:50:20 PM		2630.27	4466.84	1995.26
7:51:20 PM		3019.95	7762.47	2041.74
7:52:20 PM		8511.38	47863.01	1995.26
7:53:20 PM		91201.08	380189.40	2511.89
7:54:20 PM		14125.38	79432.82	2818.38
7:55:20 PM		9332.54	44668.36	2818.38
7:56:20 PM		9120.11	33113.11	2238.72
7:57:20 PM		5888.44	23442.29	2187.76
7:58:20 PM		3162.28	19498.45	2137.96
7:59:20 PM		3630.78	10964.78	2041.74
8:00:20 PM		3890.45	13803.84	1995.26
8:01:20 PM		3388.44	7244.36	1995.26
8:02:20 PM		3311.31	8709.64	2238.72
8:03:20 PM		2691.53	5128.61	1905.46
8:04:20 PM		11481.54	60255.96	2238.72
8:05:20 PM		4786.30	19054.61	2089.30
8:06:20 PM		6918.31	75857.76	2041.74
8:07:20 PM		9772.37	47863.01	2344.23
8:08:20 PM		2511.89	3548.13	1949.84
8:09:20 PM		3890.45	17378.01	1862.09
8:10:20 PM		10715.19	89125.09	1949.84
8:11:20 PM		19498.45	257039.58	2041.74
8:12:20 PM		16982.44	69183.10	2818.38
8:13:20 PM		4786.30	14791.08	2089.30
8:14:20 PM		2570.40	5248.07	1995.26
8:15:20 PM		2884.03	9549.93	1949.84
8:16:20 PM		3235.94	12589.25	1995.26

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	11:04:00	11:04:00		39	46	33.5
	11:05:00	11:05:00		35.9	41	33.2
	11:06:00	11:06:00		40	46.7	33.4
	11:07:00	11:07:00		41.2	47.8	33.1
	11:08:00	11:08:00		36.8	43.6	33.8
	11:09:00	11:09:00		34.3	38.3	32.9
	11:10:00	11:10:00		48.1	56.5	35.2
	11:11:00	11:11:00		42.4	49.2	35.7
	11:12:00	11:12:00		35.4	42	33
	11:13:00	11:13:00		37.8	44.1	33.4
	11:14:00	11:14:00		35.3	40.7	33
	11:15:00	11:15:00		37.8	43	33.3
	11:16:00	11:16:00		39.7	47.8	33.4
	11:17:00	11:17:00		38.2	47.4	33.4
	11:18:00	11:18:00		37.1	45.1	33.2
	11:19:00	11:19:00		36.9	42.1	33.5
	11:20:00	11:20:00		34.7	40.5	33.1
	11:21:00	11:21:00		35.7	40.7	33.3
	11:22:00	11:22:00		36	44.5	33.4
	11:23:00	11:23:00		35.7	40.5	33.8
	11:24:00	11:24:00		35.7	42.1	33.2
	11:25:00	11:25:00		35.2	41	33.1
	11:26:00	11:26:00		35.4	39.8	33.4
	11:27:00	11:27:00		41	49.4	35.2
	11:28:00	11:28:00		38.2	43.5	34
	11:29:00	11:29:00		34.8	39.5	33.3
	11:30:00	11:30:00		36.9	43.4	33
	11:31:00	11:31:00		35.3	40.7	33.2
	11:32:00	11:32:00		34.6	40.8	33.1
	11:33:00	11:33:00		39.4	46.9	33.2
	11:34:00	11:34:00		35.1	39.6	33.1
	11:35:00	11:35:00		35.2	39.8	33.3
	11:36:00	11:36:00		36	40.5	33.2
	11:37:00	11:37:00		35.3	41.1	33.3
	11:38:00	11:38:00		38.1	45.8	33.2
	11:39:00	11:39:00		34.9	41.8	33.1
	11:40:00	11:40:00		35.5	40.5	33.6
	11:41:00	11:41:00		36	42.3	33.7
	11:42:00	11:42:00		33.9	35.1	33.2
	11:43:00	11:43:00		34.1	38.3	33
	11:44:00	11:44:00		35.4	41.6	33.4
	11:45:00	11:45:00		36.1	46.1	33.3
	11:46:00	11:46:00		34.6	40.3	33.4
	11:47:00	11:47:00		34	36	33.2
	11:48:00	11:48:00		34.1	35.2	32.9
	11:49:00	11:49:00		34.6	40.3	33.3
	11:50:00	11:50:00		34.1	36.2	33.1
	11:51:00	11:51:00		33.7	34.7	33.1
	11:52:00	11:52:00		34.5	38.8	33.5
	11:53:00	11:53:00		33.9	34.9	33.1
	11:54:00	11:54:00		33.8	34.7	33.2
	11:55:00	11:55:00		35.5	43.2	32.9
	11:56:00	11:56:00		36	42.6	33.4
	11:57:00	11:57:00		35.1	39.7	33.3
	11:58:00	11:58:00		34	36.7	33.1
	11:59:00	11:59:00		36.3	42.3	33.3
	12:00:00	12:00:00		34.6	38	33.5
	12:01:00	12:01:00		36.6	41.3	34.1
	12:02:00	12:02:00		34.2	35.9	33.5
	12:03:00	12:03:00		34	35	33.1
	12:04:00	12:04:00		35.2	40.3	33.1
	12:05:00	12:05:00		34.9	36.7	33.8
	12:06:00	12:06:00		33.9	34.6	33.2
	12:07:00	12:07:00		33.9	35.1	33
	12:08:00	12:08:00		33.6	34.1	33.1
	12:09:00	12:09:00		33.9	34.8	33.1
	12:10:00	12:10:00		34.5	37.7	33.2
	12:11:00	12:11:00		33.6	34.6	32.9
	12:12:00	12:12:00		34	34.7	33.4
	12:13:00	12:13:00		33.8	34.9	33.1
	12:14:00	12:14:00		33.7	35.3	33.1
	12:15:00	12:15:00		33.6	34.5	33.1
	12:16:00	12:16:00		33.6	34.9	33.1
	12:17:00	12:17:00		33.7	34.4	33.2
	12:18:00	12:18:00		33.7	34.6	33
	12:19:00	12:19:00		33.9	34.8	33.2
	12:20:00	12:20:00		33.9	35	33.2
	12:21:00	12:21:00		34.2	34.9	33.4
	12:22:00	12:22:00		33.9	34.9	33.5
	12:23:00	12:23:00		34.4	36.2	33.7
	12:24:00	12:24:00		34	34.6	33.3
	12:25:00	12:25:00		34	34.6	33.3
	12:26:00	12:26:00		34.1	35.9	33.4

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
8:17:20 PM		7943.28	39810.72	2238.72
8:18:20 PM		3890.45	12589.25	2089.30
8:19:20 PM		10000.00	46773.51	2187.76
8:20:20 PM		13182.57	60255.96	2041.74
8:21:20 PM		4786.30	22908.68	2398.83
8:22:20 PM		2691.53	6760.83	1949.84
8:23:20 PM		64565.42	446683.59	3311.31
8:24:20 PM		17378.01	83176.38	3715.35
8:25:20 PM		3467.37	15848.93	1995.26
8:26:20 PM		6025.60	25703.96	2187.76
8:27:20 PM		3388.44	11748.98	1995.26
8:28:20 PM		6025.60	19952.62	2137.96
8:29:20 PM		9332.54	60255.96	2187.76
8:30:20 PM		6606.93	54954.09	2187.76
8:31:20 PM		5128.61	32359.37	2089.30
8:32:20 PM		4897.79	16218.10	2238.72
8:33:20 PM		2951.21	11220.18	2041.74
8:34:20 PM		3715.35	11748.98	2137.96
8:35:20 PM		3981.07	28183.83	2187.76
8:36:20 PM		3715.35	11220.18	2398.83
8:37:20 PM		3715.35	16218.10	2089.30
8:38:20 PM		3311.31	12589.25	2041.74
8:39:20 PM		3467.37	9549.93	2187.76
8:40:20 PM		12589.25	87096.36	3311.31
8:41:20 PM		6606.93	22387.21	2511.89
8:42:20 PM		3019.95	8912.51	2137.96
8:43:20 PM		4897.79	21877.62	1995.26
8:44:20 PM		3388.44	11748.98	2089.30
8:45:20 PM		2884.03	12022.64	2041.74
8:46:20 PM		8709.64	48977.88	2089.30
8:47:20 PM		3235.94	9120.11	2041.74
8:48:20 PM		3311.31	9549.93	2137.96
8:49:20 PM		3981.07	11220.18	2089.30
8:50:20 PM		3388.44	12882.50	2137.96
8:51:20 PM		6456.54	38018.94	2089.30
8:52:20 PM		3090.30	15135.61	2041.74
8:53:20 PM		3548.13	11220.18	2290.87
8:54:20 PM		3981.07	16982.44	2344.23
8:55:20 PM		2454.71	3235.94	2089.30
8:56:20 PM		2570.40	6760.83	1995.26
8:57:20 PM		3467.37	14454.40	2187.76
8:58:20 PM		4073.80	40738.03	2137.96
8:59:20 PM		2884.03	10715.19	2187.76
9:00:20 PM		2511.89	3981.07	2089.30
9:01:20 PM		2570.40	3311.31	1949.84
9:02:20 PM		2884.03	10715.19	2137.96
9:03:20 PM		2570.40	4168.69	2041.74
9:04:20 PM		2344.23	2951.21	2041.74
9:05:20 PM		2818.38	7585.78	2238.72
9:06:20 PM		2454.71	3090.30	2041.74
9:07:20 PM		2398.83	2951.21	2089.30
9:08:20 PM		3548.13	20892.96	1949.84
9:09:20 PM		3981.07	18197.01	2187.76
9:10:20 PM		3235.94	9332.54	2137.96
9:11:20 PM		2511.89	4677.35	2041.74
9:12:20 PM		4265.80	16982.44	2137.96
9:13:20 PM		2884.03	6309.57	2238.72
9:14:20 PM		4570.88	13489.63	2570.40
9:15:20 PM		2630.27	3890.45	2238.72
9:16:20 PM		2511.89	3162.28	2041.74
9:17:20 PM		3311.31	10715.19	2041.74
9:18:20 PM		3090.30	4677.35	2398.83
9:19:20 PM		2454.71	2884.03	2089.30
9:20:20 PM		2454.71	3235.94	1995.26
9:21:20 PM		2290.87	2570.40	2041.74
9:22:20 PM		2454.71	3019.95	2041.74
9:23:20 PM		2818.38	5888.44	2089.30
9:24:20 PM		2290.87	2884.03	1949.84
9:25:20 PM		2511.89	2951.21	2187.76
9:26:20 PM		2398.83	3090.30	2041.74
9:27:20 PM		2344.23	3388.44	2041.74
9:28:20 PM		2290.87	2818.38	2041.74
9:29:20 PM		2290.87	3090.30	2041.74
9:30:20 PM		2344.23	2754.23	2089.30
9:31:20 PM		2344.23	2884.03	1995.26
9:32:20 PM		2454.71	3019.95	2089.30
9:33:20 PM		2454.71	3162.28	2089.30
9:34:20 PM		2630.27	3090.30	2187.76
9:35:20 PM		2454.71	3090.30	2238.72
9:36:20 PM		2754.23	4168.69	2344.23
9:37:20 PM		2511.89	2884.03	2137.96
9:38:20 PM		2511.89	2884.03	2137.96
9:39:20 PM		2570.40	3890.45	2187.76

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	12:27:00	12:27:00		33.7	34.5	33.1
	12:28:00	12:28:00		33.6	34.5	32.9
	12:29:00	12:29:00		33.7	35	33.1
	12:30:00	12:30:00		33.5	34.2	33
	12:31:00	12:31:00		33.6	34.4	33.1
	12:32:00	12:32:00		33.8	34.4	33
	12:33:00	12:33:00		33.9	34.7	33.4
	12:34:00	12:34:00		34.2	34.9	33.5
	12:35:00	12:35:00		34.1	35.1	33.3
	12:36:00	12:36:00		34	35.6	33.4
	12:37:00	12:37:00		33.9	34.6	33.4
	12:38:00	12:38:00		34.4	35.2	33.7
	12:39:00	12:39:00		34.1	35.1	33.5
	12:40:00	12:40:00		34.1	34.8	33.5
	12:41:00	12:41:00		34.3	36.1	33.7
	12:42:00	12:42:00		34.5	35.4	33.6
	12:43:00	12:43:00		34.4	36.1	33.3
	12:44:00	12:44:00		34.6	35.6	33.9
	12:45:00	12:45:00		34.2	35.3	33.5
	12:46:00	12:46:00		34.2	36.4	33.5
	12:47:00	12:47:00		33.8	35.4	33.1
	12:48:00	12:48:00		33.9	34.6	33.3
	12:49:00	12:49:00		34.3	36.3	33.3
	12:50:00	12:50:00		33.7	34.2	33.1
	12:51:00	12:51:00		34	35	33
	12:52:00	12:52:00		33.9	34.6	33.4
	12:53:00	12:53:00		33.8	34.3	33.1
	12:54:00	12:54:00		34.1	35.2	33.5
	12:55:00	12:55:00		34.3	35.6	33.4
	12:56:00	12:56:00		34.2	35.5	33.4
	12:57:00	12:57:00		34.1	34.8	33.6
	12:58:00	12:58:00		34.3	35.3	33.6
	12:59:00	12:59:00		34.7	36.1	33.7
	13:00:00	13:00:00		34.6	36	33.6
	13:01:00	13:01:00		34.7	35.9	34
	13:02:00	13:02:00		34.8	35.4	34
	13:03:00	13:03:00		34.4	34.9	33.7
	13:04:00	13:04:00		34.5	35.4	33.3
	13:05:00	13:05:00		34.7	36.2	33.8
	13:06:00	13:06:00		34.4	36.1	33.6
	13:07:00	13:07:00		34.8	36.2	33.6
	13:08:00	13:08:00		33.9	34.8	33.3
	13:09:00	13:09:00		34.6	35.7	34
	13:10:00	13:10:00		34.5	36.3	33.7
	13:11:00	13:11:00		34.3	35.2	33.8
	13:12:00	13:12:00		34.1	35.2	33.5
	13:13:00	13:13:00		34.1	34.9	33.5
	13:14:00	13:14:00		34.5	35.4	34
	13:15:00	13:15:00		34.2	35.5	33.5
	13:16:00	13:16:00		33.8	34.6	33.3
	13:17:00	13:17:00		34.2	35.2	33.6
	13:18:00	13:18:00		34.4	35.2	33.5
	13:19:00	13:19:00		34.5	35.3	33.6
	13:20:00	13:20:00		34.7	36.1	33.7
	13:21:00	13:21:00		34.2	35	33.6
	13:22:00	13:22:00		34.6	36.9	33.6
	13:23:00	13:23:00		34.5	36.2	33.4
	13:24:00	13:24:00		34.2	35.3	33.5
	13:25:00	13:25:00		34.1	35	33.4
	13:26:00	13:26:00		34.1	34.8	33.5
	13:27:00	13:27:00		34	35	33.3
	13:28:00	13:28:00		34	35.3	33.2
	13:29:00	13:29:00		33.9	34.7	33.2
	13:30:00	13:30:00		33.9	35.1	33.1
	13:31:00	13:31:00		35.2	38.9	33.5
	13:32:00	13:32:00		34.3	35.8	33.5
	13:33:00	13:33:00		34.2	35.5	33.4
	13:34:00	13:34:00		33.9	34.7	33.4
	13:35:00	13:35:00		34.4	37.5	33.3
	13:36:00	13:36:00		34.4	36	33.4
	13:37:00	13:37:00		34.2	35.7	33.4
	13:38:00	13:38:00		34.2	36.3	33.6
	13:39:00	13:39:00		34.6	37.7	33.2
	13:40:00	13:40:00		34.2	35.7	33.3
	13:41:00	13:41:00		33.8	35.4	33
	13:42:00	13:42:00		34.2	36.2	33
	13:43:00	13:43:00		35.9	40.8	33.7
	13:44:00	13:44:00		36.1	42.5	33.6
	13:45:00	13:45:00		34.9	38.6	33.7
	13:46:00	13:46:00		34.7	37.6	33.5
	13:47:00	13:47:00		34.3	35.5	33.3
	13:48:00	13:48:00		34.3	35.8	33.5
	13:49:00	13:49:00		35.2	42	33.6

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
9:40:20 PM		2344.23	2818.38	2041.74
9:41:20 PM		2290.87	2818.38	1949.84
9:42:20 PM		2344.23	3162.28	2041.74
9:43:20 PM		2238.72	2630.27	1995.26
9:44:20 PM		2290.87	2754.23	2041.74
9:45:20 PM		2398.83	2754.23	1995.26
9:46:20 PM		2454.71	2951.21	2187.76
9:47:20 PM		2630.27	3090.30	2238.72
9:48:20 PM		2570.40	3235.94	2137.96
9:49:20 PM		2511.89	3630.78	2187.76
9:50:20 PM		2454.71	2884.03	2187.76
9:51:20 PM		2754.23	3311.31	2344.23
9:52:20 PM		2570.40	3235.94	2238.72
9:53:20 PM		2570.40	3019.95	2238.72
9:54:20 PM		2691.53	4073.80	2344.23
9:55:20 PM		2818.38	3467.37	2290.87
9:56:20 PM		2754.23	4073.80	2137.96
9:57:20 PM		2884.03	3630.78	2454.71
9:58:20 PM		2630.27	3388.44	2238.72
9:59:20 PM		2630.27	4365.16	2238.72
10:00:20 PM		2398.83	3467.37	2041.74
10:01:20 PM		2454.71	2884.03	2137.96
10:02:20 PM		2691.53	4265.80	2137.96
10:03:20 PM		2344.23	2630.27	2041.74
10:04:20 PM		2511.89	3162.28	1995.26
10:05:20 PM		2454.71	2884.03	2187.76
10:06:20 PM		2398.83	2691.53	2041.74
10:07:20 PM		2570.40	3311.31	2238.72
10:08:20 PM		2691.53	3630.78	2187.76
10:09:20 PM		2630.27	3548.13	2187.76
10:10:20 PM		2570.40	3019.95	2290.87
10:11:20 PM		2691.53	3388.44	2290.87
10:12:20 PM		2951.21	4073.80	2344.23
10:13:20 PM		2884.03	3981.07	2290.87
10:14:20 PM		2951.21	3890.45	2511.89
10:15:20 PM		3019.95	3467.37	2511.89
10:16:20 PM		2754.23	3090.30	2344.23
10:17:20 PM		2818.38	3467.37	2137.96
10:18:20 PM		2951.21	4168.69	2398.83
10:19:20 PM		2754.23	4073.80	2290.87
10:20:20 PM		3019.95	4168.69	2290.87
10:21:20 PM		2454.71	3019.95	2137.96
10:22:20 PM		2884.03	3715.35	2511.89
10:23:20 PM		2818.38	4265.80	2344.23
10:24:20 PM		2691.53	3311.31	2398.83
10:25:20 PM		2570.40	3311.31	2238.72
10:26:20 PM		2570.40	3090.30	2238.72
10:27:20 PM		2818.38	3467.37	2511.89
10:28:20 PM		2630.27	3548.13	2238.72
10:29:20 PM		2398.83	2884.03	2137.96
10:30:20 PM		2630.27	3311.31	2290.87
10:31:20 PM		2754.23	3311.31	2238.72
10:32:20 PM		2818.38	3388.44	2290.87
10:33:20 PM		2951.21	4073.80	2344.23
10:34:20 PM		2630.27	3162.28	2290.87
10:35:20 PM		2884.03	4897.79	2290.87
10:36:20 PM		2818.38	4168.69	2187.76
10:37:20 PM		2630.27	3388.44	2238.72
10:38:20 PM		2570.40	3162.28	2187.76
10:39:20 PM		2570.40	3019.95	2238.72
10:40:20 PM		2511.89	3162.28	2137.96
10:41:20 PM		2511.89	3388.44	2089.30
10:42:20 PM		2454.71	2951.21	2089.30
10:43:20 PM		2454.71	3235.94	2041.74
10:44:20 PM		3311.31	7762.47	2238.72
10:45:20 PM		2691.53	3801.89	2238.72
10:46:20 PM		2630.27	3548.13	2187.76
10:47:20 PM		2454.71	2951.21	2187.76
10:48:20 PM		2754.23	5623.41	2137.96
10:49:20 PM		2754.23	3981.07	2187.76
10:50:20 PM		2630.27	3715.35	2187.76
10:51:20 PM		2630.27	4265.80	2290.87
10:52:20 PM		2884.03	5888.44	2089.30
10:53:20 PM		2630.27	3715.35	2137.96
10:54:20 PM		2398.83	3467.37	1995.26
10:55:20 PM		2630.27	4168.69	1995.26
10:56:20 PM		3890.45	12022.64	2344.23
10:57:20 PM		4073.80	17782.79	2290.87
10:58:20 PM		3090.30	7244.36	2344.23
10:59:20 PM		2951.21	5754.40	2238.72
11:00:20 PM		2691.53	3548.13	2137.96
11:01:20 PM		2691.53	3801.89	2238.72
11:02:20 PM		3311.31	15848.93	2290.87

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	13:50:00	13:50:00		34.2	35.1	33.4
	13:51:00	13:51:00		34.7	37.9	33.3
	13:52:00	13:52:00		35.6	40.6	33.8
	13:53:00	13:53:00		35.2	40.4	33.7
	13:54:00	13:54:00		34	35	33.2
	13:55:00	13:55:00		34.1	34.9	33.4
	13:56:00	13:56:00		34.2	35.1	33.5
	13:57:00	13:57:00		34.4	36.2	33.6
	13:58:00	13:58:00		34.5	35.3	33.8
	13:59:00	13:59:00		35.1	36.3	34.1
	14:00:00	14:00:00		34.3	35.2	33.5
	14:01:00	14:01:00		34.3	35.3	33.6
	14:02:00	14:02:00		34.6	35.5	33.8
	14:03:00	14:03:00		34.5	35.9	33.7
	14:04:00	14:04:00		35.2	38.3	34
	14:05:00	14:05:00		35.3	39.9	33.9
	14:06:00	14:06:00		34.4	35.2	33.8
	14:07:00	14:07:00		34.3	35.1	33.8
	14:08:00	14:08:00		34.8	36	33.8
	14:09:00	14:09:00		34.4	36.3	33.6
	14:10:00	14:10:00		34.4	35.4	33.7
	14:11:00	14:11:00		34.1	34.6	33.2
	14:12:00	14:12:00		34.5	35.2	33.9
	14:13:00	14:13:00		34.3	35	33.5
	14:14:00	14:14:00		34.2	35.4	33.4
	14:15:00	14:15:00		34.2	35.2	33.5
	14:16:00	14:16:00		34	34.9	33.3
	14:17:00	14:17:00		34.2	34.8	33.5
	14:18:00	14:18:00		34.1	35.1	33.4
	14:19:00	14:19:00		34.1	34.9	33.5
	14:20:00	14:20:00		34	34.6	33.4
	14:21:00	14:21:00		34.3	35.2	33.7
	14:22:00	14:22:00		34	34.8	33.3
	14:23:00	14:23:00		34.2	35.4	33.4
	14:24:00	14:24:00		34	34.7	33.5
	14:25:00	14:25:00		34.5	36	33.5
	14:26:00	14:26:00		34.2	35	33.5
	14:27:00	14:27:00		34.5	35.6	33.7
	14:28:00	14:28:00		34.7	35.6	33.8
	14:29:00	14:29:00		34.3	36	33.5
	14:30:00	14:30:00		34.5	36.4	33.7
	14:31:00	14:31:00		34.9	37	33.8
	14:32:00	14:32:00		34.3	35.9	33.3
	14:33:00	14:33:00		34.2	36.1	33.3
	14:34:00	14:34:00		34.2	35.3	33.5
	14:35:00	14:35:00		34	34.8	33.1
	14:36:00	14:36:00		34.1	34.8	33.3
	14:37:00	14:37:00		34.3	35.4	33.3
	14:38:00	14:38:00		34.5	37.8	33.5
	14:39:00	14:39:00		34.4	39.1	33.3
	14:40:00	14:40:00		34.4	35.5	33.7
	14:41:00	14:41:00		34.3	35.1	33.8
	14:42:00	14:42:00		34.2	34.9	33.7
	14:43:00	14:43:00		34.2	34.8	33.6
	14:44:00	14:44:00		34.1	34.9	33.5
	14:45:00	14:45:00		34.2	35.4	33.7
	14:46:00	14:46:00		34.3	35.1	33.7
	14:47:00	14:47:00		34	34.6	33.6
	14:48:00	14:48:00		34.3	35.1	33.7
	14:49:00	14:49:00		34	34.4	33.5
	14:50:00	14:50:00		33.9	34.3	33.4
	14:51:00	14:51:00		34.3	35	33.5
	14:52:00	14:52:00		33.7	34	33.5
	14:53:00	14:53:00		33.9	34.3	33.5
	14:54:00	14:54:00		34.1	34.8	33.5
	14:55:00	14:55:00		34	34.9	33.5
	14:56:00	14:56:00		34.1	34.7	33.6
	14:57:00	14:57:00		33.9	34.5	33.3
	14:58:00	14:58:00		33.9	34.4	33.4
	14:59:00	14:59:00		33.9	34.5	33.5
	15:00:00	15:00:00		33.9	34.5	33.4
	15:01:00	15:01:00		33.8	34.4	33.2
	15:02:00	15:02:00		33.8	34.3	33.5
	15:03:00	15:03:00		33.8	34.2	33.5
	15:04:00	15:04:00		33.7	34.2	33.2
	15:05:00	15:05:00		33.6	34.2	33
	15:06:00	15:06:00		33.7	34.4	33.3
	15:07:00	15:07:00		33.8	34.3	33.3
	15:08:00	15:08:00		33.8	34.3	33.3
	15:09:00	15:09:00		34.2	41.8	33.2
	15:10:00	15:10:00		33.9	34.4	33.3
	15:11:00	15:11:00		34	35	33.4
	15:12:00	15:12:00		34	35	33.6

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
11:03:20 PM		2630.27	3235.94	2187.76
11:04:20 PM		2951.21	6165.95	2137.96
11:05:20 PM		3630.78	11481.54	2398.83
11:06:20 PM		3311.31	10964.78	2344.23
11:07:20 PM		2511.89	3162.28	2089.30
11:08:20 PM		2570.40	3090.30	2187.76
11:09:20 PM		2630.27	3235.94	2238.72
11:10:20 PM		2754.23	4168.69	2290.87
11:11:20 PM		2818.38	3388.44	2398.83
11:12:20 PM		3235.94	4265.80	2570.40
11:13:20 PM		2691.53	3311.31	2238.72
11:14:20 PM		2691.53	3388.44	2290.87
11:15:20 PM		2884.03	3548.13	2398.83
11:16:20 PM		2818.38	3890.45	2344.23
11:17:20 PM		3311.31	6760.83	2511.89
11:18:20 PM		3388.44	9772.37	2454.71
11:19:20 PM		2754.23	3311.31	2398.83
11:20:20 PM		2691.53	3235.94	2398.83
11:21:20 PM		3019.95	3981.07	2398.83
11:22:20 PM		2754.23	4265.80	2290.87
11:23:20 PM		2754.23	3467.37	2344.23
11:24:20 PM		2570.40	2884.03	2089.30
11:25:20 PM		2818.38	3311.31	2454.71
11:26:20 PM		2691.53	3162.28	2238.72
11:27:20 PM		2630.27	3467.37	2187.76
11:28:20 PM		2630.27	3311.31	2238.72
11:29:20 PM		2511.89	3090.30	2137.96
11:30:20 PM		2630.27	3019.95	2238.72
11:31:20 PM		2570.40	3235.94	2187.76
11:32:20 PM		2570.40	3090.30	2238.72
11:33:20 PM		2511.89	2884.03	2187.76
11:34:20 PM		2691.53	3311.31	2344.23
11:35:20 PM		2511.89	3019.95	2137.96
11:36:20 PM		2630.27	3467.37	2187.76
11:37:20 PM		2511.89	2951.21	2238.72
11:38:20 PM		2818.38	3981.07	2238.72
11:39:20 PM		2630.27	3162.28	2238.72
11:40:20 PM		2818.38	3630.78	2344.23
11:41:20 PM		2951.21	3630.78	2398.83
11:42:20 PM		2691.53	3981.07	2238.72
11:43:20 PM		2818.38	4365.16	2344.23
11:44:20 PM		3090.30	5011.87	2398.83
11:45:20 PM		2691.53	3890.45	2137.96
11:46:20 PM		2630.27	4073.80	2137.96
11:47:20 PM		2630.27	3388.44	2238.72
11:48:20 PM		2511.89	3019.95	2041.74
11:49:20 PM		2570.40	3019.95	2137.96
11:50:20 PM		2691.53	3467.37	2137.96
11:51:20 PM		2818.38	6025.60	2238.72
11:52:20 PM		2754.23	8128.31	2137.96
11:53:20 PM		2754.23	3548.13	2344.23
11:54:20 PM		2691.53	3235.94	2398.83
11:55:20 PM		2630.27	3090.30	2344.23
11:56:20 PM		2630.27	3019.95	2290.87
11:57:20 PM		2570.40	3090.30	2238.72
11:58:20 PM		2630.27	3467.37	2344.23
11:59:20 PM		2691.53	3235.94	2344.23
12:00:20 AM		2511.89	2884.03	2290.87
12:01:20 AM		2691.53	3235.94	2344.23
12:02:20 AM		2511.89	2754.23	2238.72
12:03:20 AM		2454.71	2691.53	2187.76
12:04:20 AM		2691.53	3162.28	2238.72
12:05:20 AM		2344.23	2511.89	2238.72
12:06:20 AM		2454.71	2691.53	2238.72
12:07:20 AM		2570.40	3019.95	2238.72
12:08:20 AM		2511.89	3090.30	2238.72
12:09:20 AM		2570.40	2951.21	2290.87
12:10:20 AM		2454.71	2818.38	2137.96
12:11:20 AM		2454.71	2754.23	2187.76
12:12:20 AM		2454.71	2818.38	2238.72
12:13:20 AM		2454.71	2818.38	2187.76
12:14:20 AM		2398.83	2754.23	2089.30
12:15:20 AM		2398.83	2691.53	2238.72
12:16:20 AM		2398.83	2630.27	2238.72
12:17:20 AM		2344.23	2630.27	2089.30
12:18:20 AM		2290.87	2630.27	1995.26
12:19:20 AM		2344.23	2754.23	2137.96
12:20:20 AM		2398.83	2691.53	2137.96
12:21:20 AM		2398.83	2691.53	2137.96
12:22:20 AM		2630.27	15135.61	2089.30
12:23:20 AM		2454.71	2754.23	2137.96
12:24:20 AM		2511.89	3162.28	2187.76
12:25:20 AM		2511.89	3162.28	2290.87

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	15:13:00	15:13:00		33.8	34.7	33.3
	15:14:00	15:14:00		34.1	35	33.4
	15:15:00	15:15:00		34.3	34.7	33.7
	15:16:00	15:16:00		34.1	34.7	33.5
	15:17:00	15:17:00		33.9	34.4	33.5
	15:18:00	15:18:00		36	49.3	33.4
	15:19:00	15:19:00		34.2	41.8	33.3
	15:20:00	15:20:00		33.9	34.4	33.6
	15:21:00	15:21:00		33.9	34.4	33.5
	15:22:00	15:22:00		34.2	34.9	33.6
	15:23:00	15:23:00		33.7	34.1	33.3
	15:24:00	15:24:00		33.6	34	33.2
	15:25:00	15:25:00		33.7	34.1	33.3
	15:26:00	15:26:00		33.7	35.1	33.2
	15:27:00	15:27:00		33.7	34.2	33.2
	15:28:00	15:28:00		33.5	33.9	33.1
	15:29:00	15:29:00		33.6	34.2	33.1
	15:30:00	15:30:00		33.4	33.8	33
	15:31:00	15:31:00		33.6	34.2	33.1
	15:32:00	15:32:00		33.7	34.1	33.4
	15:33:00	15:33:00		33.9	34.5	33.2
	15:34:00	15:34:00		34.1	34.6	33.5
	15:35:00	15:35:00		33.9	34.6	33.4
	15:36:00	15:36:00		33.8	34.4	33.2
	15:37:00	15:37:00		33.7	34.1	33.4
	15:38:00	15:38:00		33.7	34.3	33.4
	15:39:00	15:39:00		34.1	35.2	33.4
	15:40:00	15:40:00		34	34.5	33.4
	15:41:00	15:41:00		33.9	34.3	33.5
	15:42:00	15:42:00		33.9	34.5	33.3
	15:43:00	15:43:00		33.8	34.2	33.4
	15:44:00	15:44:00		34	34.7	33.4
	15:45:00	15:45:00		33.7	34.1	33.3
	15:46:00	15:46:00		33.9	34.2	33.5
	15:47:00	15:47:00		34	34.7	33.5
	15:48:00	15:48:00		34.3	35.1	33.3
	15:49:00	15:49:00		34.1	34.9	33.3
	15:50:00	15:50:00		33.7	34.6	33.2
	15:51:00	15:51:00		33.5	33.9	33.1
	15:52:00	15:52:00		33.5	33.9	33.1
	15:53:00	15:53:00		33.5	33.9	33.1
	15:54:00	15:54:00		33.7	34	33.3
	15:55:00	15:55:00		33.6	34	33.2
	15:56:00	15:56:00		33.4	33.7	33.1
	15:57:00	15:57:00		33.7	34.2	33.3
	15:58:00	15:58:00		33.7	34.6	33.2
	15:59:00	15:59:00		33.7	34.4	33.3
	16:00:00	16:00:00		33.5	34.1	33.1
	16:01:00	16:01:00		33.5	34	33
	16:02:00	16:02:00		33.5	34.1	33.1
	16:03:00	16:03:00		33.4	33.9	33
	16:04:00	16:04:00		33.9	36.2	33.3
	16:05:00	16:05:00		33.6	34	33.2
	16:06:00	16:06:00		33.7	34.2	33.3
	16:07:00	16:07:00		33.7	34.2	33.3
	16:08:00	16:08:00		33.6	34.1	33.1
	16:09:00	16:09:00		33.5	33.9	33
	16:10:00	16:10:00		33.5	34	33
	16:11:00	16:11:00		33.6	34	33.2
	16:12:00	16:12:00		33.6	34	33.3
	16:13:00	16:13:00		33.6	34	33.3
	16:14:00	16:14:00		33.7	34.3	33.1
	16:15:00	16:15:00		33.6	34.2	33.2
	16:16:00	16:16:00		33.5	33.8	33.2
	16:17:00	16:17:00		33.7	34.2	33.3
	16:18:00	16:18:00		33.6	34	33.2
	16:19:00	16:19:00		33.7	34.1	33.5
	16:20:00	16:20:00		33.6	34	33.3
	16:21:00	16:21:00		33.6	34.1	33.2
	16:22:00	16:22:00		33.8	34.2	33.3
	16:23:00	16:23:00		33.7	34.3	33.2
	16:24:00	16:24:00		33.5	33.8	33.2
	16:25:00	16:25:00		33.6	33.9	33.3
	16:26:00	16:26:00		33.8	34.1	33.4
	16:27:00	16:27:00		34.1	34.7	33.5
	16:28:00	16:28:00		34	34.6	33.3
	16:29:00	16:29:00		34.2	34.9	33.5
	16:30:00	16:30:00		34.2	35.1	33.6
	16:31:00	16:31:00		33.9	34.5	33.5
	16:32:00	16:32:00		34.4	35.9	33.5
	16:33:00	16:33:00		34.7	36.1	33.7
	16:34:00	16:34:00		33.9	34.8	33.4
	16:35:00	16:35:00		34.3	35.1	33.2

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
12:26:20 AM		2398.83	2951.21	2137.96
12:27:20 AM		2570.40	3162.28	2187.76
12:28:20 AM		2691.53	2951.21	2344.23
12:29:20 AM		2570.40	2951.21	2238.72
12:30:20 AM		2454.71	2754.23	2238.72
12:31:20 AM		3981.07	85113.80	2187.76
12:32:20 AM		2630.27	15135.61	2137.96
12:33:20 AM		2454.71	2754.23	2290.87
12:34:20 AM		2454.71	2754.23	2238.72
12:35:20 AM		2630.27	3090.30	2290.87
12:36:20 AM		2344.23	2570.40	2137.96
12:37:20 AM		2290.87	2511.89	2089.30
12:38:20 AM		2344.23	2570.40	2137.96
12:39:20 AM		2344.23	3235.94	2089.30
12:40:20 AM		2344.23	2630.27	2089.30
12:41:20 AM		2238.72	2454.71	2041.74
12:42:20 AM		2290.87	2630.27	2041.74
12:43:20 AM		2187.76	2398.83	1995.26
12:44:20 AM		2290.87	2630.27	2041.74
12:45:20 AM		2344.23	2570.40	2187.76
12:46:20 AM		2454.71	2818.38	2089.30
12:47:20 AM		2570.40	2884.03	2238.72
12:48:20 AM		2454.71	2884.03	2187.76
12:49:20 AM		2398.83	2754.23	2089.30
12:50:20 AM		2344.23	2570.40	2187.76
12:51:20 AM		2344.23	2691.53	2187.76
12:52:20 AM		2570.40	3311.31	2187.76
12:53:20 AM		2511.89	2818.38	2187.76
12:54:20 AM		2454.71	2691.53	2238.72
12:55:20 AM		2454.71	2818.38	2137.96
12:56:20 AM		2398.83	2630.27	2187.76
12:57:20 AM		2511.89	2951.21	2187.76
12:58:20 AM		2344.23	2570.40	2137.96
12:59:20 AM		2454.71	2630.27	2238.72
1:00:20 AM		2511.89	2951.21	2238.72
1:01:20 AM		2691.53	3235.94	2137.96
1:02:20 AM		2570.40	3090.30	2137.96
1:03:20 AM		2344.23	2884.03	2089.30
1:04:20 AM		2238.72	2454.71	2041.74
1:05:20 AM		2238.72	2454.71	2041.74
1:06:20 AM		2238.72	2454.71	2041.74
1:07:20 AM		2344.23	2511.89	2137.96
1:08:20 AM		2290.87	2511.89	2089.30
1:09:20 AM		2187.76	2344.23	2041.74
1:10:20 AM		2344.23	2630.27	2137.96
1:11:20 AM		2344.23	2884.03	2089.30
1:12:20 AM		2344.23	2754.23	2137.96
1:13:20 AM		2238.72	2570.40	2041.74
1:14:20 AM		2238.72	2511.89	1995.26
1:15:20 AM		2238.72	2570.40	2041.74
1:16:20 AM		2187.76	2454.71	1995.26
1:17:20 AM		2454.71	4168.69	2137.96
1:18:20 AM		2290.87	2511.89	2089.30
1:19:20 AM		2344.23	2630.27	2137.96
1:20:20 AM		2344.23	2630.27	2137.96
1:21:20 AM		2290.87	2570.40	2041.74
1:22:20 AM		2238.72	2454.71	1995.26
1:23:20 AM		2238.72	2511.89	1995.26
1:24:20 AM		2290.87	2511.89	2089.30
1:25:20 AM		2290.87	2511.89	2137.96
1:26:20 AM		2290.87	2511.89	2137.96
1:27:20 AM		2344.23	2691.53	2041.74
1:28:20 AM		2290.87	2630.27	2089.30
1:29:20 AM		2238.72	2398.83	2089.30
1:30:20 AM		2344.23	2630.27	2137.96
1:31:20 AM		2290.87	2511.89	2089.30
1:32:20 AM		2344.23	2570.40	2238.72
1:33:20 AM		2290.87	2511.89	2137.96
1:34:20 AM		2290.87	2570.40	2089.30
1:35:20 AM		2398.83	2630.27	2137.96
1:36:20 AM		2344.23	2691.53	2089.30
1:37:20 AM		2238.72	2398.83	2089.30
1:38:20 AM		2290.87	2454.71	2137.96
1:39:20 AM		2398.83	2570.40	2187.76
1:40:20 AM		2570.40	2951.21	2238.72
1:41:20 AM		2511.89	2884.03	2137.96
1:42:20 AM		2630.27	3090.30	2238.72
1:43:20 AM		2630.27	3235.94	2290.87
1:44:20 AM		2454.71	2818.38	2238.72
1:45:20 AM		2754.23	3890.45	2238.72
1:46:20 AM		2951.21	4073.80	2344.23
1:47:20 AM		2454.71	3019.95	2187.76
1:48:20 AM		2691.53	3235.94	2089.30

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	16:36:00	16:36:00		34	35	33.5
	16:37:00	16:37:00		34.2	35.1	33.7
	16:38:00	16:38:00		34.5	35.7	33.8
	16:39:00	16:39:00		34.4	35.2	33.7
	16:40:00	16:40:00		34.1	34.5	33.5
	16:41:00	16:41:00		34.3	35.1	33.7
	16:42:00	16:42:00		34.3	35.1	33.6
	16:43:00	16:43:00		34.2	35.2	33.4
	16:44:00	16:44:00		34.5	35.7	33.7
	16:45:00	16:45:00		33.9	34.6	33.4
	16:46:00	16:46:00		33.9	34.6	33.5
	16:47:00	16:47:00		34.1	34.8	33.6
	16:48:00	16:48:00		34.1	34.7	33.8
	16:49:00	16:49:00		34.3	35.1	33.6
	16:50:00	16:50:00		33.9	34.8	33.3
	16:51:00	16:51:00		33.6	34	33.2
	16:52:00	16:52:00		33.8	34.4	33.3
	16:53:00	16:53:00		34	34.7	33.4
	16:54:00	16:54:00		33.8	34.7	33.2
	16:55:00	16:55:00		34.1	34.8	33.5
	16:56:00	16:56:00		34.2	34.6	33.7
	16:57:00	16:57:00		33.9	34.4	33.6
	16:58:00	16:58:00		34.2	34.8	33.4
	16:59:00	16:59:00		34.1	34.7	33.4
	17:00:00	17:00:00		33.9	34.7	33.4
	17:01:00	17:01:00		34.1	36.5	33.3
	17:02:00	17:02:00		34.1	35.1	33.4
	17:03:00	17:03:00		34.3	34.9	33.7
	17:04:00	17:04:00		34.3	35.3	33.8
	17:05:00	17:05:00		34	34.6	33.6
	17:06:00	17:06:00		33.9	34.6	33.4
	17:07:00	17:07:00		34.1	34.7	33.4
	17:08:00	17:08:00		34.3	34.9	33.8
	17:09:00	17:09:00		33.9	34.8	33.4
	17:10:00	17:10:00		33.9	34.3	33.3
	17:11:00	17:11:00		33.9	34.5	33.3
	17:12:00	17:12:00		33.8	34.2	33.4
	17:13:00	17:13:00		34	34.5	33.5
	17:14:00	17:14:00		34.3	34.8	33.6
	17:15:00	17:15:00		34	35	33.2
	17:16:00	17:16:00		34.4	35.6	33.7
	17:17:00	17:17:00		34.1	34.8	33.7
	17:18:00	17:18:00		34.3	35.3	33.7
	17:19:00	17:19:00		34.2	34.9	33.6
	17:20:00	17:20:00		34.2	35	33.4
	17:21:00	17:21:00		34.3	35	33.7
	17:22:00	17:22:00		34.3	34.7	33.9
	17:23:00	17:23:00		34.4	35.1	33.9
	17:24:00	17:24:00		34.9	35.5	34.3
	17:25:00	17:25:00		34.6	35.9	33.8
	17:26:00	17:26:00		34.4	34.9	33.9
	17:27:00	17:27:00		34.2	35.1	33.5
	17:28:00	17:28:00		34	34.5	33.5
	17:29:00	17:29:00		34.5	35.6	33.8
	17:30:00	17:30:00		34.4	35.6	33.7
	17:31:00	17:31:00		34.1	35.2	33.5
	17:32:00	17:32:00		33.9	34.2	33.4
	17:33:00	17:33:00		33.7	34.4	33.1
	17:34:00	17:34:00		33.7	34.2	33.3
	17:35:00	17:35:00		33.9	34.4	33.6
	17:36:00	17:36:00		34.4	35	33.8
	17:37:00	17:37:00		34.8	35.8	33.9
	17:38:00	17:38:00		34	34.9	33.3
	17:39:00	17:39:00		34	34.6	33.4
	17:40:00	17:40:00		34	34.6	33.3
	17:41:00	17:41:00		34	34.5	33.4
	17:42:00	17:42:00		33.9	35.3	33.1
	17:43:00	17:43:00		33.9	34.4	33.3
	17:44:00	17:44:00		33.6	34.1	33.2
	17:45:00	17:45:00		34.3	36.7	33.5
	17:46:00	17:46:00		34.3	35	33.7
	17:47:00	17:47:00		34.4	35.4	33.6
	17:48:00	17:48:00		34.5	35.4	33.5
	17:49:00	17:49:00		34.1	34.9	33.3
	17:50:00	17:50:00		34.1	35	33.3
	17:51:00	17:51:00		34.4	35.2	33.4
	17:52:00	17:52:00		34.2	34.9	33.6
	17:53:00	17:53:00		33.8	34.6	33.2
	17:54:00	17:54:00		34	34.8	33.2
	17:55:00	17:55:00		34.2	35	33.7
	17:56:00	17:56:00		34.3	35.8	33.5
	17:57:00	17:57:00		34.3	39.8	33.4
	17:58:00	17:58:00		34.1	35.6	33.4

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
1:49:20 AM		2511.89	3162.28	2238.72
1:50:20 AM		2630.27	3235.94	2344.23
1:51:20 AM		2818.38	3715.35	2398.83
1:52:20 AM		2754.23	3311.31	2344.23
1:53:20 AM		2570.40	2818.38	2238.72
1:54:20 AM		2691.53	3235.94	2344.23
1:55:20 AM		2691.53	3235.94	2290.87
1:56:20 AM		2630.27	3311.31	2187.76
1:57:20 AM		2818.38	3715.35	2344.23
1:58:20 AM		2454.71	2884.03	2187.76
1:59:20 AM		2454.71	2884.03	2238.72
2:00:20 AM		2570.40	3019.95	2290.87
2:01:20 AM		2570.40	2951.21	2398.83
2:02:20 AM		2691.53	3235.94	2290.87
2:03:20 AM		2454.71	3019.95	2137.96
2:04:20 AM		2290.87	2511.89	2089.30
2:05:20 AM		2398.83	2754.23	2137.96
2:06:20 AM		2511.89	2951.21	2187.76
2:07:20 AM		2398.83	2951.21	2089.30
2:08:20 AM		2570.40	3019.95	2238.72
2:09:20 AM		2630.27	2884.03	2344.23
2:10:20 AM		2454.71	2754.23	2290.87
2:11:20 AM		2630.27	3019.95	2187.76
2:12:20 AM		2570.40	2951.21	2187.76
2:13:20 AM		2454.71	2951.21	2187.76
2:14:20 AM		2570.40	4466.84	2137.96
2:15:20 AM		2570.40	3235.94	2187.76
2:16:20 AM		2691.53	3090.30	2344.23
2:17:20 AM		2691.53	3388.44	2398.83
2:18:20 AM		2511.89	2884.03	2290.87
2:19:20 AM		2454.71	2884.03	2187.76
2:20:20 AM		2570.40	2951.21	2187.76
2:21:20 AM		2691.53	3090.30	2398.83
2:22:20 AM		2454.71	3019.95	2187.76
2:23:20 AM		2454.71	2691.53	2137.96
2:24:20 AM		2454.71	2818.38	2137.96
2:25:20 AM		2398.83	2630.27	2187.76
2:26:20 AM		2511.89	2818.38	2238.72
2:27:20 AM		2691.53	3019.95	2290.87
2:28:20 AM		2511.89	3162.28	2089.30
2:29:20 AM		2754.23	3630.78	2344.23
2:30:20 AM		2570.40	3019.95	2344.23
2:31:20 AM		2691.53	3388.44	2344.23
2:32:20 AM		2630.27	3090.30	2290.87
2:33:20 AM		2630.27	3162.28	2187.76
2:34:20 AM		2691.53	3162.28	2344.23
2:35:20 AM		2691.53	2951.21	2454.71
2:36:20 AM		2754.23	3235.94	2454.71
2:37:20 AM		3090.30	3548.13	2691.53
2:38:20 AM		2884.03	3890.45	2398.83
2:39:20 AM		2754.23	3090.30	2454.71
2:40:20 AM		2630.27	3235.94	2238.72
2:41:20 AM		2511.89	2818.38	2238.72
2:42:20 AM		2818.38	3630.78	2398.83
2:43:20 AM		2754.23	3630.78	2344.23
2:44:20 AM		2570.40	3311.31	2238.72
2:45:20 AM		2454.71	2630.27	2187.76
2:46:20 AM		2344.23	2754.23	2041.74
2:47:20 AM		2344.23	2630.27	2137.96
2:48:20 AM		2454.71	2754.23	2290.87
2:49:20 AM		2754.23	3162.28	2398.83
2:50:20 AM		3019.95	3801.89	2454.71
2:51:20 AM		2511.89	3090.30	2137.96
2:52:20 AM		2511.89	2884.03	2187.76
2:53:20 AM		2511.89	2884.03	2137.96
2:54:20 AM		2511.89	2818.38	2187.76
2:55:20 AM		2454.71	3388.44	2041.74
2:56:20 AM		2454.71	2754.23	2137.96
2:57:20 AM		2290.87	2570.40	2089.30
2:58:20 AM		2691.53	4677.35	2238.72
2:59:20 AM		2691.53	3162.28	2344.23
3:00:20 AM		2754.23	3467.37	2290.87
3:01:20 AM		2818.38	3467.37	2238.72
3:02:20 AM		2570.40	3090.30	2137.96
3:03:20 AM		2570.40	3162.28	2137.96
3:04:20 AM		2754.23	3311.31	2187.76
3:05:20 AM		2630.27	3090.30	2290.87
3:06:20 AM		2398.83	2884.03	2089.30
3:07:20 AM		2511.89	3019.95	2089.30
3:08:20 AM		2630.27	3162.28	2344.23
3:09:20 AM		2691.53	3801.89	2238.72
3:10:20 AM		2691.53	9549.93	2187.76
3:11:20 AM		2570.40	3630.78	2187.76

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	17:59:00	17:59:00		34.1	34.9	33.6
	18:00:00	18:00:00		34	34.7	33.5
	18:01:00	18:01:00		34	34.7	33.3
	18:02:00	18:02:00		33.5	34	33.1
	18:03:00	18:03:00		33.9	34.3	33.3
	18:04:00	18:04:00		33.6	34.1	33.1
	18:05:00	18:05:00		33.9	34.8	33.1
	18:06:00	18:06:00		33.8	35	33.2
	18:07:00	18:07:00		33.8	34.3	33.4
	18:08:00	18:08:00		33.7	35.5	33
	18:09:00	18:09:00		33.5	34.1	33.1
	18:10:00	18:10:00		34	34.8	33.4
	18:11:00	18:11:00		34.8	36.2	33.8
	18:12:00	18:12:00		34.4	35.8	33.1
	18:13:00	18:13:00		33.6	35	33
	18:14:00	18:14:00		34.1	35.7	33.4
	18:15:00	18:15:00		33.9	35	33.5
	18:16:00	18:16:00		34.2	36.1	33.2
	18:17:00	18:17:00		33.9	34.8	33.4
	18:18:00	18:18:00		34.3	35.4	33.6
	18:19:00	18:19:00		34.5	35.2	33.8
	18:20:00	18:20:00		34.5	35.5	33.9
	18:21:00	18:21:00		34.2	34.8	33.7
	18:22:00	18:22:00		34.1	34.7	33.5
	18:23:00	18:23:00		33.6	34.2	33.2
	18:24:00	18:24:00		33.9	34.5	33.4
	18:25:00	18:25:00		34.1	34.6	33.4
	18:26:00	18:26:00		33.7	34.2	33.3
	18:27:00	18:27:00		33.9	35.4	33.1
	18:28:00	18:28:00		33.4	34	32.9
	18:29:00	18:29:00		34.1	34.9	33.4
	18:30:00	18:30:00		34.2	35.3	33.5
	18:31:00	18:31:00		33.8	34.5	33.3
	18:32:00	18:32:00		33.7	34.4	33.3
	18:33:00	18:33:00		33.7	34.1	33.2
	18:34:00	18:34:00		34.1	35.3	33.3
	18:35:00	18:35:00		33.6	34.3	33.2
	18:36:00	18:36:00		33.7	34.2	33.1
	18:37:00	18:37:00		34	34.6	33.4
	18:38:00	18:38:00		34.1	34.8	33.6
	18:39:00	18:39:00		34.1	34.9	33.3
	18:40:00	18:40:00		33.9	34.3	33.5
	18:41:00	18:41:00		33.7	34.3	33.2
	18:42:00	18:42:00		34.1	35.3	33.4
	18:43:00	18:43:00		34	34.3	33.6
	18:44:00	18:44:00		33.7	34.1	33.2
	18:45:00	18:45:00		34.4	36	33.5
	18:46:00	18:46:00		34.2	35	33.8
	18:47:00	18:47:00		33.9	34.6	33.5
	18:48:00	18:48:00		33.7	34.1	33.3
	18:49:00	18:49:00		34.4	35.3	33.8
	18:50:00	18:50:00		33.9	34.8	33.5
	18:51:00	18:51:00		34.6	37	33.5
	18:52:00	18:52:00		33.9	34.3	33.6
	18:53:00	18:53:00		34.1	35	33.6
	18:54:00	18:54:00		34.1	34.7	33.6
	18:55:00	18:55:00		34.3	34.9	33.6
	18:56:00	18:56:00		33.9	34.5	33.4
	18:57:00	18:57:00		34.2	34.6	33.5
	18:58:00	18:58:00		34.6	35.4	34.1
	18:59:00	18:59:00		34.7	36.2	34.1
	19:00:00	19:00:00		34.7	35.7	34
	19:01:00	19:01:00		34.7	36.1	34.1
	19:02:00	19:02:00		35	36.1	34.1
	19:03:00	19:03:00		35.5	39.3	34.5
	19:04:00	19:04:00		36.4	40.5	34.8
	19:05:00	19:05:00		37.2	42.9	34
	19:06:00	19:06:00		34.6	36.4	33.7
	19:07:00	19:07:00		34.5	35.4	33.9
	19:08:00	19:08:00		34.8	36	33.9
	19:09:00	19:09:00		35.1	37.5	33.5
	19:10:00	19:10:00		35.3	38.5	33.5
	19:11:00	19:11:00		35.9	37.9	34.6
	19:12:00	19:12:00		35.3	37.5	34
	19:13:00	19:13:00		34.6	35.3	33.8
	19:14:00	19:14:00		36	39	34
	19:15:00	19:15:00		34.6	35.7	33.7
	19:16:00	19:16:00		34.8	35.8	33.9
	19:17:00	19:17:00		35.2	39.9	33.9
	19:18:00	19:18:00		36	38.3	34.1
	19:19:00	19:19:00		40.8	46.1	34.5
	19:20:00	19:20:00		35.9	43.8	34
	19:21:00	19:21:00		34.8	37.1	33.9

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
3:12:20 AM		2570.40	3090.30	2290.87
3:13:20 AM		2511.89	2951.21	2238.72
3:14:20 AM		2511.89	2951.21	2137.96
3:15:20 AM		2238.72	2511.89	2041.74
3:16:20 AM		2454.71	2691.53	2137.96
3:17:20 AM		2290.87	2570.40	2041.74
3:18:20 AM		2454.71	3019.95	2041.74
3:19:20 AM		2398.83	3162.28	2089.30
3:20:20 AM		2398.83	2691.53	2187.76
3:21:20 AM		2344.23	3548.13	1995.26
3:22:20 AM		2238.72	2570.40	2041.74
3:23:20 AM		2511.89	3019.95	2187.76
3:24:20 AM		3019.95	4168.69	2398.83
3:25:20 AM		2754.23	3801.89	2041.74
3:26:20 AM		2290.87	3162.28	1995.26
3:27:20 AM		2570.40	3715.35	2187.76
3:28:20 AM		2454.71	3162.28	2238.72
3:29:20 AM		2630.27	4073.80	2089.30
3:30:20 AM		2454.71	3019.95	2187.76
3:31:20 AM		2691.53	3467.37	2290.87
3:32:20 AM		2818.38	3311.31	2398.83
3:33:20 AM		2818.38	3548.13	2454.71
3:34:20 AM		2630.27	3019.95	2344.23
3:35:20 AM		2570.40	2951.21	2238.72
3:36:20 AM		2290.87	2630.27	2089.30
3:37:20 AM		2454.71	2818.38	2187.76
3:38:20 AM		2570.40	2884.03	2187.76
3:39:20 AM		2344.23	2630.27	2137.96
3:40:20 AM		2454.71	3467.37	2041.74
3:41:20 AM		2187.76	2511.89	1949.84
3:42:20 AM		2570.40	3090.30	2187.76
3:43:20 AM		2630.27	3388.44	2238.72
3:44:20 AM		2398.83	2818.38	2137.96
3:45:20 AM		2344.23	2754.23	2137.96
3:46:20 AM		2344.23	2570.40	2089.30
3:47:20 AM		2570.40	3388.44	2137.96
3:48:20 AM		2290.87	2691.53	2089.30
3:49:20 AM		2344.23	2630.27	2041.74
3:50:20 AM		2511.89	2884.03	2187.76
3:51:20 AM		2570.40	3019.95	2290.87
3:52:20 AM		2570.40	3090.30	2137.96
3:53:20 AM		2454.71	2691.53	2238.72
3:54:20 AM		2344.23	2691.53	2089.30
3:55:20 AM		2570.40	3388.44	2187.76
3:56:20 AM		2511.89	2691.53	2290.87
3:57:20 AM		2344.23	2570.40	2089.30
3:58:20 AM		2754.23	3981.07	2238.72
3:59:20 AM		2630.27	3162.28	2398.83
4:00:20 AM		2454.71	2884.03	2238.72
4:01:20 AM		2344.23	2570.40	2137.96
4:02:20 AM		2754.23	3388.44	2398.83
4:03:20 AM		2454.71	3019.95	2238.72
4:04:20 AM		2884.03	5011.87	2238.72
4:05:20 AM		2454.71	2691.53	2290.87
4:06:20 AM		2570.40	3162.28	2290.87
4:07:20 AM		2570.40	2951.21	2290.87
4:08:20 AM		2691.53	3090.30	2290.87
4:09:20 AM		2454.71	2818.38	2187.76
4:10:20 AM		2630.27	2884.03	2238.72
4:11:20 AM		2884.03	3467.37	2570.40
4:12:20 AM		2951.21	4168.69	2570.40
4:13:20 AM		2951.21	3715.35	2511.89
4:14:20 AM		2951.21	4073.80	2570.40
4:15:20 AM		3162.28	4073.80	2570.40
4:16:20 AM		3548.13	8511.38	2818.38
4:17:20 AM		4365.16	11220.18	3019.95
4:18:20 AM		5248.07	19498.45	2511.89
4:19:20 AM		2884.03	4365.16	2344.23
4:20:20 AM		2818.38	3467.37	2454.71
4:21:20 AM		3019.95	3981.07	2454.71
4:22:20 AM		3235.94	5623.41	2238.72
4:23:20 AM		3388.44	7079.46	2238.72
4:24:20 AM		3890.45	6165.95	2884.03
4:25:20 AM		3388.44	5623.41	2511.89
4:26:20 AM		2884.03	3388.44	2398.83
4:27:20 AM		3981.07	7943.28	2511.89
4:28:20 AM		2884.03	3715.35	2344.23
4:29:20 AM		3019.95	3801.89	2454.71
4:30:20 AM		3311.31	9772.37	2454.71
4:31:20 AM		3981.07	6760.83	2570.40
4:32:20 AM		12022.64	40738.03	2818.38
4:33:20 AM		3890.45	23988.33	2511.89
4:34:20 AM		3019.95	5128.61	2454.71

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	19:22:00	19:22:00		35.9	38.5	34.5
	19:23:00	19:23:00		35.8	37.2	34.3
	19:24:00	19:24:00		36	37.3	34.8
	19:25:00	19:25:00		35.7	37.3	34.8
	19:26:00	19:26:00		35.5	36.7	34.8
	19:27:00	19:27:00		35.3	36.5	34.3
	19:28:00	19:28:00		35.6	37.5	34.5
	19:29:00	19:29:00		35.2	35.9	34.4
	19:30:00	19:30:00		49.4	61.1	34.9
	19:31:00	19:31:00		36.2	39.8	35
	19:32:00	19:32:00		35.8	37.4	34.8
	19:33:00	19:33:00		35.6	37	34.7
	19:34:00	19:34:00		41	48.5	34.9
	19:35:00	19:35:00		41.4	55.2	37
	19:36:00	19:36:00		44.5	55.3	34.9
	19:37:00	19:37:00		38.1	45	35.5
	19:38:00	19:38:00		38.8	42.4	35.5
	19:39:00	19:39:00		35.6	36.5	34.9
	19:40:00	19:40:00		35.4	36.6	34.5
	19:41:00	19:41:00		36.9	39.9	35.1
	19:42:00	19:42:00		40.5	46.8	34.5
	19:43:00	19:43:00		35.7	37.2	34.6
	19:44:00	19:44:00		35.4	36.5	34.5
	19:45:00	19:45:00		35.6	37.2	34.9
	19:46:00	19:46:00		36	37.3	34.8
	19:47:00	19:47:00		36.2	38.4	35
	19:48:00	19:48:00		36.9	40.7	35.1
	19:49:00	19:49:00		43.2	48.2	36.8
	19:50:00	19:50:00		38.9	43.4	36.4
	19:51:00	19:51:00		37.2	38.4	36
	19:52:00	19:52:00		37.5	41.7	35.6
	19:53:00	19:53:00		47.6	53.3	36.6
	19:54:00	19:54:00		36.5	37.7	35.3
	19:55:00	19:55:00		35.9	37.1	35.1
	19:56:00	19:56:00		36.1	37.6	35.3
	19:57:00	19:57:00		36.7	40.6	34.5
	19:58:00	19:58:00		35.1	36.6	34.3
	19:59:00	19:59:00		36	41.8	34.3
	20:00:00	20:00:00		36.8	43	34.2
	20:01:00	20:01:00		36.4	41.1	34.6
	20:02:00	20:02:00		36.2	40.7	34.4
	20:03:00	20:03:00		38.3	43.1	35
	20:04:00	20:04:00		39.4	44.8	35.5
	20:05:00	20:05:00		37.6	41.6	35.3
	20:06:00	20:06:00		41.4	49.6	34.7
	20:07:00	20:07:00		39	46	35.1
	20:08:00	20:08:00		40.6	47.1	35.1
	20:09:00	20:09:00		35.9	39.6	34.4
	20:10:00	20:10:00		37.1	42	34.4
	20:11:00	20:11:00		35.7	38.4	34.4
	20:12:00	20:12:00		36	38	34.4
	20:13:00	20:13:00		36.6	40.3	34.4
	20:14:00	20:14:00		36.1	39.5	34.6
	20:15:00	20:15:00		36.1	38.1	34.5
	20:16:00	20:16:00		35.3	37.9	34.1
	20:17:00	20:17:00		35.8	41.1	34.4
	20:18:00	20:18:00		35.7	38.7	34.4
	20:19:00	20:19:00		35.4	37.9	34.2
	20:20:00	20:20:00		34.6	36.1	33.7
	20:21:00	20:21:00		35	37.7	33.7
	20:22:00	20:22:00		34.9	37.7	34
	20:23:00	20:23:00		37.5	41.1	34.4
	20:24:00	20:24:00		39.9	46.6	33.8
	20:25:00	20:25:00		36.8	40.7	34.4
	20:26:00	20:26:00		37	40.8	34.3
	20:27:00	20:27:00		40.6	46.3	35.9
	20:28:00	20:28:00		37.3	42.4	35.1
	20:29:00	20:29:00		35.7	41	34.4
	20:30:00	20:30:00		37	45.7	34.8
	20:31:00	20:31:00		38.5	43.8	34.7
	20:32:00	20:32:00		35.1	39.9	33.6
	20:33:00	20:33:00		34.5	35.3	33.9
	20:34:00	20:34:00		34.7	35.3	34.2
	20:35:00	20:35:00		35.2	37.1	34.1
	20:36:00	20:36:00		36.4	40.4	34.2
	20:37:00	20:37:00		36.7	43.7	34.4
	20:38:00	20:38:00		56.3	66.4	37.3
	20:39:00	20:39:00		37.1	43	34.7
	20:40:00	20:40:00		35.4	39.7	34.2
	20:41:00	20:41:00		34.7	35.4	34.1
	20:42:00	20:42:00		34.9	37.4	33.9
	20:43:00	20:43:00		34.4	34.9	34
	20:44:00	20:44:00		34.1	34.8	33.6

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
4:35:20 AM		3890.45	7079.46	2818.38
4:36:20 AM		3801.89	5248.07	2691.53
4:37:20 AM		3981.07	5370.32	3019.95
4:38:20 AM		3715.35	5370.32	3019.95
4:39:20 AM		3548.13	4677.35	3019.95
4:40:20 AM		3388.44	4466.84	2691.53
4:41:20 AM		3630.78	5623.41	2818.38
4:42:20 AM		3311.31	3890.45	2754.23
4:43:20 AM		87096.36	1288249.55	3090.30
4:44:20 AM		4168.69	9549.93	3162.28
4:45:20 AM		3801.89	5495.41	3019.95
4:46:20 AM		3630.78	5011.87	2951.21
4:47:20 AM		12589.25	70794.58	3090.30
4:48:20 AM		13803.84	331131.12	5011.87
4:49:20 AM		28183.83	338844.16	3090.30
4:50:20 AM		6456.54	31622.78	3548.13
4:51:20 AM		7585.78	17378.01	3548.13
4:52:20 AM		3630.78	4466.84	3090.30
4:53:20 AM		3467.37	4570.88	2818.38
4:54:20 AM		4897.79	9772.37	3235.94
4:55:20 AM		11220.18	47863.01	2818.38
4:56:20 AM		3715.35	5248.07	2884.03
4:57:20 AM		3467.37	4466.84	2818.38
4:58:20 AM		3630.78	5248.07	3090.30
4:59:20 AM		3981.07	5370.32	3019.95
5:00:20 AM		4168.69	6918.31	3162.28
5:01:20 AM		4897.79	11748.98	3235.94
5:02:20 AM		20892.96	66069.34	4786.30
5:03:20 AM		7762.47	21877.62	4365.16
5:04:20 AM		5248.07	6918.31	3981.07
5:05:20 AM		5623.41	14791.08	3630.78
5:06:20 AM		57543.99	213796.21	4570.88
5:07:20 AM		4466.84	5888.44	3388.44
5:08:20 AM		3890.45	5128.61	3235.94
5:09:20 AM		4073.80	5754.40	3388.44
5:10:20 AM		4677.35	11481.54	2818.38
5:11:20 AM		3235.94	4570.88	2691.53
5:12:20 AM		3981.07	15135.61	2691.53
5:13:20 AM		4786.30	19952.62	2630.27
5:14:20 AM		4365.16	12882.50	2884.03
5:15:20 AM		4168.69	11748.98	2754.23
5:16:20 AM		6760.83	20417.38	3162.28
5:17:20 AM		8709.64	30199.52	3548.13
5:18:20 AM		5754.40	14454.40	3388.44
5:19:20 AM		13803.84	91201.08	2951.21
5:20:20 AM		7943.28	39810.72	3235.94
5:21:20 AM		11481.54	51286.14	3235.94
5:22:20 AM		3890.45	9120.11	2754.23
5:23:20 AM		5128.61	15848.93	2754.23
5:24:20 AM		3715.35	6918.31	2754.23
5:25:20 AM		3981.07	6309.57	2754.23
5:26:20 AM		4570.88	10715.19	2754.23
5:27:20 AM		4073.80	8912.51	2884.03
5:28:20 AM		4073.80	6456.54	2818.38
5:29:20 AM		3388.44	6165.95	2570.40
5:30:20 AM		3801.89	12882.50	2754.23
5:31:20 AM		3715.35	7413.10	2754.23
5:32:20 AM		3467.37	6165.95	2630.27
5:33:20 AM		2884.03	4073.80	2344.23
5:34:20 AM		3162.28	5888.44	2344.23
5:35:20 AM		3090.30	5888.44	2511.89
5:36:20 AM		5623.41	12882.50	2754.23
5:37:20 AM		9772.37	45708.82	2398.83
5:38:20 AM		4786.30	11748.98	2754.23
5:39:20 AM		5011.87	12022.64	2691.53
5:40:20 AM		11481.54	42657.95	3890.45
5:41:20 AM		5370.32	17378.01	3235.94
5:42:20 AM		3715.35	12589.25	2754.23
5:43:20 AM		5011.87	37153.52	3019.95
5:44:20 AM		7079.46	23988.33	2951.21
5:45:20 AM		3235.94	9772.37	2290.87
5:46:20 AM		2818.38	3388.44	2454.71
5:47:20 AM		2951.21	3388.44	2630.27
5:48:20 AM		3311.31	5128.61	2570.40
5:49:20 AM		4365.16	10964.78	2630.27
5:50:20 AM		4677.35	23442.29	2754.23
5:51:20 AM		426579.52	4365158.32	5370.32
5:52:20 AM		5128.61	19952.62	2951.21
5:53:20 AM		3467.37	9332.54	2630.27
5:54:20 AM		2951.21	3467.37	2570.40
5:55:20 AM		3090.30	5495.41	2454.71
5:56:20 AM		2754.23	3090.30	2511.89
5:57:20 AM		2570.40	3019.95	2290.87

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	20:45:00	20:45:00		34.3	34.8	33.8
	20:46:00	20:46:00		34.6	35.5	34.1
	20:47:00	20:47:00		34.9	36.2	34.1
	20:48:00	20:48:00		34.5	35.7	34
	20:49:00	20:49:00		34.7	35.9	34.3
	20:50:00	20:50:00		35.1	36.1	34.4
	20:51:00	20:51:00		34.9	35.5	34.3
	20:52:00	20:52:00		35.3	36.3	34.6
	20:53:00	20:53:00		37.1	38.9	35.3
	20:54:00	20:54:00		37.4	39.3	35.7
	20:55:00	20:55:00		36.6	43.8	35.4
	20:56:00	20:56:00		38.4	40.3	35.8
	20:57:00	20:57:00		36.7	39.3	34.9
	20:58:00	20:58:00		35.6	36.8	34.7
	20:59:00	20:59:00		39.5	47.6	34.9
	21:00:00	21:00:00		40.7	49.2	35.7
	21:01:00	21:01:00		36.9	39.2	35.4
	21:02:00	21:02:00		36.7	38.8	34.9
	21:03:00	21:03:00		42.6	48.8	37
	21:04:00	21:04:00		39.7	44.5	36.2
	21:05:00	21:05:00		46.8	52.6	39.4
	21:06:00	21:06:00		42.6	48.5	38.3
	21:07:00	21:07:00		40.4	44.5	37.9
	21:08:00	21:08:00		48.9	55.5	39.4
	21:09:00	21:09:00		39.1	42.5	37
	21:10:00	21:10:00		50.4	58.5	38.6
	21:11:00	21:11:00		44.2	47.9	37
	21:12:00	21:12:00		45.9	51.2	38.5
	21:13:00	21:13:00		49.7	57.9	38.4
	21:14:00	21:14:00		42.8	49.9	37.2
	21:15:00	21:15:00		42.2	49.3	37.9
	21:16:00	21:16:00		42.9	47.4	38.4
	21:17:00	21:17:00		51.9	58.6	41.6
	21:18:00	21:18:00		53.4	60.5	42.2
	21:19:00	21:19:00		52.7	61.3	41.3
	21:20:00	21:20:00		51.1	58.2	41.3
	21:21:00	21:21:00		52.7	60	39.8
	21:22:00	21:22:00		50.4	58.1	37.9
	21:23:00	21:23:00		43.9	49.2	38.3
	21:24:00	21:24:00		41.9	51.4	39
	21:25:00	21:25:00		53.3	61	42.1
	21:26:00	21:26:00		51.4	58.1	41.1
	21:27:00	21:27:00		50.1	58.8	38.4
	21:28:00	21:28:00		43.7	47.6	39.9
	21:29:00	21:29:00		47.5	54.9	41.4
	21:30:00	21:30:00		49.6	57	41
	21:31:00	21:31:00		50	58.8	40.7
	21:32:00	21:32:00		53	59.4	40.4
	21:33:00	21:33:00		43.2	49.6	39.4
	21:34:00	21:34:00		57.4	64.2	44.1
	21:35:00	21:35:00		48	56.2	42.2
	21:36:00	21:36:00		53.2	61.9	43.2
	21:37:00	21:37:00		46.1	53.1	40.9
	21:38:00	21:38:00		54.2	59.3	44.6
	21:39:00	21:39:00		48.4	55.7	40.2
	21:40:00	21:40:00		50.1	58.1	39.9
	21:41:00	21:41:00		41.7	45.3	38.5
	21:42:00	21:42:00		47	55.3	38.9
	21:43:00	21:43:00		39.8	42.6	37.1
	21:44:00	21:44:00		48.9	57.7	38.4
	21:45:00	21:45:00		45.6	50.8	39.5
	21:46:00	21:46:00		49.4	58	38.9
	21:47:00	21:47:00		42.9	47.1	39.9
	21:48:00	21:48:00		41	44.6	38.6
	21:49:00	21:49:00		50.7	61.1	40.8
	21:50:00	21:50:00		51.8	61.1	42.1
	21:51:00	21:51:00		51.6	59	40.9
	21:52:00	21:52:00		52.9	61.2	40.9
	21:53:00	21:53:00		53.6	62.4	43.7
	21:54:00	21:54:00		50.2	59.1	40.1
	21:55:00	21:55:00		45.8	59.4	37.3
	21:56:00	21:56:00		51.9	59.4	37.9
	21:57:00	21:57:00		38.7	42.6	36.5
	21:58:00	21:58:00		40.9	47	36.7
	21:59:00	21:59:00		37.6	41.7	35.6
	22:00:00	22:00:00		48.2	57.3	36.8
	22:01:00	22:01:00		49.3	57.7	39.3
	22:02:00	22:02:00		37.8	39.6	36.6
	22:03:00	22:03:00		39.7	45.9	36
	22:04:00	22:04:00		43.6	51.5	37.4
	22:05:00	22:05:00		40.8	52.2	35.6
	22:06:00	22:06:00		48.1	55.7	37.6
	22:07:00	22:07:00		37.8	41.4	35.7

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
5:58:20 AM		2691.53	3019.95	2398.83
5:59:20 AM		2884.03	3548.13	2570.40
6:00:20 AM		3090.30	4168.69	2570.40
6:01:20 AM		2818.38	3715.35	2511.89
6:02:20 AM		2951.21	3890.45	2691.53
6:03:20 AM		3235.94	4073.80	2754.23
6:04:20 AM		3090.30	3548.13	2691.53
6:05:20 AM		3388.44	4265.80	2884.03
6:06:20 AM		5128.61	7762.47	3388.44
6:07:20 AM		5495.41	8511.38	3715.35
6:08:20 AM		4570.88	23988.33	3467.37
6:09:20 AM		6918.31	10715.19	3801.89
6:10:20 AM		4677.35	8511.38	3090.30
6:11:20 AM		3630.78	4786.30	2951.21
6:12:20 AM		8912.51	57543.99	3090.30
6:13:20 AM		11748.98	83176.38	3715.35
6:14:20 AM		4897.79	8317.64	3467.37
6:15:20 AM		4677.35	7585.78	3090.30
6:16:20 AM		18197.01	75857.76	5011.87
6:17:20 AM		9332.54	28183.83	4168.69
6:18:20 AM		47863.01	181970.09	8709.64
6:19:20 AM		18197.01	70794.58	6760.83
6:20:20 AM		10964.78	28183.83	6165.95
6:21:20 AM		77624.71	354813.39	8709.64
6:22:20 AM		8128.31	17782.79	5011.87
6:23:20 AM		109647.82	707945.78	7244.36
6:24:20 AM		26302.68	61659.50	5011.87
6:25:20 AM		38904.51	131825.67	7079.46
6:26:20 AM		93325.43	616595.00	6918.31
6:27:20 AM		19054.61	97723.72	5248.07
6:28:20 AM		16595.87	85113.80	6165.95
6:29:20 AM		19498.45	54954.09	6918.31
6:30:20 AM		154881.66	724435.96	14454.40
6:31:20 AM		218776.16	1122018.45	16595.87
6:32:20 AM		186208.71	1348962.88	13489.63
6:33:20 AM		128824.96	660693.45	13489.63
6:34:20 AM		186208.71	1000000.00	9549.93
6:35:20 AM		109647.82	645654.23	6165.95
6:36:20 AM		24547.09	83176.38	6760.83
6:37:20 AM		15488.17	138038.43	7943.28
6:38:20 AM		213796.21	1258925.41	16218.10
6:39:20 AM		138038.43	645654.23	12882.50
6:40:20 AM		102329.30	758577.58	6918.31
6:41:20 AM		23442.29	57543.99	9772.37
6:42:20 AM		56234.13	309029.54	13803.84
6:43:20 AM		91201.08	501187.23	12589.25
6:44:20 AM		100000.00	758577.58	11748.98
6:45:20 AM		199526.23	870963.59	10964.78
6:46:20 AM		20892.96	91201.08	8709.64
6:47:20 AM		549540.87	2630267.99	25703.96
6:48:20 AM		63095.73	416869.38	16595.87
6:49:20 AM		208929.61	1548816.62	20892.96
6:50:20 AM		40738.03	204173.79	12302.69
6:51:20 AM		263026.80	851138.04	28840.32
6:52:20 AM		69183.10	371535.23	10471.29
6:53:20 AM		102329.30	645654.23	9772.37
6:54:20 AM		14791.08	33884.42	7079.46
6:55:20 AM		50118.72	338844.16	7762.47
6:56:20 AM		9549.93	18197.01	5128.61
6:57:20 AM		77624.71	588843.66	6918.31
6:58:20 AM		36307.81	120226.44	8912.51
6:59:20 AM		87096.36	630957.34	7762.47
7:00:20 AM		19498.45	51286.14	9772.37
7:01:20 AM		12589.25	28840.32	7244.36
7:02:20 AM		117489.76	1288249.55	12022.64
7:03:20 AM		151356.12	1288249.55	16218.10
7:04:20 AM		144543.98	794328.23	12302.69
7:05:20 AM		194984.46	1318256.74	12302.69
7:06:20 AM		229086.77	1737800.83	23442.29
7:07:20 AM		104712.85	812830.52	10232.93
7:08:20 AM		38018.94	870963.59	5370.32
7:09:20 AM		154881.66	870963.59	6165.95
7:10:20 AM		7413.10	18197.01	4466.84
7:11:20 AM		12302.69	50118.72	4677.35
7:12:20 AM		5754.40	14791.08	3630.78
7:13:20 AM		66069.34	537031.80	4786.30
7:14:20 AM		85113.80	588843.66	8511.38
7:15:20 AM		6025.60	9120.11	4570.88
7:16:20 AM		9332.54	38904.51	3981.07
7:17:20 AM		22908.68	141253.75	5495.41
7:18:20 AM		12022.64	165958.69	3630.78
7:19:20 AM		64565.42	371535.23	5754.40
7:20:20 AM		6025.60	13803.84	3715.35

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	22:08:00	22:08:00		52.1	60.3	38.4
	22:09:00	22:09:00		37.5	39.6	35.7
	22:10:00	22:10:00		38.3	41.8	35.6
	22:11:00	22:11:00		39.7	44.3	36.8
	22:12:00	22:12:00		49.9	58.7	36.9
	22:13:00	22:13:00		41.4	47.6	36.9
	22:14:00	22:14:00		39.9	46.3	37
	22:15:00	22:15:00		49.2	57.6	37.3
	22:16:00	22:16:00		43.9	50.1	36.8
	22:17:00	22:17:00		38.5	42.7	36.1
	22:18:00	22:18:00		38.2	41.8	36.5
	22:19:00	22:19:00		43.9	51.6	38.2
	22:20:00	22:20:00		39.4	45.7	34.9
	22:21:00	22:21:00		49.9	58	37.6
	22:22:00	22:22:00		41.3	49.2	36.4
	22:23:00	22:23:00		53.7	61.4	41.7
	22:24:00	22:24:00		40.6	44.9	37.2
	22:25:00	22:25:00		39.7	43.3	36.3
	22:26:00	22:26:00		37.1	38.9	34.7
	22:27:00	22:27:00		49.8	57.7	38.8
	22:28:00	22:28:00		44	50.8	37.4
	22:29:00	22:29:00		48.8	56.7	38.6
	22:30:00	22:30:00		50.3	60.5	36.9
	22:31:00	22:31:00		51.8	59.9	41.1
	22:32:00	22:32:00		42	49.8	35.4
	22:33:00	22:33:00		41.4	50.7	35.9
	22:34:00	22:34:00		49.8	56.5	37.7
	22:35:00	22:35:00		53	61.5	43.6
	22:36:00	22:36:00		47.9	58	36.8
	22:37:00	22:37:00		51.2	59.1	38.1
	22:38:00	22:38:00		46.5	54.9	38.4
	22:39:00	22:39:00		53	61.2	40.3
	22:40:00	22:40:00		39.2	45.5	35.8
	22:41:00	22:41:00		50.5	58.3	38.6
	22:42:00	22:42:00		44.6	57.6	36.6
	22:43:00	22:43:00		49	57.8	38.5
	22:44:00	22:44:00		43.4	56.1	36.4
	22:45:00	22:45:00		48.9	57.9	38.7
	22:46:00	22:46:00		50.4	58.2	38.7
	22:47:00	22:47:00		39.9	43	36.3
	22:48:00	22:48:00		47	52.8	38.4
	22:49:00	22:49:00		44.8	50.8	38.6
	22:50:00	22:50:00		52.6	60.1	40.5
	22:51:00	22:51:00		45.2	53.6	39.2
	22:52:00	22:52:00		50.5	59.2	37.1
	22:53:00	22:53:00		53.1	61.2	39.2
	22:54:00	22:54:00		47.7	58.2	40.6
	22:55:00	22:55:00		53.1	62	39.5
	22:56:00	22:56:00		49.1	57.6	37
	22:57:00	22:57:00		49.9	58.5	39.5
	22:58:00	22:58:00		49.5	57.8	36.4
	22:59:00	22:59:00		38	40.2	36.1
	23:00:00	23:00:00		51.7	61.4	40.2
	23:01:00	23:01:00		49.3	57.8	39
	23:02:00	23:02:00		44.2	51	38.2
	23:03:00	23:03:00		51.4	59.5	43.6
	23:04:00	23:04:00		44.1	53.3	37.2
	23:05:00	23:05:00		43.9	53.2	38.3
	23:06:00	23:06:00		39.7	46.9	36.3
	23:07:00	23:07:00		50.1	58.8	35.9
	23:08:00	23:08:00		36	37.6	34.3
	23:09:00	23:09:00		52.2	60.2	36.8
	23:10:00	23:10:00		48.1	59.5	38.7
	23:11:00	23:11:00		51.4	60.7	38.4
	23:12:00	23:12:00		51	58.5	39.5
	23:13:00	23:13:00		51.1	62.4	37.5
	23:14:00	23:14:00		49.2	57.9	38.7
	23:15:00	23:15:00		45.6	52.1	41.6
	23:16:00	23:16:00		50.4	56.1	41.3
	23:17:00	23:17:00		50	55.2	39.8
	23:18:00	23:18:00		45.6	51.5	40.3
	23:19:00	23:19:00		53.8	61.6	41.8
	23:20:00	23:20:00		46.1	51.1	40.6
	23:21:00	23:21:00		43.5	49.7	38.9
	23:22:00	23:22:00		54.2	60.3	41.1
	23:23:00	23:23:00		53.3	60.3	40.2
	23:24:00	23:24:00		54	62.1	44.5
	23:25:00	23:25:00		49	55.5	41.8
	23:26:00	23:26:00		51.9	58.6	42.3
	23:27:00	23:27:00		50	58.6	38.3
	23:28:00	23:28:00		42.3	45.6	38.4
	23:29:00	23:29:00		52.7	61.8	43.3
	23:30:00	23:30:00		43.8	51.1	39.6

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
7:21:20 AM		162181.01	1071519.31	6918.31
7:22:20 AM		5623.41	9120.11	3715.35
7:23:20 AM		6760.83	15135.61	3630.78
7:24:20 AM		9332.54	26915.35	4786.30
7:25:20 AM		97723.72	741310.24	4897.79
7:26:20 AM		13803.84	57543.99	4897.79
7:27:20 AM		9772.37	42657.95	5011.87
7:28:20 AM		83176.38	575439.94	5370.32
7:29:20 AM		24547.09	102329.30	4786.30
7:30:20 AM		7079.46	18620.87	4073.80
7:31:20 AM		6606.93	15135.61	4466.84
7:32:20 AM		24547.09	144543.98	6606.93
7:33:20 AM		8709.64	37153.52	3090.30
7:34:20 AM		97723.72	630957.34	5754.40
7:35:20 AM		13489.63	83176.38	4365.16
7:36:20 AM		234422.88	1380384.26	14791.08
7:37:20 AM		11481.54	30902.95	5248.07
7:38:20 AM		9332.54	21379.62	4265.80
7:39:20 AM		5128.61	7762.47	2951.21
7:40:20 AM		95499.26	588843.66	7585.78
7:41:20 AM		25118.86	120226.44	5495.41
7:42:20 AM		75857.76	467735.14	7244.36
7:43:20 AM		107151.93	1122018.45	4897.79
7:44:20 AM		151356.12	977237.22	12882.50
7:45:20 AM		15848.93	95499.26	3467.37
7:46:20 AM		13803.84	117489.76	3890.45
7:47:20 AM		95499.26	446683.59	5888.44
7:48:20 AM		199526.23	1412537.54	22908.68
7:49:20 AM		61659.50	630957.34	4786.30
7:50:20 AM		131825.67	812830.52	6456.54
7:51:20 AM		44668.36	309029.54	6918.31
7:52:20 AM		199526.23	1318256.74	10715.19
7:53:20 AM		8317.64	35481.34	3801.89
7:54:20 AM		112201.85	676082.98	7244.36
7:55:20 AM		28840.32	575439.94	4570.88
7:56:20 AM		79432.82	602559.59	7079.46
7:57:20 AM		21877.62	407380.28	4365.16
7:58:20 AM		77624.71	616595.00	7413.10
7:59:20 AM		109647.82	660693.45	7413.10
8:00:20 AM		9772.37	19952.62	4265.80
8:01:20 AM		50118.72	190546.07	6918.31
8:02:20 AM		30199.52	120226.44	7244.36
8:03:20 AM		181970.09	1023292.99	11220.18
8:04:20 AM		33113.11	229086.77	8317.64
8:05:20 AM		112201.85	831763.77	5128.61
8:06:20 AM		204173.79	1318256.74	8317.64
8:07:20 AM		58884.37	660693.45	11481.54
8:08:20 AM		204173.79	1584893.19	8912.51
8:09:20 AM		81283.05	575439.94	5011.87
8:10:20 AM		97723.72	707945.78	8912.51
8:11:20 AM		89125.09	602559.59	4365.16
8:12:20 AM		6309.57	10471.29	4073.80
8:13:20 AM		147910.84	1380384.26	10471.29
8:14:20 AM		85113.80	602559.59	7943.28
8:15:20 AM		26302.68	125892.54	6606.93
8:16:20 AM		138038.43	891250.94	22908.68
8:17:20 AM		25703.96	213796.21	5248.07
8:18:20 AM		24547.09	208929.61	6760.83
8:19:20 AM		9332.54	48977.88	4265.80
8:20:20 AM		102329.30	758577.58	3890.45
8:21:20 AM		3981.07	5754.40	2691.53
8:22:20 AM		165958.69	1047128.55	4786.30
8:23:20 AM		64565.42	891250.94	7413.10
8:24:20 AM		138038.43	1174897.55	6918.31
8:25:20 AM		125892.54	707945.78	8912.51
8:26:20 AM		128824.96	1737800.83	5623.41
8:27:20 AM		83176.38	616595.00	7413.10
8:28:20 AM		36307.81	162181.01	14454.40
8:29:20 AM		109647.82	407380.28	13489.63
8:30:20 AM		100000.00	331131.12	9549.93
8:31:20 AM		36307.81	141253.75	10715.19
8:32:20 AM		239883.29	1445439.77	15135.61
8:33:20 AM		40738.03	128824.96	11481.54
8:34:20 AM		22387.21	93325.43	7762.47
8:35:20 AM		263026.80	1071519.31	12882.50
8:36:20 AM		213796.21	1071519.31	10471.29
8:37:20 AM		251188.64	1621810.10	28183.83
8:38:20 AM		79432.82	354813.39	15135.61
8:39:20 AM		154881.66	724435.96	16982.44
8:40:20 AM		100000.00	724435.96	6760.83
8:41:20 AM		16982.44	36307.81	6918.31
8:42:20 AM		186208.71	1513561.25	21379.62
8:43:20 AM		23988.33	128824.96	9120.11

Study	Study Time	Session Time	OL Status	L_{avg} Meter1	L_{max} Meter1	L_{min} Meter1
	23:31:00	23:31:00		41.4	45.2	39.4
	23:32:00	23:32:00		56.4	61.5	43.9
	23:33:00	23:33:00		47	53	40.4
	23:34:00	23:34:00		48.2	55.2	40.3
	23:35:00	23:35:00		56.3	61.4	49
	23:36:00	23:36:00		52.1	61.6	43.7
	23:37:00	23:37:00		57.4	64.1	43.1
	23:38:00	23:38:00		50	57.8	42.6
	23:39:00	23:39:00		50	57.8	42.9
	23:40:00	23:40:00		55	62.2	46.4
	23:41:00	23:41:00		51.9	60.6	45.1
	23:42:00	23:42:00		53.6	57.9	45.4
	23:43:00	23:43:00		49.9	55	43.5
	23:44:00	23:44:00		48.6	52.9	44.2
	23:45:00	23:45:00		55.1	59.8	45.2
	23:46:00	23:46:00		49	54.6	38.1
	23:47:00	23:47:00		45.2	50.4	39.6
	23:48:00	23:48:00		53.7	58.5	42.8
	23:49:00	23:49:00		54.1	58.2	44.8
	23:50:00	23:50:00		50.9	57.5	41.5
	23:51:00	23:51:00		57.3	64.4	43.4
	23:52:00	23:52:00		46.4	49.1	41.7
	23:53:00	23:53:00		49.7	54.7	43.2
	23:54:00	23:54:00		51.5	58.7	43
	23:55:00	23:55:00		48.8	52.2	43.4
	23:56:00	23:56:00		56.4	62.7	46.6
	23:57:00	23:57:00		58.9	63.4	51.9
	23:58:00	23:58:00		64.3	68.6	54.9
	23:59:00	23:59:00		69.6	75.5	54.2
	24:00:00	24:00:00		79.3	83.9	68.7

Time	Other Studies	Average $10^{(X/10)}$	Maximum $10^{(X/10)}$	Minimum $10^{(X/10)}$
8:44:20 AM		13803.84	33113.11	8709.64
8:45:20 AM		436515.83	1412537.54	24547.09
8:46:20 AM		50118.72	199526.23	10964.78
8:47:20 AM		66069.34	331131.12	10715.19
8:48:20 AM		426579.52	1380384.26	79432.82
8:49:20 AM		162181.01	1445439.77	23442.29
8:50:20 AM		549540.87	2570395.78	20417.38
8:51:20 AM		100000.00	602559.59	18197.01
8:52:20 AM		100000.00	602559.59	19498.45
8:53:20 AM		316227.77	1659586.91	43651.58
8:54:20 AM		154881.66	1148153.62	32359.37
8:55:20 AM		229086.77	616595.00	34673.69
8:56:20 AM		97723.72	316227.77	22387.21
8:57:20 AM		72443.60	194984.46	26302.68
8:58:20 AM		323593.66	954992.59	33113.11
8:59:20 AM		79432.82	288403.15	6456.54
9:00:20 AM		33113.11	109647.82	9120.11
9:01:20 AM		234422.88	707945.78	19054.61
9:02:20 AM		257039.58	660693.45	30199.52
9:03:20 AM		123026.88	562341.33	14125.38
9:04:20 AM		537031.80	2754228.70	21877.62
9:05:20 AM		43651.58	81283.05	14791.08
9:06:20 AM		93325.43	295120.92	20892.96
9:07:20 AM		141253.75	741310.24	19952.62
9:08:20 AM		75857.76	165958.69	21877.62
9:09:20 AM		436515.83	1862087.14	45708.82
9:10:20 AM		776247.12	2187761.62	154881.66
9:11:20 AM		2691534.80	7244359.60	309029.54
9:12:20 AM		9120108.39	35481338.92	263026.80
9:13:20 AM		85113803.82	245470891.57	7413102.41

1-Hour - Summary

Location #2

Serial Number	BGN110003	UNIT REV	R13H
Start Time	09:31:44 04-Aug-2021		
Run Length	1:00:00 230400		

Microphone Information		
Description	Units	Value
Sensitivity	dB	29
Polarization	Volts	0
Meter Range	dB	120
Max Level	dB	140
Meas. Floor	dB	-20

Calibration Information			
Description		Units	Value
Pre-Cal	Level	dB	114.1
	Date		09:29:24 04-Aug-2021
Post-Cal	Level	dB	
	Date		
ReCert	Date		Unavailable

Configuration Information			
Description	Units	Meter 1	Meter 2
Integration Threshold	dB	OFF	OFF
Exchange Rate	dB	3	3
Criterion Level	dB	80	80
Upper Limit Level	dB	140	140
Projected Time	Hrs	1	1
Weighting		A	A
Time Response		SLOW	SLOW

Measurement	Units	Meter 1 Broadband	Meter 2 Broadband
Lavg	dB	34.6	34.6
Lmax	dB	54.9	54.9
Lmin	dB	28.8	28.8
Lpk	dB	77.1	77.2
TWA	dB	25.6	25.6
PTWA	dB	25.6	25.6
DOSE	%	0	0
PDOSE	%	0	0
SEL	dB	70.2	70.1
EXP	p2s	0	0

Measurement	Units	Value
LDN	dB	34.6
CNEL	dB	34.6
TAKTMAX (5sec)	dB	N/A
LC-A	dB	N/A

Exceedence	Units	Value
L01	dB	44.2
L08	dB	37.4
L25	dB	33.2
L50	dB	31.4

1-Hour - Summary

Location #3

Serial Number	BGN110003	UNIT REV	R13H
Start Time	10:46:20 04-Aug-2021		
Run Length	1:00:00 230400		

Microphone Information		
Description	Units	Value
Sensitivity	dB	29
Polarization	Volts	0
Meter Range	dB	120
Max Level	dB	140
Meas. Floor	dB	-20

Calibration Information			
Description		Units	Value
Pre-Cal	Level	dB	114.1
	Date		09:29:24 04-Aug-2021
Post-Cal	Level	dB	
	Date		
ReCert	Date		Unavailable

Configuration Information			
Description	Units	Meter 1	Meter 2
Integration Threshold	dB	OFF	OFF
Exchange Rate	dB	3	3
Criterion Level	dB	80	80
Upper Limit Level	dB	140	140
Projected Time	Hrs	1	1
Weighting		A	A
Time Response		SLOW	SLOW

Measurement	Units	Meter 1 Broadband	Meter 2 Broadband
Lavg	dB	35.3	35.3
Lmax	dB	53.8	53.8
Lmin	dB	30.3	30.3
Lpk	dB	81.9	81.9
TWA	dB	26.3	26.3
PTWA	dB	26.3	26.3
DOSE	%	0	0
PDOSE	%	0	0
SEL	dB	70.9	70.9
EXP	p2s	0	0

Measurement	Units	Value
LDN	dB	35.3
CNEL	dB	35.3
TAKTMAX (5sec)	dB	N/A
LC-A	dB	N/A

Exceedence	Units	Value
L01	dB	43.1
L08	dB	38.2
L25	dB	34.5
L50	dB	32.8

1-Hour - Summary

Location #4

Serial Number	BGN110003	UNIT REV	R13H
Start Time	11:53:44 04-Aug-2021		
Run Length	1:00:00 230400		

Microphone Information		
Description	Units	Value
Sensitivity	dB	29
Polarization	Volts	0
Meter Range	dB	120
Max Level	dB	140
Meas. Floor	dB	-20

Calibration Information			
Description		Units	Value
Pre-Cal	Level	dB	114.1
	Date		09:29:24 04-Aug-2021
Post-Cal	Level	dB	
	Date		
ReCert	Date		Unavailable

Configuration Information			
Description	Units	Meter 1	Meter 2
Integration Threshold	dB	OFF	OFF
Exchange Rate	dB	3	3
Criterion Level	dB	80	80
Upper Limit Level	dB	140	140
Projected Time	Hrs	1	1
Weighting		A	A
Time Response		SLOW	SLOW

Measurement	Units	Meter 1 Broadband	Meter 2 Broadband
Lavg	dB	64.1	64.2
Lmax	dB	80	80
Lmin	dB	34	34.1
Lpk	dB	94.9	94.9
TWA	dB	55.1	55.1
PTWA	dB	55.1	55.1
DOSE	%	0.32	0.33
PDOSE	%	0.32	0.33
SEL	dB	99.7	99.7
EXP	p2s	4	4

Measurement	Units	Value
LDN	dB	64.1
CNEL	dB	64.1
TAKTMAX (5sec)	dB	N/A
LC-A	dB	N/A

Exceedence	Units	Value
L01	dB	75.5
L08	dB	68.8
L25	dB	63.2
L50	dB	56.8

1-Hour - Summary

Location #5

Serial Number	BGN110003	UNIT REV	R13H
Start Time	13:03:23 04-Aug-2021		
Run Length	1:00:00 230400		

Microphone Information		
Description	Units	Value
Sensitivity	dB	29
Polarization	Volts	0
Meter Range	dB	120
Max Level	dB	140
Meas. Floor	dB	-20

Calibration Information			
Description		Units	Value
Pre-Cal	Level	dB	114.1
	Date		09:29:24 04-Aug-2021
Post-Cal	Level	dB	
	Date		
ReCert	Date		Unavailable

Configuration Information			
Description	Units	Meter 1	Meter 2
Integration Threshold	dB	OFF	OFF
Exchange Rate	dB	3	3
Criterion Level	dB	80	80
Upper Limit Level	dB	140	140
Projected Time	Hrs	1	1
Weighting		A	A
Time Response		SLOW	SLOW

Measurement	Units	Meter 1 Broadband	Meter 2 Broadband
Lavg	dB	62.5	62.5
Lmax	dB	78.5	78.5
Lmin	dB	43	43
Lpk	dB	104.7	104.8
TWA	dB	53.4	53.5
PTWA	dB	53.4	53.5
DOSE	%	0.22	0.22
PDOSE	%	0.22	0.22
SEL	dB	98	98.1
EXP	p2s	3	3

Measurement	Units	Value
LDN	dB	62.5
CNEL	dB	62.5
TAKTMAX (5sec)	dB	N/A
LC-A	dB	N/A

Exceedence	Units	Value
L01	dB	72.5
L08	dB	66.9
L25	dB	62
L50	dB	58.7

1-Hour - Summary

Location #6

Serial Number	BGN110003	UNIT REV	R13H
Start Time	14:21:09 04-Aug-2021		
Run Length	1:00:00 230400		

Microphone Information		
Description	Units	Value
Sensitivity	dB	29
Polarization	Volts	0
Meter Range	dB	120
Max Level	dB	140
Meas. Floor	dB	-20

Calibration Information			
Description		Units	Value
Pre-Cal	Level	dB	114.1
	Date		09:29:24 04-Aug-2021
Post-Cal	Level	dB	
	Date		
ReCert	Date		Unavailable

Configuration Information			
Description	Units	Meter 1	Meter 2
Integration Threshold	dB	OFF	OFF
Exchange Rate	dB	3	3
Criterion Level	dB	80	80
Upper Limit Level	dB	140	140
Projected Time	Hrs	1	1
Weighting		A	A
Time Response		SLOW	SLOW

Measurement	Units	Meter 1 Broadband	Meter 2 Broadband
Lavg	dB	58.2	58.2
Lmax	dB	80	80
Lmin	dB	54.9	54.9
Lpk	dB	96.3	96.3
TWA	dB	49.2	49.2
PTWA	dB	49.2	49.2
DOSE	%	0.08	0.08
PDOSE	%	0.08	0.08
SEL	dB	93.8	93.8
EXP	p2s	1	1

Measurement	Units	Value
LDN	dB	58.2
CNEL	dB	58.2
TAKTMAX (5sec)	dB	N/A
LC-A	dB	N/A

Exceedence	Units	Value
L01	dB	62.4
L08	dB	59.3
L25	dB	57.9
L50	dB	57.1

1-Hour - Summary

Location #7

Serial Number	BGN110003	UNIT REV	R13H
Start Time	09:42:21 05-Aug-2021		
Run Length	1:00:00 230400		

Microphone Information		
Description	Units	Value
Sensitivity	dB	29
Polarization	Volts	0
Meter Range	dB	120
Max Level	dB	140
Meas. Floor	dB	-20

Calibration Information			
Description		Units	Value
Pre-Cal	Level	dB	114.1
	Date		09:38:21 05-Aug-2021
Post-Cal	Level	dB	
	Date		
ReCert	Date		Unavailable

Configuration Information			
Description	Units	Meter 1	Meter 2
Integration Threshold	dB	OFF	OFF
Exchange Rate	dB	3	3
Criterion Level	dB	80	80
Upper Limit Level	dB	140	140
Projected Time	Hrs	1	1
Weighting		A	A
Time Response		SLOW	SLOW

Measurement	Units	Meter 1 Broadband	Meter 2 Broadband
Lavg	dB	46.1	46.1
Lmax	dB	63.1	63.2
Lmin	dB	29.5	29.5
Lpk	dB	88.2	88.2
TWA	dB	37	37.1
PTWA	dB	37	37.1
DOSE	%	0.01	0.01
PDOSE	%	0.01	0.01
SEL	dB	81.6	81.6
EXP	p2s	0	0

Measurement	Units	Value
LDN	dB	46.1
CNEL	dB	46.1
TAKTMAX (5sec)	dB	N/A
LC-A	dB	N/A

Exceedence	Units	Value
L01	dB	57.6
L08	dB	50.9
L25	dB	42.7
L50	dB	37.2

1-Hour - Summary

Location #8

Serial Number	BGN110003	UNIT REV	R13H
Start Time	11:07:48 05-Aug-2021		
Run Length	1:00:00 230400		

Microphone Information		
Description	Units	Value
Sensitivity	dB	29
Polarization	Volts	0
Meter Range	dB	120
Max Level	dB	140
Meas. Floor	dB	-20

Calibration Information			
Description		Units	Value
Pre-Cal	Level	dB	114.1
	Date		09:38:21 05-Aug-2021
Post-Cal	Level	dB	
	Date		
ReCert	Date		Unavailable

Configuration Information			
Description	Units	Meter 1	Meter 2
Integration Threshold	dB	OFF	OFF
Exchange Rate	dB	3	3
Criterion Level	dB	80	80
Upper Limit Level	dB	140	140
Projected Time	Hrs	1	1
Weighting		A	A
Time Response		SLOW	SLOW

Measurement	Units	Meter 1 Broadband	Meter 2 Broadband
Lavg	dB	59.6	59.7
Lmax	dB	67.3	67.3
Lmin	dB	53.6	53.6
Lpk	dB	82.7	82.7
TWA	dB	50.6	50.6
PTWA	dB	50.6	50.6
DOSE	%	0.11	0.12
PDOSE	%	0.11	0.12
SEL	dB	95.2	95.2
EXP	p2s	1	1

Measurement	Units	Value
LDN	dB	59.6
CNEL	dB	59.6
TAKTMAX (5sec)	dB	N/A
LC-A	dB	N/A

Exceedence	Units	Value
L01	dB	64.4
L08	dB	62.1
L25	dB	60.3
L50	dB	58.8

1-Hour - Summary

Location #9

Serial Number	BGN110003	UNIT REV	R13H
Start Time	12:18:03 05-Aug-2021		
Run Length	1:00:00 230400		

Microphone Information		
Description	Units	Value
Sensitivity	dB	29
Polarization	Volts	0
Meter Range	dB	120
Max Level	dB	140
Meas. Floor	dB	-20

Calibration Information			
Description		Units	Value
Pre-Cal	Level	dB	114.1
	Date		09:38:21 05-Aug-2021
Post-Cal	Level	dB	
	Date		
ReCert	Date		Unavailable

Configuration Information			
Description	Units	Meter 1	Meter 2
Integration Threshold	dB	OFF	OFF
Exchange Rate	dB	3	3
Criterion Level	dB	80	80
Upper Limit Level	dB	140	140
Projected Time	Hrs	1	1
Weighting		A	A
Time Response		SLOW	SLOW

Measurement	Units	Meter 1 Broadband	Meter 2 Broadband
Lavg	dB	63.1	63.1
Lmax	dB	87.4	87.4
Lmin	dB	50.8	50.8
Lpk	dB	104	104
TWA	dB	54.1	54.1
PTWA	dB	54.1	54.1
DOSE	%	0.26	0.26
PDOSE	%	0.26	0.26
SEL	dB	98.7	98.7
EXP	p2s	3	3

Measurement	Units	Value
LDN	dB	63.1
CNEL	dB	63.1
TAKTMAX (5sec)	dB	N/A
LC-A	dB	N/A

Exceedence	Units	Value
L01	dB	70.5
L08	dB	66.9
L25	dB	62.8
L50	dB	59.4

1-Hour - Summary

Location #10

Serial Number	BGN110003	UNIT REV	R13H
Start Time	13:33:31 05-Aug-2021		
Run Length	1:00:00 230400		

Microphone Information		
Description	Units	Value
Sensitivity	dB	29
Polarization	Volts	0
Meter Range	dB	120
Max Level	dB	140
Meas. Floor	dB	-20

Calibration Information			
Description		Units	Value
Pre-Cal	Level	dB	114.1
	Date		09:38:21 05-Aug-2021
Post-Cal	Level	dB	
	Date		
ReCert	Date		Unavailable

Configuration Information			
Description	Units	Meter 1	Meter 2
Integration Threshold	dB	OFF	OFF
Exchange Rate	dB	3	3
Criterion Level	dB	80	80
Upper Limit Level	dB	140	140
Projected Time	Hrs	1	1
Weighting		A	A
Time Response		SLOW	SLOW

Measurement	Units	Meter 1 Broadband	Meter 2 Broadband
Lavg	dB	49.2	49.2
Lmax	dB	64.4	64.4
Lmin	dB	41.4	41.4
Lpk	dB	82.6	82.6
TWA	dB	40.2	40.2
PTWA	dB	40.2	40.2
DOSE	%	0.01	0.01
PDOSE	%	0.01	0.01
SEL	dB	84.8	84.8
EXP	p2s	0	0

Measurement	Units	Value
LDN	dB	49.2
CNEL	dB	49.2
TAKTMAX (5sec)	dB	N/A
LC-A	dB	N/A

Exceedence	Units	Value
L01	dB	57.4
L08	dB	52
L25	dB	49.3
L50	dB	47.3

Attachment C

Operational Source Noise Estimates/Calculations

Excavation/Open-Pit Mining Area

Reference Noise Level @ 50-Feet

Excavation/Open-Pit Mining Area					
Measurement Location	**Measured Noise Level (L_{eq})**	**Line-Of-Sight Adjustment (dBA) [C]**	**Distance from Source (feet) [A]**	**Noise Level (L_{eq}) @ 50-feet [B]**	**$10^{(X/10)}$**
#7	46.1	0	3,545	83.1	204782325.43
#8	59.6	0	895	84.7	292217393.04
#10	49.2	10	905	84.4	272494129.05
			Excavation/Open-Pit Mining - Average Noise Level (L_{eq}) @ 50-feet:	**84.1**	**dBA**

See Figure 2 (Attachment A) for the noise monitoring locations described above.

A - Distances (feet) estimated using Google Earth ™.

B - L_{eq}Calc = Selected_L_{eq} - 20*log(50/D). "Selected_L_{eq}" = reference noise level @ 50-feet. D = distance to location/receptor (feet).
Source: Federal Highway Administration's *Roadway Construction Noise Model* (FHWA, 2006).

C - The line-of-sight adjustments accounts for measurement locations which may have had only partial or no direct line-of-sight to operating mining equipment. Views of active mining equipment was partially shielded at Location #10, therefore a correction factor of +10 decibels (dBA) has been added to ensure the estimate reference level is appropriately normalized.

Primary Haul Road

Reference Noise Level @ 50-Feet

Primary Haul Road					
Measurement Location	**Measured Noise Level (L_{eq})**	**Line-Of-Sight Adjustment (dBA) [C]**	**Distance from Source (feet) [A]**	**Noise Level (L_{eq}) @ 50-feet [B]**	**$10^{(X/10)}$**
#4	64.1	0	90	69.2	8328082.34
#9	63.1	0	180	74.2	26460923.76
#1 (Hour 1)	59.1	0	470	78.6	72379389.32
#1 (Hour 2)	50.0	0	470	69.5	8815135.51
			Primary Haul Road - Average Noise Level (L_{eq}) @ 50-feet:		**74.6** **dBA**

See Figure 2 (Attachment A) for the noise monitoring locations described above.

A - Distances (feet) estimated using Google Earth ™.

B - L_{eq}Calc = Selected_L_{eq} - 20*log(50/D). "Selected_L_{eq}" = reference noise level @ 50-feet. D = distance to location/receptor (feet).
Source: Federal Highway Administration's *Roadway Construction Noise Model* (FHWA, 2006).

C - The line-of-sight adjustments accounts for measurement locations which may have had only partial or no direct line-of-sight to operating mining equipment. Each measurement location had direct line-of-sight to operating haul trucks, and therefore no decibel adjustment/correction factors are required.

Heap Leach Pad Formation

Reference Noise Level @ 50-Feet

Heap Leach Pad Formation					
Measurement Location	**Measured Noise Level (L_{eq})**	**Line-Of-Sight Adjustment (dBA) [C]**	**Distance from Source (feet) [A]**	**Noise Level (L_{eq}) @ 50-feet [B]**	**$10^{(X/10)}$**
#2	35.3	10	3,825	83.0	198300071.28
#5	62.5	0	1,250	90.5	1111424631.27
			Heap Leach Pad Formation - Average Noise Level (L_{eq}) @ 50-feet:		**88.2** **dBA**

See Figure 2 (Attachment A) for the noise monitoring locations described above.

A - Distances (feet) estimated using Google Earth ™.

B - L_{eq}Calc = Selected_L_{eq} - 20*log(50/D). "Selected_L_{eq}" = reference noise level @ 50-feet. D = distance to location/receptor (feet). Source: Federal Highway Administration's *Roadway Construction Noise Model* (FHWA, 2006).

C - The line-of-sight adjustments accounts for measurement locations which may have had only partial or no direct line-of-sight to operating mining equipment. Views of active head leach formation/equipment was partially shielded at Location #2, therefore a correction factor of +10 decibels (dBA) has been added to ensure the estimate reference level is appropriately normalized.

Gold Processing Plant

Reference Noise Level @ 50-Feet

Gold Processing Plant					
Measurement Location	**Measured Noise Level (L_{eq})**	**Line-Of-Sight Adjustment (dBA) [C]**	**Distance from Source (feet) [A]**	**Noise Level (L_{eq}) @ 50-feet [B]**	**$10^{(X/10)}$**
#6	58.2	0	220	71.1	12791025.15
			Gold Processing Plant - Average Noise Level (L_{eq}) @ 50-feet:	**71.1**	**dBA**

See Figure 2 (Attachment A) for the noise monitoring locations described above.

A - Distances (feet) estimated using Google Earth ™.

B - L_{eq}Calc = Selected_L_{eq} - 20*log(50/D). "Selected_L_{eq}" = reference noise level @ 50-feet. D = distance to location/receptor (feet).
Source: Federal Highway Administration's *Roadway Construction Noise Model* (FHWA, 2006).

C - The line-of-sight adjustments accounts for measurement locations which may have had only partial or no direct line-of-sight to operating mining equipment. Each measurement location had direct line-of-sight to operating haul trucks, and therefore no decibel adjustment/correction factors are required.

Crushing/Comminution Plant(s)

Reference Noise Level @ 50-Feet

Crushing/Comminution Plant Noise Measurements (Otay Mesa)							
Location #	Measurement #	Measured Noise Levels			Reference Noise Levels		
		Measured L_{eq}	Measured L_{eq} (Combined)	Distance from Source (ft.)	Reference Distance (ft.) [A]	L_{eq} @ 50-feet [B]	L_{eq} @ 50-feet (Combined)
Location #1	#1	76.0	81.2	205	50	88.3	93.4
	#2	80.6				92.9	
	#3	83.8				96.1	
Location #2	#1	79.4	76.4	145	50	88.6	85.7
	#2	76.3				85.5	
	#3	61.9				71.1	
Location #3	#1	77.7	80.7	42	50	76.2	79.2
	#2	83.7				82.2	
	#3	77.9				76.4	
Location #4	#1	83.4	81.5	51	50	83.6	81.6
	#2	74.3				74.5	
	#3	82.4				82.6	
Location #5	#1	83.0	81.0	54	50	83.7	81.7
	#2	82.2				82.9	
	#3	72.1				72.8	
Location #6	#1	85.1	82.7	78	50	89.0	86.5
	#2	76.7				80.6	
Location #7	#1	79.0	78.2	96	50	84.7	83.8
	#2	77.1				82.8	
Location #8	#1	83.4	83.4	140	50	92.3	92.3
Location #9	#1	73.3	73.3	120	50	80.9	80.9
Location #10	#1	72.8	72.8	70	50	75.7	75.7
					Plant Noise Level (L_{eq}) - Statistical Average @ 50-feet [C]:		**84.1** **dBA**

Note: The noise levels shown above were measured while the large crushing plant was operating "at maximum capacity". In addition to the plant, mobile equipment (haul trucks, loaders) were also operating in the vicinity during the measurements. Because these mobile sources were captured, in addition to the crushing plant, these measured sound levels are conservatively utilized to represent CMV's proposed Crushing Plant and Comminution Plant.

A - Distances (feet) estimated using Google Earth ™.

B - L_{eq}Calc = Selected_L_{eq} - 20*log(D/50). "Selected_L_{eq}" = reference noise level @ 50-feet. D = distance to location/receptor (feet).
Source: Federal Highway Administration's *Roadway Construction Noise Model* (FHWA, 2006).

C - A total of 22 noise measurements (3-minutes each) were collected at 10 locations surrounding the crushing plant at the Otay Mesa facility in 2020.
Measurements were collected while the crushing equipment was operating at approximately full capacity and within line-of-sight of the noise source(s).
Noise measurements were then statistically combined/averaged to determine an average source noise level (84.1 dBA) at a reference distance of 50-feet.

Primary/Tertiary and Secondary Crushing Plant(s)

Reference Noise Level @ 50-Feet

Crusher Plant(s)				
Equipment	**Manufacturer Specifications / Decibel Levels [A]**	**Measurement Distance (feet) [A]**	**Reference Distance (feet) [B]**	**L_{eq} @ 50-feet**
Primary/Tertiary Crusher	110	3	50	85.6
Secondary Crusher	100	3	50	75.6

A - Decibel levels for the "Primary/Tertiary Crushing Plant" and "Secondary Crushing Plant" taken from the manufacturer's (i.e., Metso Outotec) noise statement provided by CMV. Specifically, the manufacturer notes that "*typical Crushing Plant noise level while crushing ranges from 100 dB to 110 dB measured at 1 m (3 ft) from the Crushing Plant*". Therefore, 110 decibels (dB) at 3-feet is utilized for the larger primary/tertiary crusher, while 110 dBs at 3-feet is utilized for the smaller secondary crusher.

B - L_{eq}Calc = Selected_L_{eq} - 20*log(50/D). "Selected_L_{eq}" = reference noise level @ 50-feet. D = distance to location/receptor (feet).
Source: Federal Highway Administration's *Roadway Construction Noise Model* (FHWA, 2006).

Metso:Outotec

Mining Crushers – Noise Statement

A Crushing Plant by its very nature is noisy and theauxiliary equipment found at, on or around the Crushing Plant such as chutes, transfer stations, screens, etc., can at times be noisier than the Crushing Plant itself. Typical Crushing Plant noise level while crushing rangesfrom 100 dB to 110 dB measured at 1 m (3 ft) from the Crushing Plant.

Metso:Outotec recommends wearing ear protection at, on and around Crushing Plant, particularly when the noiselevel exceeds 85 dB. It is recommended that the Owner develop a signalling communication system in noisy environments to reduce the risk of accidents. Proper machine maintenance and replacement of worn parts can help reduce noise.

The most commonly applied noise reduction procedures are:

- use of isolation techniques
- equipment enclosures
- operator enclosures
- silencers

Allowable noise levels and exposure limits are regulated by various agencies such as EC, OSHA, MSHA, etc. Refer to applicable safety regulations for permissible noise exposures, and take steps to ensure compliance with those regulations.

Specifications in this document are subject to change without notice.
Product names in this publication are all trademarks of Metso Outotec Corporation.

12.2.2 Vibration Source Levels from Construction Equipment

Ground-borne vibration related to human annoyance is generally related to root mean square (rms) velocity levels expressed in VdB. However, a major concern with regard to construction vibration is building damage. Consequently, construction vibration is generally assessed in terms of peak particle velocity (PPV), as defined in Chapter 7.1.2. The relationship of PPV to rms velocity is expressed in terms of the "crest factor," defined as the ratio of the PPV amplitude to the rms amplitude. Peak particle velocity is typically a factor of 1.7 to 6 times greater than rms vibration velocity.

Various types of construction equipment have been measured under a wide variety of construction activities with an average of source levels reported in terms of velocity as shown in Table 12-2. In this table, a crest factor of 4 (representing a PPV-rms difference of 12 VdB) has been used to calculate the approximate rms vibration velocity levels from the PPV values. Although the table gives one level for each piece of equipment, it should be noted that there is a considerable variation in reported ground vibration levels from construction activities. The data provide a reasonable estimate for a wide range of soil conditions.

Table 12-2. Vibration Source Levels for Construction Equipment (From measured data.[7,8,9,10])

Equipment		PPV at 25 ft (in/sec)	Approximate L_v† at 25 ft
Pile Driver (impact)	upper range	1.518	112
	typical	0.644	104
Pile Driver (sonic)	upper range	0.734	105
	typical	0.170	93
Clam shovel drop (slurry wall)		0.202	94
Hydromill (slurry wall)	in soil	0.008	66
	in rock	0.017	75
Vibratory Roller		0.210	94
Hoe Ram		0.089	87
Large bulldozer		0.089	87
Caisson drilling		0.089	87
Loaded trucks		0.076	86
Jackhammer		0.035	79
Small bulldozer		0.003	58

† RMS velocity in decibels (VdB) re 1 micro-inch/second

EIR APPENDIX 11

2023 York Fire Burned Area Emergency Response Plan (Holbeck 2023)

2023
YORK FIRE

BURNED AREA EMERGENCY RESPONSE PLAN

NEEDLES FIELD OFFICE

BUREAU OF LAND MANAGEMENT



AUGUST 2023

DOI INTERAGENCY BAER TEAM

BURNED AREA EMERGENCY RESPONSE PLAN

2023 YORK FIRE

AGENCY/UNIT:	Bureau of Land Management
LOCATION:	Barnwell, CA
DATE:	August 21, 2023
PREPARED BY:	Interagency Burned Area Emergency Response Team (Chris Holbeck)



SUBMITTED BY: _____

Chris Holbeck, BAER Team Leader, NPS – Omaha, NE

BURNED AREA EMERGENCY RESPONSE PLAN

2023 YORK FIRE

TABLE OF CONTENTS

BAER Team Leader Signature Page	**2**
Executive Summary	**4**
Part A - Fire Location and Background Information	**7**
Part B - Nature of Plan	**7**
Part C - Team Organization	**8**
Part D - Treatment Cost Summary	**9**
Part E - Breakdown of Treatment Cost Summary	**10**
Part F - Specifications	**11**
Assessments	**28**
Appendix A - Environmental Compliance	**39**
Appendix B - Maps	**48**
Appendix C - Supporting Documents	**54**
Appendix D - Photos	**87**

BURNED AREA EMERGENCY RESPONSE PLAN
2023 YORK FIRE
EXECUTIVE SUMMARY

INTRODUCTION

This post-wildfire response plan has been prepared for the York Fire and includes both emergency stabilization (ES) and burned area rehabilitation (BAR) treatment recommendations and funding requests for the Bureau of Land Management (BLM) Needles Field Office.

This plan has been prepared in accordance with the Department of Interior (DOI) policy and guidance, including the U.S. DOI Departmental Manual, Part 620, Chapter 7 (Wildland Fire Management, Post-Wildfire Recovery 2017), Interagency Burned Area Emergency Response (BAER) Guidebook (February 2006), and Interagency Burned Area Rehabilitation Guidebook (October 2006).

FIRE BACKGROUND

The fire started on July 28, 2023, at approximately 12:09 pm and the cause is still under investigation. The fire was declared Contained on August 19, and at the time of the BAER assessment the total acreage of the fire was 92,539 acres across multiple ownerships including the National Park Service (NPS), Bureau of Land Management (BLM; CA and NV), State land (CA), and private land (CA and NV).

BAER PROGRAM

The primary objective of the Burned Area Emergency Response (BAER) program is to conduct a rapid assessment of post-fire changes to values at risk and prescribe cost effective post-fire stabilization measures necessary to protect human life, property, and critical natural and cultural resources. The scope of BAER is to address imminent (<1 year) threats caused by wildfire, and address impacts to resources not likely to recover naturally. BAER is not intended to treat long-term management, restoration, or pre-fire conditions.

The BLM requested assistance from the Department of Interior's National BAER Team to assess post fire values at risk and recommend stabilization and rehabilitation treatments on BLM managed lands. A BAER Team with expertise in hydrology, watershed modeling, soil science, range management, wildlife, botany, GIS, and environmental compliance assembled August 8, 2023. The BAER Team held an initial briefing with local staff from the BLM and National Park Service that included managers, biologists, AML specialists, facilities specialists, vegetation specialists, fire operations, and cultural/heritage resource specialists via Teams and in-person at the Mohave National Preserve Headquarters office on August 8.

The briefing served as an overview of the BAER process and followed by a discussion of local important values at risk or issues related to the fire and post-fire conditions. The BAER team paired up with local specialists from all agencies and began the field reconnaissance work on August 9th and provided daily updates on their findings at evening briefings.

On August 21, the BAER Team shared the findings and recommendations with Needles Field Office managers, resource and ES&R staff, and the BLM National BAER coordinator during a

close-out presentation. The initial BAER plan identified five (5) funding specifications totaling $129,089 encompassing $61,715 within ES and $67,374 within BAR.

ASSESSMENT PROCESS

Following field reconnaissance and consultation with natural resource and ES&R specialists from the BLM, the BAER team identified the following values most at risk due to the York Fire. Note that not all the issues identified result in recommendations for stabilization or rehabilitation treatments as they may fall outside of BLM jurisdiction, are outside the scope of BAER policy, have been mitigated by the fire Incident Management Team, and/or were found to be a non-issue through field reconnaissance and analysis.

- **Safety Risks to Public and Increased Ecological Damage in Burned Areas -** Burned vegetation that blocked public access to previously inaccessible areas now expose the public to hazards within the burned area, including mine sites, adits, stump holes, and loose footing. Increased public foot and ORUV traffic could degrade the recovery of these areas as well.

- **Risk of Noxious Weed Spread in Burned Areas -** Noxious weeds can displace native vegetation, reduce biodiversity, and modify fire behavior and fire return intervals. Areas within the fire perimeters are susceptible to invasive noxious weed spread from existing populations and inadvertent spread due to fire suppression operations. Invasive species can be aggressive colonizers of burned lands as well.

In response to the risks described above, the following ES and BAR treatments are recommended to lessen post-fire impacts and protect critical natural resources within the York Fire:

Safety Risks to Public and Increased Ecological Damage in Burned Areas: Proposed treatment specifications include:

- Installation of warning/hazardous area signs to inform the public of risks and dangers when entering the burned area, as well as when entering restoration areas.
- Providing barriers where needed to help keep the public out of areas that are recovering.
- Patrolling of areas that are recovering from the fire and may experience increased unauthorized OHV use due to the topography and current lack of vegetation.

Biological Resources: Proposed treatments specifications include:

- Noxious weed surveys and treatments in areas made vulnerable by the fire, at suppression damage areas such as dozerlines, helispots, and areas at risk from non-native plant species invasion.

Implementation Leader: This treatment will provide funding support for current staff to assist with implementing the treatments, monitoring the treatment effectiveness, and completing the required annual reporting.

Management Direction, Environmental Compliance
Management direction relevant to ES and BAR treatments proposed in this plan can be found in Appendix A Environmental Compliance. Compliance with environmental laws, regulations, policies, and local agency planning documents are required for all proposed BAER treatment actions on lands managed by the BLM. All proposed treatments were reviewed and determined

to be covered by the National Environmental Policy Act under existing Categorical Exclusions, Environmental Assessments, and Environmental Impact Statements. In order to meet their obligations under the National Historic Preservation Act, a local BLM archeologist should determine if proposed treatments will require consultation with local tribes and the State Historic Preservation Officer. Consultations and steps to ensure compliance with Section 106 of the NHPA should be completed prior to any ground disturbing treatments. The DOI BAER Team determined that there will be no effects to threatened or endangered species or critical habitat from the proposed ES and BAR treatments in this BAER Plan. Effects on species or critical habitat due to fire suppression activities is the responsibility of the BLM Needles Field Office to address in coordination with the U.S. Fish and Wildlife Service.

PLAN ORGANIZATION

The results of this planning process are documented in Resource Assessments and detailed treatment specifications. A summary of treatment costs is found in the Part E Cost Summary Table. Appendix A contains the environmental compliance documentation prepared in accordance with the requirements of NEPA. Appendix B contains the final suppression maps prepared by the IMT and BAER Plan Maps produced to assist with resource damage assessments and treatment locations. Appendix C contains relevant supporting documentation for the plan and our team's process, and Appendix D contains photographic documentation of fire effects.

CONCLUSION

Burned areas present risk to critical values identified by local resource specialists and BAER Team members. As a result, to reduce these threats and mitigate further damage to BLM land and resources, this initial Emergency Stabilization and Rehabilitation plan outlines four (4) ES and one (1) BAR specifications for the York Fire totaling $129,089.

These actions may be implemented immediately pending approval of funding and alignment of assets. BAER Team and BLM Needles Field Office ES&R staff will complete VMAP entries for funding review and authorization before day 21 following the York Fire's containment date. Any additional actions not already proposed in this plan will require additional planning, collaboration, and environmental compliance review prior to implementation.

BURNED AREA EMERGENCY RESPONSE PLAN
2023 YORK FIRE

PART A. FIRE LOCATION AND BACKGROUND INFORMATION

Fire Name	York		
Fire Number	QF3U		
Incident Number	CA-MNP-011033		
Agency Unit	BLM Needles Field Office	**Jurisdiction**	**Acres**
State	California	BLM CA	663
County	San Bernadino	BLM NV	8,250
Ignition Date/Manner	July 28, 2023 / Undetermined	NPS – MOJA	70,625
Date Contained	August 19, 2023	NPS - CAMO	2,359
		Private – CA	7,280
		Private – NV	62
		State – CA	3,301
		TOTAL ACRES	**92,540**

PART B. NATURE OF PLAN

I. Type of Plan (check one box below)

	Short-term Emergency Stabilization Plan
	Long-term Rehabilitation
X	Both Long and Short-term Rehabilitation

II. Type of Action (check one box below)

X	Initial Submission
	Updating Or Revising The Initial Submission
	Supplying Information For Accomplishment To Date On Work Underway
	Different Phase Of Project Plan
	Final Report (To Comply With The Closure Of The EFR Account)

III. EMERGENCY STABILIZATION OBJECTIVES

- Determine need for and to prescribe and implement emergency treatments; and
- Minimize threats to human life, safety, and property; and
- Identify threats to critical cultural and natural resources; and
- Promptly stabilize and prevent unacceptable degradation to resources.

PART C. TEAM ORGANIZATION

BAER TEAM MEMBERS

Name & Affiliation	*Position or Specialties*
Chris Holbeck, DOI BAER Team (NPS)	Team Leader
Emily Ramirez, DOI BAER Team (BLM)	Documentation, Wildlife, Vegetation
Rich Pyzik, DOI BAER Team (USFS)	Hydrology
Mary Ellen Miller, DOI BAER Team (MTU)	Hydro Modeling
Kevin Hyatt, DOI BAER Team (BLM)	Hydrology
Erin Kowalski, DOI BAER Team (BLM)	Range and Vegetation
Kenny Elsner, DOI BAER Team (FWS)	GIS
Sasha Travaglio, DOI BAER Team (NPS)	Public Information
Nicole Keefner, BLM CA	BLM Needles FO ES&R Lead
Tarl Norman, BLM NV	BLM Southern Nevada District ES&R Lead
Jimmy Linares, BLM NV	Resource Advisor and Outdoor Rec Planner
Mitch Sylvester, BLM NV	Zone Fire Management Officer
Matt Claire, NPS	Cultural Resources
Danilo Giordano, NPS	Cultural Resources and GIS
Jodie Bailey, NPS	NEPA and Environmental Compliance
Sofia Andeski, NPS	AML and Watershed
Neal Darby, NPS	Wildlife
Michael Burchett, NPS	Wildlife
Erin Knight, NPS	Vegetation
Ryan Mcrae, NPS	Vegetation
Nick Graver, NPS	Vegetation
Dave Nichols, NPS	Cultural Resources
Trent Martinez, NPS	Facilities
Nelson Siefkin, NPS	Regional Post-Wildfire Programs Coordinator

PART D. TREATMENT COSTS

I. 2023 YORK FIRE

2023 YORK FIRE - EMERGENCY STABILIZATION (ES)		
NUMBER	**TREATMENT**	**TOTAL**
ES-1	Non-native Invasive Plant Control (Ground-based)	$18,738
ES-2	Safety Signage	$9,888
ES-3	Implementation Leader	$15,683
ES-4	LEO Patrols	$17,406
	ES TOTAL	**$61,715**

2023 YORK FIRE – BURNED AREA REHABILITATION (BAR)		
NUMBER	**TREATMENT**	**TOTAL**
BAR-1	Non-Native Invasive Plant Control (Ground-based)	$67,374
	BAR TOTAL	**$67,734**

PART E. SUMMARY OF EMERGENCY STABILIZATION ACTIVITIES COST

I. 2023 YORK FIRE

2023 YORK FIRE – EMERGENCY STABILIZATION (ES) ACTIVITIES COST TABLE								
TREATMENT SPECIFICATION	NFPORS CATEGORY	UNIT	UNIT COST	# OF UNITS	FISCAL YEAR			TOTAL
					2023	2024	2025	
ES-1 Non-Native Invasive Plant Control (Ground-based)	Invasive Species	Acres	$92.76	220	$18,738	--	--	$18,738
ES-2 Safety Signage	Human Life & Safety	Item	$193.88	51	$9,888	--	--	$9,888
ES-3 Implementation Leader	Administration	Reports	Varies	Varies	$7,620	$4,211	$4,211	$15,683
ES-4 LEO Patrols	Human Life & Safety	Patrols	$1,450	12	$17,406	--	--	$17,406
							TOTAL	**$61,715**

2023 YORK FIRE – BURNED AREA REHABILITATION (BAR) ACTIVITIES COST TABLE								
TREATMENT SPECIFICATION	NFPORS CATEGORY	UNIT	UNIT COST	# OF UNITS	FISCAL YEAR			
					2024	2025	2026	TOTAL
BAR-1 Non-Native Invasive Plant Control (Ground-based)	Invasive Species	Acres	$102.08	220	$22,458	$22,458	$22,458	**$67,374**
							TOTAL	**$67,374**

BURNED AREA EMERGENCY RESPONSE PLAN

2023 YORK FIRE

PART F. SPECIFICATIONS

I. Emergency Stabilization (ES)

- ES-1 Non-Native Invasive Plant Control (Ground-based)
- ES-2 Safety Signage and Barricades
- ES-3 Implementation Leader
- ES-4 LEO Patrols

II. Burned Area Rehabilitation (BAR)

- BAR-1 Non-Native Invasive Plant Control (Ground-based)

PART F - INDIVIDUAL SPECIFICATION

TREATMENT/ACTIVITY NAME	Non-native Invasive Plant Control (Ground)	**PART E SPECIFICATION #**	ES-1
NFPORS TREATMENT CATEGORY*	Invasive Species	**FISCAL YEAR(S) (list each year):**	2023
NFPORS TREATMENT TYPE *	Chemical Treatment	**WUI? Y / N**	N
IMPACTED COMMUNITIES AT RISK	N/A	**IMPACTED T&E SPECIES**	Desert tortoise

* See NFPORS Restoration & Rehabilitation module - Edit Treatment screen for applicable entries.

WORK TO BE DONE (describe or attach exact specifications of work to be done):

How does this treatment mitigate potential impacts to values at risk?
The objective is to treat weed infestations identified during post-fire monitoring within the area impacted by the York Fire. Invasive plants often outcompete native vegetation in establishing in disturbed areas such as a post-fire landscape. Integrated pest management (IPM), including biological, herbicide, and mechanical methods will be used to prevent the establishment and spread of weeds in the burned area. Treatment methods may include mechanical removal, backpack sprayers, or other methods, as appropriate and approved in management plans by the BLM Needles Field Office. By quickly addressing non-native invasive plants in the disturbed area, it is less likely that non-native populations will spread further or be introduced into the area, which could lead to loss of native plant biodiversity and eventual plant community conversion if left unchecked.

General Description: Qualified BLM staff will survey all roads and staging areas for all invasive plants and propose treatments to eradicate invasive forb, woody, and select graminoid species (e.g., buffelgrass) through herbicide application when discovered. There will be two treatments applied, one in late spring and one in late summer, to account for the variation in phenological timing of different invasive plant species.

Invasive plant species observed in the burn area, staging areas, or immediate vicinity:
1. Red brome, *Bromus rubens*
2. Cheatgrass, *Bromus tectorum*
3. Arabian schismus, *Schismus arabicus*
4. Russian thistle, *Salsola tragus*
5. Saltlover, *Halogeton glomeratus* *
6. Saltcedar, *Tamarix ramosissima*
7. Puncturevine, *Tribulus terrestris*
8. Silverleaf nightshade, *Solanum elaeagnifolium*

Weeds known to be in the burn area or region, but not observed during assessment:
1. Red stork's bill, *Erodium cicutarium*
2. Sahara mustard, *Brassica tournefortii*
3. Stinkgrass, *Eragrostis cilianensis*
4. Shortpod mustard, *Hirschfeldia incana*
5. Horehound, *Marrubium vulgare*
6. Giant reed, *Arundo donax*
7. Buffelgrass, *Cenchrus ciliaris*
8. Fountaingrass, *Pennisetum setaceum*
9. Tree of heaven, *Ailanthus altissima*
10. Russian knapweed, *Acroptilon repens*
11. Mexican bird of paradise, *Caesalpinia pulcherrima*
12. Five hook bassia, *Bassia hyssopifolia*
13. Perennial pepperweed, *Lepidium latifolium*
14. Flixweed, *Descurainia sophia*
15. Tall tumblemustard *Sisymbrium altissimum*
16. Oriental mustard, *Sisymbrium orientale*
17. African mustard, *Strigosella africana*
18. London rocket, *Sisymbrium irio*
19. Stinknet, *Oncosiphon piluliferum*

Location:
Treatment of noxious weeds and invasive grasses would target those occurrences documented during the inventory along roads, suppression lines, drop points, staging areas, and helispots. These are also the most likely places for invasive plant introductions to occur. Other occurrences may be identified at this time and should also be treated to control the establishment and spread of the non-native species. The calculated estimate of acres for monitoring were based on appropriate buffer sizes according to the type of disturbance corridor. In total, there are approximately 202 acres within the BLM Needles Field Office area of the fire perimeter that should be monitored and potentially treated for weeds. See map in Appendix B of the plan for locations.

Design/Construction Specs:
Treat roadsides and other disturbed areas within and immediately adjacent to the burned area using an IPM approach. Treatment will be conducted at the appropriate time of year, as recommended by application specialists and in accordance with manufacturer's labels, tribal and federal regulations, and NEPA review. Species occurrences, abundance, and treatment method will be documented and photographed, and the location information will be recorded through global positioning system (GPS) technology. Annual reports documenting accomplishments and associated costs will be prepared. Treated sites should be resurveyed yearly for efficacy and treated until controlled. If treatments are observed to be ineffective, the BLM will implement Adaptive Management to determine if other methods should be applied.

Herbicide applications will only be made by qualified applicators according to the label and following state and federal regulations.

Applications must be documented and reported, according to State and Federal guidelines.

Purpose of Treatment Specs (related to damage/change caused by fire):
The treatment will involve applying integrated pest management (IPM) techniques to minimize the establishment of non-native invasive species within the burned area. These efforts aim to control non-native invasive plants within the burned area in a timely fashion where invasive plants may quickly invade or hamper reestablishment of native vegetation on the fragile post-fire Mojave desert landscape that is home to unique and rare endemic flora and fauna. Both early detection and rapid response (EDRR) and IPM methods will be used to prevent new weed infestations from establishing and will help promote recovery of native vegetation by reducing competition with these invasive species. Promoting better recovery of native vegetation will directly benefit other resources in the area, such as wildlife. The integrated pest management approach will include consideration of chemical, biological, mechanical, and/or hand control methods, as well as post-fire weed assessment and monitoring. The application of herbicides is anticipated to be necessary to keep non-native invasive plants from invading and dominating the post-fire environment. The purpose of applying chemical, manual, and mechanical removal of invasive species is to restore or establish a healthy, stable ecosystem even if this ecosystem cannot fully return to pre-fire conditions.

Treatment Reasonableness and Cost Effectiveness:
By using an Early Detection Rapid Response (EDRR) framework, monitoring efforts will identify invasive plants before they have a chance to spread, allowing for swift response using an IPM approach. This will reduce long-term costs of treating these populations after they have established in an area. Treatments for invasive plants are likely to continue for years following this initial treatment under ES using BAR funding until the invasive seed bank has been depleted or at least been reduced to a level where the Field Office can control it through Base funding via contracts or in-house staff. The Invasive Plant Management Team is comprised of certified experts in the field of invasive plant control and their methods are very effective. Herbicide application is the most cost-effective treatment for invasive plant control on a large scale and the herbicides used will be approved through the Pesticide Use Proposal System (PUPS). Other methods of invasive plant control (e.g., hand pulling, biocontrol) are not as cost effective as precision hand spraying at this scale.

Treatment Effectiveness Monitoring:
Roads, staging areas, and other areas disturbed by suppression will be monitored by BLM staff for new occurrences of weeds. Treated sites should be resurveyed yearly to determine efficacy of the treatment and if further application is necessary. Records will be maintained and shared as appropriate. Treatments are considered to be successful upon determination that weeds occurrences have reached a manageable level. Typically, an 80% reduction of weed species is considered control.

1. Treatment effectiveness of roads and staging areas will be monitored annually to determine the spatial extent of weeds via LAKE IPMT NISIMS GIS data.

2. Treatments will be considered effective if the spatial extent decreases over time and trajectories lead towards the eventual eradication of the occurrence. There will be considerations for annual timing and amounts of precipitation, as well as other disturbance events.

Treatment Consistent with Land Management Plan:

- This treatment is in line with the California Desert Conservation Area Plan (1980 as amended). A NEPA document will need to be drafted for this treatment that can tier off existing reviews:2016 Vegetation Treatments Using Aminopyralid, Fluroxypyr, Rimsulferon on Bureau of Land Management Lands in 17 Western States - DOI - BLM - WO- WO2100 -2012 - 0002 - EIS
- 2007 Final Vegetation Treatments Using Herbicides Programmatic Environmental Impact Statement - DOI - BLM - WO - WO2100 -2007 - 0002 - EIS

MONITORING PLAN

Treatment Objectives:

After invasive species have been introduced to a site, the best approach to weed management is early detection and rapid response. Monitoring of weeds will be conducted via ground surveys to inform the IPM approach to invasive species. Weed treatments will be cost effective if the infestations are treated when they are small or have just become established. The weed species are most susceptible at early germination stages.

Describe how implementation will be monitored:

Personnel will follow all federal laws as well as BLM handbooks and policy regarding treatment of noxious weeds. Personnel will ensure all inventory and treatment data is submitted in the VMAP database.

Describe how effectiveness will be monitored, how it will be measured, and within what time period:

Effectiveness will be monitored by conducting treatment evaluations on weed treatment sites. Weed treatments will be considered effective if greater than eighty percent of the targeted weed species are affected by the treatment(s) during that year. Treatment areas will be mapped using GPS/GIS before and after treatments.

LABOR, MATERIALS AND OTHER COST:

PERSONNEL SERVICES: (Grade @ Cost/Hours X # Hours X # Fiscal Years = Cost/Item): Do not include contract personnel costs here (see contractor services below).	QUANTITY	UNIT PRICE	AMOUNT
BLM COR/PI or Field Supervisor (GS-12): $12,000/WM X 0.5WM X 1 person X 1 FY	1	$6,000.00	$6,000.00

2 Herbicide applicators (GS-7): $25/hr X 8 hrs/day X 20 days X 1 FY	2	$4,000.00	$8,000.00
1 Data Manager (GS-7): $25/hr X 8 hrs/day X 10 days X 1 FY	1	$2,000.00	$2,000.00
TOTAL PERSONNEL SERVICES COSTS			**$16,000.00**

EQUIPMENT PURCHASE, LEASE AND/OR RENT (Item @ Cost/Hour X # of Hours X #Fiscal Years = Cost/Item): Note: Purchases require written justification that demonstrates cost benefits over leasing or renting.	QUANTITY	UNIT PRICE	AMOUNT
Backpack sprayer (4-gal): $125/pack X 2 packs X 1 FY	1	$250.00	$250.00
Backpack Sprayer Parts @ $100 X 1 FY	1	$100.00	$100.00
Herbicide Containment, Storage, and Equipment @ $200 X 1 FY	1	$200.00	$200.00
TOTAL EQUIPMENT PURCHASE, LEASE OR RENTAL COSTS			**$550.00**

MATERIALS AND SUPPLIES (Item @ Cost/Each X Quantity X #Fiscal Years = Cost/Item):	QUANTITY	UNIT PRICE	AMOUNT
Imazapyr (2.5 gal): $250/container X 1 container X 1 FY	1	$250.00	$250.00
Glyphosate (2.5-gal): $120/container X 2 containers X 1 FY	2	$120.00	$240.00
Aminopyralid (1 gal): $110/container X 1 containers X 1 FY	1	$110.00	$110.00
Adjuvants (dyes and surfactants): $100 X 1 FY	1	$100.00	$100.00
PPE set (gloves, coveralls, eye protection, face mask) @ $100/set X 2 sets X 1 FY	2	$100.00	$200.00
TOTAL MATERIALS AND SUPPLY COSTS			**$900.00**

TRAVEL COST (Personnel or Equipment @ Rate X Round Trips X #Fiscal Years = Cost/Item):	QUANTITY	UNIT PRICE	AMOUNT
4 X 4 Pickup mileage @ $0.56/mile X 2,300 miles (10 Round Trips, 230 miles each from field office to installation site and back) X 1FY	2,300	$0.56	$1,288.00
TOTAL TRAVEL COSTS			$1,288.00

CONTRACT COST (Labor or Equipment @ Cost/Hour X #Hours X #Fiscal Years = Cost/Item):	QUANTITY	UNIT PRICE	AMOUNT
TOTAL CONTRACT COSTS			**$0**

SPECIFICATION COST SUMMARY

FISCAL YEAR	PLANNED INITIATION DATE	PLANNED COMPLETION DATE	WORK AGENT	UNITS	UNIT COST	PLANNED ACCOMPLISHMENTS	PLANNED COSTS
2023	09/01/2023	09/30/2023	F	Acres	$92.76	202	$18,738.00
						SUMMARY COST TOTAL	$18,738.00
						Difference should be zero (SUMMARY COST TOTAL - SPECIFICATION TOTAL)	$0.00
						SPECIFICATION TOTAL	$18,738.00

Work Agent: C=Coop Agreement, **F**=Force Account, **G**=Grantee, **P**=Permittees, **S**=Service Contract, **T**=Timber Sales Purchaser, **V**=Volunteer

SOURCE COST ESTIMATE

1.	Estimate obtained from 2-3 independent contractual sources.	☐ P ☐ E ☐ M ☐ T ☐ C ☐ F
2.	Documented cost figures from similar project work obtained from local agency sources.	☒ P ☒ E ☐ M ☒ T ☐ C ☐ F
3.	Estimate supported by cost guides from independent sources or other federal agencies	☐ P ☐ E ☐ M ☐ T ☐ C ☐ F
4.	Estimates based upon government wage rates and material cost.	☒ P ☐ E ☐ M ☒ T ☐ C ☐ F
5.	No cost estimate required - cost charged to Fire Suppression Account	☐ P ☐ E ☐ M ☐ T ☐ C ☐ F

P = Personnel Services, **E** = Equipment **M** = Materials/Supplies, **T** = Travel, **C** = Contract, **F** = Suppression

RELEVANT DETAILS, MAPS AND DOCUMENTATION INCLUDED IN THIS REPORT

See BAER plan for further information regarding treatment information and resource assessments.

PART F - INDIVIDUAL SPECIFICATIONS

TREATMENT/ACTIVITY NAME	Signage and Barricades	**PART E SPECIFICATION #**	ES-2
NFPORS TREATMENT CATEGORY*	Human Life and Safety	**FISCAL YEAR(S) (list each year):**	2023
NFPORS TREATMENT TYPE*	Warning and Safety Signs	**WUI? Y/N**	N
IMPACTED COMMUNITIES AT RISK	N/A	**IMPACTED T&E SPECIES**	N/A

* See NFPORS Restoration & Rehabilitation module - Edit Treatment screen for applicable entries.

WORK TO BE DONE (describe or attach exact specifications of work to be done):

How does this treatment mitigate potential impacts to values at risk? Wildfire creates new hazards, accessibility concerns, and sign damage. Placing signs on roads used to access the area explaining the new conditions and replacing damaged signs will help inform the public of the changed conditions and closures.

General Description: This treatment is for the installation of information signs, warning signs, closure signs, and barricades. These signs will serve to warn the public of potential hazards present as a result of the fire. The signs shall contain language that specifies potential hazards of which to be aware when entering a burn area, such as falling trees, rolling rocks and flash floods. Closure signs shall indicate what is closed. Temporary barricades will prevent unwanted access and be appropriate for the expected user. Installation will be by staff and occur as soon as the material is available.

Location: Hazard signs will be placed on roads entering the field office and at appropriate intervals along the road. Temporary road barriers should be placed at Walking Box Ranch Road as a primary access point and on other roads as necessary for public safety. Locations for signs and barricades should be adjusted based on local knowledge and site conditions.

Design/Construction Specs: Signs will be made of a typical sign material and will be large enough to be seen from a moving vehicle. Wooden or metal posts will be installed using hand augers that will dig 4 to 6 inch holes two to three feet deep in locations with no sign infrastructure. If sign or kiosk structure exists, staff can place or attach signs using screws and/or bolts. Signs large enough to be seen from a moving vehicle will be mounted on temporary barricades. Sand bags may be used to hold barricade in place in high wind areas.

Purpose of Treatment Specs: The signs will provide users of the area with warning for potential hazards they may encounter. Temporary barricades will prevent access.

Treatment Reasonableness and Cost Effectiveness: This treatment will address public safety while the burned areas recover over time. The cost for implementing this treatment is outweighed by the benefit of promoting public safety and resource protection.

Treatment Effectiveness Monitoring: Field office staff will verify installation and locations of signs and monitor for effectiveness and potential vandalism.

Treatment Consistent with Land Management Plan: This treatment is covered by the BLM CX authority Part 516 DM 11 G.

Treatment Objectives: Install signs at appropriate locations such as major access points or common intersections. Place temporary barriers where roads affected by fire impacts become unsafe to traverse.

Describe how implementation will be monitored: Field office staff will take photos of each site before and after signs are installed.

LABOR, MATERIALS AND OTHER COST:

	PERSONNEL SERVICES: (Grade @ Cost/Hours X # Hours X # Fiscal Years = Cost/Item): Do not include contract personnel costs here (see contractor services below).	QUANTITY	UNIT PRICE	AMOUNT
+ -	WG-10 @ $62.60/hour X 80 hours X 1FY	80	$63.00	$5,040.00
+ -	WG-10 @ $90.83/hour overtime X 20 hours X 1FY	20	$91.00	$1,820.00
	TOTAL PERSONNEL SERVICE COSTS			$6,860.00
	EQUIPMENT PURCHASE, LEASE AND/OR RENT (Item @ Cost/Hour X # of Hours X #Fiscal Years = Cost/Item): Note: Purchases require written justification that demonstrates cost benefits over leasing or renting.	QUANTITY	UNIT PRICE	AMOUNT
+ -	Post driver, wrenches, miscellaneous tools	1	$300.00	$300.00
	TOTAL EQUIPMENT PURCHASE, LEASE OR RENTAL COSTS			$300.00
	MATERIALS AND SUPPLIES (Item @ Cost/Each X Quantity X #Fiscal Years = Cost/Item):	QUANTITY	UNIT PRICE	AMOUNT
+ -	Metal A-frame temporary barricade	4	$100.00	$400.00
+ -	Road closed sign for temporary barricade	2	$30.00	$60.00
+ -	Carsonite post	20	$20.00	$400.00
+ -	Sticker message for carsonite posts (e.g. Stay on designated route; e.g. Burn Area Restoration)	40	$3.00	$120.00
+ -	Metal sign 18” x 14” printed with message (e.g. Blowing Dust Area)	5	$80.00	$400.00
+ -	Metal u-post on which metal signs will be mounted	5	$12.00	$60.00
	TOTAL MATERIALS AND SUPPLY COSTS			$1,440.00
	TRAVEL COST (Personnel or Equipment @ Rate X Round Trips X #Fiscal Years = Cost/Item):	QUANTITY	UNIT PRICE	AMOUNT
+ -	4 X 4 Pickup mileage @ $0.56/mile X 2,300 miles X 1FY	2,300	$0.56	$1,288.00
	TOTAL TRAVEL COSTS			$1,288.00
	CONTRACT COST (Labor or Equipment @ Cost/Hour X #Hours X #Fiscal Years = Cost/Item):	QUANTITY	UNIT PRICE	AMOUNT
+ -				
	TOTAL CONTRACT COSTS			

SPECIFICATION COST SUMMARY

	FISCAL YEAR	PLANNED INITIATION DATE	PLANNED COMPLETION DATE	WORK AGENT	UNITS	UNIT COST	PLANNED ACCOMPLISHMENTS	PLANNED COSTS
							SUMMARY COST TOTAL	$9,888.00

	FISCAL YEAR	PLANNED INITIATION DATE	PLANNED COMPLETION DATE	WORK AGENT	UNITS	UNIT COST	PLANNED ACCOMPLISHMENTS	PLANNED COSTS
+ -	2023	09/04/2023	10/27/2023	F	Each	$193.88	51	$9,888.00
							SUMMARY COST TOTAL	$9,888.00
							Difference should be zero (SUMMARY COST TOTAL - SPECIFICATION TOTAL)	$0.00
							SPECIFICATION TOTAL	$9,888.00

Work Agent: **C**=Coop Agreement, **F**=Force Account, **G**=Grantee, **P**=Permittees, **S**=Service Contract, **T**=Timber Sales Purchaser, **V**=Volunteer

SOURCE COST ESTIMATE

1.	Estimate obtained from 2-3 independent contractual sources.	☐ P ☐ E ☐ M ☐ T ☐ C ☐ F
2.	Documented cost figures from similar project work obtained from local agency sources.	☐ P ☐ E ☐ M ☐ T ☐ C ☐ F
3.	Estimate supported by cost guides from independent sources or other federal agencies	☐ P ☐ E ☐ M ☐ T ☐ C ☐ F
4.	Estimates based upon government wage rates and material cost.	☒ P ☒ E ☒ M ☐ T ☐ C ☐ F
5.	No cost estimate required - cost charged to Fire Suppression Account	☐ P ☐ E ☐ M ☐ T ☐ C ☐ F

P = Personnel Services, **E** = Equipment **M** = Materials/Supplies, **T** = Travel, **C** = Contract, **F** = Suppression

RELEVANT DETAILS, MAPS AND DOCUMENTATION INCLUDED IN THIS REPORT

See BAER Plan and Treatment Map for locations.

PART F - INDIVIDUAL SPECIFICATIONS

TREATMENT/ACTIVITY NAME	Implementation Leader	**PART E SPECIFICATION #**	ES-3
NFPORS TREATMENT CATEGORY*	Administration	**FISCAL YEAR(S) (list each year):**	2023, 2024, 2025
NFPORS TREATMENT TYPE*	Administration	**WUI? Y/N**	N
IMPACTED COMMUNITIES AT RISK	N/A	**IMPACTED T&E SPECIES**	N/A

* See NFPORS Restoration & Rehabilitation module - Edit Treatment screen for applicable entries.

WORK TO BE DONE (describe or attach exact specifications of work to be done):

General Description: An implementation leader will coordinate work under the BAER plan, and is responsible for project implementation tracking, funds distribution, monitoring, and annual reports. The implementation leader will coordinate the tasks associated with this BAER Plan with the appropriate departments or staff at Needles field office.

Location/ (Suitable) Sites: All treatments within the burned areas are covered under Project Administration. The Implementation Leader will provide oversight to address the completion of the treatments prescribed within this plan.

Design/Construction Specifications: The project implementation leader will monitor, and coordinate activities and treatments designed in the approved BAER plan with appropriate programs and departments. The lead will track funding, coordinate accounting, document implementation, record specification completion, and coordinate compliance, contracts, and in-house work. The implementation lead will also communicate accomplishments and progress with the Regional and National BAER program.

Purpose of Treatment Specifications (relate to damage/change caused by fire): Project administration is critical to ensure that activities and treatments are implemented in an orderly, timely, and cost-effective fashion. Administration also creates an accountable position for point of contact.

Treatment Reasonableness and Cost Effectiveness: Monitoring to determine the effectiveness of ES&R treatments and inform ongoing efforts ensures the planned treatments are having the desired effects or will be appropriately modified through an adaptive management process to do so. Providing administration is critical for effective implementation of emergency stabilization and burned area rehabilitation activities and treatments.

Treatment Effectiveness Monitoring Proposed: An implementation lead funded with this specification will administer and coordinate activities and treatments, communicate with Regional and National BAER program on progress and accomplishments, and handle day to day management of the York Fire plan.

Treatment consistent with Agency Land Management Plan (identify which plan): This treatment is consistent with the California Desert Conservation Area Plan (1980 as amended).

LABOR, MATERIALS AND OTHER COST:

	PERSONNEL SERVICES: (Grade @ Cost/Hours X # Hours X # Fiscal Years = Cost/Item): Do not include contract personnel costs here (see contractor services below).	QUANTITY	UNIT PRICE	AMOUNT
+ -	GS-11 @ $53.46/hr X 80 hours X 1 FY (2023)	80	$53.46	$4,276.80
	GS-11 @ $80.19 overtime X 20 hours X 1 FY (2023)	20	$80.19	$1,603.80
+ -	GS-11 @ $53.46/hr X 40 hours X 1 FY (2024)	40	$53.46	$2,138.40
	GS-11 @ $80.19 overtime X 20 hours X 1 FY (2024)	20	$80.19	$1,603.80
+ -	GS-11 @ $53.46 X 40 hours X 1 FY (2025)	40	$53.46	$2,138.40
	GS-11 @ $80.19 overtime X 20 hours X 1 FY (2025)	20	$80.19	$1,603.80
			TOTAL PERSONNEL SERVICE COSTS	**$13,365.00**

	EQUIPMENT PURCHASE, LEASE AND/OR RENT (Item @ Cost/Hour X # of Hours X #Fiscal Years = Cost/Item): Note: Purchases require written justification that demonstrates cost benefits over leasing or renting.	QUANTITY	UNIT PRICE	AMOUNT
+ -				

TOTAL EQUIPMENT PURCHASE, LEASE OR RENTAL COSTS			**$0**
MATERIALS AND SUPPLIES (Item @ Cost/Each X Quantity X #Fiscal Years = Cost/Item):	QUANTITY	UNIT PRICE	AMOUNT
+ -			
TOTAL MATERIALS AND SUPPLY COSTS			**$0**
TRAVEL COST (Personnel or Equipment @ Rate X Round Trips X #Fiscal Years = Cost/Item):	QUANTITY	UNIT PRICE	AMOUNT
+ - 4 X 4 Pickup mileage @ $0.56/mile X 1,380 miles (6 Round Trips, 230 miles each from field office to affected area and back) X 3FY	4,140	$0.56	$2,318.40
TOTAL TRAVEL COSTS			$2,318.40
CONTRACT COST (Labor or Equipment @ Cost/Hour X #Hours X #Fiscal Years = Cost/Item):	QUANTITY	UNIT PRICE	AMOUNT
+ -			
TOTAL CONTRACT COSTS			**$0**

SPECIFICATION COST SUMMARY

	FISCAL YEAR	PLANNED INITIATION DATE	PLANNED COMPLETION DATE	WORK AGENT	UNITS	UNIT COST	PLANNED ACCOMPLISHMENTS	PLANNED COSTS
+ -	2023	08/28/2023	09/30/2023	F	Reports	$2,420.20	3	$7,260.60
+ -	2024	10/01/2023	9/30/2024	F	Reports	$4,211.40	1	$4,211.40
+ -	2025	10/1/2024	9/30/2025	F	Reports	$4,211.40	1	$4,211.40
	SUMMARY COST TOTAL							$15,683.40
	Difference should be zero (SUMMARY COST TOTAL - SPECIFICATION TOTAL)							$0.00
	SPECIFICATION TOTAL							$15,683.40

Work Agent: **C**=Coop Agreement, **F**=Force Account, **G**=Grantee, **P**=Permittees, **S**=Service Contract, **T**=Timber Sales Purchaser, **V**=Volunteer

SOURCE COST ESTIMATE

1.	Estimate obtained from 2-3 independent contractual sources.	☐ **P** ☐ **E** ☐ **M** ☐ **T** ☐ **C** ☐ **F**
2.	Documented cost figures from similar project work obtained from local agency sources.	☒ **P** ☐ **E** ☐ **M** ☒ **T** ☐ **C** ☐ **F**
3.	Estimate supported by cost guides from independent sources or other federal agencies	☐ **P** ☐ **E** ☐ **M** ☐ **T** ☐ **C** ☐ **F**
4.	Estimates based upon government wage rates and material cost.	☒ **P** ☐ **E** ☐ **M** ☒ **T** ☐ **C** ☐ **F**
5.	No cost estimate required - cost charged to Fire Suppression Account	☐ **P** ☐ **E** ☐ **M** ☐ **T** ☐ **C** ☐ **F**

P = Personnel Services, **E** = Equipment **M** = Materials/Supplies, **T** = Travel, **C** = Contract, **F** = Suppression

RELEVANT DETAILS, MAPS AND DOCUMENTATION INCLUDED IN THIS REPORT

See BAER Plan for related workload.

PART F - INDIVIDUAL SPECIFICATIONS

TREATMENT/ACTIVITY NAME	LEO Patrols	**PART E SPECIFICATION #**	ES-4
NFPORS TREATMENT CATEGORY*	Assessment	**FISCAL YEAR(S) (list each year):**	2023
NFPORS TREATMENT TYPE*	Fire Damage Assessment	**WUI? Y/N**	N
IMPACTED COMMUNITIES AT RISK	BLM California	**IMPACTED T&E SPECIES**	N/A

* See NFPORS Restoration & Rehabilitation module - Edit Treatment screen for applicable entries.

WORK TO BE DONE (describe or attach exact specifications of work to be done):

How does this treatment mitigate potential impacts to values at risk? Impacts from OHV intrusions and users that go off designated routes may cause long-term ecological detriment to the site by damaging recovering vegetation and compacting and displacing soils that are more fragile post-fire. Increased LE presence at the site can serve as a deterrent to non-compliant visitors and can monitor for evidence of prohibited OHV use in the affected area. In addition, looting and vandalism are known to occur within remote areas on public lands after fire. Fire removes vegetation that has been covering and protecting sensitive resources. Additional patrols at the burn area by law enforcement personnel will help establish a presence and monitor for potential resource damage and safety concerns.

General Description: The BLM Needles Field Office will provide a patrol to the burned area one day a week for 24 weeks.

Location: The burned area on public lands managed by BLM Needles Field Office within and around the fire area.

Design/Construction Specs: One officer one day (12 hrs) of overtime per week for 24 weeks.

Purpose of Treatment Specs: This treatment will promote public safety and resource protection through activities to include: enforce area closures, protect exposed, sensitive cultural resources, and deter looters. Special attention will be given to monitoring for OHV intrusion sites. Patrols should continue until public interest decreases and/or vegetation re-growth has served to obscure exposed artifacts and features and deter OHV use off designated routes.

MONITORING PLAN

Treatment Reasonableness and Cost Effectiveness: This method of deterrence, monitoring, and enforcement reduces the potential for noncompliant OHV behaviors- the result being a reduced cost in not having to restore areas damaged by those OHV intrusions. This method also leverages existing staff, preventing the need to hire additional staff for this treatment.

Treatment Effectiveness Monitoring: Patrol logs will be maintained to quantify hours of LE presence in the burned area, illegal acts detected, and citations/investigations/arrests made in support of this activity.

Treatment Consistent with Land Management Plan: N/A

LABOR, MATERIALS AND OTHER COST:

PERSONNEL SERVICES: (Unit Price = Grade @ Cost/Hours): Do not include contract personnel costs here (see Contractor Costs section below).	QUANTITY	UNIT PRICE	AMOUNT
+ - GS-12 @ $111.54/hour (OT) X 12 hrs/day X 12 days X 1 FY	12	$1,338.48	$16,062.00
TOTAL PERSONNEL SERVICE COSTS			$16,062.00

EQUIPMENT PURCHASE, LEASE AND/OR RENT (Units Price = Item @ Cost/Time Period): Purchases require written justification that demonstrates cost benefits over leasing or renting.		QUANTITY	UNIT PRICE	AMOUNT
+ -				
			TOTAL EQUIPMENT PURCHASE, LEASE OR RENTAL COSTS	
MATERIALS AND SUPPLIES (Unit Price = Item @ Cost/Each):		QUANTITY	UNIT PRICE	AMOUNT
+ -				
			TOTAL MATERIALS AND SUPPLY COSTS	
TRAVEL COST (Unit Price = Personnel or Equipment @ Rate):		QUANTITY	UNIT PRICE	AMOUNT
+ -	4 X 4 Pickup mileage @ $0.56/mile X 200 miles/trip X 12 trips x 1 FY	12	$112.00	$1,344.00
			TOTAL TRAVEL COSTS	$1,344.00
CONTRACT COST (Unit Price = Labor or Equipment @ Cost/Time Period):		QUANTITY	UNIT PRICE	AMOUNT
+ -				
			TOTAL CONTRACT COSTS	

SPECIFICATION COST SUMMARY

	FISCAL YEAR	PLANNED INITIATION DATE	PLANNED COMPLETION DATE	WORK AGENT	UNITS	UNIT COST	PLANNED ACCOMPLISHMENTS	PLANNED COSTS
+ -	2023	09/01/2023	08/31/2024	F	Each	$1,450.50	12	$17,406.00
							SUMMARY COST TOTAL	$17,406.00
							Difference should be zero (SUMMARY COST TOTAL - SPECIFICATION TOTAL)	$0.00
							SPECIFICATION TOTAL	$17,406.00

Work Agent: **A**=Coop Agreement, **F**=Force Account, **G**=Grantee, **P**=Permittee, **S**=Service Contract, **C**=Stewardship Contract, **T**=Timber Sales Purchaser, **V**=Volunteer

SOURCE COST ESTIMATE

1.	Estimate obtained from 2-3 independent contractual sources.	☐ P ☐ E ☐ M ☐ T ☐ C ☐ F
2.	Documented cost figures from similar project work obtained from local agency sources.	☐ P ☐ E ☐ M ☐ T ☐ C ☐ F
3.	Estimate supported by cost guides from independent sources or other federal agencies	☐ P ☐ E ☐ M ☐ T ☐ C ☐ F
4.	Estimates based upon government wage rates and material cost.	☒ P ☐ E ☐ M ☐ T ☐ C ☐ F
5.	No cost estimate required - cost charged to Fire Suppression Account	☐ P ☐ E ☐ M ☐ T ☐ C ☐ F

P = Personnel Services, **E** = Equipment **M** = Materials/Supplies, **T** = Travel, **C** = Contract, **F** = Suppression

RELEVANT DETAILS, MAPS AND DOCUMENTATION INCLUDED IN THIS REPORT

See BAER Plan and Assessments for further discussion supporting this treatment.

PART F - INDIVIDUAL SPECIFICATION

TREATMENT/ACTIVITY NAME	Non-native Invasive Plant Control (Ground)	**PART E SPECIFICATION #**	BAR-1
NFPORS TREATMENT CATEGORY*	Invasive Species	**FISCAL YEAR(S) (list each year):**	2024, 2025, 2026
NFPORS TREATMENT TYPE *	Chemical Treatment	**WUI? Y / N**	N
IMPACTED COMMUNITIES AT RISK	N/A	**IMPACTED T&E SPECIES**	Desert tortoise

* See NFPORS Restoration & Rehabilitation module - Edit Treatment screen for applicable entries.

WORK TO BE DONE (describe or attach exact specifications of work to be done):

How does this treatment mitigate potential impacts to values at risk?
The objective is to treat weed infestations identified during post-fire monitoring within the area impacted by the York Fire. Invasive plants often outcompete native vegetation in establishing in disturbed areas such as a post-fire landscape. Integrated pest management (IPM), including biological, herbicide, and mechanical methods will be used to prevent the establishment and spread of weeds in the burned area. Treatment methods may include mechanical removal, backpack sprayers, or other methods, as appropriate and approved in management plans by the BLM Needles Field Office. By quickly addressing non-native invasive plants in the disturbed area, it is less likely that non-native populations will spread further or be introduced into the area, which could lead to loss of native plant biodiversity and eventual plant community conversion if left unchecked.

General Description: Qualified BLM staff will survey all roads and staging areas for all invasive plants and propose treatments to eradicate invasive forb, woody, and select graminoid species (e.g., buffelgrass) through herbicide application when discovered. There will be two treatments applied, one in late spring and one in late summer, to account for the variation in phenological timing of different invasive plant species.

Invasive plant species observed in the burn area, staging areas, or immediate vicinity:
1. Red brome, *Bromus rubens*
2. Cheatgrass, *Bromus tectorum*
3. Arabian schismus, *Schismus arabicus*
4. Russian thistle, *Salsola tragus*
5. Saltlover, *Halogeton glomeratus* *
6. Saltcedar, *Tamarix ramosissima*
7. Puncturevine, *Tribulus terrestris*
8. Silverleaf nightshade, *Solanum elaeagnifolium*

Weeds known to be in the burn area or region, but not observed during assessment:
1. Red stork's bill, *Erodium cicutarium*
2. Sahara mustard, *Brassica tournefortii*
3. Stinkgrass, *Eragrostis cilianensis*
4. Shortpod mustard, *Hirschfeldia incana*
5. Horehound, *Marrubium vulgare*
6. Giant reed, *Arundo donax*
7. Buffelgrass, *Cenchrus ciliaris*
8. Fountaingrass, *Pennisetum setaceum*
9. Tree of heaven, *Ailanthus altissima*
10. Russian knapweed, *Acroptilon repens*
11. Mexican bird of paradise, *Caesalpinia pulcherrima*
12. Five hook bassia, *Bassia hyssopifolia*
13. Perennial pepperweed, *Lepidium latifolium*
14. Flixweed, *Descurainia sophia*
15. Tall tumblemustard *Sisymbrium altissimum*
16. Oriental mustard, *Sisymbrium orientale*
17. African mustard, *Strigosella africana*
18. London rocket, *Sisymbrium irio*
19. Stinknet, *Oncosiphon piluliferum*

Location:
Treatment of noxious weeds and invasive grasses would target those occurrences documented during the inventory along roads, suppression lines, drop points, staging areas, and helispots. These are also the most likely places for invasive plant introductions to occur. Other occurrences may be identified at this time and should also be treated to control the establishment and spread of the non-native species. The calculated estimate of acres for monitoring were based on appropriate buffer sizes according to the type of disturbance corridor. In total, there are approximately 202 acres within the BLM Needles Field Office area of the fire perimeter that should be monitored and potentially treated for weeds. See map in Appendix B of the plan for locations.

Design/Construction Specs:
Treat roadsides and other disturbed areas within and immediately adjacent to the burned area using an IPM approach. Treatment will be conducted at the appropriate time of year, as recommended by application specialists and in accordance with manufacturer's labels, tribal and federal regulations, and NEPA review. Species occurrences, abundance, and treatment method will be documented and photographed, and the location information will be recorded through global positioning system (GPS) technology. Annual reports documenting accomplishments and associated costs will be prepared. Treated sites should be resurveyed yearly for efficacy and treated until controlled. If treatments are observed to be ineffective, the BLM will implement Adaptive Management to determine if other methods should be applied.

Herbicide applications will only be made by qualified applicators according to the label and following state and federal regulations.

Applications must be documented and reported, according to State and Federal guidelines.

Purpose of Treatment Specs (related to damage/change caused by fire):
The treatment will involve applying integrated pest management (IPM) techniques to minimize the establishment of non-native invasive species within the burned area. These efforts aim to control non-native invasive plants within the burned area in a timely fashion where invasive plants may quickly invade or hamper reestablishment of native vegetation on the fragile post-fire Mojave desert landscape that is home to unique and rare endemic flora and fauna. Both early detection and rapid response (EDRR) and IPM methods will be used to prevent new weed infestations from establishing and will help promote recovery of native vegetation by reducing competition with these invasive species. Promoting better recovery of native vegetation will directly benefit other resources in the area, such as wildlife. The integrated pest management approach will include consideration of chemical, biological, mechanical, and/or hand control methods, as well as post-fire weed assessment and monitoring. The application of herbicides is anticipated to be necessary to keep non-native invasive plants from invading and dominating the post-fire environment. The purpose of applying chemical, manual, and mechanical removal of invasive species is to restore or establish a healthy, stable ecosystem even if this ecosystem cannot fully return to pre-fire conditions.

Treatment Reasonableness and Cost Effectiveness:
By using an Early Detection Rapid Response (EDRR) framework, monitoring efforts will identify invasive plants before they have a chance to spread, allowing for swift response using an IPM approach. This will reduce long-term costs of treating these populations after they have established in an area. Treatments for invasive plants are likely to continue for years following this initial treatment under ES using BAR funding until the invasive seed bank has been depleted or at least been reduced to a level where the Field Office can control it through Base funding via contracts or in-house staff. The Invasive Plant Management Team is comprised of certified experts in the field of invasive plant control and their methods are very effective. Herbicide application is the most cost-effective treatment for invasive plant control on a large scale and the herbicides used will be approved through the Pesticide Use Proposal System (PUPS). Other methods of invasive plant control (e.g., hand pulling, biocontrol) are not as cost effective as precision hand spraying at this scale.

Treatment Effectiveness Monitoring:
Roads, staging areas, and other areas disturbed by suppression will be monitored by BLM staff for new occurrences of weeds. Treated sites should be resurveyed yearly to determine efficacy of the treatment and if further application is necessary. Records will be maintained and shared as appropriate. Treatments are considered to be successful upon determination that weeds occurrences have reached a manageable level. Typically, an 80% reduction of weed species is considered control.

1. Treatment effectiveness of roads and staging areas will be monitored annually to determine the spatial extent of weeds via LAKE IPMT NISIMS GIS data.

2. Treatments will be considered effective if the spatial extent decreases over time and trajectories lead towards the eventual eradication of the occurrence. There will be considerations for annual timing and amounts of precipitation, as well as other disturbance events.

Treatment Consistent with Land Management Plan:

- This treatment is in line with the California Desert Conservation Area Plan (1980 as amended). A NEPA document will need to be drafted for this treatment that can tier off existing reviews:2016 Vegetation Treatments Using Aminopyralid, Fluroxypyr, Rimsulferon on Bureau of Land Management Lands in 17 Western States - DOI - BLM - WO- WO2100 -2012 - 0002 - EIS
- 2007 Final Vegetation Treatments Using Herbicides Programmatic Environmental Impact Statement - DOI - BLM - WO - WO2100 -2007 - 0002 - EIS

MONITORING PLAN

Treatment Objectives:

After invasive species have been introduced to a site, the best approach to weed management is early detection and rapid response. Monitoring of weeds will be conducted via ground surveys to inform the IPM approach to invasive species. Weed treatments will be cost effective if the infestations are treated when they are small or have just become established. The weed species are most susceptible at early germination stages.

Describe how implementation will be monitored:

Personnel will follow all federal laws as well as BLM handbooks and policy regarding treatment of noxious weeds. Personnel will ensure all inventory and treatment data is submitted in the VMAP database.

Describe how effectiveness will be monitored, how it will be measured, and within what time period:

Effectiveness will be monitored by conducting treatment evaluations on weed treatment sites. Weed treatments will be considered effective if greater than eighty percent of the targeted weed species are affected by the treatment(s) during that year. Treatment areas will be mapped using GPS/GIS before and after treatments.

LABOR, MATERIALS AND OTHER COST:

PERSONNEL SERVICES: (Grade @ Cost/Hours X # Hours X # Fiscal Years = Cost/Item): Do not include contract personnel costs here (see contractor services below).	QUANTITY	UNIT PRICE	AMOUNT

BLM COR/PI or Field Supervisor (GS-12): $12,000/WM X 0.5WM X 1 person (3 FY)	3	$6,000.00	$18,000.00
2 Herbicide applicators (GS-7): $25/hr X 8 hrs/day X 20 days/FY (3 FY)	3	$8,000.00	$24,000.00
1 Data Manager (GS-7): $25/hr X 8 hrs/day X 10 days (3 FY)	3	$2,000.00	$14,400.00
TOTAL PERSONNEL SERVICES COSTS			**$56,400.00**
EQUIPMENT PURCHASE, LEASE AND/OR RENT (Item @ Cost/Hour X # of Hours X #Fiscal Years = Cost/Item): Note: Purchases require written justification that demonstrates cost benefits over leasing or renting.	QUANTITY	UNIT PRICE	AMOUNT
Backpack sprayer (4-gal): $125/pack X 2 packs (3 FY)	3	$250.00	$750.00
Backpack Sprayer Parts @ $100 X 3 FY	3	$100.00	$300.00
Herbicide Containment, Storage, and Equipment @ $200 X 3 FY	3	$200.00	$600.00
TOTAL EQUIPMENT PURCHASE, LEASE OR RENTAL COSTS			**$1,650.00**
MATERIALS AND SUPPLIES (Item @ Cost/Each X Quantity X #Fiscal Years = Cost/Item):	QUANTITY	UNIT PRICE	AMOUNT
Imazapyr (2.5 gal): $250/container X 2 containers (3 FY)	3	$500.00	$1,500.00
Glyphosate (2.5-gal): $120/container X 4 containers (3 FY)	3	$480.00	$1,440.00
Aminopyralid (1 gal): $110/container X 2 containers (3 FY)	3	$220.00	$660.00
Adjuvants (dyes and surfactants): $100 (3 FY)	3	$100.00	$300.00
PPE set (gloves, coveralls, eye protection, face mask) @ $100/set X 2 sets (3 FY)	3	$200.00	$600.00
TOTAL MATERIALS AND SUPPLY COSTS			**$4,500.00**
TRAVEL COST (Personnel or Equipment @ Rate X Round Trips X #Fiscal Years = Cost/Item):	QUANTITY	UNIT PRICE	AMOUNT
4 X 4 Pickup mileage @ $0.56/mile X 2,300 miles (10 Round Trips, 230 miles each from field office to installation site and back) X 3FY	6,900	$0.56	$3,864.00
GSA Vehicle Cost $8/day x 20 days X 3 FY	3	$160.00	$960.00
TOTAL TRAVEL COSTS			**$4,824.00**
CONTRACT COST (Labor or Equipment @ Cost/Hour X #Hours X #Fiscal Years = Cost/Item):	QUANTITY	UNIT PRICE	AMOUNT

TOTAL CONTRACT COSTS	**$0**

SPECIFICATION COST SUMMARY

FISCAL YEAR	PLANNED INITIATION DATE	PLANNED COMPLETION DATE	WORK AGENT	UNITS	UNIT COST	PLANNED ACCOMPLISHMENTS	PLANNED COSTS
2024	10/01/2023	09/30/2024	F	Acres	$102.08	220	$22,458.00
2025	10/01/2024	09/30/2025	F	Acres	$102.08	220	$22,458.00
2026	10/01/2025	09/30/2026	F	Acres	$102.08	220	$22,458.00
						SUMMARY COST TOTAL	$67,374.00
						Difference should be zero (SUMMARY COST TOTAL - SPECIFICATION TOTAL)	$0.00
						SPECIFICATION TOTAL	$67,374.00

Work Agent: **C**=Coop Agreement, **F**=Force Account, **G**=Grantee, **P**=Permittees, **S**=Service Contract, **T**=Timber Sales Purchaser, **V**=Volunteer

SOURCE COST ESTIMATE

1.	Estimate obtained from 2-3 independent contractual sources.	☐ P ☐ E ☐ M ☐ T ☐ C ☐ F
2.	Documented cost figures from similar project work obtained from local agency sources.	☒ P ☒ E ☐ M ☒ T ☐ C ☐ F
3.	Estimate supported by cost guides from independent sources or other federal agencies	☐ P ☐ E ☐ M ☐ T ☐ C ☐ F
4.	Estimates based upon government wage rates and material cost.	☒ P ☐ E ☐ M ☒ T ☐ C ☐ F
5.	No cost estimate required - cost charged to Fire Suppression Account	☐ P ☐ E ☐ M ☐ T ☐ C ☐ F

P = Personnel Services, **E** = Equipment **M** = Materials/Supplies, **T** = Travel, **C** = Contract, **F** = Suppression

RELEVANT DETAILS, MAPS AND DOCUMENTATION INCLUDED IN THIS REPORT

See BAER plan for further information regarding treatment information and resource assessments.

BURNED AREA EMERGENCY RESPONSE PLAN

2023 YORK FIRE

ASSESSMENTS



YORK FIRE

ASSESSMENT FOR

WATERSHED, WILDLIFE, GRAZING, VEGETATION, HUMAN HEALTH AND SAFETY, PUBLIC USE AND CULTURAL RESOURCES

WATERSHED

The purpose of a watershed assessment is to determine potential values at risk resulting from post-fire emergency watershed conditions. Identification of values at risk occurs through consultation with individuals, state, and federal agencies, and through field investigation.

Values at Risk (VARs) were identified by BLM Needles Field Office staff, including Geologist, Rose Pettiette, and Assistant Field Manager, Mitchell Owens, during the briefing on August 12, 2023. Initial VARs with a watershed focus were associated with roads, hillslope erosion, increased stream flows, and impacts to mines and mine tailings. Potential impacts to these VARs include:

- Hillslope erosion and sedimentation; and
- Flash floods causing road damage and threats to public safety, on Hart Mine Road and Walking Box Ranch Road; and
- Erosion and transport of contaminated mine tailings downstream from Castle Mountain Venture Mine; and
- Post-fire surface water runoff and erosion impacts to Castle Mountain Venture Mine Plant Nursery and Greenhouse.

BAER Team watershed specialists conducted field visits to review resource conditions starting on August 8 and continuing through August 14, 2023. The main objectives of the field visits were to 1) evaluate soil burn severity and watershed response in order to identify potential flood and erosion source areas as well as debris flow hazards; 2) identify and inventory values at risk, 3) identify the physical and biological mechanisms that are creating risks; 4) review channel morphology and riparian conditions; 5) inspect hillslope conditions; and 6) determine needs for emergency stabilization.

We collected 37 field data/observations points of soil and ground conditions (Ground Cover, Ash Color and Depth, Root Structure, Soil Structure, Water Repellency) using the AGOL Field Map application. Data points were overlaid with the Burned Area Reflectance Classification (BARC) image to see how closely the BARC classes match collected data. Reclassification of the initial thresholds was conducted to match observed soil burn severity conditions more closely within the fire perimeter. The distribution of soil burn severity (SBS) acres within the York Fire are shown in Table 1 and represented visually in the soil burn severity map (See Appendix D-Supporting Documentation).

Table 1. Soil Burn Severity (SBS) Acres for the York Fire by Ownership.

Ownership	Soil Burn Severity Acres by Class				Total
	Unburned	Low	Moderate	High	
NPS	4,473	68,045	466	0	72,984
BLM-NV	473	7,777	0	0	8,250

Ownership	Soil Burn Severity Acres by Class				Total
	Unburned	Low	Moderate	High	
BLM-CA	**81**	**582**	**0**	**0**	**663**
State-CA	244	3,056	1	0	3,301
Private-NV	5	57	0	0	62
Private-CA	867	6,405	8	0	7,280
Total	6,143	85,922	475	0	92,540

The predominate soil burn severity class on BLM Needles managed lands within the York Fire was low, 88%, with the remaining 12% unburned patches. Characteristics associated with low soil burn severity within the fires include a thin, black colored ash layer with identifiable surface litter, intact fine roots below the ash layer, unchanged soil structure and no evidence of hydrophobicity.



Figure 1. Unburned area within the York Fire.



Figure 2. Area of Low Soil Burn Severity within the York Fire.

Watershed Response

The primary watershed response in the watersheds that contain BLM land from the effects of the York Fire are expected to include: 1) initial flush of ash with normal precipitation; 2) gully and rill erosion on steep slopes in drainages with moderate soil burn severity with normal precipitation; 3) debris flows initiated by high intensity precipitation with sediment deposition where stream gradients flatten and/or at tributary mouths; and 4) increases in average monsoon season and/or winter storm runoff. Any elevated soil erosion, sedimentation, runoff, and stream flows are expected to decrease rapidly after the first year and return to the natural hydrological watershed function in three to five years after the fire once vegetation has sufficiently recovered.

Watershed modeling is used to estimate post-fire runoff response by BAER teams to illustrate risk to life, infrastructure, and natural and cultural resources. Model results using a soil burn severity with mostly low values will result in model runs that are abnormal which is the case for the York Fire. The modeled runs for the York Fire produced outputs as expected with post-fire conditions showing no increases in peak flows and sediment, and very minimal increases in runoff (Figure 3).

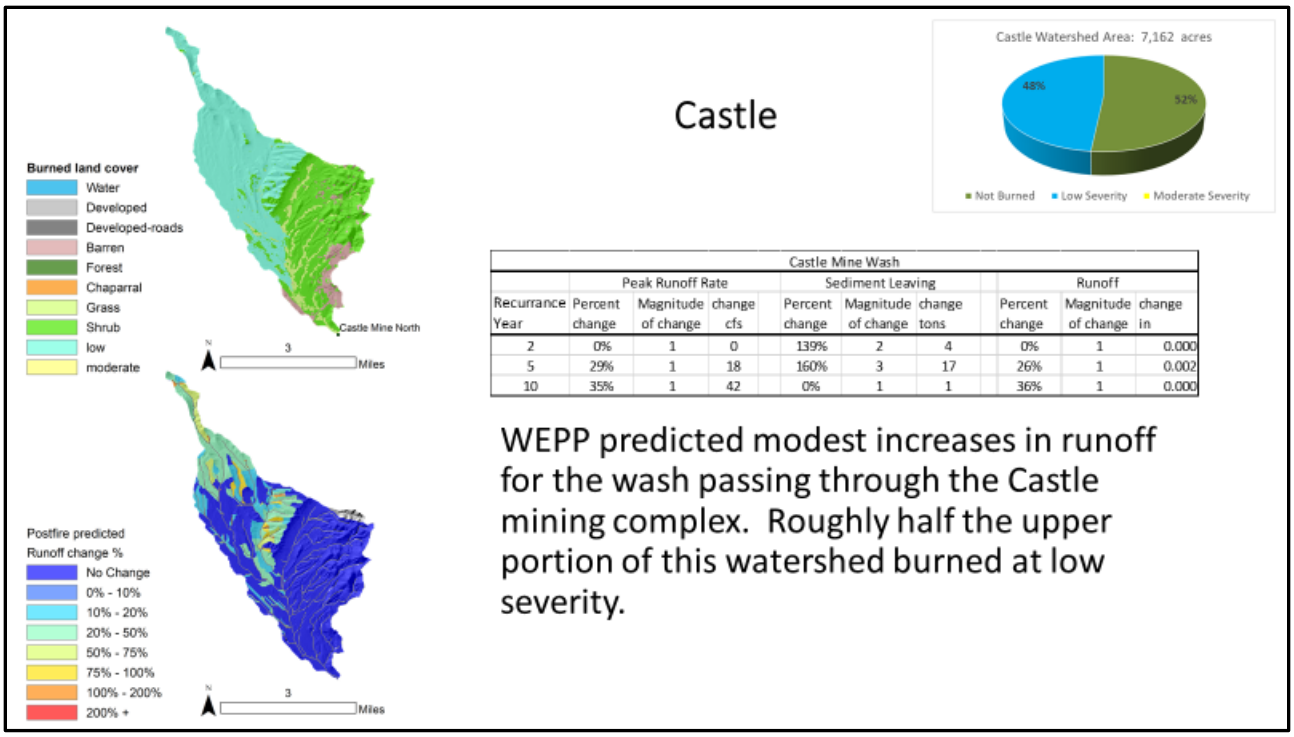


Figure 3. Modeled Results for the Castle Mountain Venture Mine.

Values at Risk

A summary of VARs, issues & concerns, and recommendations are provided the following table.

Table 2. Summary of Identified Watershed VAR's.

VAR	Issues, Concerns, & Recommendations
Walking Box Ranch Road	Increased runoff and sediment to road/stream crossing, plugging and road failure. The road/stream crossings, along with road maintenance, are the responsibility of the Castle Mountain Venture Mine. No watershed treatment specification is proposed for this VAR.
Castle Mountain Venture Mine	The fire burned the watershed upstream of the mine with a concern of increased runoff impacting the heap leach pad. Model results showed very little post-fire runoff from the watershed upstream of the heap leach pad. Additionally, the area has very little topographic relief and consists of low soil burn severity and unburned islands. No watershed treatment specification is proposed for this VAR.
Castle Mountain Venture Mine Plant Nursery	Not modeled. Nursery elevation is several feet higher than wash to the west, which is draining an area of low topography, unburned islands, and low soil burn severity. No watershed treatment specification is proposed for this VAR.

Recommendations:

There are no management recommendations or proposed treatments to address watershed resources.

WILDLIFE

The primary issues regarding wildlife consist of loss of habitat for big game and small game species, as well as the desert tortoise and its designated critical habitat. A summary of the special status species from the IPaC report for the York Fire are provided below. In addition to the species in Tables 3 and 4, the BLM Needles Field Office staff, including Wildlife Biologist, Justin Saiz, mentioned the Gila monster (*Heloderma suspectum)*, a BLM special status species, and the desert bighorn sheep (*Ovis canadensis nelsoni*), which is a focal species in the area's Land Use Plan. Based on discussions with local biologists and natural resource specialists, as well as observations from the field, it was determined that although there was a general loss of habitat that supports many species, most of the fire experienced a low soil burn severity with pockets of unburned vegetation throughout the area. With the fall and winter precipitation in the near future, it is anticipated that much of the native vegetation should recover naturally over the next growing season or two.

Table 3. Federally Listed Species known to occur within the York Fire.

SPECIES	STATUS	CRITICAL HABITAT
Southwest willow flycatcher (*Empidonax traillii extimus*)	Endangered	Final Critical Habitat – not within fire perimeter
Yellow-billed cuckoo (*Coccyzus americanus*)	Threatened	Final Critical Habitat – not within fire perimeter
Desert tortoise (*Gopherus agassizii*)	Threatened	Final Critical Habitat – occurs within fire perimeter but not on BLM CA lands
Monarch butterfly (*Danaus plexippus*)	Candidate	No Critical Habitat

Table 4. Eagles and Migratory Birds

SPECIES	BREEDING SEASON	PROBABILITY OF PRESENCE
Bendire's thrasher (*Toxostoma bendirei*)	Mar 15 to Jul 31	Not likely
Black-chinned sparrow (*Spizella atrogularis*)	Apr 15 to Jul 31	Not Likely
Costa's hummingbird (*Calypte costae*)	Jan 15 to Jun 10	Not Likely
Gilded flicker (*Colaptes chrysoides*)	May 1 to Aug 10	Possible
Golden eagle (*Aquila chrysaetos*)	Dec 1 to Aug 31	Likely
Long-eared owl (*Asio otus*)	Mar 1 to Jul 15	Not Likely
Pinyon jay (*Gymnorhinus cyanocephalus*)	Feb 15 to Jul 15	Not Likely
Rufous-winged Sparrow (*Aimophila carpalis*)	Jun 15 to Sep 30	Likely

Recommendations:
The BAER team has recommended treatment specifications that should help promote successful recovery of the native vegetation over time and return the landscape to a state that provides habitat for wildlife again. The BAER Team has also determined that none of the proposed treatments within the York Fire BAER plan will negatively impact any threatened or endangered species or designated critical habitat. Details of each treatment can be found in the Specifications section of this BAER plan.

- ES-1 and BAR-1 Non-native Invasive Plant Control (Ground-based): Monitoring of disturbed areas within the fire and treating those areas as needed to reduce the spread of existing non-natives or the introduction and establishment of new non-native species populations.
- ES-3 and BAR-3 OHV Use Patrolling: By patrolling areas to ensure members of the public are not driving OHVs off designated roadways and through the recovering landscape this will help allow native vegetation to recover more quickly.

GRAZING

The primary issues associated with grazing consisted of damage to rangeland infrastructure necessary for livestock management, and the risks and hazards that downed wire on the landscape pose to wildlife and the public.

Historic grazing practices in the area have occurred since the late 1800's. To support grazing activities in the Mojave Desert, infrastructure such as fences, holding corrals and water developments were created to facilitate wide distribution of livestock across the range. Many springs on the landscape were improved with the addition of piping and troughs to hold water for livestock. Windmills and pumps were constructed with subsequent tanks to provide water in a landscape that was void before. Corrals on this landscape were commonly built from decommissioned railroad ties, which provide sturdy holding facilities for livestock gathering. Fences are a combination of metal or wood posts and smaller wooden stays with barbwire affixed.

Fences and structures were observed during field visits and assessed for damage created by the fire or facilities that may be impacted from post-fire flooding. Corrals and fences made from wooden railroad ties and other wooden materials burned in varying degrees. Barbed wire that was once attached, is now down in several areas. The portion of the fire that affected BLM Needles Field Office, did not have many range improvements (see Cultural Resources section of this assessment).

BLM Needles Field Office Natural Resource Specialist and Rangeland Management Specialist, Nicole Keefner, confirmed the burn area is no longer within an active grazing allotment and is not within a Wild Horse and Burro Herd Area or Herd Management Area.

Recommendations:
The BAER team does not have any other management recommendations or treatments proposed to address grazing issues.

VEGETATION & NON-NATIVE INVASIVES

Three general vegetation types comprise most of the York Fire burned area: Joshua tree woodlands, Pinyon-juniper woodlands, and Mojave Yucca shrublands. Joshua tree woodlands and Pinyon-juniper woodlands tend to experience high vegetation mortality post-fire and are simultaneously threatened by

climate change. Wildfire therefore is likely to exacerbate the rate of climate-driven vegetation change by rapidly eliminating species from marginal or moderate habitat where they might otherwise persist for generations. Even in places where juvenile plants might otherwise become established, wildfire reduces canopy cover and moisture retention in soils, creating an inhospitable environment for seedling establishment.

The primary vegetation issues associated with the York Fire is the conversion of Mohavean Joshua Tree Savannah communities into herbaceous grasslands and the introduction or spread of non-native invasives due to fire suppression activities and a fire-disturbed landscape.

Observations from field reconnaissance work, GIS data analysis, and internal discussions between specialists, it was determined that although there were intact islands of Joshua trees within the fire perimeter, the recovery of this resource is critical to the overall health of the Mohavean Joshua Tree Savannah community. BLM Needles Field Office staff including, Natural Resource Specialist and Weeds Coordinator, Nicole Keefner, also informed the assessment of vegetation resources including treatment of invasive plants. Several of these non-native weed species were observed in areas of the fire or were already known to occur in this area. There is a high likelihood that those species will persist or spread further due to the newly disturbed environment. Further narrative regarding soil burn severity and vegetation mortality can be found in the Watershed portion of this assessment.

Table 5. Vegetation Mortality based on Reclassified BARC Imagery

Estimated Survivorship	Unburned	50 % Joshua Tree Mortality	70-100% Joshua Tree Mortality	High Mortality Pinyon Juniper Woodlands
MOJA	6%	6%	81%	6%
BLM-NV	6 %	3 %	88%	4%
BLM-CA	12 %	23 %	65 %	0%

Recommendations:
Based on the observations and findings of the BAER team, there are two proposed treatment specifications to address these issues. Details of each treatment can be found in the Specifications section of this BAER plan.

- ES-1 and BAR-1 Non-native Invasive Plant Control (Ground-based): Monitoring of disturbed areas within the fire and treating those areas as needed to reduce the spread of existing non-natives or the introduction and establishment of new non-native species populations.

HUMAN HEALTH AND SAFETY AND PUBLIC USE

Hazards and Public Safety

Wildfires create unsafe environments and expose previously unknown hazards with the altered landscape that it creates. Often these burned areas result in loss of vegetation that may have once acted as a natural barrier to features on the landscape that could pose a safety hazard if members of the public were to try and access them. To ensure that the public is well informed and warned of the potential new hazards within the burned area, posting signs and providing temporary barricades in certain areas are critical to mitigating these exposure risks.

Off Highway Vehicle Incursions

Off Highway Vehicle incursions are more prevalent following wildfires. These incursions can damage vegetation, hinder vegetative recovery, and create areas more susceptible to erosion. The BLM Needles Field Office lands in and adjacent to the Mojave National Preserve and Castle Mountain National Monument has significant Off Highway Vehicle (OHV) visitation. Vehicles are administratively required to operate on existing roads. Roadside vegetation restricts vehicles to existing roads, and the loss of vegetation due to fire can open areas to OHV incursions with associated vegetative and soil impacts. Vegetation mortality within the fire is significant and many open areas adjacent to roads were observed that would be attractive to OHV enthusiasts.

Recommendations:

Based on the observations and findings of the BAER team and consultation with BLM Needles Field Office Staff, including Outdoor Recreation Planners, Ramona Daniels and David Roan, the following proposed treatment specifications were developed to address these issues. Details of each treatment can be found in the Specifications section of this BAER plan.

- ES-2 Safety Signs and Barricades: This treatment is for the installation of information signs, warning signs, closure signs, and barricades. These signs will serve to inform the public of hazards, closures, and information. The signs shall contain language that specify hazards to be aware of when entering a burn area, such as falling trees, blowing dust, rolling rocks, and flash floods. Closure signs shall indicate what is closed. Signs could include directional information to allow for safe navigation of vehicles through the burn area(s). Barricades will prevent unwanted access and be appropriate for the expected user.
- ES-4 LEO Patrols: This treatment provides funding to assist with providing labor from existing staff to specifically patrol areas of the fire where unauthorized off-road OHV use is likely to occur due to topography and the absence of vegetation within the fire. This will help ensure that the landscape is able to recover.

CULTURAL RESOURCES

The primary cultural resources located in the burned area were refuse scatters related to historic ranching or mining activities. Looting and vandalism are known to occur within remote areas on public lands after fire. Fire removes vegetation that has been covering and protecting sensitive cultural resources. In addition, cultural assessments may be required in association with other post-fire treatments to comply with federal laws such as the National Historic Preservation Act (NHPA), Archaeological Resources Protection Act (ARPA), and Native American Graves Protection and Repatriation Act (NAGPRA). Identification of values at risk occurs through local archaeological and cultural resource specialists through desktop analysis followed by field investigation, as needed.

Potential cultural resources affected by fire include archaeological sites revealed that would become vulnerable to looting, damage to structures with fabric that could be damaged or consumed by high temperatures, ash, or fire, cultural landscapes visually impaired from fire disturbance, and heritage sites with altered characters.

Within the York Fire perimeter, approximately 225 acres have not been surveyed in the valley west of the Castle Mountain Mine, and the rest along Walking Box Ranch Road and the small burn east of the

road. The East Mojave Heritage Trails along with several other sites and resources of cultural significance that were once managed by the BLM Needles Field Office are now within the jurisdiction of the NPS Castle Mountain Monument and are not addressed in this report. Upon review by the BLM Needles Field Office Archaeologist and Cultural Resource Specialist, Christopher Dalu, there are expected to be minimal to no impacts to most cultural resources within the York Fire burn area. The resources have either been determined to be ineligible for nomination to the National Register of Historic Places through past evaluations or are made of materials not expected to be impacted by fire effects such as groundstone and bedrock milling features.

Regardless of prior BLM determinations for National Register eligibility, there are two range improvements near the York Fire perimeter that may be associated with a broader cultural landscape history of the Rock Spring Land and Cattle Company. These are an unnamed corral and the Hart Well with associated infrastructure of a derrick/well, tank, and what remains of a tower base (Casebier). The Hart Well and associated features were determined to be ineligible for listing on the National Register based on an evaluation from 1982.

Based on field assessments, the corral was not affected by the York Fire and the Hart Well site was mostly undamaged. The vegetation around the Hart Well site burned (see image), but the tank remains intact.



Figure 4. Hart Well site with surrounding vegetation that burned in the York Fire.



Figure 5. Hart Well site with surrounding vegetation that burned in the York Fire.



Figure 6. Hart Well site with surrounding vegetation that burned in the York Fire.

Recommendations:

The BAER team does not have any other management recommendations or treatments proposed to address cultural resource issues.

BURNED AREA EMERGENCY RESPONSE PLAN
2023 YORK FIRE

APPENDIX A
ENVIRONMENTAL COMPLIANCE



ENVIRONMENTAL COMPLIANCE

FEDERAL ENVIRONMENTAL COMPLIANCE RESPONSIBILITIES

All projects proposed in the 2023 York Fire Burned Area Emergency Response (BAER) Plan that are prescribed, funded, or implemented by federal agencies on federal lands are subject to compliance with the *National Environmental Policy Act* (NEPA) in accordance with the guidelines provided by the *Council on Environmental Quality (CEQ) Regulations (40 CFR 1500-1508)*. This Appendix documents NEPA compliance requirements for prescribed emergency stabilization and rehabilitation actions described in this plan for acres affected by the York Fire on Bureau of Land Management Needles Field Office (BLM) lands. For any proposed activities not addressed in this plan, the BLM must complete separate NEPA analyses and compliance documentation.

This plan has been developed by the Department of Interior BAER Team, with assistance from the staff of the BLM Needles Field Office. The treatments considered in this plan are in conformance with the California Desert Conservation Area Plan (1980 as amended) as well as DOI and BLM Categorical Exclusions as described below. The BLM Needles Field office will prepare a NEPA document for the ES and BAR Non-native Invasive Plant Control treatments that can tier off existing reviews:

- 2016 Vegetation Treatments Using Aminopyralid, Fluroxypyr, Rimsulfuron on Bureau of Land Management Lands in 17 Western States - DOI - BLM - WO- WO2100 -2012 - 0002 - EIS
- 2007 Final Vegetation Treatments Using Herbicides Programmatic Environmental Impact Statement - DOI - BLM - WO - WO2100 -2007 - 0002 - EIS

AGENCY SPECIFIC GUIDANCE: This NEPA documentation has been developed in accordance with the following agency specific guidelines.

- **Bureau of Land Management:** Burned area emergency stabilization and monitoring actions proposed on BLM lands will comply with NEPA compliance guidelines contained in the DOI Manual 516 DM 11.
- **Bureau of Land Management:** Burned Area Emergency Stabilization and Rehabilitation Handbook H-1742-1 describes specific policies, standards, and procedures for Emergency Stabilization and Rehabilitation programs.

RELATED PLANS

The 2023 York Fire BAER Plan was reviewed for consistency with relevant plans and policies of BLM lands impacted by the York Fire. Below are brief descriptions of plans referenced in the development of the York Fire BAER Plan.

California Desert Conservation Area Plan (1980 as amended)

The California Desert Conservation Area Plan (1980 as amended) [CDCA] is the Land Use Plan (LUP) for the areas within the BLM Needles Field Office. This LUP and associated amendments describe in detail how these areas are to be managed.

The area of the BLM Needles Field Office that was burned in the York Fire near Castle Mountain overlaps with the Castle Mountain Area of Critical Environmental Concern (ACEC) and Extensive Recreation Management Area (ERMA) which are called out in the most recent

Land Use Plan Amendment (LUPA), the Desert Renewable Energy Conservation Plan (DRECP; 2016, as amended):

- "...the BLM has adjusted the Special Unit Management Plan for the Castle Mountain ACEC and ERMA to reflect the transfer of the Castle Mountain National Monument to the National Park Service."
- "The boundary of the Castle Mountain ACEC was adjusted to reflect the newly designated Castle Mountain National Monument and the transfer of management of the monument to the Mojave National Preserve."
- "The boundary of the Castle Mountain ERMA was adjusted to reflect the newly designated Castle Mountain National Monument and the transfer of management of the monument to the Mojave National Preserve."

The Castle Mountain Special Unit Management Plan (from DRECP [2016 as amended]) includes the following goals, objectives, and management actions related to the proposed treatments:

- Overarching Goals: Protect biological values, including habitat quality, populations of sensitive species sensitive natural communities, and landscape connectivity while providing for compatible public uses. Conserve cultural values, especially obsidian source sites.
- Objective: Retain existing flow regime and volume. Protect soil crusts and proper functioning condition
    - Management Actions: Limit OHV use to designated routes.
- Objective: Maintain or Improve condition of existing vegetation. Conserve Joshua tree woodlands by monitoring population trends, removing and/or preventing threats, and taking remedial actions when impacts occur. Protect populations of special status plants. Allowable Uses: Closed to grazing. OHV limited to designated routes.
    - Management Action: Remove invasive plants, rehabilitate/revegetate disturbed areas.
- Objective: Manage recreation consistent with established conservation goals, while providing a broad range of recreation opportunities and to ensure public health and safety.
    - Management Actions: Provide interpretive, directional, and regulatory signs and materials as necessary to provide public information and reduce impacts from recreational use.

CUMULATIVE IMPACTS ANALYSIS

Cumulative effects are incremental environmental impacts of a proposed action, when added to other past, present, and reasonably foreseeable future actions, both Federal and non-federal. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. The emergency stabilization treatments for the areas affected by the York Fire, as proposed in this plan, do not result in an intensity of impact (e.g., major ground disturbance, etc.) that would cumulatively constitute a significant impact on the quality of the environment. The treatments are consistent with the above jurisdictional agency management plans and associated categorical exclusions presented below.

No direct or indirect unavoidable adverse impacts to the biological or physical environment would result from the implementation of the York Fire BAER Plan. The actions proposed in the plan would not result in any adverse effect to the environment. Conversely, implementation of the plan would be expected to result in a cumulatively beneficial response based on proposed recovery efforts.

APPLICABLE AND RELEVANT CATEGORICAL EXCLUSIONS

The individual actions proposed in this plan are Categorically Excluded from further environmental analysis as provided for in the Department of Interior Manual Part 516 (Part 516 DM). All applicable and relevant Department of Interior and BLM Categorical Exclusions are listed below. Categorical Exclusion decisions were made with consideration given to the results of emergency consultations completed by the BAER Team and documented below.

APPLICABLE DEPARTMENT OF INTERIOR CATEGORICAL EXCLUSIONS

43 CFR Part 46.205 (e)	Non-destructive data collection, inventory (including field, aerial, satellite surveying and mapping), study, research, and monitoring activities.
43 CFR Part 46.210 (f)	Routine and continuing government business, including such things as supervision, administration, operations, maintenance, renovations, and replacement activities having limited context and intensity (e.g., limited size and magnitude or short-term effects).

APPLICABLE BUREAU OF LAND MANAGEMENT CATEGORICAL EXCLUSIONS

Part 516 DM 11 G	(2) Installation of routine signs, markers, culverts, ditches, waterbars, gates, or cattleguards on/or adjacent to roads and trails identified in any land use or transportation plan, or eligible for incorporation in such plan. (3) Temporary closure of roads and trails. (4) Placement of recreational, special designation, or information signs, visitor registers, and portable sanitation devices.

APPLICABLE LAWS AND EXECUTIVE ORDERS

This section documents consideration given to the requirements of specific environmental laws in the development of the Bear Fire BAER Plan. Specific consultations initiated or completed during development and implementation of this plan are also documented. The following executive orders and legislative acts have been reviewed as they apply to the Bear Fire BAER Plan.

National Historic Preservation Act (NHPA). Certain emergency stabilization treatments may have the potential to affect significant cultural resources and thereby require that agencies comply with the implementing regulations of the National Historic Protection Act, as amended (NHPA) and as promulgated under 36 CFR Part 800. To assist the BLM in meeting their obligations under the NHPA, a BLM Needles Field Office archeologist conducted a review of site records of known cultural resource sites and assessed potential for post fire damage. It was determined that there was no concern for post-fire impacts to cultural resource sites on BLM lands from the York Fire (pers. comm. N. Keefner 8/17/23). On BLM land, a local BLM archeologist should determine if proposed treatments will require consultation with local tribes

and the State Historic Preservation Officer. Consultations and steps to ensure compliance with Section 106 of the NHPA should be completed prior to any ground disturbing treatments.

Executive Order 11988, Floodplain Management. No proposed treatments would occupy or modify floodplains and all proposed treatments are in compliance with this order.

Executive Order 11990, Protection of Wetlands. No proposed treatments would result in long-term impacts to, or loss of, wetlands and all proposed treatments are in compliance with this order.

Executive Order 12372, Intergovernmental Review. Coordination and consultation is ongoing with affected Tribes, Federal, and local agencies. A copy of the BAER Plan will be disseminated to all affected parties by the Needles Field Office.

Executive Order 12892, Federal actions to address Environmental Justice in Minority and Low-Income Populations. All Federal actions must address and identify, as appropriate, disproportionately high and adverse human health or low-income populations, and Indian Tribes in the United States. The BAER Team has determined that the actions proposed in this plan will result in no adverse human health or environmental effects for minority or low-income populations and Indian Tribes.

Executive Order 13112, Invasive Species. To prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause. The BAER Team has proposed treatments to address this issue that complies with the executive order.

Endangered Species Act. The BAER Team requested an official species list from the U.S. Fish and Wildlife Service Information for Planning and Consultation website (https://ecos.fws.gov/ipac/) and consulted with local BLM wildlife biologists to address the impacts of fire suppression actions and BAER Emergency Stabilization and Rehabilitation treatments.

The proposed activities are located within the potential range of 4 threatened or endangered wildlife species. There is no Critical Habitat within the portion of the York Fire on BLM CA administered lands. Through discussions with local biologists and review of relevant monitoring data, the desert tortoise (*Gopherus agassizii*; Threatened) is known to occur within the BLM CA portion of the fire; however, the proposed treatment activities of this BAER plan have been determined to either have “no effect” on the species, or the potential effects have already been analyzed and consulted on by the BLM Needles Field Office.

The BLM should re-initiate emergency consultation should new information be found indicating the presence of other listed species, or new emergency stabilization treatments be proposed.

Clean Water Act. No proposed treatments would result in long-term impacts to, or loss of, wetlands and all proposed treatments are in compliance with this order.

Clean Air Act. Federal Ambient Air Quality Primary and Secondary Standards are provided by the National Ambient Air Quality Standards, as established by the U.S. Environmental Protection agency (EPA) (Clean Air Act, 42 U.S.C. 7470, et seq., as amended). The BAER Team has determined that treatments prescribed in this BAER Plan will have short-term minor

impacts to air quality due to equipment emissions and/or increase in particulates during ground-based activities, but they would not differ significantly from routine land use practices for the area. As such, all proposed treatments are in compliance with this Act.

Federal Noxious Weeds Act. Established the authority of the Secretary of Agriculture to designate plants as noxious weeds by regulation and prohibited the movement of all such weeds in interstate and foreign commerce, except under permit. Required Federal land-managing agencies to control, eradicate, or prevent or retard the spread of such weeds; to designate an office or person adequately trained in managing undesirable plant species and coordinate a program to control such plants on the agency's land; establish and adequately fund this plant management program through the agency's budget process; complete and implement cooperative agreements with States regarding undesirable plants on agency land; and establish integrated management systems to control or contain undesirable plants targeted under the cooperative agreements. The BAER Team has proposed treatments to address this issue that complies with the Act.

CONSULTATIONS

The BAER Team held an initial briefing with local staff from the BLM and National Park Service that included managers, biologists, AML specialists, facilities specialists, vegetation specialists, fire operations, and cultural/heritage resource specialists via Teams and in-person at the Mohave National Preserve Headquarters office on August 8, 2023. Internal scoping continued daily by the BAER Team at each evening briefing as new issues found in the field were added into the record of issues and concerns and Values at Risk Tables. Where necessary, consultations will be initiated prior to implementation of BAER treatments.

SUMMARY OF COMPLIANCE DOCUMENTATION

The following table summarizes the NEPA compliance in place for the BAER Emergency Stabilization (ES) and Burned Area Rehabilitation (BAR) treatments proposed for the York Fire BAER Plan.

TREATMENT OR ACTION	NEPA DOCUMENTATION (EIS, EA, OR CE)
ES-1 Non-Native Invasive Plant Control (Ground-based)	California Desert Conservation Area Plan (1980 as amended) Site-specific CX: 43 CFR Part 46.205 (e)
ES-2 Safety Signage and Barricades	Site-specific CX: Part 516 DM 11 G
ES-3 Implementation Leader	Site-specific CX: 43 CFR Part 46.210 (f)
ES-4 LEO Patrols	Site-specific CX: 43 CFR Part 46.210 (f)
BAR-1 Non-Native Invasive Plant Control (Ground-based)	California Desert Conservation Area Plan (1980 as amended) Site-specific CX: 43 CFR Part 46.205 (e)

STATEMENT OF COMPLIANCE

The CEQ Regulations at 40 CFR 1508.4 require agencies to consider whether routine actions involve extraordinary circumstances that, per NEPA, trigger an agency to prepare additional assessment and consideration. If it is determined that any of the exemptions listed in 516 DM Appendix 2 apply to a proposed action, that action may not be categorically excluded, and an EA or an EIS must be prepared. All treatments that are proposed as a Categorical Exclusion for the York Fire BAER Plan have been compared against the list of extraordinary circumstances and were found not to trigger any exceptions. All proposed actions tier to existing EAs or qualify as BLM Categorical Exclusions and would not result in any significant effect on the environment. BAER Team specialists have/will complete necessary coordination and consultation to ensure compliance with the National Historic Preservation Act, Endangered Species Act, Clean Water Act, Federal Noxious Weeds Act, and other Federal, State, and local environmental review requirements. All acres proposed for ground disturbance require Section 106 NHPA survey and compliance.

The Exception Checklist for BLM Categorical Exclusions is provided on the following two pages.

EXCEPTION CHECKLIST FOR BLM CATEGORICAL EXCLUSIONS

Project: York Fire Burned Area Emergency Response (BAER) Plan Date: 8-21-2021

Nature of Proposed Action: Approval and Implementation of Emergency Stabilization Treatments in the Bear Fire BAER Plan.

APPLICABLE DEPARTMENT OF INTERIOR AND BLM CATEGORICAL EXCLUSIONS

DOI

43 CFR Part 46.205 (e)
43 CFR Part 46.210 (f)

BLM

Part 516 DM 11 C (3)
Part 516 DM 11 G (2), (3), (4)

See above for descriptions of individual categorical exclusions.

EVALUATION OF EXCEPTION TO USE OF CATEGORICAL EXCLUSION

1.	This action would have significant adverse effects on public health or safety.	**No** ☒	Yes ☐
2.	This action would have an adverse effect on unique geographical features, such as wetland, wild or scenic rivers, refuges, floodplains, rivers placed on nationwide river inventory, or prime or unique farmlands.	**No** ☒	Yes ☐
3.	The action will have highly controversial environmental effects.	**No** ☒	Yes ☐
4.	The action will have highly uncertain environmental effects or involve unique or unknown environmental risks.	**No** ☒	Yes ☐
5.	This action will establish a precedent for future actions.	**No** ☒	Yes ☐
6.	This action is related to other actions with individually insignificant, but cumulatively significant environmental effects.	**No** ☒	Yes ☐
7.	This action will affect properties listed or eligible for listing in the National Register of Historic Places.	**No** ☒	Yes ☐

8.	This action will affect a species listed or proposed to be listed as endangered or threatened.	**No** ☒	Yes ☐
9.	This action threatens to violate federal, state, local, or tribal law or requirements imposed for protection of the environment.	**No** ☒	Yes ☐
10.	This action will have a disproportionately high and adverse effect on low income or minority populations.	**No** ☒	Yes ☐
11.	This action will limit access to, and ceremonial use of Indian sacred sites on federal lands by Indian religious practitioners, or significantly adversely affect the physical integrity of such sacred sites.	**No** ☒	Yes ☐
12.	This action will contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area, or may promote the introduction growth, or expansion of the range of such species.	**No** ☒	Yes ☐

A “yes” to any of the above exceptions will require that an EA be prepared.

NEPA Action - - - **CE** X **EA** _____

Preparer’s Name and Title: Emily Ramirez, National Interagency BAER Team

Concur: _____ **Date:**
Field Office Archeologist

Concur: _____ **Date:**
Field Office Environmental Coordinator

Approved: _____ **Date:**
Field Manager

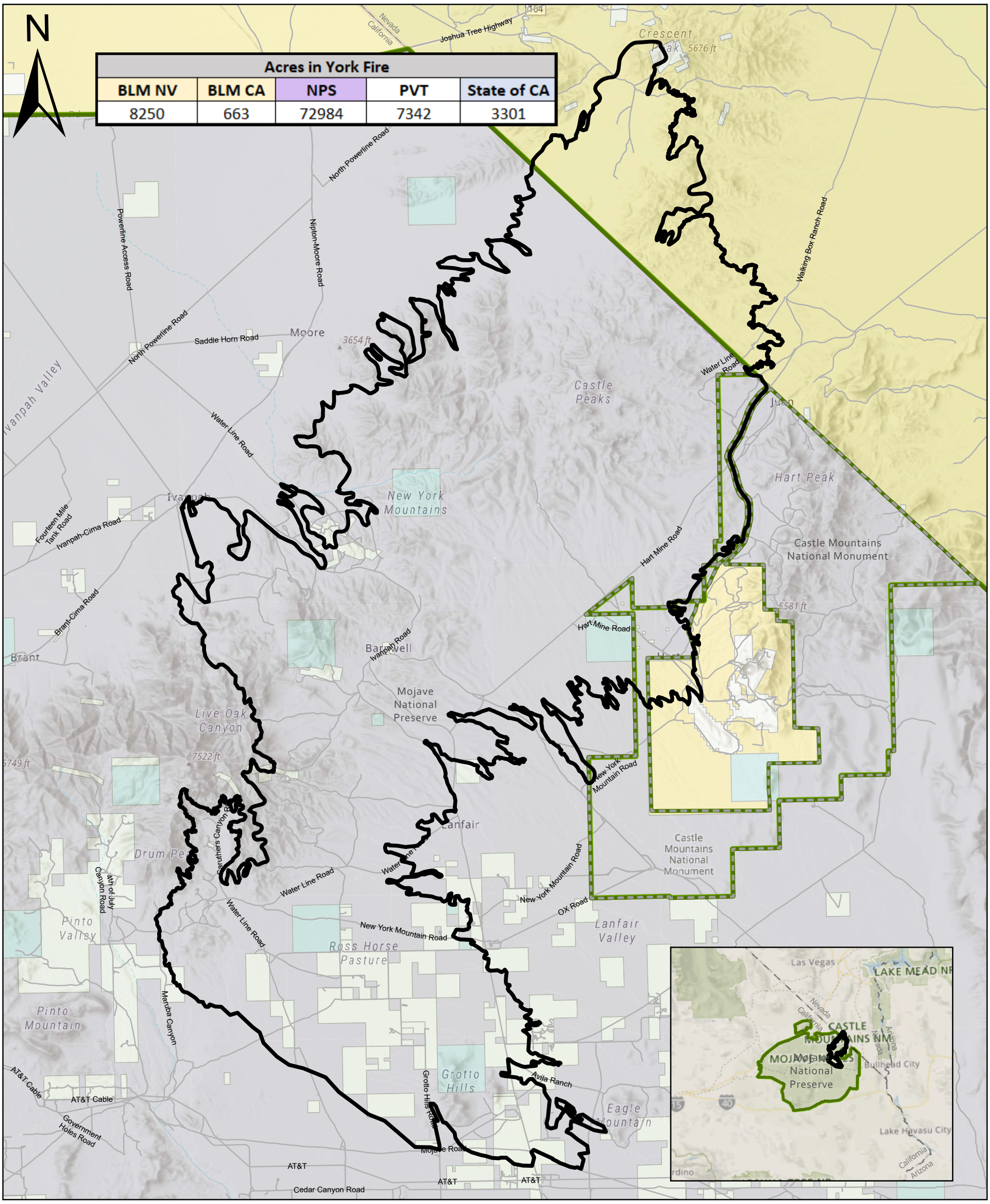
BURNED AREA EMERGENCY RESPONSE PLAN
2023 YORK FIRE

APPENDIX B
SUPPRESSION AND BAER PLAN MAPS

1. Land Ownership
2. Fire Progression
3. Fire History
4. Soil Burn Severity
5. ES & BAR Treatments

N

Acres in York Fire				
BLM NV	BLM CA	NPS	PVT	State of CA
8250	663	72984	7342	3301



Ownership with Acres in the Perimeter

- BLM
- NPS
- State of California
- Private
- York Fire Perimeter 92,540 Acres
- Roads
- Castle Mountains National Monument Boundary
- Mojave National Preserve Boundary

York Fire BAER

Ownership Map

0 1.25 2.5 5

Miles

Scale: 1:125,000

BLM Surface Management Agency (SMA) data was altered using NPS boundary data inside the York Fire Perimeter to better represent NPS Managed Lands.

This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

FIRE PROGRESSION

YORK

CA-MNP-010701

8/05/2023

Acreage by Date

- 7/28 - 2,580 ac
- 7/29-7/30 - 68,733 ac
- 7/30-8/02 - 92,733 ac
- 8/03-8/05 - 93,078 ac

115°34'W 115°32'W 115°30'W 115°28'W 115°26'W 115°24'W 115°22'W 115°20'W 115°18'W 115°16'W 115°14'W 115°12'W 115°10'W 115°8'W 115°6.01'W 115°4'W 115°2'W 115°0'W 114°58'W 114°56'W 114°54'W 114°52'W 114°50'W

35°30'N 35°28'N 35°26'N 35°23.99'N 35°22'N 35°20'N 35°18'N 35°16'N 35°14'N 35°12'N 35°10'N 35°8'N 35°7'N 35°6'N 35°5'N

Nipton Rd
Ivanpah Rd
Morning Star Mine Rd
Cima Rd
Kelso Cima Rd

15 164 95 95 163 95

Interagency Incident Management

N
W E
S

Miles

0 ½ 1 2 3 4 5

1:200,000

Last Updated
8/5/2023
12:21

FIRE PROGRESSION

YORK

CA-MNP-010701

8/05/2023

Acreage by Date

- 7/28 - 2,580 ac
- 7/29-7/30 - 68,733 ac
- 7/30-8/02 - 92,733 ac
- 8/03-8/05 - 93,078 ac

115°34'W 115°32'W 115°30'W 115°28'W 115°26'W 115°24'W 115°22'W 115°20'W 115°18'W 115°16'W 115°14'W 115°12'W 115°10'W 115°8'W 115°6.01'W 115°4'W 115°2'W 115°0'W 114°58'W 114°56'W 114°54'W 114°52'W 114°50'W

35°30'N 35°28'N 35°26'N 35°23.99'N 35°22'N 35°20'N 35°18'N 35°16'N 35°14'N 35°12'N 35°10'N 35°8'N 35°7'N 35°6'N 35°5'N

Nipton Rd
Ivanpah Rd
Morning Star Mine Rd
Cima Rd
Kelso Cima Rd

15 164 95 95 163 95

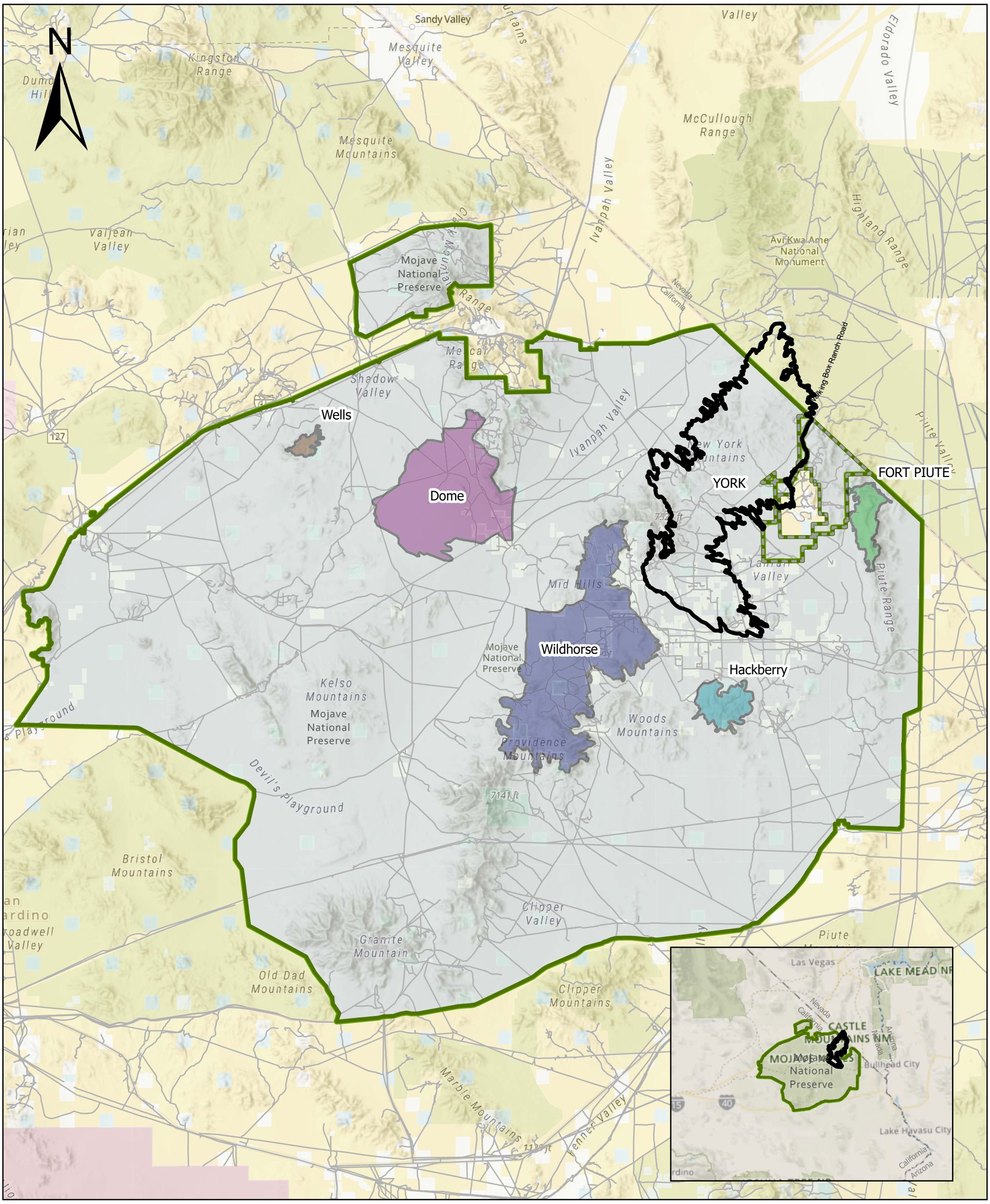
50

Miles

0 ½ 1 2 3 4 5

1:200,000

Last Updated
8/5/2023
12:21



- York Fire Perimeter 2023 92,540 Acres
- Roads
- Castle Mountains National Monument Boundary
- Mojave National Preserve Boundary

Previous Fire Perimeters > 1,000 acres

- Dome 2020 44,249 Acres
- Fort Piute 1994 6,350 Acres
- Hackberry 2005 7,158 Acres
- Wells 2011 1,708 Acres
- Wildhorse 2005 63,771 Acres

York Fire BAER
Fire History Map of the Mojave National Preserve and Surrounding BLM

0 5 10 20

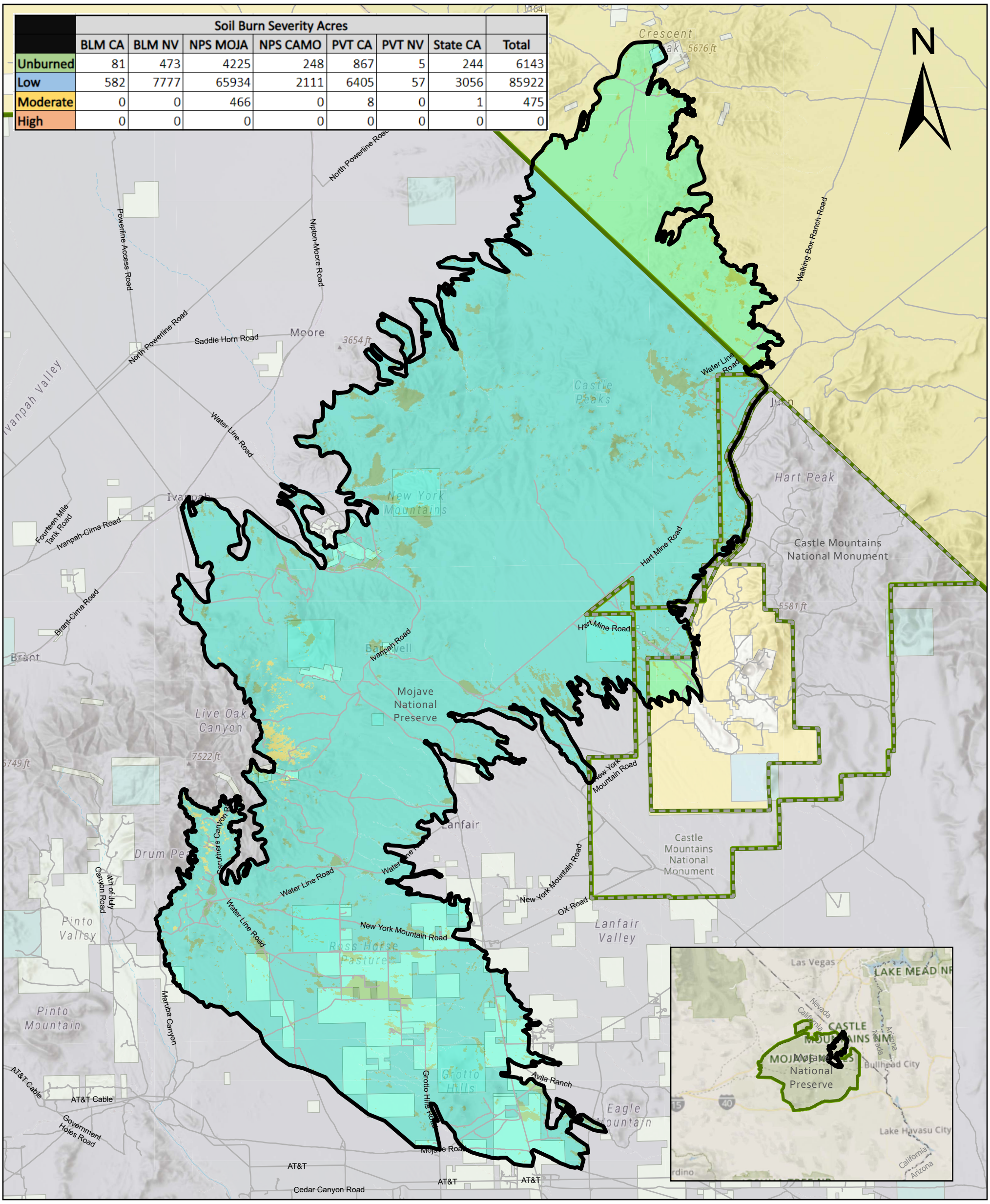
Miles

Scale: 1:450,000

Fire perimeters with less than 1,000 acres are omitted from this map.

This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

	Soil Burn Severity Acres							
	BLM CA	BLM NV	NPS MOJA	NPS CAMO	PVT CA	PVT NV	State CA	Total
Unburned	81	473	4225	248	867	5	244	6143
Low	582	7777	65934	2111	6405	57	3056	85922
Moderate	0	0	466	0	8	0	1	475
High	0	0	0	0	0	0	0	0



Soil Burn Severity
- Unburned
- Low Soil Burn Severity
- Moderate Soil Burn Severity

Ownership with Acres in the Perimeter
- BLM
- NPS
- State of California
- Private
- York Fire Perimeter 92,540 Acres
- Roads
- Castle Mountains National Monument Boundary
- Mojave National Preserve Boundary

York Fire BAER Soil Burn Severity Map

0 1.25 2.5 5

Miles

Scale: 1:125,000

The York Soil Burn Severity was created by validating soil conditions within the York Fire Perimeter. Ground conditions informed adjustments made to the Burned Area Reflectance Classification (BARC) product.

This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

York Fire BAER
Needles Field Office

Weeds and Signage Treatments

- ES-1 BAR-1 Non-Native Invasive Plant Control (Ground-based)
- ES-2 Suggested Location for Burned Area Sign
- Roads
- Wilderness
- York Fire Perimeter 92,540 Acres
- Castle Mountains National Monument Boundary
- Mojave National Preserve Boundary

Ownership with Acres in the Perimeter

- BLM
- NPS
- State of California
- Private

0 0.75 1.5 3

Miles

Scale: 1:75,000

Field observations were conducted by the BAER team between 8/8/2023 and 8/16/2023.

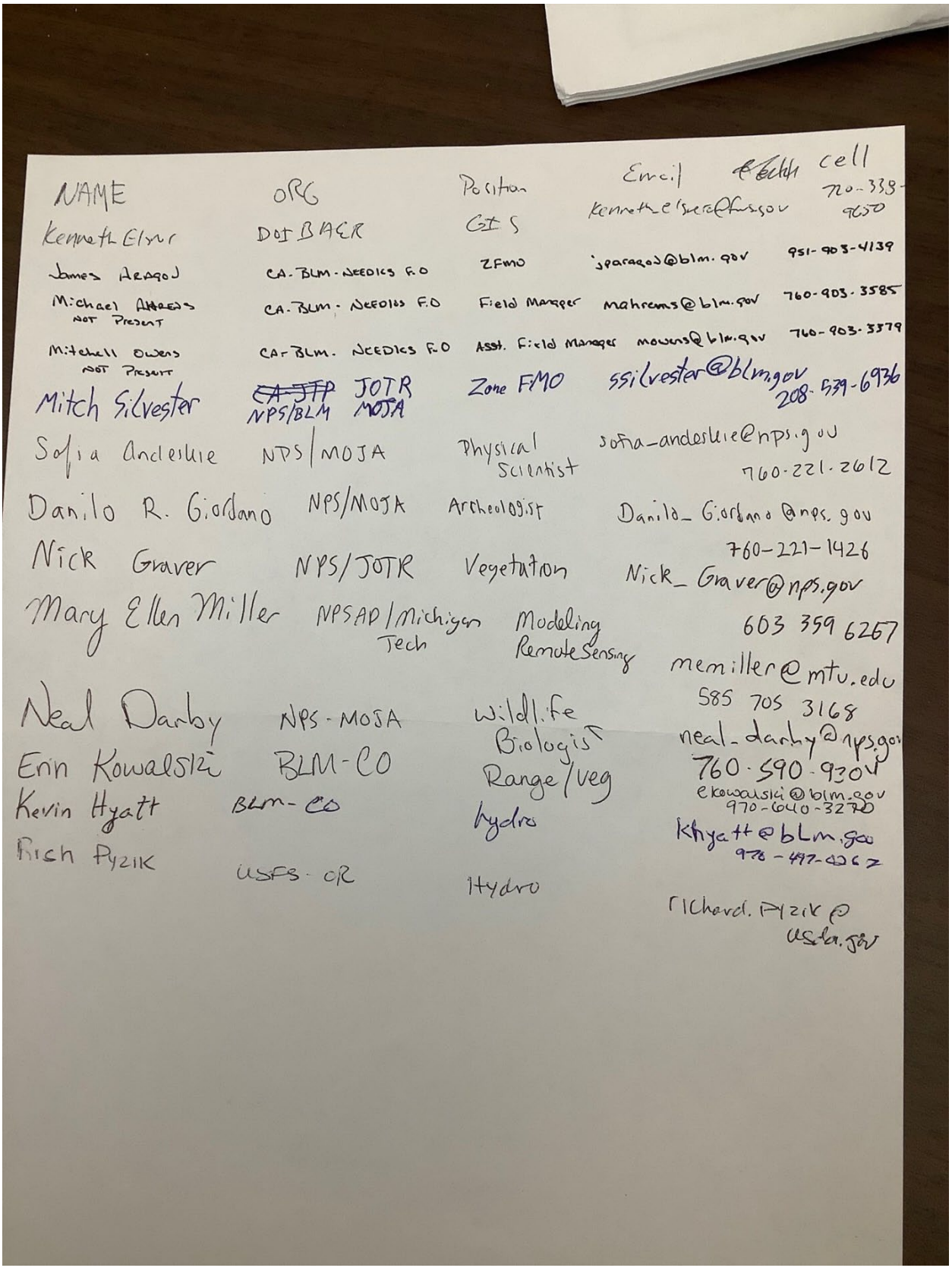
This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

BURNED AREA EMERGENCY RESPONSE PLAN
2023 YORK FIRE

APPENDIX C
SUPPORTING DOCUMENTS



York Fire BAER In-Briefing Sign-in Sheet (8/8/2023)



NAME	ORG	Position	Email	cell
Kenneth Elmer	DOI BAER	GIS	kenneth_elmer@fws.gov	720-338-9650
James Aragon	CA-BLM-NEEDLES F.O	ZFMO	jaragon@blm.gov	951-903-4139
Michael Ahrens NOT PRESENT	CA-BLM-NEEDLES F.O	Field Manager	mahrens@blm.gov	760-903-3585
Mitchell Owens NOT PRESENT	CA-BLM-NEEDLES F.O	Asst. Field Manager	mowens@blm.gov	760-903-3379
Mitch Silvester	~~CA-JTP~~ JOTR NPS/BLM MOJA	Zone FMO	ssilvester@blm.gov	208-539-6936
Sofia Anderlucie	NPS/MOJA	Physical Scientist	sofia_anderlucie@nps.gov	760-221-2612
Danilo R. Giordano	NPS/MOJA	Archeologist	Danilo_Giordano@nps.gov	760-221-1426
Nick Graver	NPS/JOTR	Vegetation	Nick_Graver@nps.gov	
Mary Ellen Miller	NPSAD/Michigan Tech	Modeling Remote Sensing	memiller@mtu.edu	603 359 6267
Neal Darby	NPS-MOJA	Wildlife Biologist	neal_darby@nps.gov	585 705 3168
Erin Kowalski	BLM-CO	Range/veg	ekowalski@blm.gov	760-590-9301 970-640-3280
Kevin Hyatt	BLM-CO	hydro	khyatt@blm.gov	928-497-0062
Rich Pyzik	USFS-OR	Hydro	Richard.Pyzik@usda.gov	

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

NOT FOR CONSULTATION

Location

California and Nevada



Local offices

Southern Nevada Fish And Wildlife Office

(702) 515-5230
(702) 515-5231

4701 N. Torrey Pines Drive

Las Vegas, NV 89130-2301

Carlsbad Fish And Wildlife Office

(760) 431-9440
(760) 431-5901

2177 Salk Avenue - Suite 250
Carlsbad, CA 92008-7385

NOT FOR CONSULTATION

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

---

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).

NOT FOR CONSULTATION

2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Birds

NAME	STATUS
Southwestern Willow Flycatcher Empidonax traillii extimus Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/6749	Endangered
Yellow-billed Cuckoo Coccyzus americanus There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/3911	Threatened

Reptiles

NAME	STATUS
Desert Tortoise Gopherus agassizii There is **final** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/4481	Threatened

Insects

NAME	STATUS
Monarch Butterfly Danaus plexippus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9743	Candidate

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

This location overlaps the critical habitat for the following species:

NAME	TYPE

NOT FOR CONSULTATION

Desert Tortoise Gopherus agassizii https://ecos.fws.gov/ecp/species/4481#crithab	Final

Bald & Golden Eagles

Bald and golden eagles are protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act.

Any person or organization who plans or conducts activities that may result in impacts to bald or golden eagles, or their habitats, should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

Additional information can be found using the following links:

- Eagle Managment https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf

There are bald and/or golden eagles in your project area.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list,click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Golden Eagle Aquila chrysaetos This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1680	Breeds Dec 1 to Aug 31

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and

NOT FOR CONSULTATION

understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

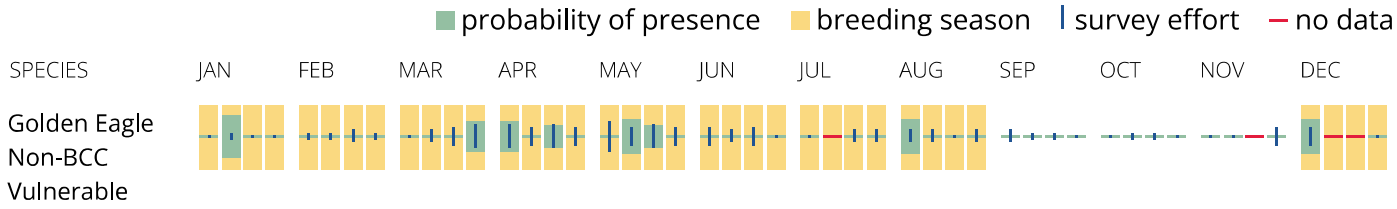
To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe

NOT FOR CONSULTATION

Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



What does IPaC use to generate the potential presence of bald and golden eagles in my specified location?

The potential for eagle presence is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply). To see a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What does IPaC use to generate the probability of presence graphs of bald and golden eagles in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur. Please contact your local Fish and Wildlife Service Field Office if you have questions.

Migratory birds

NOT FOR CONSULTATION

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern https://www.fws.gov/program/migratory-birds/species
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Bendire's Thrasher Toxostoma bendirei This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9435	Breeds Mar 15 to Jul 31

NOT FOR CONSULTATION

Black-chinned Sparrow Spizella atrogularis — Breeds Apr 15 to Jul 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9447

Costa's Hummingbird Calypte costae — Breeds Jan 15 to Jun 10
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/9470

Gilded Flicker Colaptes chrysoides — Breeds May 1 to Aug 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/2960

Golden Eagle Aquila chrysaetos — Breeds Dec 1 to Aug 31
This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1680

Long-eared Owl asio otus — Breeds Mar 1 to Jul 15
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3631

Pinyon Jay Gymnorhinus cyanocephalus — Breeds Feb 15 to Jul 15
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9420

Rufous-winged Sparrow Aimophila carpalis — Breeds Jun 15 to Sep 30
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

NOT FOR CONSULTATION

Probability of Presence (▪)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (▪)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

NOT FOR CONSULTATION



NOT FOR CONSULTATION

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may query your location using the RAIL Tool and look at the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

NOT FOR CONSULTATION

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

NOT FOR CONSULTATION

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

There are no refuge lands at this location.

Fish hatcheries

There are no fish hatcheries at this location.

Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Wetland information is not available at this time

This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the NWI map to view wetlands at this location.

NOT FOR CONSULTATION

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and

nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

NOT FOR CONSULTATION

8/14/2023

15.945 - Cooperative Research and Training Programs – Resources of the National Park System, Grant No. P22AC01419-00 to the University of California, Riverside

Post-wildfire resprouting and survival of Joshua trees and banana yucca after the 2020 Dome Fire, Mojave National Preserve

Lynn Sweet, Principal Investigator

Prepared by: Melanie Davis, Field Ecologist and Lynn Sweet

Preliminary Results:

The best uniform-time data we have at this time is our 2-year post-fire survey from our work at Mojave Preserve within the Dome Fire area in collaborators Joseph McAuliffe and Tasha La Doux. We surveyed 10 plots across the Dome Fire area in October 2022, all within Joshua Tree Woodlands (see McAuliffe 2021, Mojave National Preserve Science Newsletter for plot location selection information). Standardized plots established for the purposes of demographic surveys were 40x20m (800m2, ~0.2 acres). Data below for *Yucca jaegeriana* ("YUCJAE").

Density:

- The pre-fire density of living YUCJAE on the landscape may be estimated using our post-burn data and may be extrapolated from 0.2 acres as follows:
- Average of 11 YUCJAE per 800m^2 plot (min 7, max 20; n = 110)
- Average/acre: 55.64 YUCJAE/acre (min 35.41/acre, max 101.17/acre).

Burn Impact and Mortality:

- We recorded 106 of the 110 YUCJAE impacted by fire.

Burn Mortality:

- 106 YUCJAE were burned.
- 25 YUCJAE (19.8% of total burned, 10.62/acre) were considered alive (parent terminal ends green and/or producing basal sprouts).
- 9 YUCJAE survived to the crown (parent tree terminal ends green)
- 20 YUCJAE had basal sprouts (*4 trees overlapped these categories with both post-fire basal sprouts and survival to the crown)

Recruitment by seed/seedling:

- None observed. 0 YUCJAE/Acre

Notes:

It was noted that there was a lot of herbivory on basal sprouts this year (2023); and as well, some basal sprouts may have died since the 2-year survey. We did not include here data taken on another set of plots in the prior spring 2022, since it was not temporally comparable. Our full uniform dataset at 2.5 years is being prepared, but summaries are not available at this time. Of note, however, we can say that we similarly did not observe any YUCJAE recruitment in any surveys so far, to 2.5 years.

Preliminary estimation of Joshua tree densities within the York Fire perimeter

In 2019 the Dome Fire burned a large portion of Mojave National Preserve on Cima Dome including one of the densest populations of Joshua trees. USGS has been studying the effects of fire on vegetation and Joshua trees in particular since that fire. One part of the project included using remote sensing to estimate Joshua tree densities and crown size. The following briefly describes that ongoing study.

LiDAR point cloud data collected in 2019 were processed to detect individual crowns of all plants greater than 1.25 m tall. A 0.5 m resolution canopy height model was first generated in R using the 'p2r' function in the lidR library. Joshua tree crowns were classified as Joshua Trees based on manual interpretation of high-resolution imagery; Joshua Trees have unique shadows and low greenness that make it possible to differentiate them from other tall vegetation in the Mojave Desert, primarily juniper trees. Additional Joshua Tree training points were collected in the field using handheld GPS, along with non-Joshua Tree plants. The final training dataset included 4411 Joshua tree crowns and 14,592 crowns that were not Joshua Trees, typically juniper trees or rock outcroppings. The final training dataset was then randomly split into 80% training and 20% testing datasets. A random forest model with 1000 trees and default parameters was then used to classify each crown as a Joshua tree or not.

The Dome fire boundary was not completely covered by the LiDAR imagery. Assuming an average density of Joshua trees, over 800,000 Joshua trees occurred within the Dome fire boundary. As of August 9, 2023, the York fire was almost entirely within the study domain; and there were an estimated 1.2 million Joshua trees within the fire boundary. It is important to note that the estimate is for Joshua trees >1.25 m tall which are potentially breeding adults, because it is too difficult to identify shorter trees. Also, while Joshua trees are susceptible to fire, wildland fires tend to burn in a mosaic of intensity and 100% mortality is unlikely. A dedicated field effort that surveys for surviving trees within the footprint of the LiDAR is needed to generate a more accurate estimate Joshua tree mortality in these fires. There are other important caveats being developed for the full report on this topic, including ways that the flightlines affected the quality of the data used in the model and how steeper or south facing slopes were more challenging than others.

Suggested Temporary Citation:

Buffington, K.J., Thorne, K.M, Esque, T., Chen, F., Van Gaalen, R. *Preliminary Data*. Mapping Joshua Trees with a fusion of LiDAR and multispectral airborne imagery. Unpubl. Project Report prepared for the U.S. National Park Service, U.S. Geological Survey, Western Ecological Research Center.

Predicting post-fire runoff and erosion for National Park Service Values at Risk impacted by the York fire, CA & NV

Mary Ellen Miller, Ph.D., memiller@mtu.edu
Michigan Tech Research Institute (MTRI)
3600 Green Ct., Ste. 100 • Ann Arbor, MI 48105

Kevin Hyatt, khyatt@blm.gov
Bureau of Land Management
Colorado

The York fire burned large swaths of the Mojave preserve at low severity with many refugia of not burned pockets and a very small portion of moderate severity. During the field observations carried out to create the soil burn severity map it was noted that although vegetation mortality and consumption of fuels was high, the soils were not strongly impacted. This is not surprising given the smaller fuel loads of the Mojave Desert. Soil structure was not altered, and soils were not hydrophobic. Ash color was predominately black indicating incomplete combustion of organic materials. Because of the low severity of the burn scar, the hydrological response to the fire is expected to be limited under normal summer monsoonal storms and winter snow melt events. In dry desert environments a heavy rain can be expected to generate a lot of runoff and debris regardless of whether or not the watershed has burned. Fires will increase the impacts of medium-sized storms resulting in additional need for repairing roads after storms. The amount of runoff and erosion generated by a watershed is controlled by the climate, topography, land cover and soil properties. Fire can drastically change both soils and land cover. Models attempt to account for these parameters in order to predict post-fire effects.

Modeling approach and inputs:
Potential post-fire runoff and erosion rates were predicted for Values at Risk affected by the York fire in California/Nevada using spatial WEPP (Water Erosion Prediction Project) interfaces. WEPP is a process-based hydrological model developed by a team of interagency scientists (Laflen et al. 1997). WEPP technology encompasses two versions: a hillslope model to estimate the distribution of erosion on individual hillslopes, and the WEPP Watershed model that links the hillslope version with channels and in-stream structures in order to predict sediment delivery from small watersheds. The surface hydrology component of the WEPP model uses climate, soils, topography, and vegetation input files to calculate rainfall and snowmelt infiltration, daily soil moisture, runoff volume, and peak discharge for each simulated storm or snowmelt event. WEPP uses these results to calculate both rill and inter-rill erosion as well as sediment deposition and hillslope sediment yield, and then routes the sediment through the channel system, estimating deposition or erosion for each channel segment (Flanagan and Nearing 1995).

The WEPP model is the underlying basis for a series of model interfaces developed by the USDA Forest Service to predict erosion due to fires, roads, and forest harvest operations (http://forest.moscowfsl.wsu.edu/fswepp/). Disturbed WEPP is an online interface that predicts post-fire runoff and erosion rates at a hillslope scale. It is more accurate than the Revised Universal Soil Loss Equation for post-fire conditions (Larsen and MacDonald, 2007). Disturbed WEPP specializes in modeling forest disturbance so the soil and land cover parameters from this interface are used in the spatial models. WEPP Cloud, an online USDA Forest Service spatial WEPP interface uses disturbed WEPP parameters (Lew et al., 2022; Dobre et al., 2022; https://wepp.cloud/weppcloud/). The Cloud interface has incorporated newer soil and land cover parameter files but is not always available and it does not

handle larger basin areas or custom datasets. To model larger spatial areas the Rapid Response Erosion Database (RRED; http://rred.mtri.org/rred/) (Miller et al., 2016a) and QWEPP were used (Renschler, 2003; Miller et al., 2016b). Each of these frameworks played a pivotal role in modeling post-fire impacts.

The primary inputs for spatial WEPP interfaces include a digital elevation model (DEM), climate data, soil maps, and land cover/land management information. The soil burn severity map is combined with land cover and soil data to reflect changes wrought by the fire. Utilizing spatial WEPP interfaces with Disturbed WEPP input parameters represents an ideal method for predicting post-fire erosion at the hillside and small watershed scale across large burn scars.

Topographic data, watershed delineation, and processing

The 30 m or 10 m DEM data available through the RRED database and WEPP Cloud is from the USGS national elevation map. The DEM, along with all the spatial datasets, are reprojected into NAD 1983 UTM Zone 11N coordinates to facilitate modeling. Spatial WEPP has built in Topographic Parameterization, also known as TOPAZ (Garbrecht and Martz 1999), to delineate watersheds and create the files needed to run WEPP. Required input parameters for TOPAZ include the critical source area (CSA) and minimum source channel length (MSCL). The 30 m DEM was used for modeling the two larger watersheds, Castle Mine and Ivanpah blow out. Smaller watersheds were modeled using the 10 m DEM. TOPAZ parameters were set to 5 ha for CSA and 100 m for MSCL for the 10 meter DEM runs and 10 ha for CSA and 100 m for the larger 30 m watersheds.

Soils data

The soil input layer is created automatically by the WEPP interfaces by combining the York soil burn severity map with a base soil layer derived from both the SSURGO and STATSGO datasets. SSURGO datasets contain the most detailed soil maps created by the NRCS but contain some data gaps (Miller and White, 1998; Soil Survey Staff, 2014). The STATSGO database was used to fill in the gaps since it has complete coverage and is a seamless layer derived from soil surveys conducted by the U.S. Department of Agriculture (USDA, 1991). The STATSGO database has a coarser spatial resolution than the SSURGO database. This lower resolution is not a great concern because in post-fire modeling, the erosion potential of the soil is more a function of fire severity than of other soil properties (Elliot, 2013). When soils are impacted by fire, the soil parameters are adjusted using Disturbed WEPP parameters based on land cover prior to burning (forest or grass), soil texture, and low or high severity soil impacts.

Climate data

The WEPP model has a built-in stochastic weather generator, Cligen, which generates WEPP climate inputs from an extensive database of over 2,600 weather stations within the US (Flanagan and Nearing, 1995). Cligen uses the weather station parameter files to predict mean daily precipitation, minimum and maximum daily temperatures, mean daily solar radiation, and mean daily wind speed and direction. In the continental US, these statistics can be modified using Rock:Clime (Elliot et al. 1999; http://forest.moscowfsl.wsu.edu/fswepp/, accessed 30 July 2022) and PRISM's (Parameter-elevation Regressions on Independent Slopes Model) monthly precipitation database to account for spatial variation and elevation effects. PRISM uses DEM, climate station data, and other spatial data sets to generate grids of climate data at a resolution of 4 km^2 or finer (Daly et al. 1997). Rock:Clime is an online interface that accesses precipitation data from PRISM to interpolate between weather stations in order to improve the stochastic climate file used by WEPP; the interface gives users the option to adjust temperature by elevation using adiabatic lapse rate. This tool is especially useful in remote mountainous terrain (Elliot, 2004).

A multi-year stochastic climate was developed based on nearby stations of Searchlight, Nevada; Mitchell Caverns, California; and Mountain Pass, California. Stations were modified using both Rock:Clime and PRISM datasets to represent a central location within the watersheds of interest. The predicted annual precipitation for the climate files developed for the York scar ranged between 7 and 12 inches. WEPP compiles return period interval predicted peak flows that can be used to test culvert sizes.

Table 1. Designer storms used in modeling watersheds and hillslopes.

Climate Station	Annual Precipitation (in)	2 year storm (in)	5 year storm (in)	10 year storm (in)
Searchlight, Nevada	7.29	1.4	1.8	2.2
Mitchell Caverns, California	11.32	2.0	3.2	3.8
Mountain Pass, CA	8.46	1.4	1.8	2.2
Searchlight modified Walking Box Ranch culverts	9.15	1.4	1.9	2.3
Searchlight modified for Castle Mine	7.9	1.3	1.8	2.1
Mountain Pass modified for Boomerang and Hart culverts	9.65	1.4	1.9	2.4
Searchlight modified for Ivanpah road	8.38	1.4	1.9	2.2
Mountain Pass modified for USGS	10.25	1.5	1.9	2.4
Mitchell Caverns modified for Ivanpah Blowout	11.68	2.0	3.1	3.8

Land cover - plant/management input files

The land cover data layer within WEPP Cloud is based on the National Land Cover map (Dewitz, 2021). Within the RRED database, land cover is based on the LANDFIRE Existing Vegetation Type (EVT) data (Rollins, 2009; LANDFIRE, 2011). Land cover types in both interfaces are reclassified into Disturbed WEPP land cover categories. The York soil burn severity map was rapidly combined with vegetation to create a burned land cover map on-demand (Fig. 1). This map was then reclassified to create a burned soils layer. This step is important as grasses and shrublands do not have enough fuel to create high-severity impacts on soils. The plant/management input files needed by the WEPP model were developed for Disturbed WEPP to maintain a uniform cover for modeling post-fire effects. The unburned areas within and near the York fire were modeled with input files developed for undisturbed shrubs, grass, and forests. Ground cover is an important driver for predicting erosion. The low severity burned area was assigned a uniform cover of 60% and the moderate burn severity was set at 45% cover. These cover settings were based on the observations collected by the BAER team for adjusting the initial burn severity map into the Soil Burn Severity map.

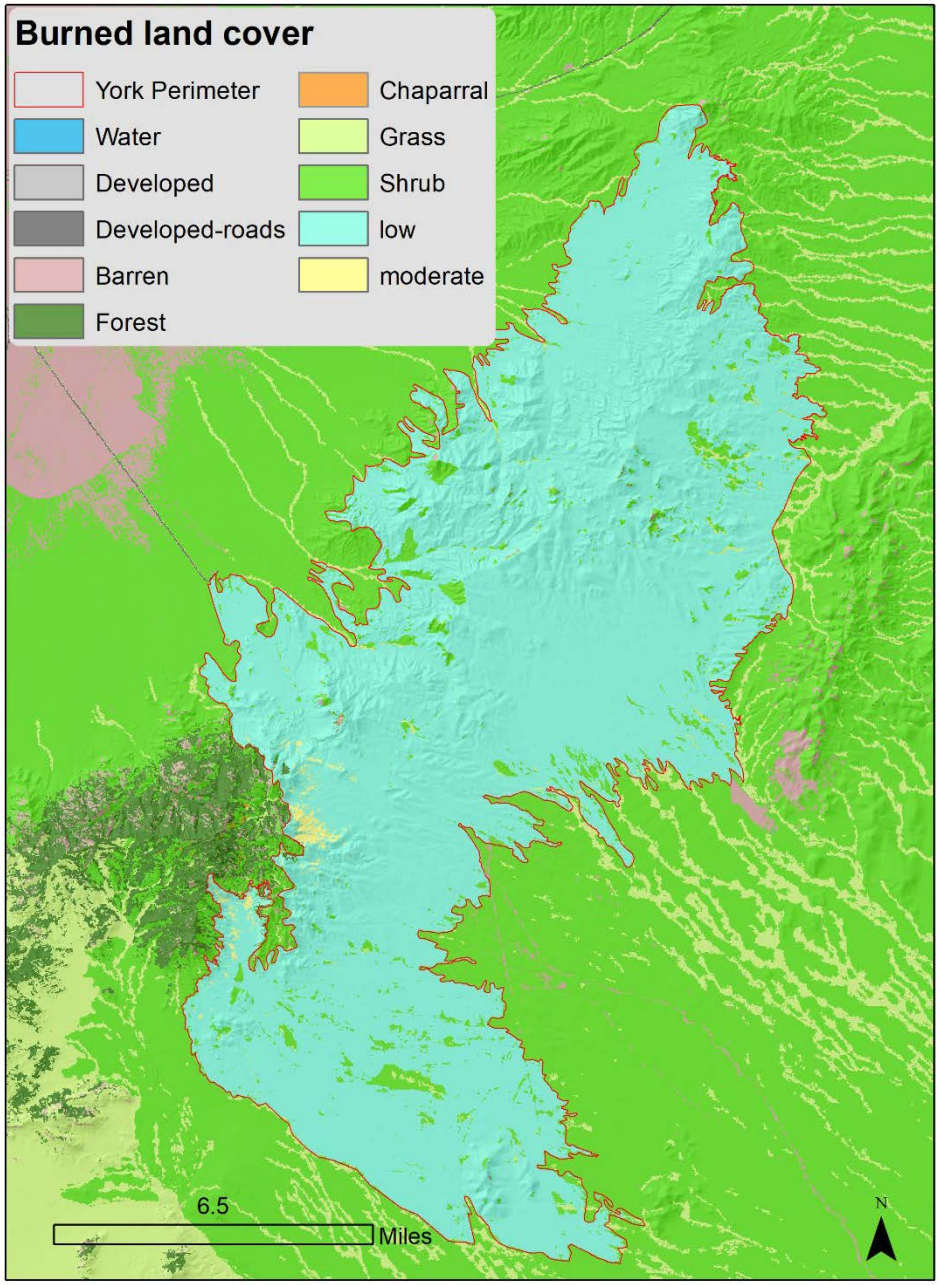


Figure 1. Burned land cover layer generated by RRED for the York fire.

Modeling

WEPP was run in watershed mode using the Rock:Clime modified climates created for the York fire (Table 1). VAR watersheds identified by the BAER team and local resources were modeled for both the burned and not burned conditions. Hillslopes that are modeled using the watershed option are set to the predominant soil and land cover type. This assumption results in hillslopes with mixed cover types being assigned to one soil and cover type. Model uncertainty is high; therefore care needs to be used in interpreting the results. Much of the predicted erosion from the larger watersheds is due to channel erosion and we suspect that additional work is need in calibrating the channel parameters.

Results

Model watershed parameters were developed using an ArcGIS WERT toolbox under development for the California Geological Survey and are the basis for running the empirical models (Table 2). These parameters were used to parameterize empirical models runs and are listed below.

Table 2. Spatial information for modeled watersheds that can be used in hydrological models.

Watershed	Watershed acres	Burned acres	relief ft	flow length mi	mean slope %	Area with slope > 30 %	mean dNBR	not burned acres	Low Severity acres	Moderate Severity acres	Avg Elevation ft		percent burned
Castle North	7162	3460	1417	9	13	12	56	3702	3460	0	4616		48%
Ivanpah blowout	2849	2476	2227	10	6	3	108	372	2475	1	4719		87%
Ivanpah	2604	1801	2702	8	23	30	151	803	1759	42	5241		69%
Boomerang wash	2523	2338	1544	4	28	42	206	185	2338	0	4718		93%
USGS	561	26	1845	2	48	81	3	535	26	0	6398		5%
Walking Box 4	417	331	665	3	15	9	115	86	331	0	4619		79%
Walking Box 3	141	134	303	1	9	2	120	7	134	0	4465		95%

Gauged USGS Watershed

The Caruthers USGS gauge was within the burn perimeter of the York fire and offered an opportunity to compare predictions with observations (Fig. 2). We were unable to download the actual station data, however the range of observed peak flows was in the same range as predicted by WEPP. We were able to download the return period statistics and compare them with WEPP predictions for not burned conditions (Fig. 3). The WEPP predictions of return period storms was lower than the streamstats reported peak flows. The gauged watershed was delineated at 561 acres and only 5% of the watershed burned at low severity. The lower reach containing the gauge was the small portion that burned. We predicted minimal changes to the watershed.



Figure 2. Caruthers Canyon,USGS gauge shortly after the 2023 York fire.

Name	Value			
USGS Station Number	9423350			
Station Name	CARUTHERS C NR IVANPAH CA			
Statistic Name	Peak-Flow (cfs)	Years of Record	Comments	WEPP Predictions not burned (cfs)
50-percent Annual Exceedance Probability flood	25.2	43	Statistic Date Range 10/1/1963 - 9/30/2006	2
20-percent Annual Exceedance Probability flood	149	43	Statistic Date Range 10/1/1963 - 9/30/2006	5.8
10-percent Annual Exceedance Probability flood	381	43	Statistic Date Range 10/1/1963 - 9/30/2006	7.3
4-percent Annual Exceedance Probability flood	1050	43	Statistic Date Range 10/1/1963 - 9/30/2006	370
2-percent Annual Exceedance Probability flood	2040	43	Statistic Date Range 10/1/1963 - 9/30/2006	760

Figure 3. Comparison of Caruthers gauge data peak flow statistics with WEPP predictions, note that WEPP predictions are lower than observed.

Boomerang Wash Watershed

The VAR of concern in this watershed is a historic mine tailing pile from the Boomerang mine. The tailing pile is located in the wash of a small 6-acre watershed next to a larger 2,500-acre watershed that we referred to as the Boomerang Wash watershed. The tailing pile has eroded in the past as the wash cuts through the middle of the pile. Modeling results for the larger watershed showed a greater post-fire response than the other modeled watersheds. This watershed contained steep slopes and 93% of the watershed burned at low soil burn severity. A typical 2-, 5-, or 10-year post-fire watershed response is not expected to impact the mine tailings as the wash from the main watershed has a large area to carry flow. No watershed treatment specification for this VAR**.**

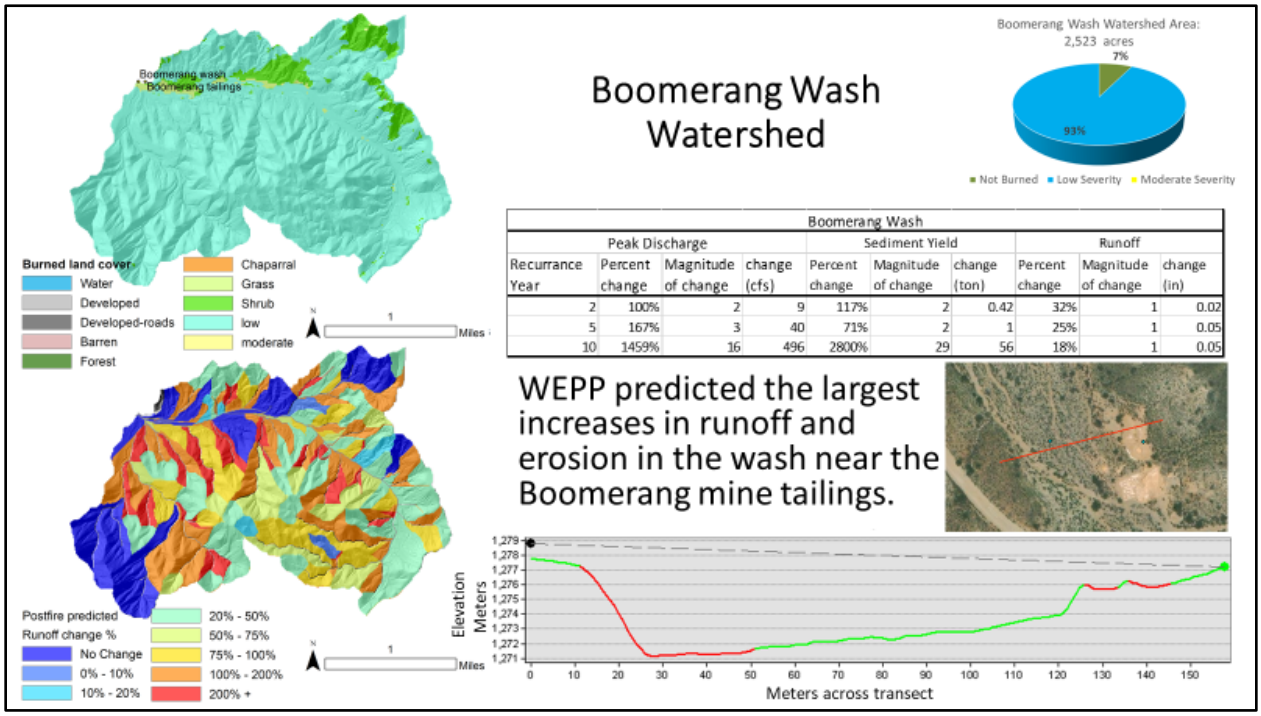
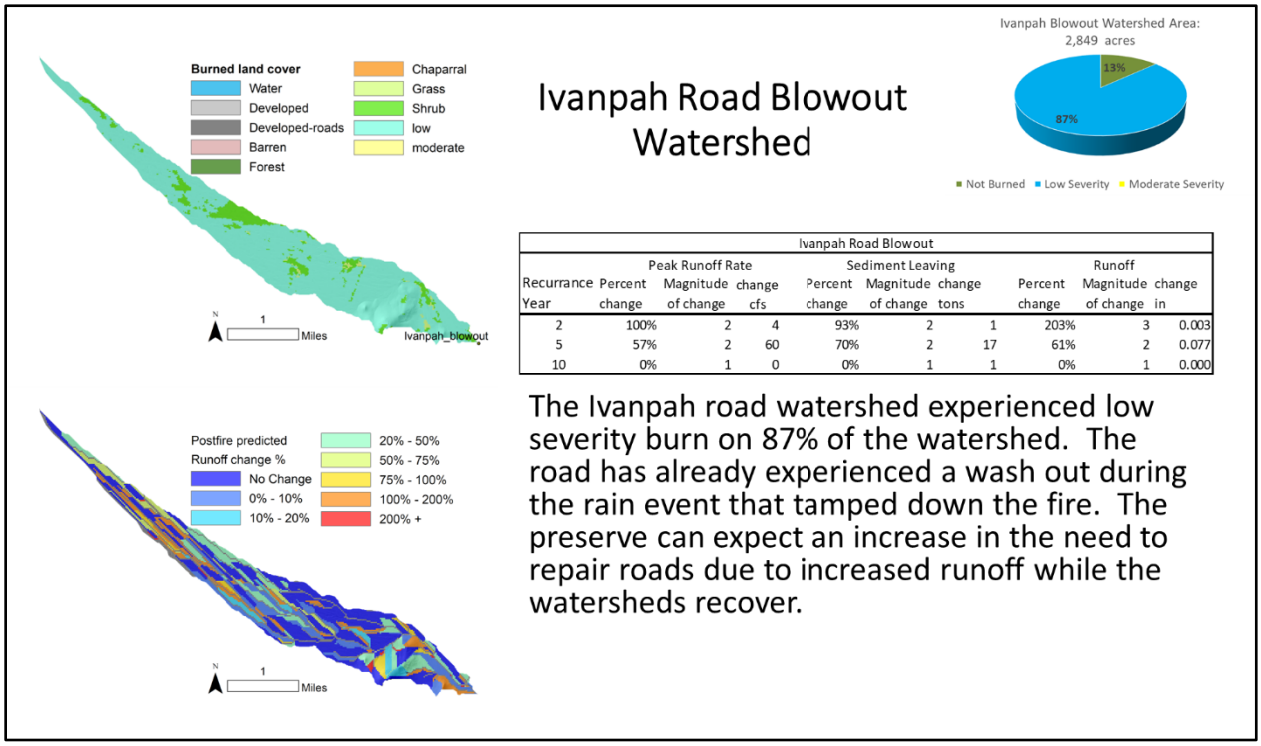


Figure 4. Boomerang Mine Watersheds modeling results including burned land cover and predicted post-fire hillslope scale runoff change. This watershed was predicted to have the greatest increases in peak discharge and sediment yield.

Ivanpah Road Blowout Watershed

The wash above a blowout on the Ivanpah road was identified as a watershed of interest as the storm that helped contain the York fire resulted in the Ivanpah road washing out. This storm was between a 2- and 5-year return interval event. This is the second largest watershed modeled at 2,849 acres with 87% of the watershed burned at low severity. The 2- and 5-year return period storms were predicted to have greater percent increases in runoff and erosion. Interestingly the 10-year storm was not predicted to have greater amounts of runoff and erosion. This location did not have a culvert and after the storm passed needed to be repaired. Wash and road intersections with burned watersheds can be expected to require repairs due to increased runoff and erosion from the loss of ground cover in the burned areas.



Ivanpah Road Blowout

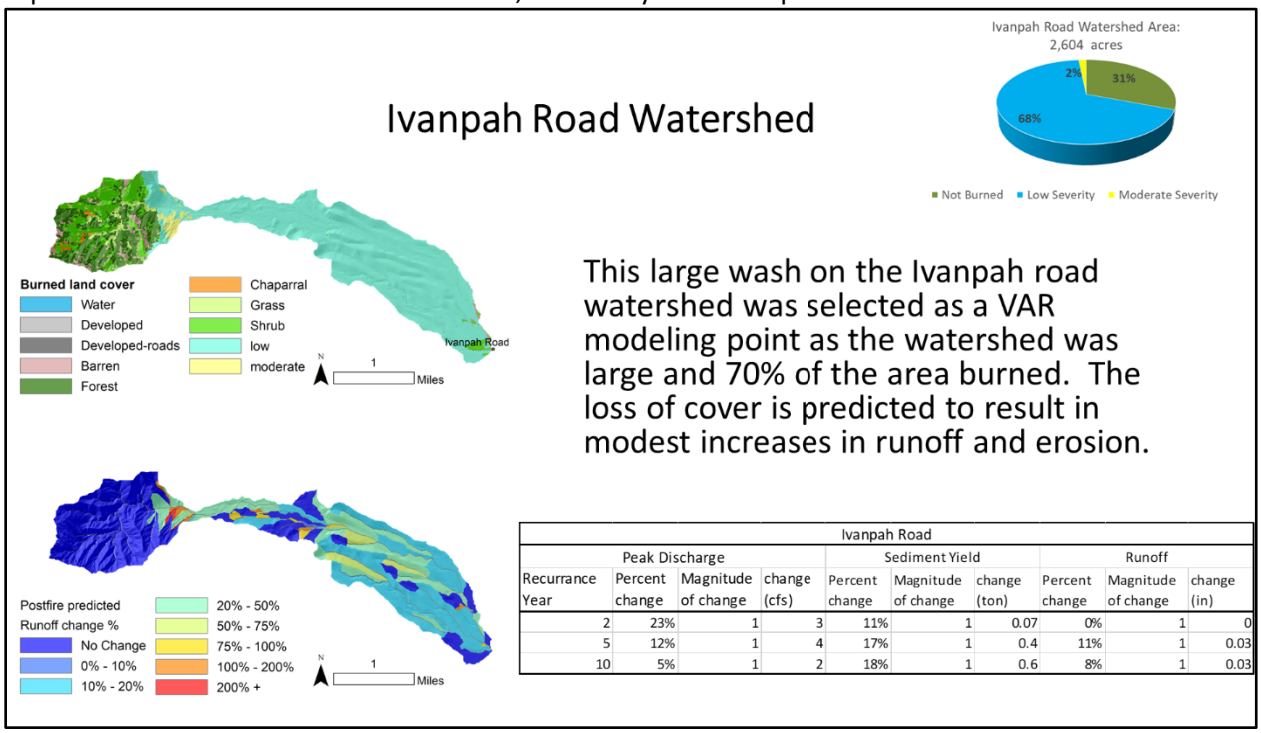
Recurrance Year	Peak Runoff Rate Percent change	Peak Runoff Rate Magnitude of change	Peak Runoff Rate change cfs	Sediment Leaving Percent change	Sediment Leaving Magnitude of change	Sediment Leaving change tons	Runoff Percent change	Runoff Magnitude of change	Runoff change in
2	100%	2	4	93%	2	1	203%	3	0.003
5	57%	2	60	70%	2	17	61%	2	0.077
10	0%	1	0	0%	1	1	0%	1	0.000

The Ivanpah road watershed experienced low severity burn on 87% of the watershed. The road has already experienced a wash out during the rain event that tamped down the fire. The preserve can expect an increase in the need to repair roads due to increased runoff while the watersheds recover.

Figure 5. Ivanpah Road Blowout Watershed modeling results including burned land cover and predicted post-fire hillslope scale runoff change. A large percentage of this watershed burned resulting in increased runoff and erosion.

Ivanpah Road Watershed

This road and wash intersection on Ivanpah road was selected as a potential value at risk as the 2,600-acre watershed contained some of the limited moderate severity burn in the upper portion of the watershed. The lower portion of the watershed is dominated by low severity burn with much of the upper portion of the watershed left untouched by the fire. The terrain near the outlet of the watershed on Ivanpah road has lower slopes and the watershed was predicted to have relatively small increases in expected runoff and erosion for modeled 2, 5 and 10 year return period events.



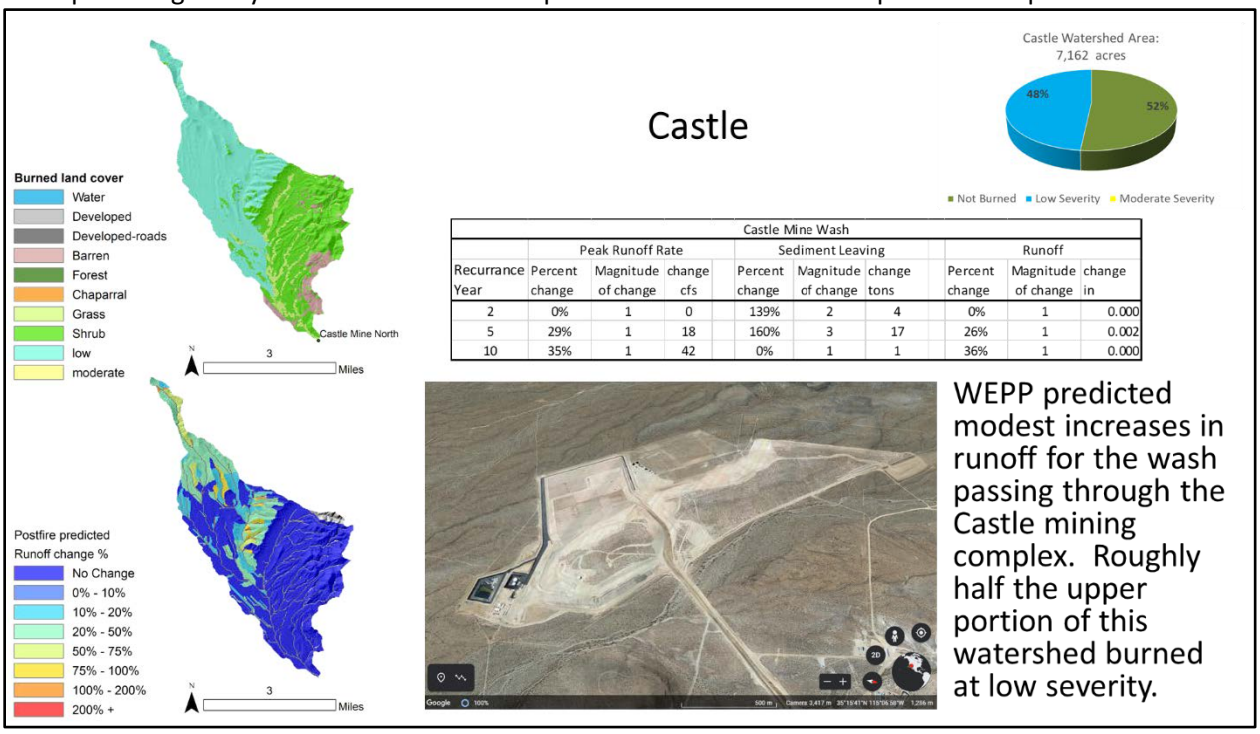
Ivanpah Road									
Peak Discharge				Sediment Yield			Runoff		
Recurrance Year	Percent change	Magnitude of change	change (cfs)	Percent change	Magnitude of change	change (ton)	Percent change	Magnitude of change	change (in)
2	23%	1	3	11%	1	0.07	0%	1	0
5	12%	1	4	17%	1	0.4	11%	1	0.03
10	5%	1	2	18%	1	0.6	8%	1	0.03

Figure 6. Ivanpah Road Watershed modeling results including burned land cover and predicted post-fire hillslope scale runoff change. A small percentage of this watershed burned at moderate severity and 68% at low severity. WEPP predicted modest increases in runoff and erosion.

Castle Mine Wash Watershed

The Castle mine is intersected by a wash fed by the largest modeled watershed at 7,160 acres. This site is of concern due to a large active mine tailing pile that sits next to the wash. The upper half of the watershed burned at low severity and the lower half near the pour point within the mine did not burn. The topography of the watershed was relatively gentle with an average slope of 13% and only 12% of the watershed has slopes greater than 30% (Table 2). WEPP predicted only modest increases in post-fire erosion and runoff for this watershed.

From aerial imagery obtained from Google Earth it does appear that the mine tailings are experiencing riling and erosion. The tailing pile slopes are typically between 10-20%. Mitigation measures that appear to be undertaken include maintaining an approximately 5-6 m flat deposition area at the base of the tailing slopes. Vegetation on the tailing pile's eastern side closest to the wash will also help stabilize the pile. Using a one-meter DEM we created a typical tailing slope profile of 120 m with a slope of 18% that included the 5-meter buffer strip at the bottom of the slope. The soil around the mine was used to represent the tailings pile, the Searchlight Nevada climate station was used to represent climate. For land cover we modeled the slope assuming a shrub land cover and then a lower 30% cover parameter file. The hillslope did not deliver sediment past the buffer zone under the shrub land cover. If the pile was considered to have only 30% cover, then the site was predicted to only generate sediment off the hillslope during a 50 year event. Given these predictions the fire is not expected to impact this site.



Castle Mine Wash									
	Peak Runoff Rate			Sediment Leaving			Runoff		
Recurrance Year	Percent change	Magnitude of change	change cfs	Percent change	Magnitude of change	change tons	Percent change	Magnitude of change	change in
2	0%	1	0	139%	2	4	0%	1	0.000
5	29%	1	18	160%	3	17	26%	1	0.002
10	35%	1	42	0%	1	1	36%	1	0.000

Figure 7. Castle Mine Watersheds modeling results including burned land cover and predicted post-fire hillslope scale runoff change. This watershed was predicted to have minimal increases in peak discharge and sediment yield due to the fire.

Culvert Modeling and Walking Box Ranch

The BAER team identified two culverts to predict peak flows for return interval storms based on contributing watershed size and burn severity (Fig. 8). The two culverts at Walking Box Ranch have a diameter of at least 24 inches. A new ArcMap toolbox developed for the California Geological Survey

was used to delineate and gather spatial information on culvert watersheds (Table 2). The information is useful for running empirical models and for understanding watershed response as it includes watershed size, percentage of watershed burned, burn severity and slope data. WEPP was run for 100 years to predict peak flows for 2, 5, 10, 25, and 50-year return intervals in both burned and not burned conditions. StreamStats was used to calculate return period storms for not burned conditions and the Moody 2012 Nevada/California 2 yr and 10 yr peak flow predictions were used to calculated burned conditions (Moody, 2012). These peak flows were then entered into an orifice flow equation to predict the needed culvert size based on the modeled peak flow rate - q (cfs), gravity - g (32.2 ft sec^{-2}), and an estimate of height - h (ft) which is the distance in feet from the center of the culvert to about a foot below the road service (Eq. 1, Huffman et al., 2011). A high resolution 1-meter Lidar DEM was used to estimate distance between the culvert and road surface. This equation assumes culvert has a slope greater than 5% and the entrance to the culvert limits flow.

$$Needed\ Culvert\ Diameter = \sqrt{\frac{8q}{\pi\sqrt{2gh}}}12 \qquad \text{Eq. 1}$$

The Walking Box Ranch Culvert 3 watershed covers 141 acres of which 95% of the area burned at low severity. WEPP predicts the culvert is adequately sized in both burned and not burned conditions for the 2 – 25-year return period runoff events. StreamStats predictions consider the culvert to be undersized for all but the 2-year storm. Walking Box Ranch Culvert 4 watershed covers 417 acres of which 79% of the area burned at low severity. Once again streamstats and the empirical Moody equations predict the culvert is undersized. Note that the Moody equations for California and Nevada are only considering the total area burned within the watersheds and are not taking into account the low severity of the York fire burnscar. The WEPP runs indicates the culvert is undersized in burned conditions at the 10-year storm and at the 25-year event for not burned. The predictions for burned conditions are for the first-year post-fire. Vegetation recovery will lead to hydrological recovery.

Table 3. Predictions of culvert sizing needed to handle post-fire clear water flows based on estimated culvert heights (h) and actual diameters (in) located to the left of each table. When a culvert is predicted to be undersized the needed diameter is highlighted in red. Burned conditions are on the left in red and not burned are on the right in green. a) Walking Box Ranch Culvert 3 and b) Walking Box Ranch Culvert 4.

a)

		Burned			Not Burned						
Culvert		Moody NV/CA			StreamStats						
D (in)		2 yr	10 yr		2 yr	5 yr	10 yr	25 yr	50 yr	100 yr	
	q	2	7	m^3s	q	0	1	2	5	10	17 m^3s
	q	73	240	cfs	q	4.56	26.6	66.9	178	337	598 cfs
	pi	3.1416	3.14		pi	3.14	3.14	3.14	3.14	3.14	3.14
	g	32.2	32.2	ft/s^2	g	32.2	32.2	32.2	32.2	32.2	32.2 ft/s^2
	h	1.9576	1.96	ft	h	1.96	1.96	1.96	1.96	1.96	1.96 ft
24	D	49	89	in.	D	12	29	47	76	105	140 in.
24	D	4.1	7.4	ft.	D	1.0	2.5	3.9	6.4	8.7	11.6 ft.

	Walking Box Ranch Culvert 3				WEPP		Walking Box Ranch Culvert 3					
	Burned	2 yr	5 yr	10 yr	25 yr	50 yr	No Burn	2 yr	5 yr	10 yr	25 yr	50 yr
	sediment	0.0	0.0	0.0	0.5	20.4 tons	sediment	0.00	0.00	0.00	0.00	12.70 tons
	q	0.31	0.92	1.3	1.6	41 cfs	q	0.31	0.97	1.4	1.6	31 cfs
	pi	3.142	3.142	3.142	3.142	3.142	pi	3.142	3.142	3.142	3.142	3.142
	g	32.2	32.2	32.2	32.2	32.2 ft/s^2	g	32.2	32.2	32.2	32.2	32.2 ft/s^2
D (in)	h	0.958	0.958	0.958	0.958	0.958 ft	h	0.958	0.958	0.958	0.958	0.958 ft
24	D	4	7	8	9	44 in.	D	4	7	8	9	38 in.
24	D	0.3	0.5	0.6	0.7	3.6 ft.	D	0.3	0.6	0.7	0.7	3.2 ft.

b)

	Burned		Not Burned					
Culvert	Moody NV/CA		StreamStats					
D (in)	2 yr	10 yr	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
q	5	17 m^3s	0	1	3	9	17	29 m^3s
q	180	593 cfs	7.95	46.3	117	311	587	1040 cfs
pi	3.1416	3.14	3.14	3.14	3.14	3.14	3.14	3.14
g	32.2	32.2 ft/s^2	32.2	32.2	32.2	32.2	32.2	32.2 ft/s^2
h	1	1 ft	1	1	1	1	1	1 ft
30 D	91	165 in.	19	46	73	119	164	218 in.
30 D	7.5	13.7 ft.	1.6	3.8	6.1	9.9	13.6	18.2 ft.

	Walking Box Ranch Culvert 4 Burned	2 yr	5 yr	10 yr	25 yr	50 yr	WEPP Walking Box Ranch Culvert 4 No Burn	2 yr	5 yr	10 yr	25 yr	50 yr
	sediment	0	18	50	117	166 tons	sediment	0.0	0.0	1.5	22.5	24.9 tons
	q	1.6	4.4	73	240	750 cfs	q	1.4	3.7	6.3	160	620 cfs
	pi	3.142	3.142	3.142	3.142	3.142	pi	3.142	3.142	3.142	3.142	3.142
	g	32.2	32.2	32.2	32.2	32.2 ft/s^2	g	32.2	32.2	32.2	32.2	32.2 ft/s^2
D (in)	h	1	1	1	1	1 ft	h	1	1	1	1	1 ft
30	D	9	14	58	105	185 in.	D	8	13	17	86	168 in.
30	D	0.7	1.2	4.8	8.7	15.4 ft.	D	0.7	1.1	1.4	7.1	14.0 ft.

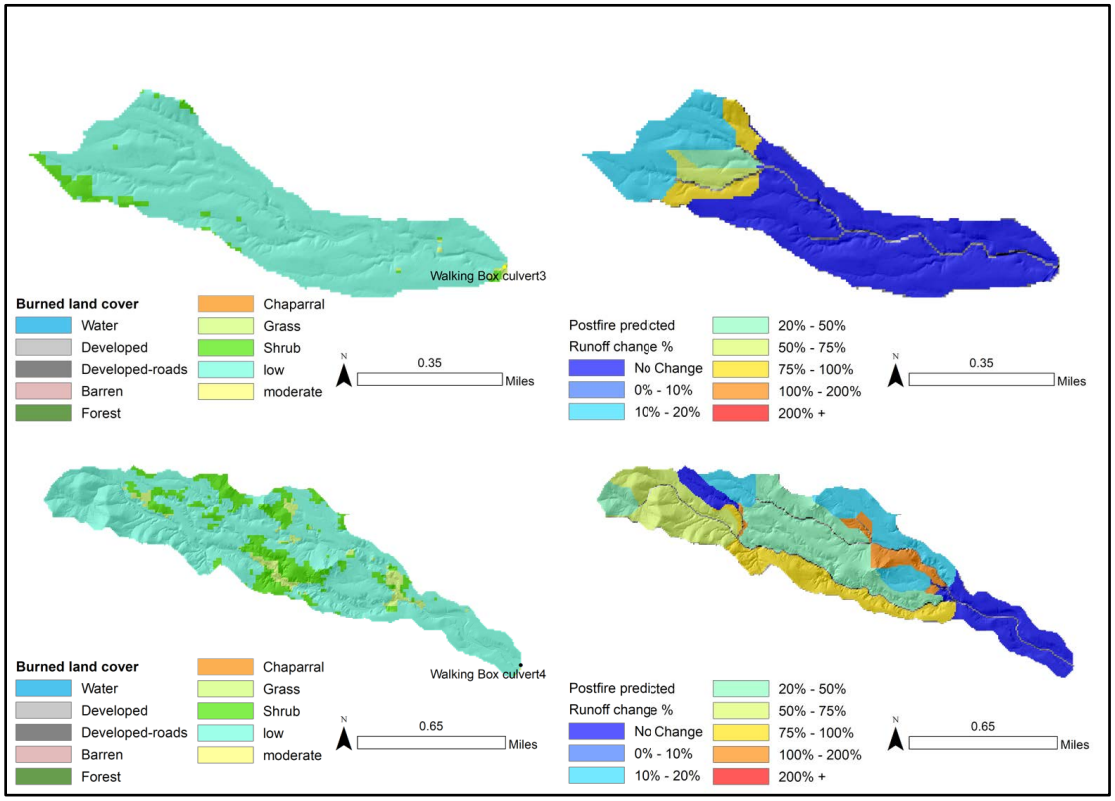


Figure 8 Walking Box Ranch Culvert Watersheds burned land cover and predicted post-fire hillslope scale runoff change.

Culvert Modeling for Hart Road

The largest Hart culvert was modeled using WEPP, Moody's 2012 equations and streamstats. WEPP predicted the culvert 2 was adequately sized for storms until the 50-year return interval for both burned and not burned conditions. Streamstats predicts the culvert may be undersized for storms with peak discharge at or greater than the 10-year storm and the empirical Moody equations predict the watershed is undersized. The Moody equations for California and Nevada are only considering the total area burned within the watersheds and does not account for the low severity of the burn.

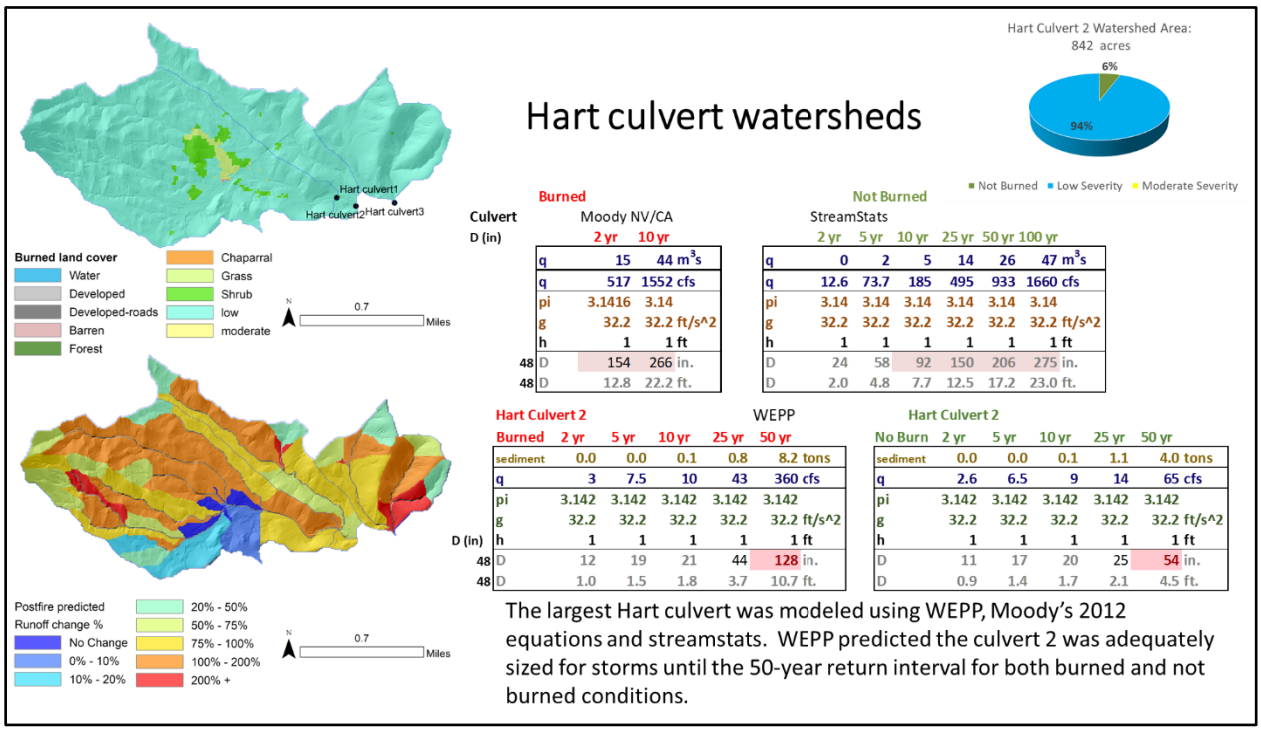


Figure 8 Hart culvert modeling results including burned land cover and predicted post-fire hillslope scale runoff change. Peak flows for the largest culvert watershed were modeled to estimate culvert sizing for the watershed.

References:

Dewitz, J., (2021) National Land Cover Database (NLCD) 2019 Products [Dataset]. US Geological Survey: Sioux Falls, SD, USA.

Dobre, M., Srivastava, A., Lew, R., Deval, C., Brooks, E.S., Elliot, W.J. and Robichaud, P.R., 2022. WEPPcloud: an online watershed-scale hydrologic modeling tool. Part II. Model performance assessment and applications to forest management and wildfires. Journal of Hydrology, 610, p.127776.

Elliot, W.J. (2004) WEPP internet interfaces for forest erosion prediction. Journal of the American Water Resources Association 40, 299–309.

Elliot, W. J. (2013) Erosion processes and prediction with WEPP technology in forests in the Northwestern U.S. Transactions of the ASABE, 56(2): 563-579.

Flanagan D.C., Nearing M.A. (1995) 'USDA – Water Erosion Prediction Project: hillslope profile and watershed model documentation.' USDA-ARS National Soil Erosion Research Laboratory, NSERL Report No. 10. (West Lafayette, Indiana).

Garbrecht J., Martz L.W. (1999) 'TOPAZ: an automated digital landscape analysis tool for topographic evaluation, drainage identification, watershed segmentation and subcatchment parameterization.' USDA Agricultural Research Service Publication No.GRL 99-1. (El Reno, Oklahoma).

Huffman, R.L., Fangmeier, D.D., Elliot, W.J., Workman, S.R. and Schwab, G.O., 2011. Soil and water conservation engineering. St. Joseph: American Society of Agricultural and Biological Engineers.

LANDFIRE: LANDFIRE 1.1.0 (2011) Existing Vegetation Type and Biophysical Settings layers. Available online at http://landfire.cr.usgs.gov/viewer/; last accessed Apr. 1st, 2015.

Larsen I.J., MacDonald L.H. (2007) Predicting postfire sediment yields at the hillslope scale: Testing RUSLE and Disturbed WEPP. Water Resources Research 43, W11412, doi:10.1029/2006WR005560.

Lew, R., Dobre, M., Srivastava, A., Brooks, E.S., Elliot, W.J., Robichaud, P.R. and Flanagan, D.C., (2022) WEPPcloud: an online watershed-scale hydrologic modeling tool. Part I. Model description. Journal of Hydrology, 608, p.127603.

Miller, D.A. and R.A. White. (1998) A Conterminous United States Multi-Layer Soil Characteristics Data Set for Regional Climate and Hydrology Modeling. Earth Interactions, 2(2), 1-26.

Miller M. E., Elliot W. J., Billmire M., Robichaud P. R., Endsley K. A. (2016a) Rapid-response tools and datasets for post-fire remediation: linking remote sensing and process-based hydrological models. International Journal of Wildland Fire 25, 1061-1073. http://dx.doi.org/10.1071/WF15162

Miller, M. E., Billmire, M., Elliot, W. J. and Robichaud, P. R. (2016b) Rapid Response Tools and Datasets: Linking Remote Sensing and Process-based Hydrological Models to support Post-fire Remediation and Fuels Planning. High Park Fire Science Workshop Fort Collins, CO, November 15, 2016.

Moody, J. A. (2012). An analytical method for predicting postwildfire peak discharges (p. 36). US Department of the Interior, US Geological Survey.

Nicks A.D., Lane L.J., Gander G.A. (1995) Weather generator.In 'USDA-Water Erosion Prediction Project Hillslope Profile and Watershed Model Documentation.'(Eds DC Flanagan and MA Nearing) pp. 2.1-2.22. (USDA Agricultural Research Service: West Lafayette, Indiana).

Renschler, C.S. (2003) Designing geo-spatial interfaces to scale process models: the GeoWEPP approach. Hydrological Processes 17, 1005-1017.

Rollins, M.G. (2009) LANDFIRE: a nationally consistent vegetation, wildland fire, and fuel assessment. International Journal of Wildland Fire, 18(3), 235-249.

Soil Survey Staff. (2014) Soil Survey Geographic (SSURGO) Database. Available online at http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx; last accessed Apr. 1st, 2015.

USDA. (1991) 'State soil geographic (STATSGO) data base data use information.' U.S. Department of Agriculture Miscellaneous Publication 1492. (Washington, D.C.).

BURNED AREA EMERGENCY RESPONSE PLAN
2023 YORK FIRE

APPENDIX D
PHOTOS



Measuring culvert on Box Ranch Road



Damaged desert tortoise fence barrier



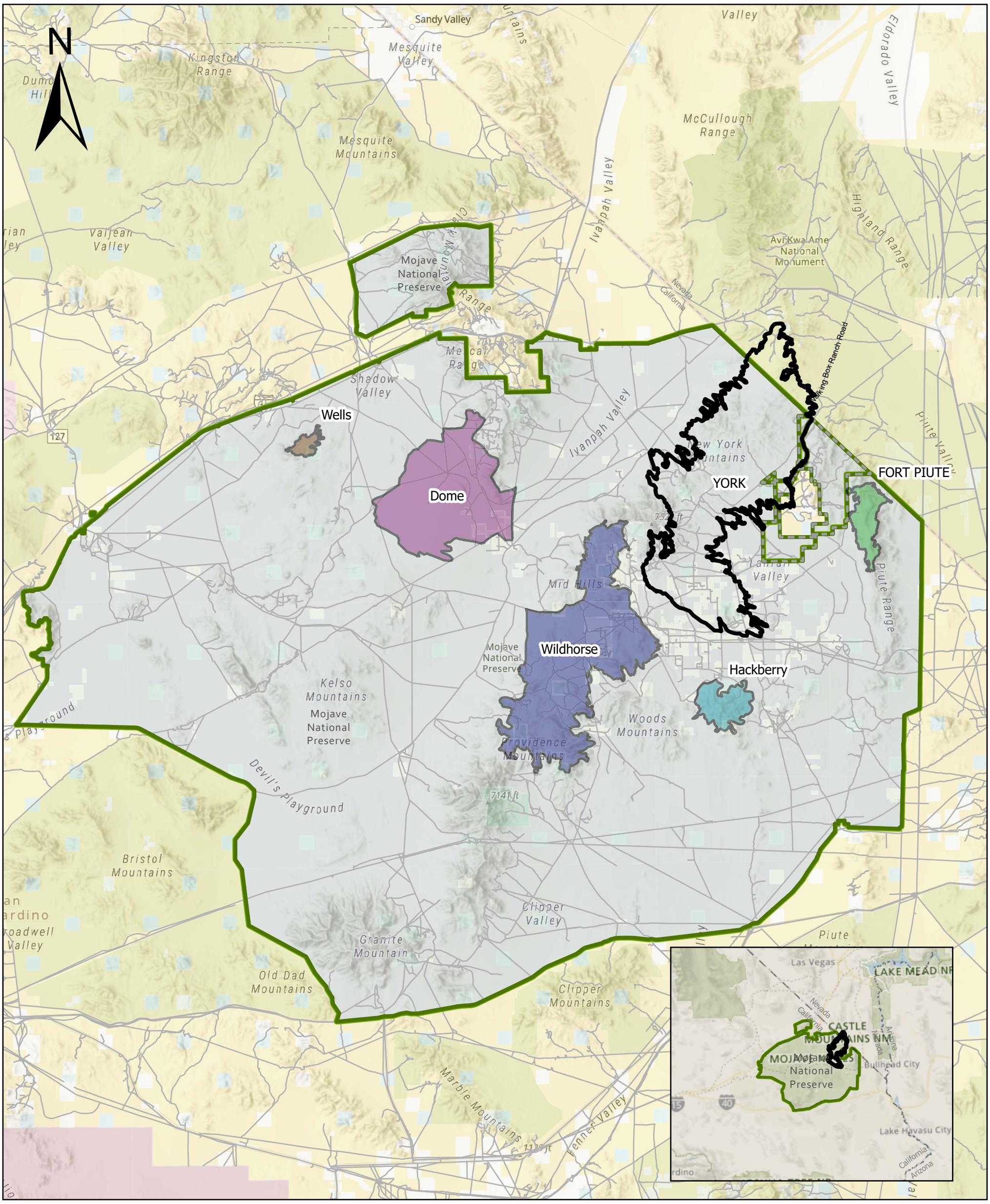
Nursery plants inside the fire perimeter



Mine adjacent to the plant nursery



Light damage to range fence near fire perimeter



York Fire BAER
Fire History Map of the Mojave National Preserve and Surrounding BLM

- York Fire Perimeter 2023 92,540 Acres
- Roads
- Castle Mountains National Monument Boundary
- Mojave National Preserve Boundary

Previous Fire Perimeters > 1,000 acres

- Dome 2020 44,249 Acres
- Fort Piute 1994 6,350 Acres
- Hackberry 2005 7,158 Acres
- Wells 2011 1,708 Acres
- Wildhorse 2005 63,771 Acres

0 5 10 20

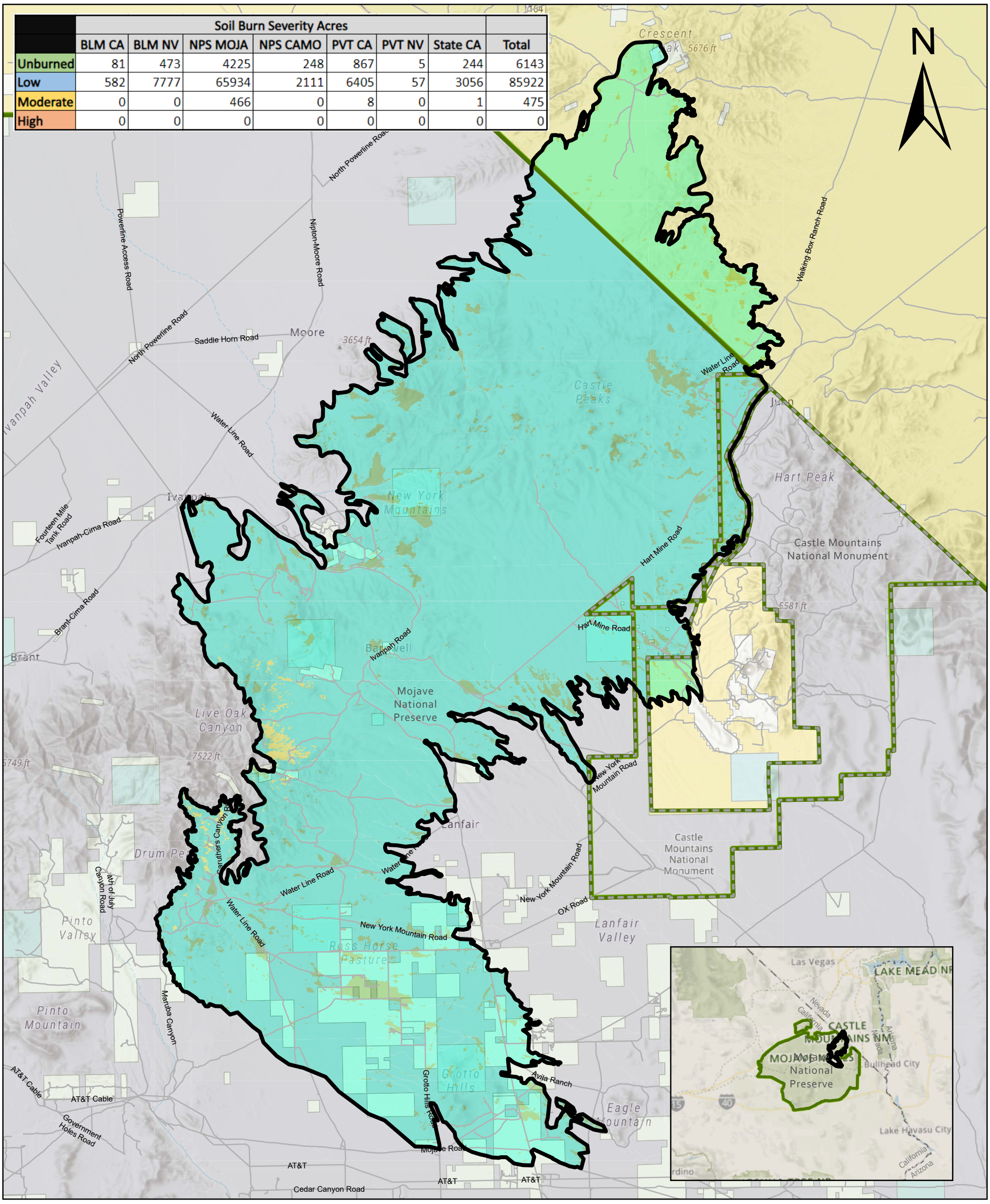
Miles

Scale: 1:450,000

Fire perimeters with less than 1,000 acres are omitted from this map.

This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

	Soil Burn Severity Acres							
	BLM CA	BLM NV	NPS MOJA	NPS CAMO	PVT CA	PVT NV	State CA	Total
Unburned	81	473	4225	248	867	5	244	6143
Low	582	7777	65934	2111	6405	57	3056	85922
Moderate	0	0	466	0	8	0	1	475
High	0	0	0	0	0	0	0	0



Soil Burn Severity
- Unburned
- Low Soil Burn Severity
- Moderate Soil Burn Severity

Ownership with Acres in the Perimeter
- BLM
- NPS
- State of California
- Private
- York Fire Perimeter 92,540 Acres
- Roads
- Castle Mountains National Monument Boundary
- Mojave National Preserve Boundary

York Fire BAER Soil Burn Severity Map

0 1.25 2.5 5

Miles

Scale: 1:125,000

The York Soil Burn Severity was created by validating soil conditions within the York Fire Perimeter. Ground conditions informed adjustments made to the Burned Area Reflectance Classification (BARC) product.

This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

York Fire BAER
Needles Field Office

Weeds and Signage Treatments

- ES-1 BAR-1 Non-Native Invasive Plant Control (Ground-based)
- ES-2 Suggested Location for Burned Area Sign
- Roads
- Wilderness
- York Fire Perimeter 92,540 Acres
- Castle Mountains National Monument Boundary
- Mojave National Preserve Boundary

Ownership with Acres in the Perimeter

- BLM
- NPS
- State of California
- Private

0 0.75 1.5 3

Miles

Scale: 1:75,000

Field observations were conducted by the BAER team between 8/8/2023 and 8/16/2023.

This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

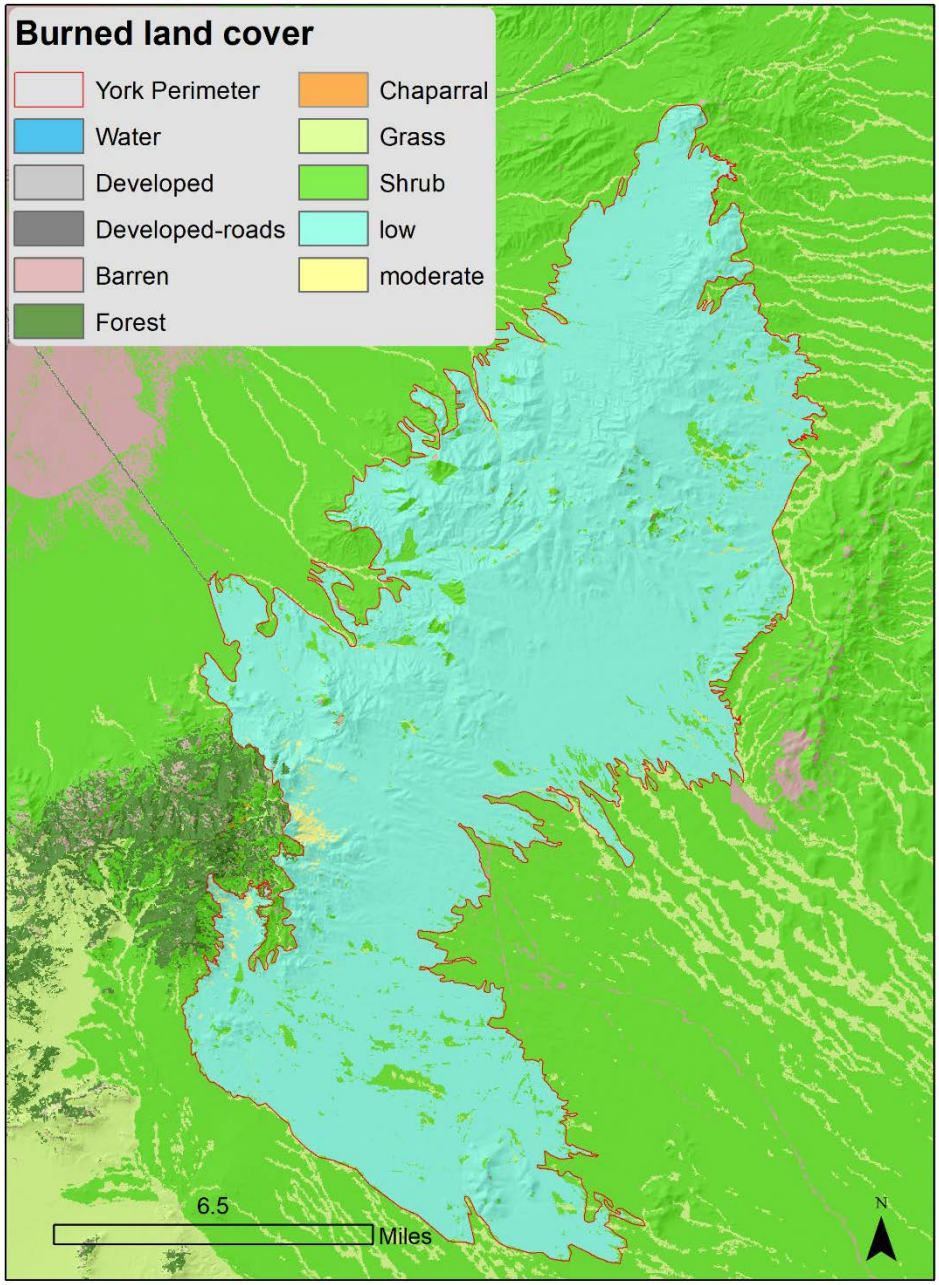


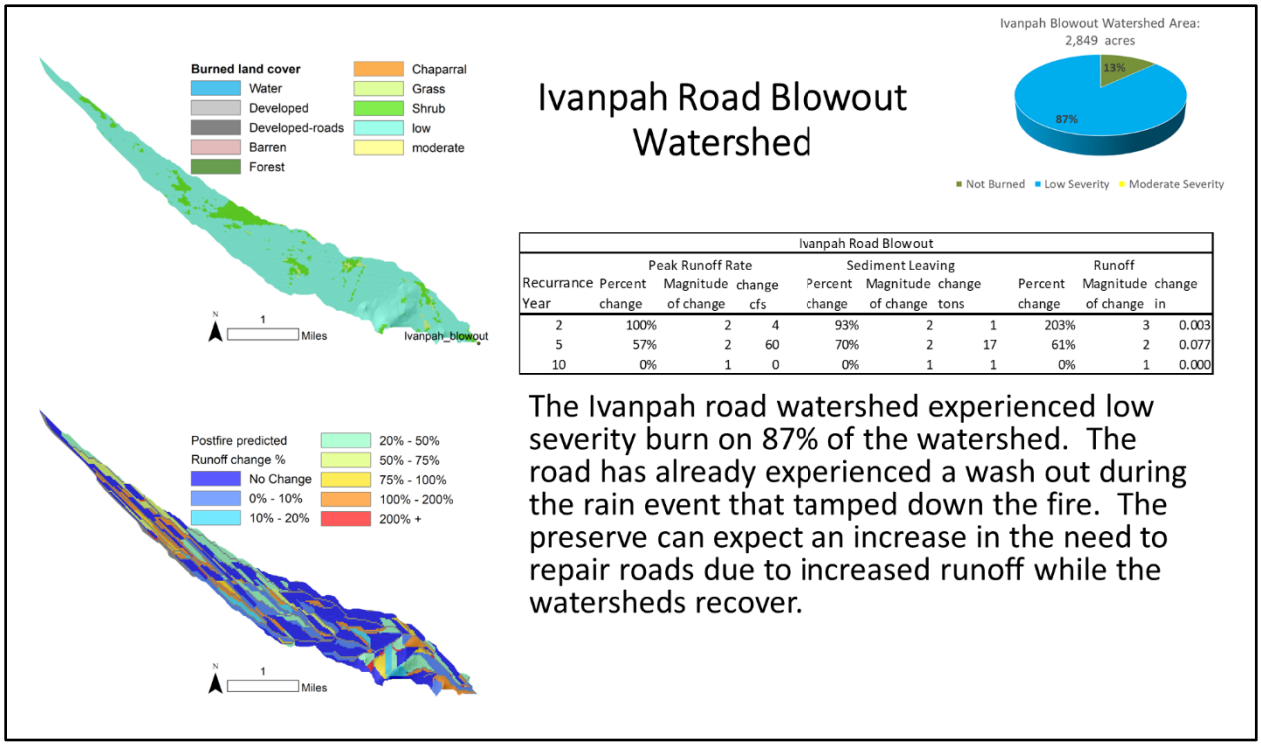
Figure 1. Burned land cover layer generated by RRED for the York fire.

Modeling

WEPP was run in watershed mode using the Rock:Clime modified climates created for the York fire (Table 1). VAR watersheds identified by the BAER team and local resources were modeled for both the burned and not burned conditions. Hillslopes that are modeled using the watershed option are set to the predominant soil and land cover type. This assumption results in hillslopes with mixed cover types being assigned to one soil and cover type. Model uncertainty is high; therefore care needs to be used in interpreting the results. Much of the predicted erosion from the larger watersheds is due to channel erosion and we suspect that additional work is need in calibrating the channel parameters.

Ivanpah Road Blowout Watershed

The wash above a blowout on the Ivanpah road was identified as a watershed of interest as the storm that helped contain the York fire resulted in the Ivanpah road washing out. This storm was between a 2- and 5-year return interval event. This is the second largest watershed modeled at 2,849 acres with 87% of the watershed burned at low severity. The 2- and 5-year return period storms were predicted to have greater percent increases in runoff and erosion. Interestingly the 10-year storm was not predicted to have greater amounts of runoff and erosion. This location did not have a culvert and after the storm passed needed to be repaired. Wash and road intersections with burned watersheds can be expected to require repairs due to increased runoff and erosion from the loss of ground cover in the burned areas.



Ivanpah Road Blowout

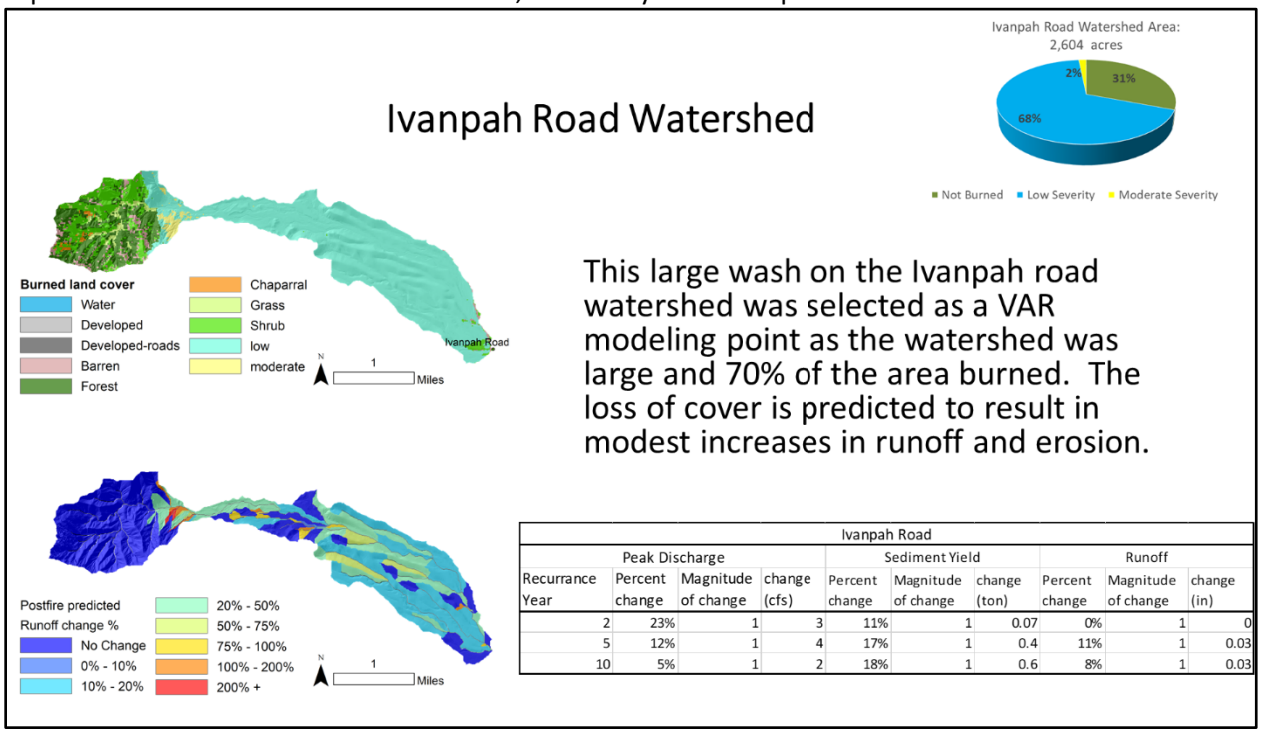
Recurrance Year	Peak Runoff Rate Percent change	Peak Runoff Rate Magnitude of change	Peak Runoff Rate change cfs	Sediment Leaving Percent change	Sediment Leaving Magnitude of change	Sediment Leaving change tons	Runoff Percent change	Runoff Magnitude of change	Runoff change in
2	100%	2	4	93%	2	1	203%	3	0.003
5	57%	2	60	70%	2	17	61%	2	0.077
10	0%	1	0	0%	1	1	0%	1	0.000

The Ivanpah road watershed experienced low severity burn on 87% of the watershed. The road has already experienced a wash out during the rain event that tamped down the fire. The preserve can expect an increase in the need to repair roads due to increased runoff while the watersheds recover.

Figure 5. Ivanpah Road Blowout Watershed modeling results including burned land cover and predicted post-fire hillslope scale runoff change. A large percentage of this watershed burned resulting in increased runoff and erosion.

Ivanpah Road Watershed

This road and wash intersection on Ivanpah road was selected as a potential value at risk as the 2,600-acre watershed contained some of the limited moderate severity burn in the upper portion of the watershed. The lower portion of the watershed is dominated by low severity burn with much of the upper portion of the watershed left untouched by the fire. The terrain near the outlet of the watershed on Ivanpah road has lower slopes and the watershed was predicted to have relatively small increases in expected runoff and erosion for modeled 2, 5 and 10 year return period events.



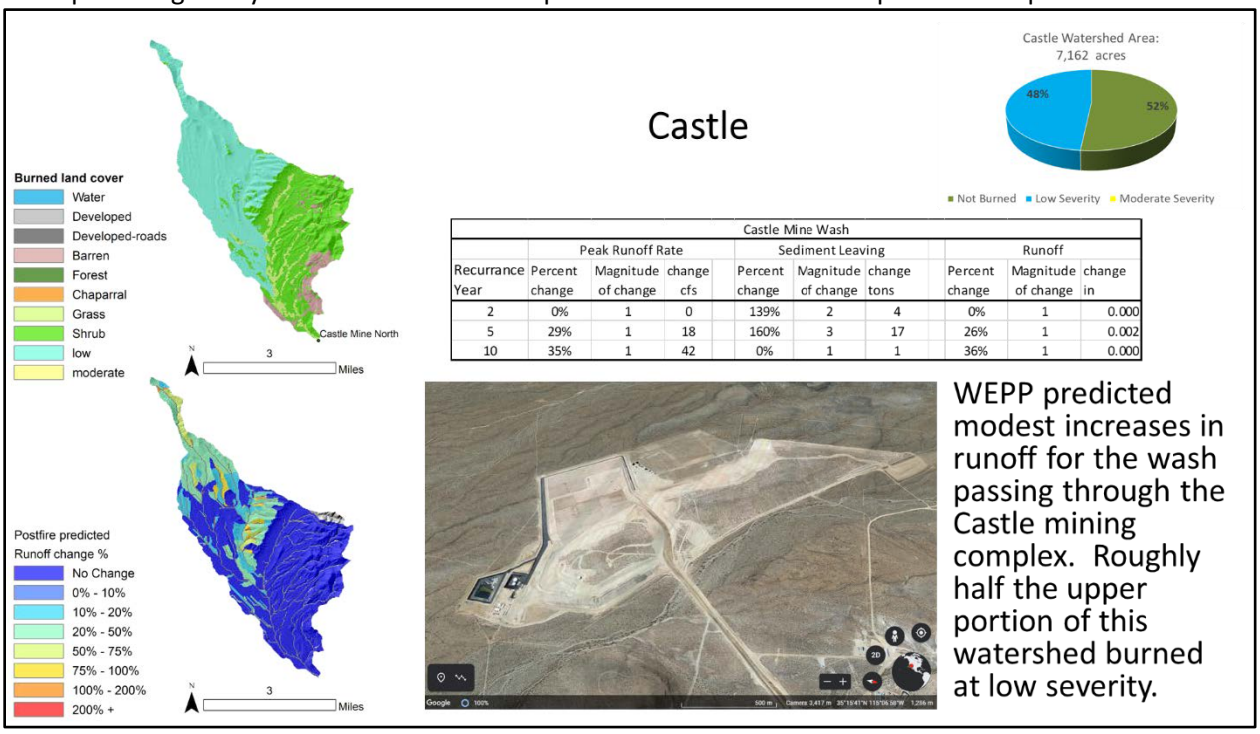
Ivanpah Road									
Peak Discharge				Sediment Yield			Runoff		
Recurrance Year	Percent change	Magnitude of change	change (cfs)	Percent change	Magnitude of change	change (ton)	Percent change	Magnitude of change	change (in)
2	23%	1	3	11%	1	0.07	0%	1	0
5	12%	1	4	17%	1	0.4	11%	1	0.03
10	5%	1	2	18%	1	0.6	8%	1	0.03

Figure 6. Ivanpah Road Watershed modeling results including burned land cover and predicted post-fire hillslope scale runoff change. A small percentage of this watershed burned at moderate severity and 68% at low severity. WEPP predicted modest increases in runoff and erosion.

Castle Mine Wash Watershed

The Castle mine is intersected by a wash fed by the largest modeled watershed at 7,160 acres. This site is of concern due to a large active mine tailing pile that sits next to the wash. The upper half of the watershed burned at low severity and the lower half near the pour point within the mine did not burn. The topography of the watershed was relatively gentle with an average slope of 13% and only 12% of the watershed has slopes greater than 30% (Table 2). WEPP predicted only modest increases in post-fire erosion and runoff for this watershed.

From aerial imagery obtained from Google Earth it does appear that the mine tailings are experiencing riling and erosion. The tailing pile slopes are typically between 10-20%. Mitigation measures that appear to be undertaken include maintaining an approximately 5-6 m flat deposition area at the base of the tailing slopes. Vegetation on the tailing pile's eastern side closest to the wash will also help stabilize the pile. Using a one-meter DEM we created a typical tailing slope profile of 120 m with a slope of 18% that included the 5-meter buffer strip at the bottom of the slope. The soil around the mine was used to represent the tailings pile, the Searchlight Nevada climate station was used to represent climate. For land cover we modeled the slope assuming a shrub land cover and then a lower 30% cover parameter file. The hillslope did not deliver sediment past the buffer zone under the shrub land cover. If the pile was considered to have only 30% cover, then the site was predicted to only generate sediment off the hillslope during a 50 year event. Given these predictions the fire is not expected to impact this site.



Castle Mine Wash									
	Peak Runoff Rate			Sediment Leaving			Runoff		
Recurrance Year	Percent change	Magnitude of change	change cfs	Percent change	Magnitude of change	change tons	Percent change	Magnitude of change	change in
2	0%	1	0	139%	2	4	0%	1	0.000
5	29%	1	18	160%	3	17	26%	1	0.002
10	35%	1	42	0%	1	1	36%	1	0.000

Figure 7. Castle Mine Watersheds modeling results including burned land cover and predicted post-fire hillslope scale runoff change. This watershed was predicted to have minimal increases in peak discharge and sediment yield due to the fire.

Culvert Modeling and Walking Box Ranch

The BAER team identified two culverts to predict peak flows for return interval storms based on contributing watershed size and burn severity (Fig. 8). The two culverts at Walking Box Ranch have a diameter of at least 24 inches. A new ArcMap toolbox developed for the California Geological Survey

was used to delineate and gather spatial information on culvert watersheds (Table 2). The information is useful for running empirical models and for understanding watershed response as it includes watershed size, percentage of watershed burned, burn severity and slope data. WEPP was run for 100 years to predict peak flows for 2, 5, 10, 25, and 50-year return intervals in both burned and not burned conditions. StreamStats was used to calculate return period storms for not burned conditions and the Moody 2012 Nevada/California 2 yr and 10 yr peak flow predictions were used to calculated burned conditions (Moody, 2012). These peak flows were then entered into an orifice flow equation to predict the needed culvert size based on the modeled peak flow rate - q (cfs), gravity - g (32.2 ft sec^{-2}), and an estimate of height - h (ft) which is the distance in feet from the center of the culvert to about a foot below the road service (Eq. 1, Huffman et al., 2011). A high resolution 1-meter Lidar DEM was used to estimate distance between the culvert and road surface. This equation assumes culvert has a slope greater than 5% and the entrance to the culvert limits flow.

$$Needed\ Culvert\ Diameter = \sqrt{\frac{8q}{\pi\sqrt{2gh}}}12 \qquad \text{Eq. 1}$$

The Walking Box Ranch Culvert 3 watershed covers 141 acres of which 95% of the area burned at low severity. WEPP predicts the culvert is adequately sized in both burned and not burned conditions for the 2 – 25-year return period runoff events. StreamStats predictions consider the culvert to be undersized for all but the 2-year storm. Walking Box Ranch Culvert 4 watershed covers 417 acres of which 79% of the area burned at low severity. Once again streamstats and the empirical Moody equations predict the culvert is undersized. Note that the Moody equations for California and Nevada are only considering the total area burned within the watersheds and are not taking into account the low severity of the York fire burnscar. The WEPP runs indicates the culvert is undersized in burned conditions at the 10-year storm and at the 25-year event for not burned. The predictions for burned conditions are for the first-year post-fire. Vegetation recovery will lead to hydrological recovery.

Table 3. Predictions of culvert sizing needed to handle post-fire clear water flows based on estimated culvert heights (h) and actual diameters (in) located to the left of each table. When a culvert is predicted to be undersized the needed diameter is highlighted in red. Burned conditions are on the left in red and not burned are on the right in green. a) Walking Box Ranch Culvert 3 and b) Walking Box Ranch Culvert 4.

a)

		Burned			Not Burned						
Culvert		Moody NV/CA			StreamStats						
D (in)		2 yr	10 yr		2 yr	5 yr	10 yr	25 yr	50 yr	100 yr	
	q	2	7	m^3s	q	0	1	2	5	10	17 m^3s
	q	73	240	cfs	q	4.56	26.6	66.9	178	337	598 cfs
	pi	3.1416	3.14		pi	3.14	3.14	3.14	3.14	3.14	3.14
	g	32.2	32.2	ft/s^2	g	32.2	32.2	32.2	32.2	32.2	32.2 ft/s^2
	h	1.9576	1.96	ft	h	1.96	1.96	1.96	1.96	1.96	1.96 ft
24	D	49	89	in.	D	12	29	47	76	105	140 in.
24	D	4.1	7.4	ft.	D	1.0	2.5	3.9	6.4	8.7	11.6 ft.

	Walking Box Ranch Culvert 3				WEPP		Walking Box Ranch Culvert 3					
	Burned	2 yr	5 yr	10 yr	25 yr	50 yr	No Burn	2 yr	5 yr	10 yr	25 yr	50 yr
	sediment	0.0	0.0	0.0	0.5	20.4 tons	sediment	0.00	0.00	0.00	0.00	12.70 tons
	q	0.31	0.92	1.3	1.6	41 cfs	q	0.31	0.97	1.4	1.6	31 cfs
	pi	3.142	3.142	3.142	3.142	3.142	pi	3.142	3.142	3.142	3.142	3.142
	g	32.2	32.2	32.2	32.2	32.2 ft/s^2	g	32.2	32.2	32.2	32.2	32.2 ft/s^2
D (in)	h	0.958	0.958	0.958	0.958	0.958 ft	h	0.958	0.958	0.958	0.958	0.958 ft
24	D	4	7	8	9	44 in.	D	4	7	8	9	38 in.
24	D	0.3	0.5	0.6	0.7	3.6 ft.	D	0.3	0.6	0.7	0.7	3.2 ft.

b)

	Burned		Not Burned					
Culvert	Moody NV/CA		StreamStats					
D (in)	2 yr	10 yr	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
q	5	17 m^3s	0	1	3	9	17	29 m^3s
q	180	593 cfs	7.95	46.3	117	311	587	1040 cfs
pi	3.1416	3.14	3.14	3.14	3.14	3.14	3.14	3.14
g	32.2	32.2 ft/s^2	32.2	32.2	32.2	32.2	32.2	32.2 ft/s^2
h	1	1 ft	1	1	1	1	1	1 ft
30 D	91	165 in.	19	46	73	119	164	218 in.
30 D	7.5	13.7 ft.	1.6	3.8	6.1	9.9	13.6	18.2 ft.

	Walking Box Ranch Culvert 4 Burned	2 yr	5 yr	10 yr	25 yr	50 yr	WEPP Walking Box Ranch Culvert 4 No Burn	2 yr	5 yr	10 yr	25 yr	50 yr
	sediment	0	18	50	117	166 tons	sediment	0.0	0.0	1.5	22.5	24.9 tons
	q	1.6	4.4	73	240	750 cfs	q	1.4	3.7	6.3	160	620 cfs
	pi	3.142	3.142	3.142	3.142	3.142	pi	3.142	3.142	3.142	3.142	3.142
	g	32.2	32.2	32.2	32.2	32.2 ft/s^2	g	32.2	32.2	32.2	32.2	32.2 ft/s^2
D (in)	h	1	1	1	1	1 ft	h	1	1	1	1	1 ft
30	D	9	14	58	105	185 in.	D	8	13	17	86	168 in.
30	D	0.7	1.2	4.8	8.7	15.4 ft.	D	0.7	1.1	1.4	7.1	14.0 ft.

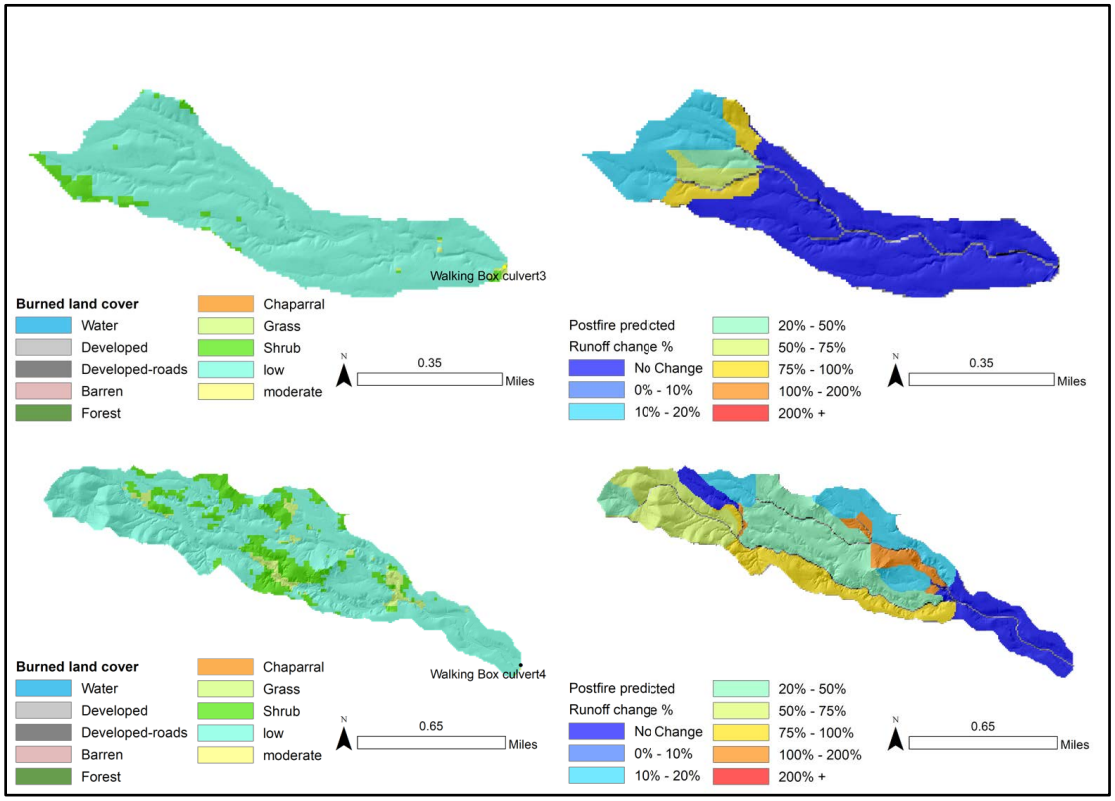


Figure 8 Walking Box Ranch Culvert Watersheds burned land cover and predicted post-fire hillslope scale runoff change.

Culvert Modeling for Hart Road

The largest Hart culvert was modeled using WEPP, Moody's 2012 equations and streamstats. WEPP predicted the culvert 2 was adequately sized for storms until the 50-year return interval for both burned and not burned conditions. Streamstats predicts the culvert may be undersized for storms with peak discharge at or greater than the 10-year storm and the empirical Moody equations predict the watershed is undersized. The Moody equations for California and Nevada are only considering the total area burned within the watersheds and does not account for the low severity of the burn.

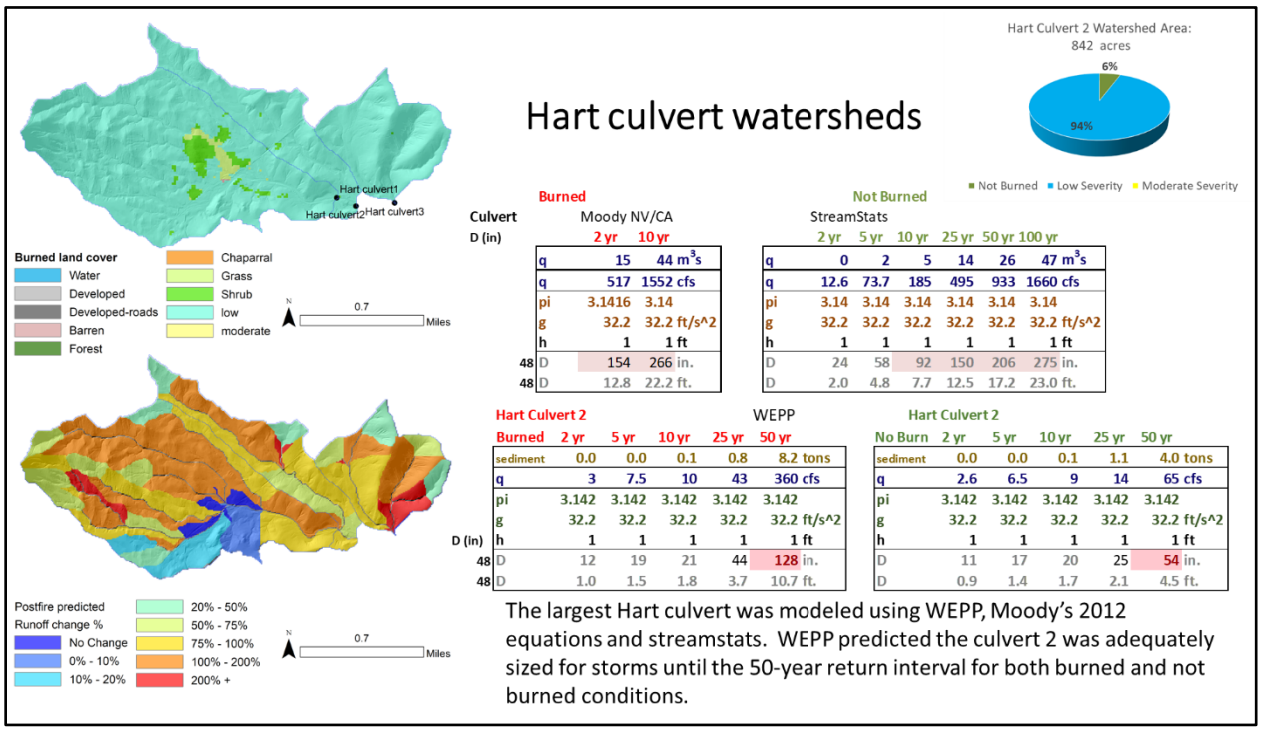


Figure 8 Hart culvert modeling results including burned land cover and predicted post-fire hillslope scale runoff change. Peak flows for the largest culvert watershed were modeled to estimate culvert sizing for the watershed.

References:

Dewitz, J., (2021) National Land Cover Database (NLCD) 2019 Products [Dataset]. US Geological Survey: Sioux Falls, SD, USA.

Dobre, M., Srivastava, A., Lew, R., Deval, C., Brooks, E.S., Elliot, W.J. and Robichaud, P.R., 2022. WEPPcloud: an online watershed-scale hydrologic modeling tool. Part II. Model performance assessment and applications to forest management and wildfires. Journal of Hydrology, 610, p.127776.

Elliot, W.J. (2004) WEPP internet interfaces for forest erosion prediction. Journal of the American Water Resources Association 40, 299–309.

Elliot, W. J. (2013) Erosion processes and prediction with WEPP technology in forests in the Northwestern U.S. Transactions of the ASABE, 56(2): 563-579.

Flanagan D.C., Nearing M.A. (1995) 'USDA – Water Erosion Prediction Project: hillslope profile and watershed model documentation.' USDA-ARS National Soil Erosion Research Laboratory, NSERL Report No. 10. (West Lafayette, Indiana).

Garbrecht J., Martz L.W. (1999) 'TOPAZ: an automated digital landscape analysis tool for topographic evaluation, drainage identification, watershed segmentation and subcatchment parameterization.' USDA Agricultural Research Service Publication No.GRL 99-1. (El Reno, Oklahoma).

EIR APPENDIX 12

Mitigation Monitoring and Reporting Program

CASTLE MOUNTAIN MINE PHASE II EXPANSION PROJECT ENVIRONMENTAL IMPACT REPORT MITIGATION MONITORING AND REPORTING PROGRAM

1. INTRODUCTION

San Bernardino County (County) has prepared the following Mitigation Monitoring and Reporting Program (MMRP) for the Environmental Impact Report (EIR) (State Clearinghouse No. 2025100846) for the Castle Mountain Mine Phase II Expansion (Project). The EIR analyzes the significant and potentially significant environmental impacts that may occur as a result of the Project. The Draft EIR is being published on April 17, 2026. In compliance with the California Environmental Quality Act (CEQA), a Notice of Completion and the Draft EIR were filed with the State Clearinghouse at the time of publishing and are posted on the State Clearinghouse CEQAnet Web Portal.

2. STATUTORY REQUIREMENTS

When making findings on significant environmental effects identified in an EIR, the Lead Agency must adopt a "reporting or monitoring program for the changes to the project which it has adopted or made a condition of approval in order to mitigate or avoid significant effects on the environment" (Public Resources Code [PRC] Section 21081.6(a) and State CEQA Guidelines Sections 15091(d) and 15097). The MMRP is designed to ensure that mitigation measures and revisions to the Project identified in the EIR are implemented. Therefore, the MMRP must include all changes in the proposed Project either adopted by the Project Applicant or made conditions of approval by the Lead or Responsible Agency.

3. ADMINISTRATION OF THE MITIGATION MONITORING AND REPORTING PROGRAM

The State CEQA Guidelines identify the Lead Agency as the public agency with the principal responsibility for carrying out or approving a project (State CEQA Guidelines Section 15367). The County is the Local Lead Agency, and the U.S. Bureau of Land Management (BLM) is the Responsible Agency for the preparation of this EIR. Separately, the BLM is acting as the Federal Lead Agency pursuant to the National Environmental Policy Act (NEPA) and preparing an Environmental Impact Statement (EIS), while the County is acting as the Local Lead Agency pursuant to CEQA in the preparation of the EIR.

The County and the BLM have determined that the proposed Project constitutes a discretionary project subject to CEQA, as defined in PRC Section 21065 and State CEQA Guidelines Section 15378. The EIR has been prepared to evaluate the potential environmental effects associated with the implementation of the proposed Project and to inform discretionary approval decisions by the Lead and Responsible Agencies.

4. MITIGATION MEASURES

Table MMRP-1 is structured to enable quick reference to mitigation measures and the associated monitoring program based on the environmental resource. The numbering of mitigation measures correlates with the numbering of measures found in Chapter 4, *Environmental Impact Analysis*, of the EIR. Table MMRP-1 also describes the timing for mitigation measure implementation (e.g., when the measure shall be implemented) and the responsible parties—such as the County, the BLM, and/or the Project Applicant—that ensure implementation of all aspects of each measure.

This page intentionally left blank.

Table MMRP-1. Mitigation Monitoring and Reporting Program Identified in the EIR

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
Air Quality					
MM-AQ-1	**Dust Control Measures**. The Project shall implement the following dust control measures outlined in the 1997 Castle Mountain Mine Expansion Project Environmental Impact Statement/Environmental Impact Report (EIS/EIR): a. Haul roads within the site boundary shall be surfaced with durable gravel and shall be well maintained. b. Water or surface binding agents shall be applied to haul and access roads within the site boundary as needed, depending on traffic volumes, ambient wind, and climatological conditions. c. Speed restrictions of 35 miles per hour or less shall be enforced on mine roads to minimize surface disturbance of the roadways. d. Vehicle travel shall be restricted within the site boundary to minimize surface disturbance of the roadways. e. Vehicle travel to and from the Project site shall be reduced by the promotion of van pools/busing for workers. f. During all drilling operations, air drilling equipment shall be shrouded with standard debris collection devices and/or wet drilling techniques. Manufacturer specifications for all shrouding devices shall be submitted to the Mojave Desert Air Quality Management District (MDAQMD) for review before use. The debris collection devices shall have a minimum design efficiency of 90%. g. The live storage portion of the coarse ore stockpile shall be covered to minimize windblown dust. h. Blasting during high winds shall be minimized or curtailed to minimize windblown dust. i. The primary, secondary, and tertiary crushers, screens, and all transfer points shall be completely enclosed or shrouded to minimize exposure to wind and, at a minimum shall use spray bars to control fugitive dust emissions. Conveyors shall be enclosed in selected areas where the moisture content and/or consistency of the material would allow generation of wind blown dust. j. Dust suppression for secondary/tertiary ore crushing operations shall be controlled using baghouses constructed to specifications acceptable to the MDAQMD.	Implement during equipment and vehicle use on the Project site.	Prior to finalization and approval of construction, grading, and building plans and approvals and during construction.	Project Applicant	BLM and San Bernardino County

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
MM-AQ-2	**Emission Control Measures**. Potential emissions associated with the Project shall be controlled by various methods and technologies. Emissions from the operation of generators and off-road equipment shall be minimized through the use of engines which meet Federal Tier 4 Final standards during construction and operations when feasible. Potential emissions associated with the crushers, screens, and select material transfer handling points shall be either controlled with moisture, enclosure, and/or vented to baghouses and bin vents. Fugitive dust from disturbed operational areas and off-road areas with vehicular traffic shall be controlled using water application on an hourly basis. Unpaved road fugitive dust emissions from the access road and primary haul roads shall be controlled by applying a chemical suppressant. On-site haul roads shall also be controlled with watering. Blast hole drilling and blasting particulate matter emissions shall be reduced because the pit in which blasting activities take place will effectively act as a windscreen. Mercury emissions from the retort system shall be controlled with carbon scrubbers.	Implement during equipment use on the Project site and Utilize Tier 4 equipment during construction and operations	Prior to issuance of construction, grading, and/or building permits and during construction.	Project Applicant	BLM and San Bernardino County
Biological Resources					
MM-BI-1.1	**Special Status Plant Species and Cacti Impact Avoidance and Minimization**. This measure will provide guidance on how Project personnel can avoid unintended impacts to special status plants in the Project Area and provide for the salvage of protected cacti prior to construction. This measure includes the following requirements: a. Preconstruction Special Status Plant Species Surveys Measures. Prior to Project initiation, surveys shall be conducted for special status plant species. Surveys shall be conducted by a qualified botanist during the appropriate season (i.e., blooming periods). All special status plants detected during the surveys shall be documented in preconstruction survey reports. b. The Project Applicant shall establish Environmentally Sensitive Areas (ESA) around special status plant populations that have been identified in the Project Area during the preconstruction surveys and/or may be identified in Project disturbance areas during site preparation. Prior to Project ground disturbance, a minimum 100-foot exclusion area shall be established around the plants, which shall be clearly identified and maintained throughout construction to ensure that avoided plants are not inadvertently harmed. ESAs shall be clearly delineated in the field with temporary construction staking,	Retain a Project Biologist to ensure compliance with biological resource mitigation measures for special status plant species.	Prior to construction.	Project Applicant	BLM and San Bernardino County

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	flagging, and fencing and signs prohibiting movement of the fencing or sediment controls under penalty of work stoppages or compensatory mitigation. c. Herbicide and Soil Stabilizer Drift Control Measures. Special status plant occurrences within 100 feet of the Project disturbance area shall be protected from herbicide and soil stabilizer drift. The Integrated Weed Management Plan (IWMP) includes measures to avoid chemical drift or residual toxicity to special status plants consistent with guidelines such as those provided by the Nature Conservancy's Global Invasive Species Team (Hillmer and Liedtke 2003), the U.S. Environmental Protection Agency, and the Pesticide Action Network Database. d. Erosion and Sediment Control Measures. Erosion and sediment control measures shall not inadvertently impact special status plants (e.g., by using invasive or non–Mojave Desert native plants in seed mixtures, introducing pest plants through contaminated seed or straw, etc.). These measures shall be incorporated in the Comprehensive Drainage, Stormwater, and Sedimentation Control Plan. e. Salvage and Translocation Plan Measures. If avoidance of special status plants is not feasible, a salvage and translocation plan shall be implemented to mitigate impacts to special status plants. The salvage and translocation plan will include, at a minimum, the species and locations of plants identified for salvage; criteria for determining whether a species or an individual plant is appropriate for salvage; the appropriate season for salvage; salvage and translocation equipment and methods; details regarding storage of plants or seed banks for each species; location of proposed translocation sites, and detailed site preparation and plant introduction methods for top soil storage, if applicable; a description of maintenance activities; success criteria; and a detailed monitoring program. The salvage and translocation plan shall be reviewed and approved by the County and BLM, in consultation with California Department of Fish and Wildlife (CDFW) and U.S. Fish and Wildlife Service (USFWS), prior to Project ground disturbance.				

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
MM-BI-1.2	**Best Management Practices**. To reduce indirect impacts to special status plants and wildlife that may occur in the Project Area, BMPs shall be implemented prior to and during construction to control dust pollution, prevent discharge of potentially harmful chemicals, and prevent changes in hydrology. BMPs may include the installation of erosion and sedimentation control devices, applying water to control dust, placing drip pans under equipment when not in use, refueling in designated areas, and containing concrete washout properly, among other practices.	Implement BMPs prior to and during construction.	Prior to and during construction.	Project Applicant	BLM and San Bernardino County
MM-BI-1.3	**Monitoring During Grubbing and Grading**. Designated Biologist (identified in Mitigation Measure MM-BI-1.6) will remain on-site daily while vegetation salvage, grubbing, grading, and other ground-disturbing construction activities are taking place to avoid or minimize take of special status species, and verify personally or have Biological Monitor(s) verify compliance with all impact avoidance and minimization measures, including checking all exclusion zones to ensure that signs, stakes, and fencing are intact and that human activities are restricted in these protective zones. a. Monthly Compliance Inspections. Conduct compliance inspections at a minimum of once per month after clearing, grubbing, and grading are completed and submit a monthly compliance report to CDFW and USFWS during construction.	Retain a Project Biologist to monitor daily ground-disturbing activities and ensure compliance with impact avoidance and minimization measures.	Prior to and during construction.	Project Applicant	BLM; San Bernardino County; CDFW; USFWS
MM-BI-1.4	**Worker Environmental Awareness Program (WEAP)**. Prior to Project initiation, the Designated Biologist (identified in Mitigation Measure MM-BI-1.6) shall develop and implement the WEAP, which will be available in English and Spanish. WEAP trainings shall be provided to all Project personnel on-site by the Designated Biologist or biological monitor(s). Alternatively, a recording of the WEAP training will be available for Project personnel to receive the training. Wallet-sized cards summarizing the information shall be provided to all construction and operation and maintenance personnel. The WEAP shall include the following: a. An explanation of the sensitivity of the vegetation communities and special status plant and wildlife species within and adjacent to work areas, and proper identification of these resources. b. Biology and status of the desert tortoise, golden eagle, burrowing owl, other nesting birds, desert bighorn sheep, kit fox, American badger, Monarch butterfly, bats, reptiles, and other sensitive species and measures to reduce potential effects on these species.	Retain a Project Biologist to develop and implement a WEAP.	Prior to Project initiation.	Project Applicant	BLM and San Bernardino County

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	c. Actions and reporting procedures to be used if desert tortoise, golden eagle, burrowing owl, other nesting birds, desert bighorn sheep, kit fox, or American badger, Monarch butterfly, bats, reptiles, or other sensitive species are encountered. d. An explanation of the function of flagging that designates authorized work areas. e. Driving procedures and techniques to reduce mortality of wildlife on roads. f. Discussion of the federal ESA and CESA, BGEPA, and MBTA and the consequences of non-compliance with these acts. g. The importance of avoiding the introduction of invasive weeds onto the Project Area and surrounding areas. h. A discussion of general safety protocols such as hazardous substance spill prevention and containment measures and fire prevention and protection measures. i. A review of mitigation requirements that are applicable to their work.				
MM-BI-1.5	**Minimize Vehicle and Equipment Impacts during Operation and Maintenance.** The Project Applicant/owner shall implement measures to minimize the potential for desert tortoise and other wildlife species mortality along access and maintenance roads. These measures shall include: a. Speed limits identified in Mitigation Measure MM-BI-1.18 shall continue to be applied during operation and maintenance. b. Pedestrian access outside the limits of the designated access/maintenance roads is permitted year-round as long as no ground-disturbing activities take place. c. Vehicle traffic and parking shall be confined to designated access roads, and equipment and materials staging areas shall be clearly defined to avoid impacting habitat during the operation phase. d. Employees and contractors shall look under vehicles and equipment for the presence of wildlife prior to moving vehicles and equipment. If present, the animal shall be left to move on its own or until it is removed by the Designated Biologist or Biological Monitor. No listed species shall be handled without concurrence from USFWS and/or CDFW, as applicable.	Implement during vehicle and equipment use on the Project site.	During operations and maintenance.	Project Applicant	BLM and San Bernardino County

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
MM-BI-1.6	**Compliance Monitoring by the Designated Biologist**. The Designated Biologist shall be employed for the period during which ongoing construction and postconstruction monitoring and reporting by an approved biologist is required. Each successive Designated Biologist shall be approved by CDFW. The Designated Biologist shall have the authority to ensure compliance with all measures set forth in the BO and CESA Section 2081 take authorization and with all mitigation measures included herein, and shall be the primary agency contact for the implementation of these measures. The Designated Biologist shall have the authority and responsibility to halt any Project activities that are in violation of the terms of the BO, Section 2081 take authorization, or Project mitigation measures. A list of responsibilities of the Designated Biologist is summarized below. a. The Designated Biologist must meet the following minimum qualifications: 1. Have a bachelor's degree in biological sciences, zoology, botany, ecology, or a closely related field; 2. Have 3 years of experience in field biology or current certification of a nationally recognized biological society, such as The Ecological Society of America or The Wildlife Society; 3. Have at least 1 year of field experience with biological resources found in or near the study area; 4. Meet the current USFWS Authorized Biologist qualifications criteria, demonstrate familiarity with protocols and guidelines for the desert tortoise, and be approved by the USFWS; 5. Possess a CESA Memorandum of Understanding pursuant to Section 2081(a) for desert tortoise. 6. In lieu of the above requirements, the resume shall demonstrate to the satisfaction of the BLM Authorized Officer, in consultation with CDFW and USFWS, that the proposed Designated Biologist or alternate has the appropriate training and background to effectively implement the mitigation measures. b. To avoid and minimize effects to biological resources, the Designated Biologist shall: 1. The Designated Biologist shall have the authority to ensure compliance with all measures set forth in the BO and CESA Section 2081 take authorization and with all mitigation measures included herein, and shall be the primary agency contact for the implementation	Retain a Project Biologist for the duration on the Project including the construction, postconstruction, and reporting period.	Prior to and during construction.	Project Applicant	BLM; San Bernardino County; CDFW; USFWS

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	of these measures. The Designated Biologist shall have the authority and responsibility to halt any Project activities that are in violation of the terms of the BO, Section 2081 take authorization, or Project mitigation measures. A list of responsibilities of the Designated Biologist is summarized below. 2. Notify CDFW and USFWS at least 14 calendar days before initiation of ground-disturbing activities. 3. Immediately notify the CDFW in writing if the Project Applicant/owner does not comply with any of the mitigation measures or terms of the BO and/or the Section 2081 take authorization including, but not limited to, any actual or anticipated failure to implement such measures within the periods specified. 4. Ensure performance of daily compliance inspections during ongoing construction as clearing, grubbing, and grading are completed, and submit a monthly compliance report to CDFW until construction is complete.				
MM-BI-1.7	**Biological Monitoring**. Biological Monitor(s) shall be employed to assist the Designated Biologist in conducting preconstruction surveys and monitoring for vegetation removal, ground disturbance, grading, construction, decommissioning, and restoration activities for the period during which ongoing construction and postconstruction monitoring and reporting by an approved biologist is required. Additionally, biological monitoring shall be performed during any ground disturbance or grading activities that occur during operation and maintenance. The Biological Monitor(s) shall have sufficient education and field experience to understand resident wildlife species biology; have experience conducting desert tortoise, burrowing owl, kit fox, and badger field monitoring; and be able to identify these species and their sign (including active burrows). The Designated Biologist shall submit a resume, at least three references, and contact information for each prospective Biological Monitor to CDFW and USFWS for approval. To avoid and minimize effects on biological resources, the Biological Monitor(s) shall assist the Designated Biologist with the following: a. Be present during construction activities that take place in suitable habitat for desert tortoise, burrowing owl, kit fox, badger, or other protected species to prevent or minimize harm or injury to these species. This also includes construction activities in areas without fencing that	Retain a Project Biologist to conduct surveys, monitor daily ground-disturbing activities, and ensure compliance with impact avoidance and minimization measures.	Prior to and during construction.	Project Applicant	BLM; San Bernardino County; CDFW; USFWS

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	excludes desert bighorn sheep (see Mitigation Measure MM-BI-1.17). b. Activities of the Biological Monitor(s) include, but are not limited to, ensuring compliance with all avoidance and minimization measures; monitoring for desert tortoise, burrowing owl, kit fox, badger, and other protected species; halting construction activity in the area if an individual is found; and checking the staking/flagging of all disturbance areas to be sure that they are intact and that all construction activities are being kept within the staked/flagged limits. If a desert tortoise, burrowing owl, desert bighorn sheep, kit fox, badger, or other protected species is found within a work area, the Biological Monitor(s) shall immediately notify the Designated Biologist, who shall determine measures to be taken to ensure that the individual is not harmed. c. Inspect the work area for any special status wildlife species. d. Ensure that potential habitats within the construction zone (the designated area where ground disturbance, grading, construction, decommissioning, and restoration activities occur) are not occupied by special status species (e.g., potential burrows or nests are inspected). e. In the event of the discovery of a non-listed, special status ground-dwelling animal, recover and relocate the animal to adjacent suitable habitat at least 200 feet from the limits of construction activities. f. At the end of each work day, inspect all potential wildlife pitfalls (e.g., trenches, bores, other excavations) for wildlife and remove wildlife as necessary. If the potential pitfalls will not be immediately backfilled following inspection, the Biological Monitor(s) will ensure that the construction crew slopes the ends of the excavation (3:1 slope), provides wildlife escape ramps, or completely and securely covers the excavation to prevent wildlife entry. g. Inspect the site to ensure trash and food-related waste is placed in closed-lid containers and that workers do not feed wildlife. Also inspect the work area each day to ensure that no micro trash (e.g., bolts, screws, etc.) is left behind.				

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
MM-BI-1.8	**Desert Tortoise Protection**. The Project Applicant/owner shall undertake appropriate measures to manage the construction site and related facilities in a manner to avoid or minimize impacts to desert tortoise. Methods for clearance surveys, fence specification and installation, tortoise handling, artificial burrow construction, egg handling, and other procedures shall be consistent with those described in the USFWS's Desert Tortoise (Mojave Population) Field Manual (USFWS 2009) or more current guidance provided by CDFW and USFWS. The Project Applicant/owner shall also implement all terms and conditions described in the BO to be prepared by USFWS. These measures include, but are not limited to, the following, subject to modification by the terms of incidental take authorizations issued by the USFWS.	Implement desert tortoise protection measures in consultation with CDFW and USFWS, as appropriate.	Prior to and during construction.	Project Applicant	BLM; San Bernardino County; CDFW; USFWS
MM-BI-1.9	**Desert Tortoise Exclusion Fence Installation**. To avoid impacts to desert tortoise, permanent desert tortoise exclusion fencing shall be installed along the permanent perimeter security fence and temporarily installed along road corridors during construction. The proposed alignments for the permanent perimeter fence and temporary fencing shall be flagged and surveyed within 24 hours prior to the initiation of fence construction. Clearance surveys of the perimeter fence and temporary fencing areas shall be conducted by the Designated Biologist(s) using techniques outlined in the USFWS's Desert Tortoise (Mojave Population) Field Manual and may be conducted in any season with USFWS and CDFW approval. Biological Monitors may assist the Designated Biologist under his or her supervision. These fence clearance surveys shall provide 100% coverage of all areas to be disturbed and an additional transect along both sides of the fence line covering an area approximately 90 feet wide centered on the fence alignment. Transects shall be no greater than 15 feet apart. All desert tortoise burrows and burrows constructed by other species that might be used by desert tortoise shall be examined to assess occupancy of each burrow by desert tortoise and handled in accordance with the USFWS's Desert Tortoise Field Manual. Any desert tortoise located during fence clearance surveys shall be handled by the Designated Biologist in accordance with the USFWS's 2009 Desert Tortoise (Mojave Population) Field Manual (USFWS 2009). a. Timing, Supervision of Fence Installation. The exclusion fencing shall be installed prior to the onset of site clearing and grubbing. The fence installation shall be supervised by the Designated Biologist and monitored by the Biological Monitors to ensure the safety of any tortoise present.	Install tortoise exclusion fencing and retain a Project Biologist to conduct clearance surveys of fencing areas.	Prior to onset of site clearing, grubbing, and construction.	Project Applicant	BLM; San Bernardino County; CDFW; USFWS

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	b. Fence Material and Installation. The permanent tortoise exclusionary fencing shall be constructed in accordance with the USFWS's Desert Tortoise (Mojave Population) Field Manual (Chapter 8 – Desert Tortoise Exclusion Fence) (USFWS 2009). c. Security Gates. Security gates shall be designed with minimal ground clearance to deter ingress by tortoises. The gates may be electronically activated to open and close immediately after the vehicle(s) have entered or exited to prevent the gates from being kept open for long periods of time. Cattle grating designed to safely exclude desert tortoise shall be installed at the gated entries to discourage tortoises from gaining entry. d. Fence Inspections. Following installation of the desert tortoise exclusion fencing for both the permanent site fencing and temporary fencing, the fencing shall be regularly inspected. If tortoises were moved out of harm's way during fence construction, permanent and temporary fencing shall be inspected at least two times per day for the first 7 days to ensure a recently moved tortoise has not been trapped within the fence. Thereafter, permanent fencing shall be inspected monthly and during or within 24 hours following all major rainfall events. Exceptions to inspections during major rainfall events may be made as needed to maintain crew safety. A major rainfall event is defined as one for which flow is detectable within the fenced drainage. Any damage to the fencing shall be temporarily repaired immediately to keep tortoises out of the site, and permanently repaired within 48 hours of observing damage. Inspections of permanent site fencing shall occur for the life of the proposed Project. Temporary fencing shall be inspected weekly and, where drainages intersect the fencing, during and within 24 hours following major rainfall events. All damaged temporary fencing shall be repaired immediately upon discovery and, if the fence may have permitted tortoise entry while damaged, the Designated Biologist shall inspect the area for tortoise.				

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
MM-BI-1.10	**Desert Tortoise Clearance Surveys**. Clearance surveys shall be conducted in accordance with the USFWS Desert Tortoise (Mojave Population) Field Manual (USFWS 2009) (Chapter 6 – Clearance Survey Protocol for the Desert Tortoise – Mojave Population) and shall consist of two surveys covering 100% of the study area by walking transects no more than 15 feet apart. If a desert tortoise is located during the second survey, a third survey shall be conducted. Each separate survey shall be walked in a different direction to allow opposing angles of observation. Clearance surveys of the Project Area may only be conducted when tortoises are most active (April–May or September–October) unless the Project receives approval from CDFW and USFWS. Clearance surveys of linear features may be conducted during any time of the year. Any tortoise located during clearance surveys shall be translocated or relocated and monitored in accordance with the Desert Tortoise Translocation Plan (DTTP) (MM-BI-1.13). The Designated Biologist, who may be assisted by the Biological Monitors, shall assess occupancy of each burrow by desert tortoise in accordance with the USFWS Desert Tortoise (Mojave Population) Field Manual (USFWS 2009). All potential desert tortoise burrows located during clearance surveys shall be excavated by hand, tortoises removed, and burrows collapsed or blocked to prevent occupation by desert tortoise in accordance with the DTTP.	Retain a Project Biologist and Biological Monitors to conduct tortoise clearance surveys, monitor the Project site, and translocate or relocate tortoise.	Prior to and during construction.	Project Applicant	BLM; San Bernardino County; CDFW; USFWS
MM-BI-1.11	**Monitoring Following Clearing**. Following the desert tortoise clearance and removal from the Project Area, workers and heavy equipment shall be allowed to enter the Project Area to perform clearing, grubbing, leveling, and trenching activities. A Designated Biologist or Biological Monitor shall be on-site for clearing and grading activities to move tortoises missed during the initial tortoise clearance survey. Should a tortoise be discovered, it shall be relocated or translocated as described in the Desert Tortoise Translocation Plan (DTTP).	Retain a Project Biologist or Biological Monitor to monitor clearing and grading activities, and translocate or relocate tortoise.	Prior to clearing and grading activities.	Project Applicant	BLM; San Bernardino County; CDFW; USFWS
MM-BI-1.12	**Reporting**. The Designated Biologist shall record the following information for any desert tortoise handled: a. the locations (narrative and maps) and dates of observation; b. general condition and health, including injuries, state of healing and whether desert tortoise voided their bladders; c. location moved from and location moved to (using GPS); d. gender, carapace length, and diagnostic markings (i.e., identification numbers or marked lateral scutes); e. ambient temperature when handled and released; and	Retain a Project Biologist to report data on desert tortoises handled.	Prior to construction.	Project Applicant	BLM; San Bernardino County; CDFW; USFWS

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	f. digital photograph of each handled tortoise. Desert tortoise moved from within the Project Area shall be marked and monitored in accordance with the Desert Tortoise Translocation Plan (DTTP). All collected data related to tortoise relocation shall be provided to CDFW and USFWS.				
MM-BI-1.13	**Desert Tortoise Translocation Plan**. The Project Applicant/owner shall develop and implement a USFWS- and CDFW-approved Desert Tortoise Translocation Plan (DTTP). The DTTP, which shall be approved prior to any ground disturbance or tortoise relocation, shall include measures to minimize the potential for repeated translocations of individual desert tortoise. The goals of the DTTP shall be to relocate all desert tortoise from the Project Area to nearby suitable habitat; minimize impacts on resident desert tortoise outside the Project Area; minimize stress, disturbance, and injuries to relocated/translocated tortoises; and assess the success of the translocation effort through monitoring. The DTTP shall follow the Translocation of Mojave Desert Tortoises from Project Sites: Plan Development Guidance (USFWS 2011b) and shall clearly define how it addresses the 11 steps outlined in the guidance. The final DTTP shall be based on the draft DTTP prepared by the Project Applicant/owner and shall include all revisions deemed necessary by CDFW and USFWS. The final plan will be subject to modification for consistency with the USFWS take authorization and/or BO conservation requirements.	Retain a Project Biologist to develop and implement a DTTP.	Prior to ground-disturbing activities and tortoise relocation.	Project Applicant	BLM; San Bernardino County; CDFW; USFWS
MM-BI-1.14	**Desert Tortoise Compliance Verification.** The Project Applicant/owner shall provide CDFW and USFWS staff with unfettered access to the Project Area and compensation lands under the control of the Project owner and shall otherwise fully cooperate with the CDFW's efforts to verify the Project owner's compliance with, or the effectiveness of, adopted mitigation measures. The Designated Biologist shall: a. Notification. Notify CDFW at least 14 calendar days before initiating construction-related ground disturbance activities; immediately notify CDFW in writing if the Project owner is not in compliance with any conditions of certification, including but not limited to any actual or anticipated failure to implement mitigation measures within the time periods specified in the conditions of certification.	Retain a Project Biologist to notify CDFW of initiation of ground-disturbing activities and compliance violations.	Prior to and during construction.	Project Applicant	BLM; San Bernardino County; CDFW
MM-BI-1.15	**Notification of Injured or Dead Listed Species**. If an injured or dead federally or state-listed species is detected on or near the Project Area CDFW and USFWS shall be notified immediately by phone. Notification shall occur no later than noon on the business	Retain a Project Biologist to notify CDFW and USFWS	Prior to and during construction.	Project Applicant	BLM; San Bernardino County; CDFW; USFWS

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	day following the event if it occurs outside normal business hours so that the agencies can determine whether further actions are required to protect listed species. Written follow-up notification via facsimile or electronic communication shall be submitted to these agencies within two calendar days of the incident and include the following information as relevant: a. Injured Desert Tortoise. If a desert tortoise is injured as a result of Project-related activities during construction, the Designated Biologist or Biological Monitor(s) shall immediately take it to a CDFW-approved wildlife rehabilitation and/or veterinarian clinic. Any veterinarian bills for such injured animals shall be paid by the Project Applicant/owner. Following phone notification as required above, CDFW and USFWS shall determine the final disposition of the injured animal, if it recovers. Written notification shall include, at a minimum, the date, time, location, and circumstances of the incident and the name of the facility where the animal was taken. b. Desert Tortoise Fatality. If a desert tortoise is killed by Project-related activities during construction, operation and maintenance, or decommissioning, a written report with the same information as an injury report shall be submitted CDFW and USFWS. These desert tortoises shall be salvaged according to federally established guidelines. The Project Applicant/owner shall pay to have the desert tortoises transported and necropsied. The report shall include the date and time of the finding or incident. 1. Final Listed Species Mitigation Report. The Designated Biologist shall provide CDFW a Final Listed Species Mitigation Report that includes, at a minimum, 1) all available information about Project-related incidental take of listed species; 2) information about other Project impacts to the listed species; 3) construction dates; 4) an assessment of the effectiveness of conditions of certification in minimizing and compensating for Project impacts; 5) recommendations on how mitigation measures might be changed to more effectively minimize and mitigate the impacts of future projects on the listed species; and 6) any other pertinent information, including the level of take of the listed species associated with the Project. 2. Stop Work Order. CDFW may issue the Project owner a written stop work order to suspend any activity	of injury or fatality to listed species.			

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	related to the construction or operation of the Project to prevent or remedy a violation of one or more conditions of certification (including but not limited to failure to comply with reporting, monitoring, or habitat acquisition obligations) or to prevent the illegal take of an endangered, threatened, or protected species. The Project owner shall comply with the stop work order immediately upon receipt thereof.				
MM-BI-1.16	**Desert Tortoise Compensatory Mitigation**: To fully mitigate for habitat loss and potential take of desert tortoise, the Project owner shall provide compensatory mitigation consistent with federal requirements, adjusted to reflect the final Project footprint. The acreage for mitigation of desert tortoise habitat will be at a 1:1 ratio. For the purposes of this condition, the Project footprint means all lands disturbed in the construction and operation of the Project, including all Project linears, as well as undeveloped areas inside the Project's boundaries that will no longer provide viable long-term habitat for the desert tortoise. To satisfy this condition, the Project owner shall acquire, protect, and transfer 1 acre of desert tortoise habitat for every acre of habitat within the final Project footprint, and provide associated funding for the acquired lands, as specified below. If compensation lands are acquired in fee title or in easement, the requirements for acquisition, initial improvement, and long-term management of compensation lands include all of the following, subject to modification by the terms of incidental take authorizations issued by USFWS and CDFW: a. Selection Criteria for Compensation Lands. The compensation lands selected for acquisition in fee title or in easement shall: 1. Be within the Western Mojave Recovery Unit, or, with prior USFWS and CDFW approval, within the Eastern Mojave Recovery Unit as defined in the 2011 Revised Recovery Plan (USFWS 2011), with potential to contribute to desert tortoise habitat connectivity and build linkages between desert tortoise designated critical habitat, known populations of desert tortoise, and/or other preserve lands; 2. Provide habitat for desert tortoise with capacity to regenerate naturally when disturbances are removed; 3. Be prioritized near larger blocks of land that are either already protected or planned for protection, such as Desert Wildlife Management Areas within the Eastern	Develop and submit formal acquisition proposal for compensatory mitigation describing parcels intended for purchase.	Prior to final approvals	Project Applicant	BLM; San Bernardino County; CDFW; USFWS

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	Mojave Recovery Unit (or nearby portions of the Western Mojave Recovery Unit with prior USFWS and CDFW approval) or which could feasibly be protected long-term by a public resource agency or a nongovernmental organization dedicated to habitat preservation; 4. Be connected to lands with desert tortoise habitat equal to or better quality than the Project Area, ideally with populations that are stable, recovering, or likely to recover; 5. Not have a history of intensive recreational use or other disturbance that does not have the capacity to regenerate naturally when disturbances are removed or might make habitat recovery and restoration infeasible; 6. Not be characterized by high densities of invasive species, either on or immediately adjacent to the parcels under consideration, that might jeopardize habitat recovery and restoration; 7. Not contain hazardous wastes that cannot be removed to the extent that the site could not provide suitable habitat; and 8. Have water and mineral rights included as part of the acquisition, unless BLM and CDFW, in consultation with CDFW and USFWS, agree in writing to the acceptability of the land. b. Review and Approval of Compensation Lands Prior to Acquisition. The Project owner shall submit a formal acquisition proposal to BLM, CDFW, and USFWS describing the parcel(s) intended for purchase. This acquisition proposal shall discuss the suitability of the proposed parcel(s) as compensation lands for desert tortoise in relation to the criteria listed above. Approval from the BLM and CDFW in consultation with USFWS shall be required for acquisition of all compensatory mitigation parcels.				
MM-BI-1.17	**Fence Design and Site Permeability**. Permanent site fencing installed around the Project should be designed to allow for the passage of wildlife, to the extent feasible given the need for the fencing to prevent ingress by desert tortoise. Depending on the fencing material, the fence line should have gaps of approximately 4 to 6 inches accessible to wildlife other than desert tortoise and the fencing material should be knuckled back to create a smooth edge.	Develop and submit fencing plans for permanent site fencing.	Prior to site disturbance.	Project Applicant	BLM; San Bernardino County; CDFW; USFWS

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	Alternate designs may also be constructed with prior written approval from CDFW and USFWS. Regardless, the Project shall ensure that any such fence meets existing specifications that have been developed to preclude accidental entanglement of desert bighorn sheep, deer, and other animals. Fencing should be sufficient to allow desert bighorn sheep passage and access to existing guzzlers located throughout the Project Area, but exclude them from active mining areas gaps of approximately four to six inches should occur at the bottom of the fence to allow small wildlife, mesocarnivores, coyote and American badger to pass under. Care should be taken when connecting the fences to make sure that they are physically connected or directly abut one another such that wildlife can't pass through or get stuck between them. The ultimate fencing plans should be reviewed by CDFW for final approval prior to site disturbance activities.				
MM-BI-1.18	**Speed Limits**. Speed limits along all access roads outside of permanent desert tortoise fencing shall not exceed 15 mph to minimize dust during construction activities. Speed limits within permanent desert tortoise fencing shall not exceed 25 mph to minimize impacts during operation and maintenance. Nighttime vehicle traffic associated with Project activities shall be kept to a minimum volume and speed (maximum of 15 mph) to prevent mortality of nocturnal wildlife species.	Enforce speed limits.	During construction, operations, and maintenance.	Project Applicant	BLM and San Bernardino County
MM-BI-1.19	**Desert Tortoise Biological Opinion.** Prior to ground disturbance, the Project Applicant shall obtain take authorization for desert tortoise pursuant to Section 7 of the ESA (16 USC 1536). Mitigation shall include avoidance, minimization, and compensatory measures sufficient to achieve no net loss of habitat value and ensure impacts are reduced to a less-than-significant level, consistent with USFWS requirements. Measures shall include, at a minimum: a. The Project Applicant will provide compensatory mitigation at a proposed ratio of 1:1, or other USFWS-determined ratio, for permanent impacts to approximately 1,559 acres of habitat for desert tortoise. b. The Project Applicant will provide compensatory mitigation at a proposed ratio of 5:1, or other USFWS-determined ratio, and a ratio consistent with the DRECP, for permanent impacts to approximately 118 acres of critical habitat for desert tortoise.	Obtain take authorization for desert tortoise and provide compensatory mitigation, as needed.	Prior to ground-disturbing activities.	Project Applicant	BLM; San Bernardino County; CDFW; USFWS

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
MM-BI-1.20	**Desert Bighorn Sheep Compensatory Mitigation**. If Desert Bighorn Sheep Compensatory Mitigation is adhered to and occurs within approximately one kilometer of desert bighorn sheep-occupied or CDFW-identified/modeled desert bighorn sheep habitat, then no additional compensatory habitat mitigation would be required as the acquired habitat would also satisfy the foraging needs of desert bighorn sheep. However, if the mitigation lands acquired for desert bighorn sheep do not satisfy this requirement, then separate compensatory mitigation for loss of desert bighorn sheep foraging habitat at a 1:1 ratio meeting all of the other requirements (i.e., requirements for acquisition, initial improvement, and long-term management of compensation lands) and protections afforded under Desert Bighorn Sheep Compensatory Mitigation will be required.	Implement compensatory mitigation, as required.	Prior to Project initiation.	Project Applicant	BLM and San Bernardino County
MM-BI-1.21	**Desert Bighorn Sheep Mitigation and Monitoring Plan**. Prior to site disturbance, the Project will prepare a desert bighorn sheep mitigation and monitoring plan. The plan will be approved by CDFW and BLM. This plan will require monitoring of fencing effectiveness, water sources, and all other implemented mitigation measures for a minimum of eight years with an annual monitoring report provided to CDFW by January 31, and a final report covering the entire monitoring period (i.e., at least five years) by January 31st of the final year. Components of this requirement may be modified if already covered by other monitoring efforts. The plan will include the methods for monitoring, identify what is being monitored, identify the goals of the measures, methods for determining the effectiveness of the measures, and remedial triggers and measures if the mitigation does not meet the goals.	Prepare a desert bighorn sheep mitigation and monitoring plan.	Prior to site disturbance.	Project Applicant	BLM; San Bernardino County; CDFW
MM-BI-1.22	**Limited Operating Period**. Noises greater than 85 A-weighted decibels (dBA) maximum sound level (Lmax) will not be allowed between December 1 and June 30. If loud work must occur, even briefly, then the Project must get CDFW concurrence that the desert bighorn sheep lambing period is done or verify, in coordination with CDFW, that there are no desert bighorn sheep on a facing slope within a distance that would be expected to be subject to an 85 dBA Lmax sound level. If the Project believes that they may need to ultimately perform loud work during the lambing period, then they shall coordinate with CDFW early (i.e., ideally as soon as possible, but minimally before the lambing period) to determine how much additional desert bighorn sheep-specific monitoring will be needed for CDFW to evaluate whether the request is feasible.	Implement and coordinate with CDFW.	Prior to Project initiation.	Project Applicant	BLM and San Bernardino County

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
MM-BI-1.23	**Work Boot Decontamination**. All construction personnel will be trained on the importance of and procedures for decontaminating boots to prevent transmission of disease from domesticated sheep and goats to desert bighorn sheep. In addition, all quarry workers who have potential contact with domesticated sheep and/or goats (for example at farms, fairs, etc.) will be identified and shall decontaminate work boots prior to entering the Project Area. Decontamination shall involve scrubbing the soles of work boots with a 10% bleach solution to remove all organic matter and kill pathogens. Alternatively, footwear may be changed to ensure that potentially contaminated footwear does not enter any quarry area.	Develop and implement decontamination training.	Prior to and during construction, operations, and maintenance.	Project Applicant	BLM and San Bernardino County
MM-BI-1.24	**American Badger and Desert Kit Fox Protection**. To avoid direct impacts to American badger and desert kit fox, preconstruction surveys shall be conducted for these species concurrently with the desert tortoise surveys. Surveys shall be conducted as described below: a. Biological Monitors shall perform preconstruction surveys for badger and kit fox dens in the Project disturbance area, including a 20-foot swath beyond the disturbed area, utility corridors, and access roads. If dens are detected, each den shall be classified as inactive, potentially active, or definitely active. b. Inactive dens that would be directly impacted by construction activities shall be excavated by hand and backfilled to prevent reuse by badgers or kit fox. c. Potentially and definitely active dens that would be directly impacted by construction activities shall be monitored by the Biological Monitor for three consecutive nights using a tracking medium (such as diatomaceous earth or fire clay) and/or infrared camera stations at the entrance. d. If no tracks are observed in the tracking medium or no photographs of the target species are captured after three consecutive nights, the den shall be excavated and backfilled by hand. e. If tracks are observed, the den shall be progressively blocked with natural materials (rocks, dirt, sticks, and vegetation piled in front of the entrance) for the next three to five nights to discourage the badger or kit fox from continued use. After verification that the den is unoccupied it shall then be excavated and backfilled by hand to ensure that no badgers or kit fox are trapped in the den. f. If an active natal den is detected on the site, the BLM Authorized Officer and CDFW shall be contacted within 24	Retain a Project Biologist to conduct preconstruction surveys and implement measures.	Prior to and during construction.	Project Applicant	BLM; San Bernardino County; CDFW

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	hours to determine the appropriate course of action to minimize the potential for harm or mortality. The course of action would depend on the age of the pups, location of the den on the site (e.g., is the den in a central area or in a perimeter location), status of the perimeter site fence (completed or not), and the pending construction activities proposed near the den. A 500-foot no disturbance buffer shall be maintained around active natal dens. g. The following measures are required to reduce the likelihood of distemper transmission: 1. No pets shall be allowed on the site prior to or during construction, with the possible exception of kit fox scat detection dogs during preconstruction surveys, and then only with prior CDFW approval; 2. Any kit fox hazing activities that include the use of animal repellents such as coyote urine must be cleared through CDFW prior to use; and 3. Any documented kit fox mortality shall be reported to CDFW and the BLM Authorized Officer within 24 hours of identification. If a dead kit fox is observed, it shall be retained and protected from scavengers until CDFW determines whether the collection of necropsy samples is justified.				
MM-BI-1.25	**Burrowing Owl Protection Measures.** No more than 14 days prior to the start of ground disturbance, a preconstruction survey for burrowing owls in conformance with the CDFW Staff Report on Burrowing Owl Mitigation (CDFW 2012) shall be completed within suitable habitat at every work area and within a 200-meter buffer zone of each work area. Work areas will be resurveyed following periods of inactivity of 2 weeks or more. The Project Applicant/owner shall submit the results of the preconstruction survey to BLM's Authorized Officer and CDFW. The Project Applicant/owner shall also submit evidence of conformance with federal and state regulations regarding the protection of the burrowing owl by demonstrating compliance with the following: a. Unless otherwise authorized by BLM and CDFW, a 650-foot (200-meter) buffer within which no activity will be permissible shall be maintained between Project activities and nesting burrowing owls during the nesting season. This protected area shall remain in effect until August 31 or at CDFW's discretion and, based on monitoring evidence, until the young owls are foraging independently. No disturbance shall occur within 160 feet (50 meters) of	Retain a Project Biologist to conduct preconstruction surveys and implement measures.	Prior to and during construction.	Project Applicant	BLM; San Bernardino County; CDFW; USFWS

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	occupied burrows during the non-breeding season (September 1–January 31). Eviction outside the nesting season may be permitted pending evaluation of eviction plans (developed in accordance with CDFW protocol for burrowing owls) by CDFW and receipt of formal written approval from CDFW authorizing the eviction. A Burrowing Owl Mitigation and Monitoring Plan following the guidance in the CDFW's Staff Report on Burrowing Owl Mitigation (CDFW 2012) shall be submitted to the BLM's Authorized Officer and CDFW for review and approval prior to passive relocation. b. In the event that an occupied burrow cannot be avoided, passive relocation of owls may be implemented prior to construction activities only if a qualified biologist approved by BLM and CDFW verifies through non-invasive methods that either the birds have not begun egg-laying and incubation or that juveniles from the occupied burrows are foraging independently and are capable of independent survival. Eviction outside the nesting season may be permitted pending evaluation of eviction plans (developed in accordance with BLM protocol for burrowing owls) by CDFW and receipt of formal written approval from BLM authorizing the eviction. A Burrowing Owl Mitigation and Monitoring Plan shall be submitted to the BLM and CDFW for review and approval prior to passive relocation. c. If accidental take (disturbance, injury, or death of owls) occurs, the Designated Biologist shall be notified immediately. d. Impacts to active burrowing owl territories shall be mitigated at a 1:1 ratio through a combination of off-site habitat compensation and/or off-site restoration of disturbed habitat capable of supporting this species. The acquisition of occupied habitat off-site shall be in an area where energy facilities would not pose a mortality risk. Acquisition of habitat shall be consistent with the CDFW's Staff Report on Burrowing Owl Mitigation (CDFW 2012). The preserved habitat shall be occupied by burrowing owl and shall be of superior or similar habitat quality to the impacted areas in terms of soil features, extent of disturbance, habitat structure, and dominant species composition, as determined by a qualified ornithologist. The site shall be approved by BLM and CDFW. Land shall be purchased and/or placed in a conservation easement in perpetuity and managed to maintain suitable habitat. The				

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	off-site area to be preserved can coincide with other off-site mitigation lands, with the approval of CDFW. e. The Designated Biologist or Biological Monitor(s) shall remain on-site until all vegetation is cleared and, at a minimum, conduct site and fence inspections on a regular (monthly) schedule throughout construction to ensure that the proposed Project is in compliance with the mitigation measures. f. Employees and contractors shall look under vehicles and equipment for the presence of wildlife prior to moving vehicles and equipment. If present, the animal shall be left to move on its own or until it is removed by the approved biologist. No listed species shall be handled without concurrence from USFWS and/or CDFW, as applicable.				
MM-BI-1.26	**Avoid Disturbance to Nesting Birds**. Vegetation clearing shall take place outside of the general avian breeding season (February 15–September 1), when feasible. If vegetation clearing cannot occur outside the avian breeding season, the Designated Biologist/Biological Monitor(s) shall conduct a preconstruction survey for nesting birds no more than 3 days prior to vegetation clearing. If no active nests are found, clearing can proceed. If active nests are found, no clearing shall be allowed within 150 feet (for passerines) to 1,500 feet (for raptors) of the active nests until the Designated Biologist/Biological Monitor(s) determines the nest is no longer active or the nest fails. Based on observation of the individual birds' tolerance to human activity, this buffer may be reduced by a qualified biologist. Encroachment into the buffer may occur at the discretion of a qualified biologist. The Designated Biologist/Biological Monitor(s) shall submit the results of the preconstruction nesting bird surveys to BLM, USFWS, and CDFW. Following agency coordination, the size of the next buffer may be adjusted based upon the magnitude of proposed activities and observed sensitivity of the bird to disturbance.	Retain a Project Biologist to conduct preconstruction surveys and implement measures.	Prior to and during construction.	Project Applicant	BLM; San Bernardino County; CDFW; USFWS
MM-BI-1.27	**Lighting Specifications to Minimize Bird and Bat Impacts**. The Project Applicant/owner shall minimize night lighting during construction by using shielded directional lighting that is pointed downward, thereby avoiding illumination to adjacent natural areas and the night sky.	Include measures on grading and building plans and implement during equipment use on the Project site.	Prior to finalization and approval of construction, grading, and building plans and approvals and during construction.	Project Applicant	BLM and San Bernardino County

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
MM-BI-1.28	**Bird and Bat Conservation Strategy (BBCS)**. The Project Applicant/owner shall develop a BBCS to address Project impacts to special status avian and bat species. The Project Applicant/owner shall submit the BBCS to the CDFW and USFWS for review and approval prior to initiation of Project construction. The BBCS shall include an assessment of potential avian and bat impacts from lighting, noise, collision, electrocution, and attraction of ravens, as applicable; measures to mitigate for the effects to birds; a description of general avoidance and minimization measures applicable during construction, operation and maintenance, and postconstruction to include nest management and postconstruction monitoring; a description of the reporting requirements and reporting schedule and duration; and the adaptive management strategy. A raven management element shall be included in the BBCS or provided separately that includes measures such as storage of garbage in raven-proof containers and installation of anti-nesting devices on structures where raven nests could be built.	Develop, submit, and implement a BBCS.	Prior to the initiation of Project construction.	Project Applicant	BLM; San Bernardino County; CDFW; USFWS
MM-BI-1.29	**Milkweed Avoidance**. Prior to construction, all individual milkweed plants will be surveyed and mapped. Identified plants will be examined for the presence of monarch butterfly eggs or larvae and those that have monarch butterfly presence will be flagged for re-survey and avoidance. Individual plants without eggs and larvae will be removed. Flagged plants will be resurveyed and removed when no eggs or larvae are present.	Conduct survey of all individual milkweed plants on the Project site to determine presence or absence of monarch eggs and/or larvae and implement measures based on survey findings.	After obtaining permits and prior to construction.	Project Applicant	BLM and San Bernardino County
MM-BI-2.1	**Vegetation Best Management Practices**. The Project Applicant shall undertake the following measures to manage the construction site and related facilities in a manner to avoid or minimize impacts to vegetation resources: a. Limit Area of Disturbance. The boundaries of all areas to be disturbed (including staging areas, access roads, and sites for temporary placement of spoils) shall be delineated with stakes and flagging prior to construction activities in consultation with the Designated Biologist. Spoils and topsoil shall be stockpiled in disturbed areas within the Project Area. Parking areas and staging and disposal site locations shall similarly be located in areas without native vegetation or special status species habitat. All disturbances, Project vehicles, and equipment shall be confined to the flagged areas.	Implement vegetation BMPs and retain a Project Biologist to monitor ground-disturbing activities.	Prior to and during all phases of construction, operations, and maintenance.	Project Applicant	BLM and San Bernardino County

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	b. Minimize Road Impacts. New and existing roads that are planned for construction, widening, or other improvements shall not extend beyond the flagged impact area as described above. All vehicles passing or turning around would do so within the planned impact area or in previously disturbed areas. Where new access is required outside of existing roads or the construction zone, the route shall be clearly marked (i.e., flagged and/or staked) prior to the onset of construction. c. Minimize Traffic Impacts. Vehicular traffic during Project construction and operation shall be confined to existing routes of travel to and from the Project Area, and cross-country vehicle and equipment use outside designated work areas shall be prohibited. d. Monitor During Construction. In areas that have not been fenced with desert tortoise exclusion fencing and cleared, a Designated Biologist shall be present at the construction site during all Project construction activities that have potential to disturb soil, vegetation, and wildlife. The Designated Biologist or Biological Monitor shall review areas immediately ahead of equipment during brushing and grading activities. e. Minimize Impacts of Staging Areas. Staging areas for construction on the Project Area shall be within the area that has been fenced with desert tortoise exclusion fencing. For construction activities outside of the Project Area, access roads, pulling sites, and storage and parking areas shall be designed, used, and maintained with the goal of avoiding or minimizing impacts to native plant communities and sensitive biological resources. Staging areas outside of the Project Area shall maintain a minimal disturbance footprint, avoid jurisdictional wetlands, and avoid disturbance to native plant communities whenever possible. f. Avoid Use of Toxic Substances. Soil bonding and weighting agents used on unpaved surfaces shall be non-toxic to plants and wildlife. g. Implement Erosion Control Measures. All erosion control measures promoted by the Lahontan Regional Water Quality Control Board (RWQCB) in its Project Guidelines for Erosion Control (Board Order No R6T-2003-0-04 Attachment G) (Lahontan RWQCB 2003) shall be implemented for all phases of construction and operation where sediment runoff from exposed slopes threatens to				

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	enter "waters of the State." Sediment and other flow-restricting materials shall be moved to a location where they shall not be washed back into drainages. All disturbed soils and roads within the Project Area shall be stabilized to reduce erosion potential, both during and following construction. Areas of disturbed soils (access and staging areas) with slopes toward a drainage shall be stabilized to reduce erosion potential. To avoid impacts associated with generation of fugitive dust, surface application of water would be employed during construction and operation and maintenance activities.				
MM-BI-2.2	**Revegetation of Temporarily Disturbed Areas**. The Project Applicant shall prepare and implement a Temporary Disturbance Revegetation Plan to restore all areas subject to temporary disturbance to pre-Project grade and conditions. The plan shall be submitted to the BLM and CDFW for review and approval, prior to the issuance of any County permits and/or authorizations, and at least 30 days prior to the start of ground-disturbing activities. Temporarily disturbed areas within the Project Area include, but are not limited to, all proposed locations for linear facilities, temporary access roads, berms, construction work temporary laydown areas, and construction equipment staging areas. The Temporary Disturbance Revegetation Plan shall include a description of topsoil salvage and seeding techniques and a monitoring and reporting plan, and plan to achieve the following performance standards by the end of monitoring year 3: a. At temporarily disturbed areas treated by vegetation trimming, drive and crush, or similar disturbance, at least 80% of the species observed within the area will be native species that naturally occur in local desert scrub habitats. b. At temporarily disturbed areas treated by grading or scarification, which have resulted in loss of native soils and rootstocks, at least 60% of the species observed within the area will be native species that naturally occur in local desert scrub habitats. c. Cover and density of nonnative plant species within the temporarily disturbed areas will be no more than twice their cover and density in comparable adjacent lands that have not been disturbed by the proposed Project. d. Soil stability and potential for erosion or dust source will be comparable to adjacent lands that have not been disturbed by the proposed Project.	Develop, submit, and implement a Temporary Disturbance Revegetation Plan.	Prior to ground-disturbing activities.	Project Applicant	BLM; San Bernardino County; CDFW

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
MM-BI-2.3	**Integrated Weed Management Plan**. This measure provides further detail and clarifies requirements for the Project Applicant's draft Integrated Weed Management Plan (IWMP). Prior to the issuance of any County permits and/or authorizations, and at least 30 days prior to the start of ground-disturbing activities, the Project Applicant shall prepare, circulate to BLM for comment and approval, and then implement an IWMP that meets the approval of BLM's Authorized Officer and conforms to the CDCA Plan to prevent the spread of existing invasive species and the introduction of new invasive species to the Project Area. The plan shall be consistent with BLM's Record of Decision for Vegetation Treatments Using Herbicides on BLM Lands in 17 Western States (BLM 2007) and the 2008–2012 National Invasive Species Management Plan (National Invasive Species Council 2008). The IWMP shall include, at a minimum, specific management objectives and measures for each target invasive species, baseline conditions, weed risk assessment, measures (both preventative and containment/control) to prevent/limit the introduction and spread of invasive species, monitoring and surveying methods, and reporting requirements. The BLM-approved IWMP shall include: a. Preventative measures to prevent the spread of weeds into new habitats, such as equipment inspections, use of weed-free erosion control materials and soils, and a mandatory site training element that includes weed management; b. Weed containment and control measures such as the removal of invasive species primarily via mechanical means, with the use of herbicides restricted to BLM-policies and approved usage (e.g., BLM's Herbicide Use Standard Operating Procedures provided in Appendix B of the Record of Decision for the Final Vegetation Treatments Using Herbicides Programmatic Environmental Impact Statement [BLM 2007]); c. Monitoring and reporting standards annually during construction and following the completion of construction to describe trends in weed distribution and direct weed management measures, and; d. Reporting of monitoring and management efforts in annual reports and a final monitoring report completed at the end of 3 years of postconstruction monitoring. Copies of these reports will be provided to BLM for review and comment. BLM will use the results of these reports to determine whether any additional monitoring or control measures are necessary. Weed control will be ongoing on the Project Area for the life of the proposed Project, but plan success	Prepare, circulate, and implement an IWMP.	Prior to construction.	Project Applicant	BLM and San Bernardino County

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	will be determined by BLM after the 3 years of operations monitoring through the reporting and review process. Success criteria will be defined as having no more than a 10% increase in a weed species or in overall weed cover in any part of the Project Area.				
MM-BI-2.4	**Reclamation Plan**. At least 12 months prior to Project closure, the Project Applicant shall prepare a Reclamation Plan to restore the site's topography and hydrology to a relatively natural condition and to establish native vegetation communities within the Project Area. The Reclamation Plan shall include a cost estimate for implementing the proposed reclamation activities, and shall cover the estimated cost as though BLM were to contract with a third party to decommission the proposed Project and reclaim the Project Area. The plan shall be subject to review and revisions from the BLM Authorized Officer in consultation with USFWS and CDFW.	Develop and submit a Reclamation Plan.	12 months prior to Project closure.	Project Applicant	BLM; San Bernardino County; CDFW; USFWS
MM-BI-2.5	**Preconstruction Vegetation Salvage**. The Project Applicant shall provide a draft Vegetation Resources Management Plan detailing the methods for the salvage and transplantation of target succulent species covered under the CDNPA. The plan shall be submitted to CDFW and the BLM for review and approval at least 30 days prior to the start of ground-disturbing activities and shall include, at a minimum, the following elements: a. Soil baseline characterization. The characterization shall be presented to CDFW prior to ground disturbance and shall include: 1. Profile description of three representative pedons. (A pedon is the smallest three-dimensional sampling unit displaying the full range of characteristics of a particular soil and typically occupies an area ranging from about 1 to 10 square yards.) 2. Characterization of surface application (desert pavement or biological soil crust present). Description of biological soil crust shall include major groups of organisms identified at the site (filamentous cyanobacteria, other cyanobacteria, mosses, lichens, liverworts) and the characteristics by which they were identified (see item b, below). 3. Documentation of soil macro-invertebrates (that is, presence of ants, termites, and other significant macro-invertebrates).	Develop and submit a draft Vegetation Resources Management Plan.	Prior to ground-disturbing activities.	Project Applicant	BLM; San Bernardino County; CDFW

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	i. Bulk density, along with a reference to a generally accepted method for making the determination. ii. Fertility (nutrient status, electrical conductivity, sodium adsorption ratio), along with methods by which composite samples were collected and the laboratory methods used to determine these properties. Composite samples will contain equal contributions from at least six randomly located collection points within the soil donor area. iii. Organic matter content and total carbon and nitrogen content, along with a reference to generally accepted methods for making the determinations. 4. Soil compaction shall be determined by measurement of bulk density in grams per cubic centimeter (or numerically equivalent units). Bulk density may be determined by any of several standard measurements, but the method used must be referenced to a widely accepted soil methodology publication. In no case shall soil be compacted to a bulk density that exceeds 1.6 grams per cubic centimeter except where no planting is to take place. Penetrometer measurements are not a substitute for bulk density measurements. Once characterized, the top 3 inches of topsoil shall be salvaged from the areas where traditional grading will be used per the following protocol, and stored within the Project Area. The upper 0.25 inch may be collected separately to preserve biological crust organisms. Topsoil may not be distinguishable from subsoils by color or organic content at the time of salvage but is characterized as the layer that contains fine roots during the active growing season. Soil shall be collected, transported, and formed into stockpiles only while the soil is dry. The vegetation in place at or immediately before topsoil collection shall be healthy native vegetation with less than 15% absolute cover of exotic weed growth. Soil occupied by vegetation of high plant diversity shall be given priority over soil occupied by low-diversity native vegetation. Soil may be collected with a front loader, bulldozer, or scraper and transported to storage areas by front loader, dump truck, or scraper. The equipment transporting				

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	the soil may not travel across the stockpile more than the minimum number of times required to build the soil to its intended depth. The depth of the stockpiles shall not exceed 4 feet in the case of sandy loam or loamy sand soils. Topsoil stockpiles shall be kept dry and covered if no vegetation is introduced. If native vegetation is grown on the stockpiles to increase seeds and soil organisms, no cover is required. Artificial watering may be provided at the Project Applicant's option. Stockpiled topsoil shall be used to grow native plant species for the purpose of producing native seeds and building beneficial microorganisms in the soil volume. All native plant species encountered in the vegetation surveys shall be included in the growing rotation on the stockpiles. Most growing space needs to be dedicated to the species for which the most seeds shall be required. At least half by area of the growing area during each growing cycle shall be dedicated to plant species known to be good mycorrhizal host plants. Members of the families Chenopodiaceae and Amaranthaceae should be limited to less than half the area of the soil stockpiles, with the other half occupied by known mycorrhizal host plant species. b. Biological Soil Crust Characterization and Preservation. Biological soil crust is defined here as a mixture of organisms that occupy and protect the surface of the soil in most desert ecosystems. The organisms often include filamentous and non-filamentous cyanobacteria, mosses, lichens, liverworts, and fungi. Biological soil crust shall be preserved by collecting the upper 0.25 inch of topsoil from areas to be graded. The Project Applicant and/or its contractor(s) shall collect from specific areas known to contain biological crust organisms or collect upper soil from the entire area to be graded. Collections shall emphasize filamentous cyanobacteria, but other cyanobacteria, mosses, lichens, and liverworts are also considered valuable contributors to biological soil crust and important in protecting against erosion and reducing weed invasion, and shall be collected as a secondary priority. Soil surface crust shall be air dried and stored dry in a shaded location in containers that allow air movement, such as loose-weave fabric bags. In no case may the stored crust be subject to wetting or direct sunlight during storage. All				

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	containers shall be clearly labeled with date and location of original collection; name and contact information of persons responsible for identifying suitable material to collect; and the persons who collected, stored, and maintained collections. Biological soil crust shall be reapplied at the time of replanting by crumbling the stored material and broadcasting it on the surface of the soil. Approximately 10% of the stored material shall be broadcast on topsoil storage areas among plants being grown for seed and soil microorganisms. When the growing cycle progresses to new planting, the soil supporting biological crust shall be collected and stored by the same methods prescribed for collections from the original soil, in clearly labeled bags or other suitable containers. c. Succulent Transplant. The majority of the succulent plants located in areas to be dragged, rolled, or spot graded, or above mowing height, shall be salvaged and transplanted into a nursery area. The Succulent Transplant portion of the Vegetation Resources Management Plan shall include, at a minimum: 1. The location of target plants on the Project Area; 2. Criteria for determining which individual plants are appropriate for salvage; 3. The proposed methods for salvage, propagation, transport, and planting; 4. Procedures for identifying target species during preconstruction clearance surveys; 5. Considerations for storing salvaged plants or pre-planting requirements; and 6. Suggested transplantation sites. Succulents to be transplanted into the nursery area shall be placed in their same compass orientation as they were in their original location. The salvaged plants also shall be kept in long-term soil stockpiles, along with natives grown on the stockpiles, to keep the soil biota fresh. Succulent transplants done during preparation of the Project Area shall be fully documented and serve as trials of methods to be used during plant salvage on the Project Area. Records shall be maintained for each transplanted specimen including species; height; number of branches or pads as appropriate; donor location by UTM coordinates; methods used to remove, transport, and store the plant;				

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	period of temporary storage; location; facility description; planting medium used for storage; and frequency of watering during storage. Records shall be kept at the time of planting at the storage area, and quarterly thereafter during storage until such time as each plant is placed in the field or dies. Transplanted individuals shall be maintained for 3 years, including removal of invasive species and irrigation (if necessary), as well as monitored for 3 years to determine the percentage of surviving plants each year and to adjust maintenance activities using an adaptive management approach. d. Seed Collection. Seed collection shall be carried out within the ROW grant area and within 10 miles of the boundaries of the Project Area on similar terrain, soil, exposure, slope and elevation to the Project Area. Seed collection guidelines shall conform to all laws and regulations in effect at the time of collection. Seed collection shall include all plant species known to be removed from the facility. If insufficient seeds are provided by "seed farming" and collection within 10 miles of the site, CDFW may approve collection from a greater distance provided other environmental factors at the collection site are good matches to the Project Area. Collected seed may be used to seed salvaged topsoil piles during the construction phase and after decommissioning related to restoring the Project Area.				
MM-BI-3.1	The Project Proponent shall implement the following measures to avoid, minimize, and mitigate for direct and indirect impacts to waters of the State and to satisfy requirements of California Fish and Game Code Sections 1602 and the Porter-Cologne Water Quality Control Act. Details and final acreages will be determined through permitting process with the CDFW and RWQCB. a. The Project Proponent shall notify CDFW and RWQCB of unavoidable impacts to potentially jurisdictional aquatic resources through their respective SAA and Waste Discharge Requirements programs. b. To compensate for the loss of aquatic resources resulting from Project impacts by implementing off-site mitigation measures that ensure no net loss of aquatic functions and values, the Project Applicant shall implement Mitigation Measure MM-BI-3.1.b.1 OR MM-BI-3.1.b.2: 1. The Project Proponent shall purchase mitigation credits from a CDFW-approved mitigation bank that	Implement measures, notify CDFW and RWQCB of unavoidable impacts, and implement off-site mitigation.	Prior to and during Project construction, operations, and maintenance.	Project Applicant	BLM; San Bernardino County; CDFW; RWQCB

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	provides credits for similar aquatic resource types and functions as those ephemeral drainages impacted by the proposed Project. Mitigation credits shall include at least 9.75 acres of state waters (including 9.33 acres of RWQCB-regulated areas) or comparable area based on actual Project impacts to ephemeral drainages (depending upon the actual Project impacts) that meet 1:1 mitigation ratios for no net loss. The number of credits purchased shall be sufficient to fully offset the loss of aquatic resource functions and values. Mitigation for impacts to state waters shall occur as close to the Project Area as possible. Temporary impacts to 1.68 acres of CDFW-regulated areas (including 1.31 acres of RWQCB-regulated areas) will be replaced through a revegetation plan, or through purchasing mitigation credits, whichever is determined appropriate during permitting process. OR 2. The Project Proponent shall fund or undertake habitat creation or restoration activities at an off-site location. This will include restoring aquatic habitats to ensure the replacement of lost functions and values. The habitat creation or restoration site shall be selected based on its ecological suitability to ensure 1:1 mitigation ratios and no net loss. The Project Proponent shall develop and implement a monitoring plan to assess the success of the off-site mitigation over time. The monitoring plan report shall detail the success criteria including relative plant cover and timeframe in which the success criteria will be achieved. Reports detailing the progress and effectiveness of the mitigation efforts shall be prepared annually until the defined success criteria has been met. If monitoring indicates that the mitigation is not achieving the desired outcomes, the Project Proponent shall implement adaptive management strategies. Adaptive management strategies may include additional habitat enhancements, further monitoring, or other corrective actions. c. The Project Applicant shall comply with the following conditions to protect drainages which are not designated to be impacted by the proposed Project in and near the				

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	Project Area by implementing the following best management practices: 1. The Project Proponent shall minimize road building, construction activities and vegetation clearing within ephemeral drainages to the extent feasible. 2. The Project Proponent shall not allow water containing mud, silt, or other pollutants from Project activities to enter ephemeral drainages or be placed in locations that may be subjected to high storm flows. 3. Spoil sites shall be at least 50 feet from drainages or locations that may be subjected to high storm flows, where spoils might be washed back into drainages. 4. Any substances that could be hazardous to vegetation or wildlife resources, resulting from Project-related activities, shall be prevented from contaminating the soil and/or entering drainages. These materials, placed within or where they may enter a drainage by the Project Proponent or any party working under contract or with the permission of the Project Proponent, shall be removed immediately. 5. No equipment maintenance shall occur within 100 feet of any drainage where petroleum products or other pollutants from equipment may enter these areas under any flow.				
Cultural and Tribal Cultural Resources					
MM-CR-1.1	**Historical Resources Treatment Plan (HRTP).** A Historical Resources Treatment Plan (HRTP) shall be prepared and submitted for approval for California Register of Historical Resources (CRHR)-eligible cultural resources and tribal cultural resources. Treatment of cultural resources and tribal cultural resources shall follow the procedures established by State and local regulations. Avoidance, documentation, and/or data recovery will be used as mitigation alternatives. The HRTP shall be submitted to San Bernardino County for review and approval. As part of the HRTP, a research design and a scope of work shall be prepared for evaluation of cultural resources and data recovery investigations or additional treatment of CRHR-eligible sites or tribal cultural resources that cannot be avoided. Data recovery of most resources would consist of sample excavation and/or surface artifact collection, as well as site documentation. A possible exception would be a site or tribal cultural resource where burials, cremations, or sacred features are discovered that cannot be avoided. The HRTP	Retain a qualified Historic Preservation Professional to prepare and implement a HRTP.	Prior to the commencement of construction activities.	Project Applicant	BLM and San Bernardino County

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	shall define and map all known CRHR-eligible resources and tribal cultural resources and shall identify the cultural values that contribute to their CRHR eligibility and significance to the affiliated Tribes. A cultural resources protection plan shall be included in the HRTP that details how CRHR-eligible resources and tribal cultural resources will be avoided and protected during construction. Measures shall include, at a minimum, designation and marking of Environmentally Sensitive Areas (ESAs), cultural resource monitoring, and Worker Environmental Awareness Program (WEAP) training. The HRTP shall provide detailed provisions for cultural monitoring activities and include procedures for halting construction; making appropriate notifications to agencies, officials, and Native Americans; assessing CRHR eligibility in the event that unknown cultural resources are discovered during construction; and reporting requirements. For all unanticipated cultural resource and tribal cultural resource discoveries, the HRTP shall detail the methods, consultation procedures, and timelines for assessing CRHR eligibility, formulating a mitigation plan, and implementing treatment. Mitigation and treatment plans for unanticipated discoveries shall be approved by San Bernardino County, the Bureau of Land Management (if applicable), and Native American consulting Tribes prior to implementation. The HRTP shall include provisions for analysis of data in a regional context; reporting of results; the disposition of artifacts and data; and dissemination of reports to State and local repositories. The HRTP will be prepared and implemented by archaeologists and other discipline specialists conducting the studies that meet the Secretary of the Interior's Standards (per 36 Code of Federal Regulations 61).				
MM-CR-3.1	**Identification of Human Remains.** For human remains discovered on Bureau of Land Management (BLM)-administered land, a plan for securing the discovery site and subsequent actions shall be included in the Historical Resources Treatment Plan (HRTP) required under Mitigation Measure MM-CR-1.1. In the event of a discovery, the BLM must be contacted immediately and California Health and Safety Code (HSC) Section 7050.5 states that no further disturbance shall occur until San Bernardino County (County) Coroner has made the necessary findings as to origin. If the discovery is determined to be subject to the Native American Graves Protection and Repatriation Act (25 United States Code 3001 and 43 Code of Federal Regulations 10), the plan will describe the necessary process for	Cease work in the event of discovery and contact the BLM and County Coroner.	During ground-disturbing activities.	Project Applicant	BLM and San Bernardino County

Mitigation Measure	Requirements of Measure	Compliance Method	Verification Timing	Responsible Party	
				Implementation	Verification of Compliance
	notification of Tribes and subsequent steps as required by law and regulations. For human remains discovered on private lands, HSC Section 7050.5 states that no further disturbance shall occur until the County Coroner has made the necessary findings as to origin. Further, pursuant to California Public Resources Code (PRC) Section 5097.98(b), remains shall be left in place and free from disturbance until a final decision as to treatment and disposition has been made. If the County Coroner determines the remains to be Native American, the Native American Heritage Commission (NAHC) shall be contacted within the period specified by law. The NAHC shall identify the "Most Likely Descendant," who shall then make recommendations to and engage in consultation with the County and property owner concerning the treatment of the remains as provided in PRC Section 5097.98. The landowner may reach an agreement with the Most Likely Descendant for treating and disposing of human remains pursuant to State CEQA Guidelines Section 15064.5(d). Human remains from other ethnic/cultural groups with recognized historical associations to the Project Area shall also be subject to consultation between appropriate representatives from that group and the County.				
Greenhouse Gas Emissions					
MM-GHG-1.1	Before a building permit is issued, the Project Applicant must submit documentation to the San Bernardino County Land Use Services Department (Planning Division) demonstrating that design measures achieving at least 100 points, as outlined in Castle Mountain Mine Phase II Expansion Project Environmental Impact Report Table 4.8-6, have been incorporated into the Project design. These measures must be selected from Table 2, Screening Table for Implementing GHG Performance Standards for Commercial Development and Public Facilities, as specified in the San Bernardino County Regional Greenhouse Gas Reduction Plan Update (adopted September 2021).	Submit design documentation.	Prior to issuance of building permits.	Project Applicant	BLM and San Bernardino County