Appendix K. Geotechnical, Subsurface, Seismic, and Paleontological Resources Technical Report

SEPULVEDA TRANSIT CORRIDOR PROJECT

Geotechnical, Subsurface, Seismic, and Paleontological Technical Report

March 2025

Metro

SEPULVEDA TRANSIT CORRIDOR PROJECT

Contract No. AE67085000

Geotechnical, Subsurface, Seismic, and Paleontological Technical Report

Task 5.24.11

Prepared for:

Metro

Los Angeles County
Metropolitan Transportation Authority

Prepared by:

HTA PARTNERS
HNTB + TAHA + AECOM

777 S. Figueroa Street, Suite 2300
Los Angeles, California 90017

Review		
	Date	Name
Originator	3/17/2025	Jaime Guzman
Checker	3/17/2025	Nick Suarez
Backchecker/Updater	3/17/2025	Jaime Guzman
Verifier	3/17/2025	Nick Suarez
QA Review	3/17/2025	Aaron Grisel

March 2025

Table of Contents

Appendix

Figures

Tables

Abbreviations and Acronyms

APM	automated people mover
BMP	best management practice
BRT	Bus Rapid Transit
C/NR	Conservation and Natural Resources
Cal/OSHA	California Division of Occupational Safety and Health
Caltrans	California Department of Transportation
CBC	California Building Code
CCR	California Code of Regulations
CDWRSD	California Department of Water Resources, Southern District
CEQA	California Environmental Quality Act
CGP	Construction General Permit
CGS	California Geological Survey
CIDH	cast-in-drilled hole
CMP	Construction Management Plan
CoLA CEO	County of Los Angeles Chief Executive Officer
CPUC	California Public Utilities Commission
CWA	Clean Water Act
eGIS	Enterprise GIS
EIR	Environmental Impact Report
ExpressLanes project	I-405 Sepulveda Pass ExpressLanes project
FTA	Federal Transit Administration
FTIP	Federal Transportation Improvement Plan
g	gravity
GO	General Order
HRT	Heavy Rail Transit
HTA	HTA Partners
I-10	Interstate 10
I-405	Interstate 405
ICC	International Code Council
IGP	Industrial General Permit
J	Jurassic
Jsm	Santa Monica slate undivided
Jsmp	Santa Monica slate phyllite
Jsms	Santa Monica slate spotted slate
K	Cretaceous
Kt	Cretaceous tonalite

LACM	Natural History Museum of Los Angeles County Paleontological Locality Prefix
LADWP	City of Los Angeles Department of Water and Power
LASRE	LA SkyRail Express
LAX	Los Angeles International Airport
LHZ	Landslide Hazard Zone
LID	Low Impact Development
LOSSAN	Los Angeles-San Diego-San Luis Obispo Rail Corridor
LRT	Light Rail Transit
M	Richter Magnitude
MDE	maximum design earthquake
Metro	Los Angeles County Metropolitan Transportation Authority
MM	mitigation measure
mm/year	millimeters per year
MMI	Modified Mercalli Intensity
MOW	maintenance-of-way
MRDC	Metro Rail Design Criteria
MRT	monorail transit
MRZ	Mineral Resource Zone
MSF	maintenance and storage facility
M_w	Moment Magnitude
NEH	National Engineering Handbook
NEHRP	National Earthquake Hazards Reduction Program
NHMLAC	Natural History Museum of Los Angeles County
NOP	Notice of Preparation
NPDES	National Pollutant Discharge Elimination System
OAERP	Operational Area Emergency Response Plan
ODE	operating design earthquake
OSHA	Occupational Safety and Health Administration
PRC	Public Resources Code
PRIMP	Paleontological Resources Impact Mitigation Program
Project	Sepulveda Transit Corridor Project
PTASP	Public Transportation Agency Safety Plan
Q	Quaternary
Qa	Alluvium
Qof2	Old alluvial fan deposits, unit 2
Qya2	Young alluvium, unit 2
Qyf1	Young alluvial fan deposits, unit 1
Qyf2	Young alluvial fan deposits, unit 2

ROW	right-of-way
RSA	Resource Study Area
S	Safety
SCAG	Southern California Association of Governments
SCEDC	Southern California Earthquake Data Center
SCORE	Southern California Optimized Rail Expansion
SCR	Stone Canyon Reservoir
SDC	Seismic Design Criteria
SMARA	Surface Mining and Reclamation Act
State Mining and Geology Board	California Department of Conservation State Mining and Geology Board
STCP	Sepulveda Transit Corridor Partners
SUSMP	Standard Urban Storm Water Mitigation Plan
SVP	Society of Vertebrate Paleontologists
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
SZ	Scientific Resource Zone
T	Tertiary
TBM	tunnel boring machine
Tm	Modelo Formation undivided
Tmd	Modelo Formation diatomaceous shale
Tms	Modelo Formation sandstone
TPSS	Traction Power Substation
Tt	Modelo Formation Topanga Group undivided
UCLA	University of California, Los Angeles
U.S.	United States
US-101	U.S. Highway 101
USCR	Upper Stone Canyon Reservoir
USGS	United States Geological Survey
VA	U.S. Department of Veterans Affairs
Valley	San Fernando Valley
VHFHZ	Very High Fire Hazard Severity Zone
WEAP	Workers Environmental Awareness Program
Westside	Westside of Los Angeles

1 INTRODUCTION

1.1 Project Background

The Sepulveda Transit Corridor Project (Project) is intended to provide a high-capacity rail transit alternative to serve the large and growing travel market and transit needs currently channeled through the Sepulveda Pass and nearby canyon roads between the San Fernando Valley (Valley) and the Westside of Los Angeles (Westside). The Project would have a northern terminus with a connection to the Van Nuys Metrolink/Amtrak Station and a southern terminus with a connection to the Los Angeles County Metropolitan Transportation Authority's (Metro) E Line. In addition to providing local and regional connections to the existing and future Metro rail and bus network, the Project is anticipated to improve access to major employment, educational, and cultural centers in the greater Los Angeles area.

In 2019, Metro completed the Sepulveda Transit Corridor Feasibility Study and released the Project's *Final Feasibility Report* (Metro, 2019), which documented the transportation conditions and travel patterns in the Sepulveda corridor; identified mobility problems affecting travel between the Valley and the Westside; and defined the Purpose and Need, goals, and objectives of the Project. Using an iterative evaluation process, the Feasibility Study identified feasible transit solutions that met the Purpose and Need, goals, and objectives of the Project. The Feasibility Study determined that a reliable, high-capacity, fixed guideway transit system connecting the Valley to the Westside could be constructed along several different alignments. Such a transit system, operated as either heavy rail transit (HRT) or monorail transit (MRT), would serve the major travel markets in the Sepulveda Transit corridor and would provide travel times competitive with the automobile.

1.2 Project Alternatives

In November 2021, Metro released a Notice of Preparation (NOP) of an Environmental Impact Report (EIR) pursuant to the California Environmental Quality Act, for the Project that included six alternatives (Metro, 2021). Alternatives 1 through 5 included a southern terminus station at the Metro E Line Expo/Sepulveda Station, and Alternative 6 included a southern terminus station at the Metro E Line Expo/Bundy Station. The alternatives were described in the NOP as follows:

- Alternative 1: Monorail with aerial alignment in the Interstate 405 (I-405) corridor and an electric bus connection to the University of California, Los Angeles (UCLA)
- Alternative 2: Monorail with aerial alignment in the I-405 corridor and an aerial automated people mover connection to UCLA
- Alternative 3: Monorail with aerial alignment in the I-405 corridor and underground alignment between the Getty Center and Wilshire Boulevard
- Alternative 4: Heavy rail with underground alignment south of Ventura Boulevard and aerial alignment generally along Sepulveda Boulevard in the San Fernando Valley
- Alternative 5: Heavy rail with underground alignment including along Sepulveda Boulevard in the San Fernando Valley
- Alternative 6: Heavy rail with underground alignment including along Van Nuys Boulevard in the San Fernando Valley and a southern terminus station on Bundy Drive

The NOP also stated that Metro is considering a No Project Alternative that would not include constructing a fixed guideway line. Metro established a public comment period of 74 days, extending from November 30, 2021 through February 11, 2022. Following the public comment period, refinements to the alternatives were made to address comments received. Further refinements to optimize the designs and address technical challenges of the alternatives were made in 2023 following two rounds of community open houses.

In July 2024, following community meetings held in May 2024, Alternative 2 was removed from further consideration in the environmental process because it did not provide advantages over the other alternatives, and the remaining alternatives represent a sufficient range of alternatives for environmental review, inclusive of modes and routes (Metro, 2024a). Detailed descriptions of the No Project Alternative and the five remaining "build" alternatives are presented in Sections 5 through 10.

1.3 Project Study Area

Figure 1-1 shows the Project Study Area. It generally includes Transportation Analysis Zones from Metro's travel demand model that are within 1 mile of the alignments of the four "Valley-Westside" alternatives from the *Sepulveda Transit Corridor Project Final Feasibility Report* (Metro, 2019). The Project Study Area represents the area in which the transit concepts and ancillary facilities are expected to be located. The analysis of potential impacts encompasses all areas that could potentially be affected by the Project, and the EIR will disclose all potential impacts related to the Project.

1.4 Purpose of this Report and Structure

This technical report examines the environmental impacts of the Project as it relates to geotechnical, subsurface, seismic, and paleontological conditions. It describes existing geotechnical, subsurface, seismic, and paleontological conditions in the Project Study Area, the regulatory setting, methodology for impact evaluation, and potential impacts from operation and construction of the project alternatives, including maintenance and storage facility (MSF) site options.

The report is organized according to the following sections:

- Section 1 Introduction
- Section 2 Regulatory and Policy Framework
- Section 3 Methodology
- Section 4 Future Baseline Projects
- Section 5 No Project Alternative
- Section 6 Alternative 1
- Section 7 Alternative 3
- Section 8 Alternative 4
- Section 9 Alternative 5
- Section 10 Alternative 6
- Section 11 Preparers of the Technical Report
- Section 12 References

Appendix A: Paleontological Technical Memorandum is an appendix to this report which this report relies upon to evaluate the environmental impacts of the Project as it relates to paleontology. The appendix also describes existing paleontological conditions in the Project Study Area, the regulatory setting, methodology for impact evaluation, and potential impacts from operation and construction of the Project Alternatives including MSF site options. While this report evaluates elements related to paleontological resources, details are elaborated in Appendix A.

Figure 1-1. Sepulveda Transit Corridor Project Study Area

Source: HTA, 2024

2 REGULATORY AND POLICY FRAMEWORK

2.1 Federal

2.1.1 United States Code Title 42

Federal law codified in the United States (U.S.) Code Title 42, Chapter 86 (Earthquake Hazard Reduction Act of 1977) was enacted to reduce the risks to life and property from earthquakes in the U.S. through the establishment and maintenance of an effective earthquake hazards reduction program. Implementation of these requirements are regulated, monitored, and enforced at the state and local levels.

2.1.2 United States Code of Federal Regulations Title 29 Part 1926. 650

The Occupational Safety and Health Administration's (OSHA) Excavation and Trenching standard, outlined in Title 29 Code of Federal Regulations (CFR) Part 1926.650, establishes essential safety requirements to protect workers involved in excavation and trenching operations, which are among the most hazardous construction activities. This standard mandates that all excavations five feet or deeper must have protective systems unless made entirely of stable rock. Employers are responsible for implementing protective measures, such as sloping, shoring, or using trench boxes, to prevent cave-ins and ensure safe egress through ladders or ramps. The standard also includes requirements for inspections by a competent person to assess soil stability and recognize potential hazards, including water accumulation or nearby structures that could increase risk. Compliance with these regulations aims to prevent accidents, injuries, and fatalities commonly associated with excavation and trenching work.

2.1.3 National Earthquake Hazards Reduction Program

The National Earthquake Hazards Reduction Program (NEHRP) was established in 1977 and is a joint effort involving multiple federal agencies, including the Federal Emergency Management Agency, the National Institute of Standards and Technology, the National Science Foundation, and the United States Geological Survey (USGS). These agencies collaborate to advance the understanding of earthquake hazards, develop earthquake-resistant design and construction standards, and promote public education on earthquake preparedness. The program's primary objective is to improve the nation's earthquake resilience through extensive research and development, as well as implementation of risk reduction measures.

NEHRP provides scientific and engineering information necessary for developing building codes and standards that ensure the safety and resilience of structures in earthquake-prone areas. The program supports research on the causes and effects of earthquakes, which informs the creation of technical guidance and best practices for seismic design and construction. Additionally, NEHRP's efforts in public education and outreach help communities understand and mitigate earthquake risks, thereby enhancing overall public safety and reducing economic losses from seismic events.

2.1.4 National Engineering Handbook

The National Engineering Handbook (NEH) serves as a comprehensive guide for the planning, design, and implementation of engineering practices that support conservation efforts. Specifically, the Section 8 of the NEH emphasizes the importance of understanding geologic, hydrogeologic, and geomorphic processes, conditions, and hazards. These guidelines help identify and mitigate potential geologic hazards, ensuring that engineering projects do not adversely impact the environment. The NEH supports the classification and designation of significant geological features. Additionally, this section ensure that the physical and engineering properties of earth materials are properly characterized to protect public health, safety, welfare, and the environment. The NEH outlines responsibilities for geologists and engineers, detailing the necessary qualifications and procedures for conducting geologic investigations. This includes adherence to standards set by recognized entities such as the American Geological Institute.

2.2 State

2.2.1 Alquist-Priolo Earthquake Fault Zoning Act

The purpose of the Alquist-Priolo Earthquake Fault Zoning Act of 1972 is “to regulate development near active faults so as to mitigate the hazard of surface fault rupture.” This state law was passed in response to the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures. At the directive of the Alquist-Priolo Earthquake Fault Zoning Act, in 1972 the State Geologist began delineating earthquake fault zones (called special studies zones prior to 1994) around active and potentially active faults to reduce fault-rupture risks to structures for human occupancy (California Public Resources Code [PRC] Division 2, Chapter 7.5, Sections 2621 through 2630). The Alquist-Priolo Earthquake Fault Zoning Act provides for special seismic design considerations if developments are planned in areas that are adjacent to active or potentially active faults. Cities and counties affected by the zones must regulate certain development within the zones. The cities and counties must withhold development permits for sites within the zones until geologic investigations demonstrate that the sites are not threatened by surface displacement from future faulting. Typically, structures for human occupancy are not allowed within generally 50 feet of the trace of an active fault.

2.2.2 California Building Code

California Code of Regulations (CCR), Title 24, Part 2, the California Building Code (CBC), provides minimum standards for building design in California. The 2022 CBC, effective on January 1, 2023, is based on the current (2021) International Building Code that is published by the International Code Council (California Building Standards Commission, 2022). Each jurisdiction in California may adopt its own building code based on the 2022 CBC. Local codes are permitted to be more stringent than the 2022 CBC, but at a minimum, the codes are required to meet all state standards and enforce the regulations of the 2022 CBC beginning on January 1, 2023.

2.2.2.1 Chapter 16 – Structural Design:

This chapter establishes minimum design requirements so that the structural components of buildings are proportioned to resist the loads that are likely to be encountered. In addition, this chapter assigns buildings and structures to risk categories that are indicative of their intended use for buildings and structures, including guidelines for loads (e.g., live, dead, wind, snow, and earthquake loads). It includes design standards to ensure structural integrity, safety, and stability under various stressors, tailored for California's seismic activity and other regional factors.

Related to geohazards, Chapter 16 of the CBC deals with structural design requirements governing seismically resistant construction (Section 1604) and includes (but is not limited to) factors and coefficients that are used to establish the seismic site class and seismic occupancy category for the soil(s) or rock(s) at the building location and the proposed building design.

2.2.2.2 Chapter 18 – Soils and Foundations:

This chapter provides criteria for geotechnical and structural considerations in the selection, design and installation of foundation systems to support the loads imposed by the structure above. It addresses issues like bearing capacity, soil classification, load-bearing values, and foundation types. Requirements are set to mitigate risks from soil instability, expansive soils, and seismic activity, crucial in California's diverse geology.

Chapter 18 includes (but is not limited to) the requirements for foundation and soil investigations (Section 1803); excavation, grading, and fill (Section 1804); allowable load-bearing values of soils (Section 1806); and the design of footings, foundations, and slope clearances (Sections 1808 and 1809), retaining walls (Section 1807), and pier, pile, driven, and cast-in-place (CIP) foundation support systems (Section 1810).

2.2.2.3 Chapter 33 – Safeguards During Construction:

Chapter 33 covers safety protocols to protect public health and property during construction activities. It includes regulations on temporary structures, demolition, excavations, and ensuring safe access around construction sites. This chapter aims to minimize risks associated with construction hazards.

Chapter 33 includes (but is not limited to) requirements for safeguards at work sites to ensure stable excavations and cut or fill slopes (Section 3304).

2.2.2.4 Appendix J – Grading:

Appendix J offers guidelines for grading, which includes excavation, filling, and earthwork. It defines grading permit requirements, inspections, and standards to control erosion, manage stormwater, and ensure site stability. This appendix is essential for managing the environmental and safety impacts of grading, especially in areas prone to landslides or erosion.

Appendix J includes (but is not limited to) grading requirements for the design of excavations and fills (Sections J106 and J107) and for erosion control (Section J110).

Construction activities are subject to occupational safety standards for excavation, shoring, and trenching, as specified in California Division of Occupational Safety and Health (Cal/OSHA) regulations (CCR Title 8).

2.2.3 California Department of Transportation Seismic Design Criteria (2019)

The *California Department of Transportation (Caltrans) Seismic Design Criteria (SDC) Version 2.0*, last updated in 2019, sets comprehensive seismic design requirements to ensure the resilience and safety of bridges and other structures within Caltrans' right-of-way (ROW). These criteria apply specifically to new bridges on the California State Highway System, aiming to withstand California's high seismic activity. The SDC synthesizes and organizes critical seismic design guidelines from Caltrans' Division of Engineering Services (DES) publications, addressing aspects like structural response, ductility, displacement, and load resistance during earthquakes.

Key features of the SDC include provisions for soil-structure interaction, pier and abutment design, and foundation requirements to mitigate seismic forces. The SDC allows for various construction methods, such as CIP and precast construction, including Accelerated Bridge Construction (ABC) techniques to speed up project timelines while maintaining structural integrity. The SDC also emphasizes "no-collapse" requirements, ensuring that bridges maintain at least minimal functionality immediately after seismic events to facilitate emergency response and traffic flow. Furthermore, the SDC mandates rigorous testing and analysis for performance-based design, requiring detailed evaluations of seismic risk factors for specific bridge sites, such as proximity to fault lines and soil composition, to tailor seismic resistance measures.

ABC refers to innovative construction techniques and project management strategies aimed at reducing the time needed to construct or replace bridges. ABC involves the use of prefabricated bridge components (such as beams, decks, and abutments), advanced construction materials, and sometimes entirely modular bridge systems that can be quickly assembled on-site. By preparing components off-site and then transporting and installing them in a short period, ABC significantly minimizes disruption to traffic, enhances safety for workers and travelers, and can lower overall project costs.

2.2.4 California Division of Occupational Safety and Health

Cal/OSHA enforces safety and health regulations for construction activities under Title 8 of the CCR, aiming to protect workers from hazards on construction sites. Title 8 covers a wide range of safety requirements, including rules for scaffolding, electrical safety, fall protection, confined spaces, excavation, shoring, trenching, and hazardous materials. These tasks require stringent protective measures to prevent cave-ins, equipment accidents, and exposure to hazardous materials. Cal/OSHA's Title 8 standards encompass requirements for scaffolding, electrical safety, fall protection, confined spaces, and handling hazardous substances, ensuring robust safeguards for construction workers. The agency inspects job sites, investigates accidents, and issues citations for non-compliance, with particular emphasis on tasks like fall prevention and trench safety. Additionally, Cal/OSHA provides training, outreach, and educational resources, and often exceeds federal OSHA standards.

2.2.5 Public Resources Code Section 5097.5 and Section 30244

PRC Sections 5097.5 and 30244 prohibit the removal of any paleontological site or feature from public lands without permission of the jurisdiction agency, define the removal of paleontological sites or features as a misdemeanor, and require reasonable mitigation of adverse impacts to paleontological resources from development on public (state, county, city, district) lands.

2.2.6 Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act became effective in 1990 to identify and map seismic hazard zones for the purpose of assisting cities and counties in preparing the safety elements of their general plans and to encourage land use management policies and regulations that reduce seismic hazards. This act protects the public from the effects of strong ground shaking, liquefaction, landslides, ground failure, or other hazards caused by earthquakes. In addition, California Geological Survey (CGS) Special Publication 117A, *Guidelines for Evaluating and Mitigating Seismic Hazards in California*, provides guidance for the evaluation and mitigation of earthquake-related hazards for projects in designated zones of required investigations (CGS, 2008).

2.2.7 State of California National Pollutant Discharge Elimination System

In accordance with Clean Water Act (CWA) Section 402(p), which regulates municipal and industrial stormwater discharges under the National Pollutant Discharge Elimination System (NPDES) program, State Water Resources Control Board (SWRCB) adopted an Industrial General Permit (IGP) and Construction General Permit (CGP), which are detailed in this section. The Los Angeles County Metropolitan Transportation Authority (Metro) would be responsible for compliance with both of these NPDES permits.

Amendments made to the CWA in 1987 require that stormwater associated with industrial activities that discharge either directly to surface waters or indirectly through municipal storm sewers must be regulated by an NPDES permit (Water Quality Order No. 2014-0057-DWQ, and amendments 2015-0122-DWQ and 2018-0028-DWQ [SWRCB Division of Water Quality]) (SWRCB, 2014). In order to obtain authorization for stormwater discharges associated with industrial activities under this permit, the facility operator must submit a Notice of Intent. The Project would be subject to the regulations of this NPDES permit under category 8 of the categories that require coverage under the IGP. Category 8 includes "vehicle maintenance shops, equipment cleaning operations, or airport deicing operations." Only those portions of the facility involved in vehicle maintenance (including vehicle, rehabilitation, mechanical repairs, painting, fueling, and lubrication) would be covered under this permit.

As with the IGP, the SWRCB administers the CGP, which is applicable to all stormwater discharges associated with construction activity. In addition, the CGP includes requirements on dewatering discharge. The NPDES General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (the CGP) was adopted on September 8, 2022. The provisions of the new CGP (Order No. 2022-0057-DWQ, NPDES No. CAS000002 [SWRCB Division of Water Quality]) (SWRCB, 2022a) became effective September 1, 2023. Order No. 2022-0057-DWQ supersedes the previous CGP (Order No. 2009-0009-DWQ).

The main objectives of the CGP are to:

- Reduce erosion from construction projects or activities
- Minimize or eliminate sediment in stormwater discharges from construction projects
- Prevent materials used at a construction site from contacting stormwater
- Implement a sampling and analysis program to monitor construction site runoff
- Eliminate unauthorized non-stormwater discharges from the construction sites
- Implement appropriate measures to reduce potential impacts on waterways both during and after construction projects
- Establish maintenance commitments on post-construction pollution control measures

The CGP requirements apply to any construction project that either result in the disturbance of at least one acre of land or is part of a larger common development plan. Additionally, the CGP is required for related construction or demolition activities, including clearing, grading, grubbing, or excavation, or any other activity that results in greater than one acre of land disturbance (SWRCB, 2022a).

Minimum stormwater control requirements under the permit are determined by project risk categories. Risk categories include the sediment risk factor and the receiving water risk factor. The sediment risk factor and the receiving water risk factor are combined to determine a construction site's project risk level. The project risk level governs the applicable minimum best management practices (BMPs), monitoring requirements, reporting requirements, and the effluent standards used to assess monitoring data and compliance.

Once the project risk level is determined, minimum BMP requirements are specified in attachments to the CGP. BMPs are separated into five overall categories:

- Good Site Management "Housekeeping"
- Non-stormwater Management

- Erosion Control
- Sediment Controls
- Run-on and Runoff Controls

Monitoring and reporting requirements under the permit are also dependent on the project risk level. Visual monitoring of stormwater and non-stormwater discharges is required of all projects. Water quality sampling and analysis requirements increase with risk category. Monitoring is required during normal construction site hours. Rain events also trigger monitoring in the case that there is a forecast of a 50 percent or greater probability of precipitation and a quantitative precipitation forecast of one-half inch or more within a period of 24 hours.

The CGP requires that a registered Qualified Stormwater Pollution Prevention Plan (SWPPP) Developer (QSD) prepare a SWPPP, and a registered QSD, Qualified SWPPP Practitioner (QSP), and/or a properly trained and supervised QSP delegate perform inspections, sampling, and BMP implementation.

In order to obtain coverage under the CGP, the permit applicant must submit the following documents to the SWRCB:

- Notice of Intent
- Risk Assessment
- Site Map
- Stormwater Pollution Prevention Plan
- Annual Fee
- Signed Certification Statement

2.2.7.1 California Department of Transportation National Pollutant Discharge Elimination System Permit

The California Department of Transportation (Caltrans) is subject to the NPDES *Statewide Stormwater Permit and Waste Discharge Requirement*s (WDR) for the State of California Department of Transportation (Order No. 2022-0033-DWQ, NPDES No. CAS000003) (SWRCB, 2022b) that regulates the discharge of construction- and post-construction phase stormwater from Caltrans properties, facilities, and activities. The Caltrans NPDES permit applies to those portions of the Project Study Area that are under the jurisdiction of Caltrans.

Redevelopment projects within the Caltrans right-of-way (ROW) are subject to construction site BMPs and would be required to comply with the *Construction Site Best Management Practices (BMP) Manual* (Caltrans, 2017) to control and minimize the impacts of construction-related activities. The Construction Site BMP Manual incorporates the requirements of the Caltrans NPDES Statewide Stormwater Permit and the CGP. Post-construction phase stormwater from the portions of the Project under the jurisdiction of Caltrans would also be required to comply with the *Project Planning and Design Guide* (Caltrans, 2023) and related requirements in accordance with the Caltrans NPDES Statewide Stormwater Permit for incorporating treatment BMPs. In addition, the Caltrans NPDES permit includes policies and requirements for maintaining drainage systems, including culverts, to protect roadways from flooding. This includes modifications and/or removal and replacement of these systems.

In compliance with the Caltrans Statewide Stormwater Permit, the Caltrans Statewide Stormwater Management Plan addresses stormwater pollution control related to Caltrans activities, including planning, design, construction, maintenance, and operation of roadways and facilities to reduce or eliminate the discharge of pollutants to storm drain systems and receiving waters. The Statewide

Stormwater Management Plan addresses discharges resulting from stormwater, as well as non-stormwater discharges, including illicit discharges, authorized non-stormwater discharges, and initial emergency response activities. The Statewide Stormwater Management Plan requires implementation of stormwater management procedures and practices including training, public education, monitoring, program evaluation, and reporting activities, in addition to the implementation of construction BMPs to reduce or eliminate pollutants from construction sites.

The *I-405 Stormwater Quality Master Plan* (Caltrans, 2008) was prepared in response to a Stipulation and Order (Case No. 93-6073-ER [JRX]) signed by the U.S. District Court on January 17, 2008, which mandates stormwater management studies to be prepared on the Caltrans District 7 drainage systems for freeway corridors situated in Los Angeles and Ventura Counties. In order to meet the Stipulation and Order, the I-405 Stormwater Quality Master Plan evaluates and identifies potential opportunities to include treatment BMPs (e.g., infiltration devices, media filters, detention devices, biofiltration strips, biofiltration swales) in the I-405 corridor.

2.2.8 Surface Mining and Reclamation Act

The state adopted the Surface Mining and Reclamation Act (SMARA) PRC Section 2710 et seq. with the primary objectives being the assurance of adequate supplies of mineral resources important to California's economy and the reclamation of mined lands. The agencies responsible for administering this program at the state level are the CGS and the California Department of Conservation State Mining and Geology Board (State Mining and Geology Board). The objectives of the SMARA are implemented by local government agencies, with the assistance of the state, through land use planning and regulatory programs. The SMARA's mineral resource conservation objective is achieved through a mineral inventory and land use planning process termed classification/designation, which jointly involves the CGS, the State Mining and Geology Board, and local government. The CGS develops information on the location of important mineral deposits through a process of mineral land classification. State Mining and Geology Board then uses the classification report in designating deposits that are of economic significance to a region, the state, or the nation (California Department of Conservation, State Mining and Geology Board, 2022).

2.2.9 Public Resources Code Section 2762

PRC Section 2762 of the SMARA states that within 12 months of receiving the mineral information described in Section 2761, and also within 12 months of designating an area of statewide or regional significance within its jurisdiction, every lead agency shall, in accordance with state policy, establish mineral resource management policies to be incorporated in the lead agency's general plan that will recognize mineral information classified by the State Geologist (California Legislative Information, 2023a and 2023b). This will assist in managing areas of statewide and regional significance and help emphasize the conservation and development of identified mineral deposits.

2.2.10 California State Division of Mines and Geology Board Mineral Resource Management Goals and Policies

In addition to the informal guidance provided by the previously referenced sections of the SMARA, the California State Division of Mines and Geology Board has prepared "Mineral Resource Management Goals and Policies," which, in accordance with the SMARA, provide additional guidance in the preparation of California's Mineral Resource Management Program. These goals and policies are achieved through a joint effort between the CGS, the State Division of Mines and Geology Board, and local government (i.e., the City of Los Angeles).

2.2.11 Public Resources Code Sections 5097.5 and 30244

PRC Sections 5097.5 and 30244 prohibit the removal of any paleontological site or feature from public lands without permission of the jurisdiction agency, define the removal of paleontological sites or features as a misdemeanor, and require reasonable mitigation of adverse impacts to paleontological resources from development on public (state, county, city, district) lands.

2.3 Regional

2.3.1 County of Los Angeles General Plan – Safety Element

The purpose of the *County of Los Angeles General Plan*, Safety (S) Element (LA County Planning, 2022a) is to reduce the potential risk of death, injuries, property damage, economic loss, and social dislocation resulting from natural and human-made hazards. The Safety Element works in conjunction with the Operational Area Emergency Response Plan (OAERP). The following goals and policies of the *County of Los Angeles General Plan's*, Safety Element address geotechnical, subsurface, and seismicity topics:

- **Goal S 1** – An effective regulatory system that prevents or minimizes personal injury, loss of life, and property damage due to seismic and geotechnical hazards.
  - **Policy S 1.1** – Discourage development in Seismic Hazard and Alquist-Priolo Earthquake Fault Zones.
  - **Policy S 1.2** – Prohibit construction of structures of human occupancy adjacent to active faults unless a comprehensive fault study that addresses seismic hazard risks and proposes appropriate actions to minimize the risk is approved.
  - **Policy S 1.3** – Require developments to mitigate geotechnical hazards, such as soil instability and landslides, in Hillside Management Areas through siting and development standards.
  - **Policy S 1.4** – Support the retrofitting of unreinforced masonry structures and soft-story buildings to help reduce the risk of structural and human loss due to seismic hazards.

2.3.2 County of Los Angeles Code, Title 26 – Building Code

The County of Los Angeles has adopted the 2022 CBC, with local changes as part of the County of Los Angeles Code, Title 26, Building Code. Chapter 1, Section 111 (Engineering Geology and Soils Engineering Reports) addresses engineering geology or soils engineering reports to address safety of a site from hazards such as landslides, settlement, or slippage, and a finding regarding the effect. Section 112 (Earthquake Fault Maps) and Section 113 (Earthquake Faults) address requirements and regulations for buildings or structures within earthquake fault zones. Chapter 18 addresses soils and foundations requirements and regulations (County of Los Angeles, 2023).

2.3.3 County of Los Angeles Chief Executive Office – Operational Area Emergency Response Plan

The County of Los Angeles, Chief Executive Office - Office of Emergency Management prepares the OAERP, which addresses the County of Los Angles operational area's coordinated response to emergency situations associated with natural, human-made, and technological incidents. The OAERP does not address normal day-to-day emergencies; the operational concepts reflected in this plan focus on potential large-scale disasters that can generate unique situations that require an unusual or extraordinary emergency response. The OAERP establishes the coordinated emergency management system, which includes prevention, protection, response, recovery, and mitigation within the operational area. This plan describes the emergency organization, authorities, and responsibilities of the operational area emergency organization and the mutual aid process during emergencies to ensure effective coordination of needed resources (CoLA CEO, 2012).

2.3.4 County of Los Angeles All-Hazards Mitigation Plan

In 2020, the County of Los Angeles prepared an *All-Hazards Mitigation Plan* (CoLA CEO, 2020) to identify the County of Los Angeles's hazards, review and assess past disaster occurrences, estimate the probability of future occurrences, and set goals to reduce or eliminate long-term risk to people and property from natural hazards. Potential hazards evaluated by the *All-Hazards Mitigation Plan* include hazards resulting from earthquake, flooding, wildfires, tsunami, landslide, dam failure, and climate change.

2.3.5 Los Angeles County Metropolitan Transportation Authority – Public Transportation Agency Safety Plan

The *Public Transportation Agency Safety Plan* (PTASP) addresses all requirements and standards as set forth in Federal Transit Administration's (FTA) Public Transportation Safety Program and the *National Public Transportation Safety Plan*, in addition to adhering to requirements of the California Public Utilities Commission (CPUC) (Metro, 2020). The LA Metro Board of Directors approved Version 1.3 of the PTASP in January of 2024 (Metro, 2024b).

CPUC General Order (GO) 143-B, Section 14.05, requires the establishment of a track inspection and maintenance program. All rail system tracks must be inspected and maintained in accordance with CPUC GO 143-B, Section 14.05. In addition to these track-specific requirements, the CPUC GO 164 series requires rail transit agencies to conduct annual internal safety reviews of compliance with their PTASPs. The internal safety review evaluates both qualitative and quantitative aspects of performance. In addition, every three years, the CPUC conducts a review of the rail transit agency's safety programs and compliance with applicable safety standards. For new projects, rail transit agencies must obtain safety certification from the CPUC to ensure that all safety requirements are met before the project begins service. This safety certification process includes CPUC review of design, construction, testing, and operational readiness. All design and construction will be done using the *American Railway Engineering and Maintenance of Way Association Manual* as a guideline, as required by CPUC GO 143-B, Section 9.01.

As a result, frequent track inspection is performed to identify potential safety hazards and to report on the changing conditions of track geometry. For example, previous projects have accommodated this objective by inspecting mainline track twice each week with at least a one-day interval between inspections. Track geometry and fit is inspected for obvious gage and alignment defects, improper ballast section and washouts, and tightness and proper fit of switch points and other moving parts. Rail is checked for cracks, deterioration, corrugation, and excessive wear. The ROW is inspected for vegetation growth and for possible clearance infringements.

Under requirements of the CPUC GO 164 series, the annual PTASP internal safety review reviews and evaluates state of California required elements of the PTASP on an on-going basis and is completed over a three-year cycle. The internal safety review evaluates both qualitative and quantitative aspects of performance.

2.3.6 Los Angeles County Metropolitan Transportation Authority - Rail Design Criteria

The Los Angeles County Metropolitan Transportation Authority (Metro) Rail Design Criteria (MRDC) incorporates various design specifications from the Federal Highway Administration, Caltrans, State of California, County of Los Angeles, and other sources by reference. The MRDC is applicable to Alternative 6 and an equivalent to the MRDC guidance is required for Alternatives 1, 3, 4, and 5. Section 5 of the MRDC provides specifications for structural and geotechnical work and governs all matters pertaining to the design of Metro-owned facilities, including the following:

- Bridges
- Aerial guideways
- Cut-and-cover subway structures
- Tunnels
- Passenger stations
- Earth-retaining structures
- Surface buildings
- Miscellaneous structures such as culverts, sound walls, and equipment enclosures
- Other non-structural and operationally critical components and facilities supported on or inside Metro structures

These criteria also establish the design parameters for temporary structures. The main reference document controlling the seismic design of Metro facilities under these criteria is the *Section 5 Appendix, Metro Supplemental Seismic Design Criteria (SSDC)* (Metro, 2015). Section 5.3 of the MRDC provides specifications for aerial guideways and structures. Section 5.4 provides specifications for underground structures used for rail transit. Section 5.6 requires subsurface investigation and laboratory testing, geotechnical reporting and temporary excavation, and detailed foundation design requirements to address geological hazards.

Per MRDC, Section 5.5.1, the criteria and codes specified in MRDC shall govern all matters pertaining to the design of Metro-owned facilities including bridges, elevated rail guideways, underground structures, trenches, stations, earth-retaining structures, surface buildings, miscellaneous structures such as culverts, sound walls, and equipment enclosures, and other non-structural and operationally critical components and facilities supported on or inside Metro structures. These criteria also establish the design parameters for temporary structures. The Metro SSDC outlined in the MRDC Section 5 appendix (Metro, 2017) provides seismic design guidelines for structures including aerial guideways and bridges, underground structures, tunnels, and surface structures. The Metro SSDC follows a two-level ground motion approach for the seismic design of structures: Operating Design Earthquake (ODE) and Maximum Design Earthquake (MDE). The ODE is defined as an earthquake event likely to occur only once in the design life where structures are designed to respond without significant damage, and MDE is defined as an earthquake event with a low probability of occurring in the design life where structures are designed to respond with repairable damage and to maintain a life-safety-performance level (no collapse) of structural elements (Metro, 2017). Current Metro design criteria is based on probabilistic seismic ground motion criteria; the design earthquake motions are defined as:

- ODE: 50 percent probability of exceedance in 100 years, design return period of 150 years.
- MDE: 4 percent probability of exceedance in 100 years, design return period of 2,500 years.

Seismic design of aerial and surface structures is based on site-specific ODE and MDE horizontal ground surface 5 percent damped acceleration response spectra developed using the USGS Unified Hazard Tool

(USGS, 2022). Based on the Metro SSDC, acceleration response spectrum (ARS) for rail transit structures should not result in less performance capability than that required by Caltrans ARS. The Metro SSDC also considers seismic design based on Caltrans SDC (Caltrans, 2019) for rail transit structures. The seismic design of surface structures and aboveground structures not subject to rail transit loading should comply with the requirements of the CBC and the site-specific ODE and MDE horizontal ground motions per Metro's SSDC (2017). SSDC outlined in the MRDC Section 5 appendix (Metro, 2017) provides seismic design for ground and embankment stability. The appendix recommends the seismic stability and potential permanent deformation of sloping ground or embankments supporting aerial guideway and bridges along proposed alignments be investigated. The appendix also provides guidance for liquefaction studies to assess the potential for liquefaction.

2.3.7 Los Angeles County Metropolitan Transportation Authority – Systemwide Station Design Standards Policy

The Metro System Safety Program Plan (SSPP) outlines comprehensive safety management protocols for Metro's rail and bus operations, developed in compliance with federal and state regulations. The SSPP covers a range of critical safety elements, including hazard identification, risk assessment, and emergency response procedures. It is structured to ensure the safety of passengers, employees, and contractors through a combination of engineering controls, operational guidelines, and ongoing training. Furthermore, the SSPP includes guidelines for inspections, maintenance protocols, and safety audits to prevent and mitigate risks. These efforts are coordinated across departments to ensure compliance with safety standards, such as those set by the FTA and CPUC.

2.3.8 Los Angeles County Metropolitan Transportation Authority – Tunnel Advisory Panel

Metro requires the formation of a Tunnel Advisory Panel (TAP) for major transit tunnel projects as part of its commitment to safety, reliability, and transparency in underground construction. The TAP provides expert oversight to assess and mitigate risks associated with tunneling, including technical issues like ground stability and environmental considerations. This advisory group includes geotechnical and structural engineers, construction experts, and environmental specialists who review tunnel design, construction methods, and mitigation strategies to reduce potential hazards.

2.3.9 County of Los Angeles General Plan – Conservation and Natural Resources Element

The purpose of the *County of Los Angeles General Plan*, Mineral and Energy Resources section of the Conservation and Natural Resources (C/NR) Element (LA County Planning, 2022b) is to address the use and management of valuable mineral resources in the unincorporated areas, and the importance of sustaining and maintaining these resources for future users. The following goals and policies of the *County of Los Angeles General Plan's*, Conservation and Natural Resources Element address mineral resources:

- **Goal C/NR 10** – Locally available mineral resources to meet the needs of construction, transportation, and industry.
  - **Policy C/NR 10.1** – Protect Mineral Resource Zones (MRZ)-2s and access to MRZ-2s from development and discourage incompatible adjacent land uses.
  - **Policy C/NR 10.2** – Prior to permitting a use that threatens the potential to extract minerals in an identified MRZ, the County shall prepare a statement specifying its reasons for permitting the proposed use and shall forward a copy to the State Geologist and the State Mining and Geology Board for review, in accordance with the PRC, as applicable.

- **Policy C/NR 10.3** – Recognize newly identified MRZ-2s within 12 months of transmittal of information by the State Mining and Geology Board.
- **Policy C/NR 10.4** – Work collaboratively with agencies to identify MRZs and to prioritize mineral land use classifications in regional efforts.
- **Policy C/NR 10.5** – Manage mineral resources in a manner that effectively plans for access to and development and conservation of mineral resources for existing and future generations.
- **Policy C/NR 10.6** – Require that new non-mining land uses adjacent to existing mining operations be designed to provide a buffer between the new development and the mining operations. The buffer distance shall be based on an evaluation of noise, aesthetics, drainage, operating conditions, biological resources, topography, lighting, traffic, operating hours, and air quality.

Goals and policies related to paleontological resources within the *County of Los Angeles General Plan's* Conservation and Natural Resources Element are discussed in detail in Appendix A.

2.4 Local

2.4.1 City of Los Angeles General Plan – Safety Element

The Safety Element of the *City of Los Angeles General Plan* (DCP, 2021) addresses the issue of protecting its people from unreasonable risks associated with disasters (e.g., fires, floods, and earthquakes). The Safety Element is a contextual framework for understanding the relationship between hazard mitigation, response to a natural disaster, and initial recovery from a natural disaster. The Safety Element sets forth the following policy that is applicable to the Project for geology, soil, and seismicity:

- **Policy 1.1.8** Land Use – Consider hazard information and available mitigations when making decisions about future land use. Maintain existing low density and open space designations in Very High Fire Hazard Severity Zones (VHFHSZ). Ensure mitigations are incorporated for new development in hazard areas such as VHFHSZs, landslide areas, flood zones and in other areas with limited adaptive capacity.

2.4.2 City of Los Angeles Municipal Code - Los Angeles City Building Code

The City of Los Angeles adopted the 2022 CBC within the Los Angeles City Building Code 2022. The Los Angeles City Building Code 2022 is a portion of the City of Los Angeles Municipal Code. The purpose of the Los Angeles City Building Code 2022 is to safeguard the public by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of all buildings and structures within the City of Los Angeles (City of Los Angeles, 2022). Chapters 18/18A address soils and foundations, and Chapter 70 addresses grading, excavations, and fills. Chapters 91 through 96 address earthquake hazard reduction for tilt-up concrete wall buildings, wood-frame buildings, hillside buildings, reinforced concrete buildings, and masonry buildings.

2.4.3 Los Angeles Building Code, Article 4, Public Benefit Projects

The applicant shall retain an independent construction monitor, approved by the Department of Building and Safety (DBS), who shall be responsible for monitoring implementation of the construction standards. The construction monitor shall also prepare documentation of the applicant's compliance with the construction standards during construction every 90 days in a form and manner satisfactory to the DBS. The documentation must be signed by the applicant and the construction monitor. DBS shall verify that the applicant has or will (by having an appropriately qualified expert(s) under contract as may be necessary) comply with the construction standards prior to issuance of any permits.

(i) No pile driving shall be allowed unless required due to geological conditions. Where piles are needed, they shall be installed through quiet techniques such as vibratory piles.

(ii) If excavating below previously excavated depths, the applicant shall have appropriately qualified experts use all reasonable methods, consistent with professional standards, to determine the potential that archaeological resources, paleontological resources or unique geological feature (resources) are present on the project site, including through record searches and surveys. If a qualified expert determines there is a medium to high potential that resources are on the project site and the project has the potential to impact resources, the qualified expert(s) shall monitor and direct any excavation, grading or construction activities to identify resources and avoid potential impacts to resources.

(iii) If archaeological resources, paleontological resources, or unique geological features (resources) are discovered during excavation, grading or construction activities, applicant shall cease work in the area of discovery until a qualified expert has evaluated the find and the City has taken any necessary measures to preserve and protect the find in accordance with federal, state and local law and guidelines.

2.4.4 City of Los Angeles Local Hazard Mitigation Plan

The City of Los Angeles developed *a Local Hazard Mitigation Plan* (City of Los Angeles, 2018) to reduce risks from disasters to the people, property, economy, and environment within the City of Los Angeles. The *City of Los Angeles Local Hazard Mitigation Plan* is the use the use of long-term and short-term policies, programs, projects, and other activities to alleviate the death, injury, and property damage that can result from a disaster. The *Local Hazard Mitigation Plan* is incorporated as a component of the Safety Element to illustrate the *Safety Element's* adherence to state requirements. Potential hazards evaluated by the *Local Hazards Mitigation Plan* include hazards resulting from earthquake, flooding, wildfires, tsunami, landslide, dam failure, and other potential hazards.

2.4.5 City of Los Angeles General Plan – Conservation Element

The Conservation Element of the *City of Los Angeles General Plan* (DCP, 2001) sets forth the following policies that are applicable to the Project for mineral resources:

- **Policy 1** – Continue to implement the provisions of the California Surface Mining and Reclamation Act (Public Resources Code Section 2710 et seq.) so as to establish extraction operations at appropriate sites; to minimize operation impacts on adjacent uses, ecologically important areas (e.g., the Tujunga Wash), and ground water; to protect the public health and safety; and to require appropriate restoration, reclamation, and reuse of closed sites.
- **Policy 2** – Continue to encourage the reuse of sand and gravel products, such as concrete, and the use of alternative materials in order to reduce the demand for extraction of natural sand and gravel.

The Conservation Element of the *City of Los Angeles General Plan* also recognizes paleontological resources in Section 3: "Archaeological and Paleontological" (II-3), and identifies protection of paleontological resources as an objective (II-5), stating (DCP, 2001):

"Pursuant to CEQA, if a land development project is within a potentially significant paleontological area, the developer is required to contact a bona fide paleontologist to arrange for assessment of the potential impact and mitigation of potential disruption of or damage to the site. If significant paleontological resources are uncovered during project excavation, authorities are to be notified and the designated paleontologist may order excavations stopped, within reasonable time limits, to enable assessment, removal, or protection of the resources."

3 METHODOLOGY

3.1 Geology, Soils, Seismicity, Mineral and Paleontological Resources

The purpose of this assessment is to evaluate the Project against thresholds of significance as the basis for determining the level of impacts related to geology, soils, seismicity, mineral and paleontological resources. The Project was evaluated against Appendix G of the California Environmental Quality Act (CEQA) Guidelines.

The method for assessing the geologic and seismic impacts involved reviewing available published and unpublished literature, and consultants' reports within the project area for known geologic hazards. Documents included:

- *County of Los Angeles General Plan* (LA County Planning, 2022a)
- *City of Los Angeles General Plan* (DCP, 2021)
- *County of Los Angeles All-Hazards Mitigation Plan* (CoLA CEO, 2020)
- *City of Los Angeles 2018 Local Hazard Mitigation Plan* (City of Los Angeles, 2018)
- *Official Alquist-Priolo Earthquake Fault Zone Maps*
- *Seismic Hazard Zone Maps*
- *Geologic and topographic maps,*
- *Other publications by the California Geological Survey*

Geologic impacts pertain primarily to construction activities. Operational impacts of the Project are considered in the context of seismic and/or other geological hazards to residents, employees, and visitors. Adherence to design and construction standards, as required by state and local regulations, would ensure maximum practicable protection for users of the buildings and associated infrastructure. Potential effects related to mineral resources were evaluated through a review of mineral resource locations, as identified by the *County of Los Angeles General Plan* and the *City of Los Angeles General Plan*.

Paleontological resources are defined by the Society of Vertebrate Paleontology (2010) as "fossils and fossiliferous deposits, here defined as consisting of identifiable vertebrate fossils, large or small, uncommon invertebrate, plant, and trace fossils, and other data that provide taphonomic, taxonomic, phylogenetic, paleoecologic, stratigraphic, and/or biochronologic information. Paleontological resources are considered to be older than recorded human history and/or older than middle Holocene (i.e., older than about 5,000 radiocarbon years)."Potential effects related to paleontological resources were evaluated through record searches of the Natural History Museum of Los Angeles County (NHMLAC), and the review of professional paleontological publications. Further details regarding the paleontological record search and literature review are provided in Appendix A.

3.2 Resource Study Area

The Resource Study Area (RSA) for geotechnical, subsurface, and seismic conditions is the Project Study Area. Given the nature of geological formations and seismic systems, the RSAs for both are defined distinctly. The RSA for soils and geology is defined as the project footprint (composed of all underground and aboveground features). Geologic formations exposed within the RSA can be found in Table 3-1. The RSA for seismicity, however, is the entirety of Southern California. This relatively large scale is due to the fault system that spans multiple miles and that is typically connected to a system of multiple faults. As such, a seismic activity in one part of a region often affects structures (underground and aboveground) many miles away.

The RSA for paleontological resources is defined as the area necessary to construct, operate, and maintain the Project Alternatives, and includes all proposed ROW and acquisition and construction areas, and all parcels adjacent to permanent site improvements and facilities, including tunnel boring machine (TBM) launch sites, stations, and power substations; parking facilities; and maintenance yards and buildings. For paleontological resources, this includes areas where temporary or permanent ground disturbance may occur. Typically, the RSA extends out from the alignment from one to three parcels, depending on parcel sizes, intervening landscape, and buildings, and whether the historic land use is sensitive to the proposed change in setting. The RSA for paleontological resources is documented on a series of maps provided in Attachment 1.

Where potential geological hazards are identified, such hazards would be expected to affect any proposed development in the hazard area. In *California Building Industry v. Bay Area Air Quality Management District* (2015) 62 Cal.4th 369, the California Supreme Court clarified that CEQA does not generally require an analysis of the impacts of the existing environment on a proposed project, but rather focuses on the potential impacts of the project on the environment. As it pertains to geology and soils, this ruling means that while CEQA requires an assessment of how the Project might exacerbate existing geological conditions – such as increasing erosion potential or causing instability – it does not mandate an analysis of how existing geological hazards, such as earthquakes or landslides, might affect the project itself. Instead, those considerations are typically addressed through compliance with state and local building codes and safety standards, such as those set forth in the CBC, which are designed to minimize risks to future users. Therefore, this Draft Environmental Impact Report's (DEIR) analysis of geology, soils, and seismicity focuses on evaluating the potential for the Project to contribute to adverse environmental effects. Adherence to design and construction standards, as required by state and local regulations, would ensure maximum practicable protection for users of buildings and associated infrastructure, including the aerial and underground alignments.

Adherence to design and construction standards, as required by state and local regulations, would ensure maximum practicable protection for users of the buildings and associated infrastructure. The potential increased geologic hazards resulting from development under the proposed Project were evaluated against the sample initial study checklist in Appendix G of the CEQA Guidelines, as well as the existing goals and policies of the *County of Los Angeles General Plan* (County of Los Angeles, 2022a), the *City of Los Angeles General Plan* (City of Los Angeles, 2021), and the *County of Los Angeles All-Hazard Mitigation Plan* (County of Los Angeles CEO, 2020) and the *City of Los Angeles Local Hazard Mitigation Plan* (City of Los Angeles, 2018).

Table 3-1. Geologic Units Within the Study Area

Geologic Map Unit	Description	Age
Qf	Artificial Fill	Recent
Qa	Very young alluvium	Holocene
Qya_2	Young alluvium – unit 2	Holocene
Qof_2	Older alluvial fan deposits – unit 2	Pleistocene
Qof_1	Older alluvial fan deposits – unit 1	Pleistocene
Qom	Older shallow marine deposits	Pleistocene
Qls	Quaternary landslide debris	Pleistocene
Qvoa	Very old alluvium	Pleistocene
Tmud	Modelo Formation – Undivided	Miocene
Tmd	Modelo Formation – Diatomaceous Shale Member	Miocene
Tmss	Modelo Formation – Sandstone	Miocene
Tt	Topanga Group – Undivided	Miocene
Kt	Tonalite	Cretaceous
Jsm	Santa Monica Slate – Undivided	Late Jurassic
Jsms	Santa Monica Slate – Spotted slate	Late Jurassic
Jsmp	Santa Monica Slate – Phyllite	Late Jurassic

Source: Campbell et al., 2016

3.3 CEQA Thresholds of Significance

For the purposes of this technical report, geology and soils impacts are considered significant if the Project would:

- Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:
  - Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault. Refer to Division of Mines and Geology Special Publication 42.
  - Strong seismic ground shaking.
  - Seismic-related ground failure, including liquefaction.
  - Landslides.
- Result in substantial soil erosion or the loss of topsoil.
- Be located on a geographic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse.
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property.
- Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

For the purposes of this technical report, mineral resources impacts are considered significant if the Project would:

- Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state.
- Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan.

For the purposes of this technical report, paleontological resources impacts are considered significant if the Project would:

- Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

4 FUTURE BACKGROUND PROJECTS

This section describes planned improvements to highway, transit, and regional rail facilities within the Project Study Area and the region that would occur whether or not the Project is constructed. These improvements are relevant to the analysis of the No Project Alternative and the project alternatives because they are part of the future regional transportation network within which the Project would be incorporated. These improvements would not be considered reasonably foreseeable consequences of not approving the Project as they would occur whether or not the Project is constructed.

The future background projects include all existing and under-construction highway and transit services and facilities, as well as the transit and highway projects scheduled to be operational by 2045 according to the *Measure R Expenditure Plan* (Metro, 2008), the *Measure M Expenditure Plan* (Metro, 2016), the Southern California Association of Governments (SCAG) *Connect SoCal, 2020-2045 Regional Transportation Plan/Sustainable Communities Strategy* (2020-2045 RTP/SCS) (SCAG, 2020a, 2020b), and the Federal Transportation Improvement Program (FTIP), with the exception of the Sepulveda Transit Corridor Project (Project). The year 2045 was selected as the analysis year for the Project because it was the horizon year of SCAG's adopted RTP/SCS at the time Metro released the NOP for the Project.

4.1 Highway Improvements

The only major highway improvement in the Project Study Area included in the future background projects is the Interstate 405 (I-405) Sepulveda Pass ExpressLanes project (ExpressLanes project). This would include the ExpressLanes project as defined in the *2021 FTIP Technical Appendix, Volume II of III* (SCAG, 2021a), which is expected to provide for the addition of one travel lane in each direction on I-405 between U.S. Highway 101 (US-101) and Interstate 10 (I-10). Metro is currently studying several operational and physical configurations of the ExpressLanes project, which may also be used by commuter or rapid bus services, as are other ExpressLanes in Los Angeles County.

4.2 Transit Improvements

Table 4-1 lists the transit improvements that would be included in the future background projects. This list includes projects scheduled to be operational by 2045 as listed in the *Measure R and Measure M Expenditure Plans* (with the exception of the Project) as well as the Inglewood Transit Connector and LAX APM. In consultation with the Federal Transit Administration, Metro selected 2045 as the analysis year to provide consistency across studies for Measure M transit corridor projects. The Inglewood Transit Connector, a planned automated people mover (APM), which was added to the FTIP with *Consistency Amendment #21-05* in 2021, would also be included in the future background projects (SCAG, 2021b). These projects would also include the Los Angeles International Airport (LAX) APM, currently under construction by Los Angeles World Airports. The APM will extend from a new Consolidated Rent-A-Car Center to the Central Terminal Area of LAX and will include four intermediate stations. In addition, the new Airport Metro Connector Transit Station at Aviation Boulevard and 96th Street will also serve as a direct connection from the Metro K Line and Metro C Line to LAX by connecting with one of the APM stations.

During peak hours, heavy rail transit (HRT) services would generally operate at 4-minute headways (i.e., the time interval between trains traveling in the same direction), and light rail transit (LRT) services would operate at 5- to 6-minute headways. During off-peak hours, HRT services would generally operate at 8-minute headways and LRT services at 10- to 12-minute headways. Bus rapid transit (BRT) services would generally operate at peak headways between 5 and 10 minutes and off-peak headways between

10 and 14 minutes. The Inglewood Transit Connector would operate at a headway of 6 minutes, with more frequent service during major events. The LAX APM would operate at 2-minute headways during peak and off-peak periods.

Table 4-1. Fixed Guideway Transit System in 2045

Transit Line	Mode	Alignment Description[a]
Metro A Line	LRT	Claremont to downtown Long Beach via downtown Los Angeles
Metro B Line	HRT	Union Station to North Hollywood Station
Metro C Line	LRT	Norwalk to Torrance
Metro D Line	HRT	Union Station to Westwood/VA Hospital Station
Metro E Line	LRT	Downtown Santa Monica Station to Lambert Station (Whittier) via downtown Los Angeles
Metro G Line	BRT	Pasadena to Chatsworth[b]
Metro K Line	LRT	Norwalk to Expo/Crenshaw Station
East San Fernando Valley Light Rail Transit Line	LRT	Metrolink Sylmar/San Fernando Station to Metro G Line Van Nuys Station
Southeast Gateway Line	LRT	Union Station to Artesia
North San Fernando Valley Bus Rapid Transit Network Improvements	BRT	North Hollywood to Chatsworth[c]
Vermont Transit Corridor	BRT	Hollywood Boulevard to 120th Street
Inglewood Transit Connector	APM	Market Street/Florence Avenue to Prairie Avenue/Hardy Street
Los Angeles International Airport APM	APM	Aviation Boulevard/96th Street to LAX Central Terminal Area

Source: HTA, 2024

[a]Alignment descriptions reflect the project definition as of the date of the Project's Notice of Preparation (Metro, 2021).

[b]As defined in Metro Board actions of July 2018 and May 2021, the Metro G Line will have an eastern terminus near Pasadena City College and will include aerial stations at Sepulveda Boulevard and Van Nuys Boulevard.

[c]The North San Fernando Valley network improvements are assumed to be as approved by the Metro Board in December 2022.

4.3 Regional Rail Projects

The future background projects would include the Southern California Optimized Rail Expansion (SCORE) program, which is Metrolink's Capital Improvement Program that will upgrade the regional rail system (including grade crossings, stations, and signals) and add tracks as necessary to be ready in time for the 2028 Olympic and Paralympic Games. The SCORE program will also help Metrolink to move toward a zero emissions future. The following SCORE projects planned at Chatsworth and Burbank Stations will upgrade station facilities and allow 30-minute all-day service in each direction by 2045 on the Metrolink Ventura County Line:

1. Chatsworth Station: This SCORE project will include replacing an at-grade crossing and adding a new pedestrian bridge and several track improvements to enable more frequent and reliable service.
2. Burbank Station: This SCORE project will include replacing tracks, adding a new pedestrian crossing, and realigning tracks to achieve more frequency, efficiency, and shorter headways.

In addition, the Link Union Station project will provide improvements to Los Angeles Union Station that will transform the operations of the station by allowing trains to arrive and depart in both directions, rather than having to reverse direction to depart the station. Link Union Station will also prepare Union Station for the arrival of California High-Speed Rail, which will connect Union Station to other regional multimodal transportation hubs such as Hollywood Burbank Airport and the Anaheim Regional Transportation Intermodal Center.

5 NO PROJECT ALTERNATIVE

The only reasonably foreseeable transportation project under the No Project Alternative would be improvements to Metro Line 761, which would continue to serve as the primary transit option through the Sepulveda Pass with peak-period headways of 10 minutes in the peak direction and 15 minutes in the other direction. Metro Line 761 would operate between the Metro E Line Expo/Sepulveda Station and the Metro G Line Van Nuys Station, in coordination with the opening of the East San Fernando Valley Light Rail Transit Line, rather than to its current northern terminus at the Sylmar Metrolink Station.

5.1 Existing Conditions

5.1.1 Regional Geology

The No Project Alternative includes the northwestern portion of the Los Angeles Basin, including the Santa Monica Mountains, and the south and central portions of the San Fernando Valley. The No Project Alternative includes portions of three distinct geographies: the San Fernando Valley, the Santa Monica Mountains, and the Los Angeles Basin.

The Project Study Area is within two geologic provinces (City of Los Angeles, 2018):

- The northern portion of the No Project Alternative would be located within the Transverse Ranges geomorphic province.
- The southern portion of the No Project Alternative would be located within the Los Angeles Basin, which is the northern-most basin of the Peninsular Ranges geomorphic province.

5.1.1.1 Transverse Ranges Geomorphic Province

The Transverse Ranges geomorphic province is composed of several mountain ranges oriented in an east–west direction and extends over 320 miles from the Mojave and Colorado Desert Provinces to Point Arguello at the Pacific Ocean. Included within the Transverse Ranges are portions of Riverside, San Bernardino, Los Angeles, and Ventura Counties. Acting as a northern boundary, the Transverse Ranges truncate the northwest-trending structural grain of the Peninsular Ranges geomorphic province. Most active faults in the Transverse Ranges are east–west-trending faults. Rock types in this province include gneiss, granitic rocks, and sedimentary rocks. Volcanic rocks are found in the Santa Monica Mountains. Alluvial sediments are typically in canyon bottoms and valleys, with broad alluvial fans at the mouths of steep canyons (City of Los Angeles, 2018).

5.1.1.2 Peninsular Ranges Geomorphic Province

The Peninsular Ranges geomorphic province, composed of multiple mountain ranges and valleys, extends southward 775 miles past the United States-Mexico border. The Peninsular Ranges geomorphic province extends southward from the southern edge of the Transverse Ranges geomorphic province to the tip of Baja California in Mexico. The Peninsular Ranges are characterized by northwest–southeast trending hills and valleys that are separated by similarly trending faults. Most active faults in the Peninsular Ranges province are northwest trending. Rock types in this province in the City of Los Angeles region generally include schist and sedimentary rocks. Surface materials in canyon bottoms and basins generally consist of alluvium (City of Los Angeles, 2018).

5.1.1.3 San Fernando Valley

The San Fernando Valley is a triangular east–west-trending structural depression located within the Transverse Ranges geomorphic province. The Transverse Ranges province trends east–west from the offshore Channel Islands (Santa Rosa, Santa Cruz, Anacapa, etc.) to the eastern Mojave Desert. The province is characterized by east–west-trending mountain ranges (such as the Santa Monica Mountains, San Gabriel Mountains, and San Bernardino Mountains) separated by similar trending intermontane valleys. The San Fernando Valley is bordered on the east by the Verdugo Mountains, on the north by the San Gabriel and Santa Susana Mountains, on the west by the Simi Hills, and on the south by the Santa Monica Mountains. The mountains that bound the San Fernando Valley are actively deforming anticlinal ranges bounded by thrust faults. Because the ranges have risen and deformed, the valley has subsided and accumulated sediment to create the elongated basin (Metro, 2023a).

5.1.1.4 Santa Monica Mountains

The Santa Monica Mountains are an east–west-trending linear mountain range within the western Transverse Ranges geomorphic province. Major east-trending folds, reverse faults, and left-lateral, strike-slip faults reflect regional north–south compression and are characteristic of the Transverse Ranges. The Santa Monica Mountains are being actively uplifted along a series of segmented frontal reverse faults (Malibu Coast fault, Santa Monica fault, and Raymond fault) on the south side of the range that extend from Arroyo Sequit in the west to Glendale in the east. This fault system is aligned with the Santa Cruz Island fault. The Los Angeles Basin on the southern side of the range is one of a series of basins forming a transition zone between the Transverse Ranges and the northwest–southeast-trending Peninsular Ranges geomorphic province to the south (Metro, 2023a).

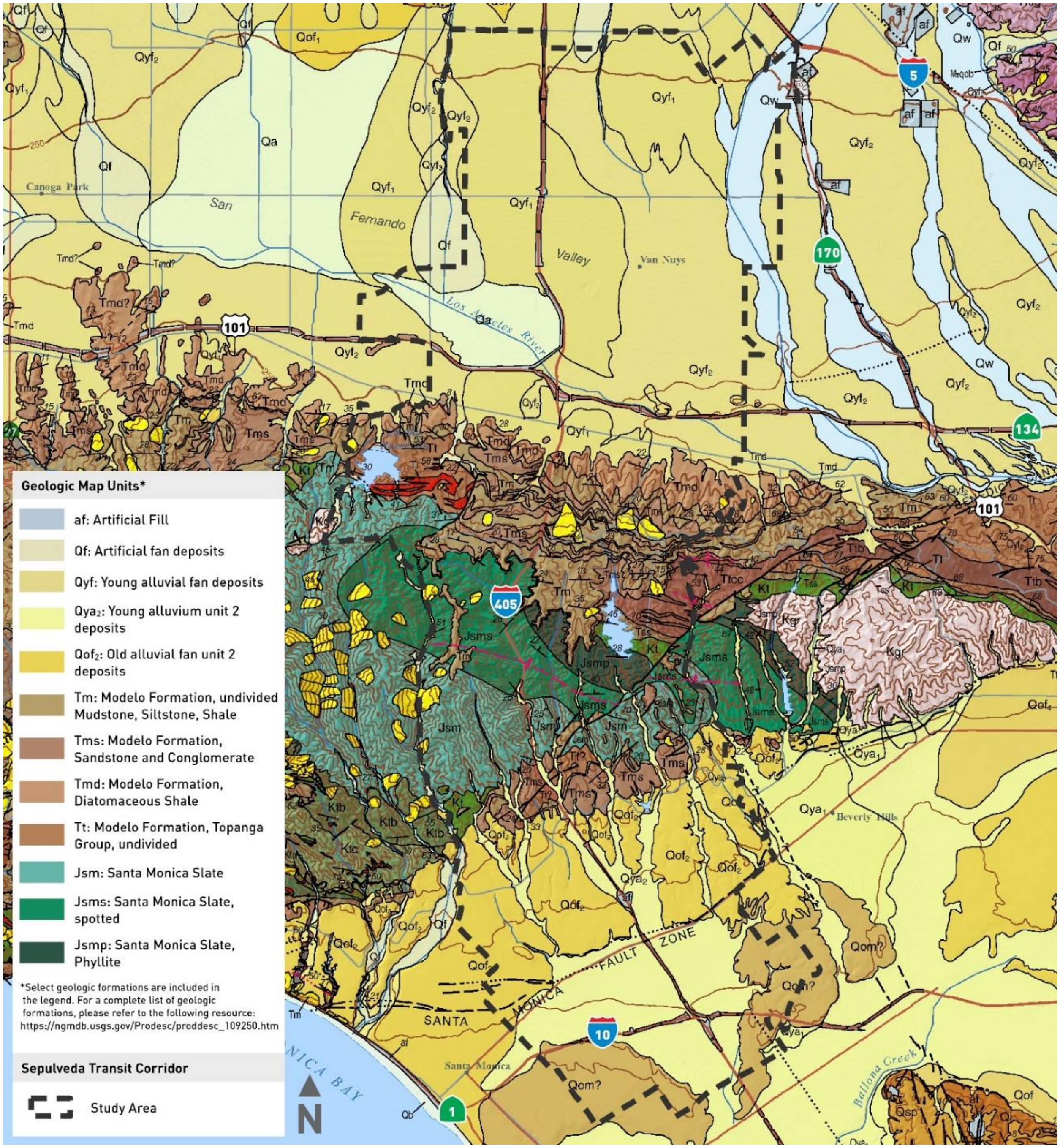
5.1.1.5 Los Angeles Basin

The Los Angeles Basin is a large low-lying coastal plain bordered by the Santa Monica Mountains on the north, the Repetto and Puente Hills on the northeast, the Santa Ana Mountains on the east, and the San Joaquin Hills on the south. The western margin of the basin is open to the Pacific Ocean except for one prominent hill: the Palos Verdes Peninsula. The floor of the Los Angeles Basin is a relatively flat surface that rises gently from sea level along the coastline to an apron of uplifted terrain along the base of the surrounding mountains, which rise abruptly to a few thousand feet above the plain. The flat basin floor is interrupted in a few localities by small hills, the most prominent of which are a northwest–southeast-trending alignment of hills and mesas that extend from the Newport Beach area on the south to the Beverly Hills area on the north (Metro, 2023a).

5.1.2 Project Site Soil Types and Characteristics

Figure 5-1 shows the geologic features of the Project Study Area. The No Project Alternative is generally underlain by nearly horizontal Quaternary sediments overlying Tertiary-age sediments and sedimentary rocks. All the geologic units within the No Project Alternative have been deformed into folds and offset by faults. The sedimentary strata lap onto the Santa Monica Slate that forms the core of the Santa Monica Mountains; bedrock units on the south flank generally dip southerly and bedrock units on the north flank generally dip northerly. Along the higher elevations within the No Project Alternative, particularly through the Santa Monica Mountains, sedimentary and metamorphic bedrock are exposed at the surface with some localized colluvial and alluvial soils within tributary valleys.

Figure 5-1. No Project Alternative: Geologic Units



Source: USGS, 2016; HTA 2024

Alluvial deposits are found in the valley/basin portions of the Project Study Area, including the areas north and south of the Santa Monica Mountains. The San Fernando Valley to the north is underlain by up to 2,000 feet of alluvial sediment, with Cretaceous-aged crystalline bedrock below the alluvium (Metro, 2023a).

The Project Study Area is directly underlain by unconsolidated, Quaternary-age, sandy sediments. The soil could be subdivided into loose, unconsolidated, Holocene-age sediments, which cover the bulk of the basin, and late-Pleistocene materials, which comprise the surface over much of the uplifts of the Newport Inglewood Structural Zone and the marginal plains. Lithified and crystalline rocks occur only in the mountains surrounding the basins and at depths ranging from about 5,000 feet to as much as 30,000 feet in the deepest part of the central basin.

The lithologic units exposed along the No Project Alternative include artificial fill, landslide debris, young and old alluvium, and bedrock most commonly associated with the Modelo Formation and Santa Monica Slate. Much of I-405 and associated improvements are underlain by artificial fill associated with the construction of I-405. Young and old alluvial fan and stream deposits are found predominantly along the northern and southern sides of the Santa Monica Mountains. These surficial units are generally composed of unconsolidated to poorly to moderately consolidated sediments of Holocene to Pleistocene ages and are found either at the surface or buried under the fill associated with I-405 (Metro, 2023a).

5.1.2.1 Artificial Fill

Artificial fill (af) is comprised of silty sand, a mixture of moist, brown and gray, silty sand of fine-grained to coarse-grained composure. Some clay or gray pockets may be observed. The most commonly observed lithology for the No Project Alternative is typically at the ground surface (Metro, 2023a).

5.1.2.2 Modelo Formation

The Modelo Formation (Tm, Tms, Tmd) is a late Miocene-age sedimentary bedrock that generally consists of gray to brown, thinly bedded mudstone, and shale and siltstone, with interbeds of very fine-grained to coarse-grained sandstone. The most commonly observed lithology for the No Project Alternative is near I-405, with thinly bedded shale to shaley siltstone with interbeds of fine sandstone. Additionally, localized diatomaceous shale and siltstone with interbeds of bentonite and fine sandstone are within the formation (Metro, 2023a).

5.1.2.3 Old Alluvial Fan Deposits

Older (late to middle Pleistocene) alluvial fan deposits (Qof), which form the Santa Monica Plain, are mapped along the southern edge of the Santa Monica Mountains. They continue in the subsurface in the Los Angeles Basin. These sediments were deposited by stream channels that had flowed southward from the Santa Monica Mountains during the late Pleistocene. They consist of a thick series of alluvial fans that spread out southward from the mountain front toward the ocean. These deposits are described by Campbell et al. (2016) as moderately consolidated, silt, sand, and gravel deposits on alluvial fans.

5.1.2.4 Santa Susana Formation

The Paleocene Santa Susana Formation (Tss), which underlies the Topanga Formation, is exposed in the slopes bordering the west side of the Stone Canyon Reservoir (SCR). Campbell et al. (2016) described the formation as consisting predominantly of fine- to medium-grained sandstone with some interbeds of gray clay shale, mudstone and siltstone, and some lenses of pebble-cobble conglomerate. Shale beds commonly contain indurated limestone concretions.

5.1.2.5 Santa Monica Slate

The Santa Monica Slate (Jsm, Jsms, Jsmp) is a Jurassic-age metamorphic rock that generally consists of black slate and, to a lesser degree, meta-siltstone and fine-grained meta-graywacke. The rock is generally sheared and intensely jointed due to the localized folding and faulting within the Santa Monica Mountains. The Santa Monica Slate is exposed throughout the southern side of the Santa Monica Mountains, with exposures generally highly fractured with small surficial slides within the fractured rock (Metro, 2023a).

5.1.2.6 Topanga Formation

In the Project Study Area, the middle Miocene Topanga Formation (Tt and Tb) unconformably underlies the Modelo Formation. The Topanga Formation is exposed in slopes that are adjacent to the east side of SCR and Upper Stone Canyon Reservoir (USCR). Campbell et al. (2016) described the Topanga Formation as a heterogenous sequence of sedimentary and volcanic rocks containing marine facies. Campbell et al., (2016) subdivided the Topanga Formation into undifferentiated sedimentary rocks (Regional Geologic Map Symbol: Tt) or volcanic rocks (Regional Geologic Map symbol: Tb). Sedimentary rock lithologies include interbedded gray, micaceous claystone, clay shale, and siltstone; semi-friable to well cemented arkosic sandstone; and locally includes gravely sandstone and lenses of pebble to cobble conglomerate. In general, the lower portion of the Topanga Formation (toward the south) commonly contains the coarser-grained lithologies (sandstones and conglomerates), and the upper portion contains fine-grained sandstone, siltstone, and shales. Volcanic rocks within the Topanga Formation (Tb) include extrusive flows, intrusive sills, tuffs, and volcanic breccias.

5.1.2.7 Tuna Canyon Formation

The Cretaceous Tuna Canyon Formation (Kt), which underlies the Santa Susana Formation, is exposed in the slopes bordering SCR. Campbell et al. (2014) described the formation as consisting of marine sandstone, siltstone, and conglomerate. The sandstones range from thinly to very thickly bedded and locally contain abundant fragments of black slate. City of Los Angeles Department of Water and Power (LADWP) (1998) reported that the formation, as exposed in roadcuts along the west side of SCR, includes very thick to massive conglomerate beds that contain weak to extremely strong cobble to boulder-sized granitic, metavolcanic, and quarzitic clasts up to 18-inches in diameter.

5.1.2.8 Younger Alluvial Fan Deposits

The younger alluvial units (QyF and Qya) along both the northern and southern sides of the Santa Monica Mountains consist of sand, silt, silty clay, silty sand, and clayey sand with some interbedded units of gravel to cobble-size clasts. The gravel units are composed of slate and are scattered through the alluvium along the southern side of the mountains; while along the northern side, the gravel transitions to sandstone and is less frequent and abundant. The younger alluvium generally varies in thickness from a few feet to over 50 feet or more in some areas along the No Project Alternative (Metro, 2023a).

5.1.3 Seismicity

The entire Southern California region is seismically active. A network of major regional faults and minor local faults crisscrosses the region. The faulting and seismicity are dominated by the San Andreas fault system, which separates two of the major tectonic plates that comprise the earth’s crust. The Pacific Plate lies west of the San Andreas fault system. This plate is moving in a northwesterly direction relative to the North American Plate, which lies east of the San Andreas fault system. This relative movement between the two plates is the driving force of fault ruptures in western California. The San Andreas fault generally trends northwest–southeast; however, north of the Transverse Ranges province, the fault trends more in an east–west direction, causing a north–south compression between the two plates. North–south compression in Southern California has been estimated from 5 millimeters per year (mm/year) to 20 mm/year. This compression has produced rapid uplift of many of the mountain ranges in Southern California (Metro, 2023a).

In addition to the San Andreas fault, numerous faults in Southern California are categorized as active, potentially active, and inactive. A fault is classified as active if it has either moved during the Holocene epoch (from about 11,700 years to the present) or is included in an Alquist-Priolo Earthquake Fault Zone (as established by California Geological Survey [CGS]). A fault is classified as potentially active if it has experienced movement within the Quaternary period (geologic time starting 1.6 million years ago and continuing to the present day). Faults that have not moved in the last 1.8 million years generally are considered inactive. Surface displacement can be recognized by the existence of cliffs in alluvium, terraces, offset stream courses, fault troughs, and saddles, the alignment of depressions, sag ponds, and the existence of steep mountain fronts.

Generally defined, an earthquake is an abrupt release of accumulated energy in the form of seismic waves that are created when movement occurs along a fault plane. The severity of an earthquake is generally expressed in two ways: magnitude and intensity. The energy released, measured on the Moment Magnitude (M_w) scale, represents the "size" of an earthquake. The Richter Magnitude (M) scale has been replaced in most modern building codes by the M_W scale because the M_W scale provides more useful information to design engineers. The No Project Alternative is subject to earthquakes of M_W 6.0 to M_W 8.0 by the surrounding faults (CGS, 2023; USGS, 2017a, 2017b, 2017c, 2017d, 2023; SCEDC, 2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2023g, 2023h, 2023i, 2023j, 2023k, 2023l, 2023m, 2023n, 2023o, 2023p, 2023q, 2023r; and Shaw et al., 2022).

The intensity of an earthquake is measured by the Modified Mercalli Intensity (MMI) scale, which emphasizes the current seismic environment at a particular site and measures ground-shaking severity according to damage done to structures, changes in the earth surface, and personal accounts. Table 5-1 identifies the level of intensity according to the MMI scale and describes that intensity with respect to how it would be received or sensed by its receptors.

Table 5-1. No Project Alternative: Modified Mercalli Intensity Scale

Intensity	Shaking	Description/Damage
I	Not Felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration is similar to the passing of a truck. Duration is estimated.
IV	Light	Felt indoors by many and outdoors by few during the day. At night, some are awakened. Dishes, windows, doors are disturbed; walls make cracking sound. Sensation is like a heavy truck striking a building. Standing motor cars are rocked noticeably.
V	Moderate	Felt by nearly everyone; many are awakened. Some dishes and windows are broken. Unstable objects are overturned. Pendulum clocks may stop.
VI	Strong	Felt by all; many are frightened. Some heavy furniture is moved; there are a few instances of fallen plaster. Damage is slight.

Intensity	Shaking	Description/Damage
VII	Very Strong	Damage is negligible in buildings of good design and construction, slight to moderate in well-built ordinary structures, and considerable in poorly built structures; some chimneys are broken.
VIII	Severe	Damage is slight in specially designed structures, considerable in ordinary substantial buildings with partial collapse, and great in poorly built structures. Chimneys, factory stacks, columns, monuments, and walls fall. Heavy furniture is overturned.
IX	Violent	Damage is considerable in specially designed structures; well-designed frame structures are thrown out of plum. Damage is great in substantial buildings, with partial collapse. Buildings are shifted off foundations.
X	Extreme	Some well-built wooden structures are destroyed; most masonry and frame structures are destroyed with foundations. Rails are bent.

Source: USGS, 2022

Ground motions are also reported in terms of a percentage of the acceleration of gravity (percent g, where g equals 32 feet per second). One hundred percent of gravity (1g) is the acceleration a skydiver would experience during free-fall. An acceleration of 0.4g is equivalent to accelerating from 0 to 60 miles per hour in about 7 seconds.

Over the past 54 years, Southern California has experienced three significant earthquakes: the 1971 San Fernando earthquake (also known as the Sylmar earthquake, on the Sierra Madre Fault), which registered as M_W 6.6; the 1987 Whittier Narrows earthquake, which registered as M_W 5.9; and the Northridge earthquake, which occurred in January 1994 and registered as M_W 6.7.

5.1.4 Regional and Local Faults

Major regional and local faults are identified in Table 5-2 and are shown on Figure 5-2 and Figure 5-3.

Table 5-2. No Project Alternative: Major Regional and Local Faults

Fault Name	Alquist-Priolo Earthquake Fault Zone	Maximum Moment Magnitude (M_w)
Charnock Fault	No	6.5
Chatsworth Fault	No	6.8
Clearwater Fault	No	—
Del Valle Fault	No	—
Eagle Rock Fault	No	—
Hollywood Fault	Yes	6.5
Holser Fault	No	6.5
Malibu Coast Fault	Yes	6.7
Mission Hills Fault	No	—
Newport-Inglewood-Rose Canyon Fault	Yes	7.2
Northridge Blind Thrust Fault	No	6.9
Northridge Hills Fault	No	—
Overland Avenue Fault	No	7.5
Oak Ridge Fault	No	6.6
Palos Verdes Fault	No	7.1
Puente Hills Blind Thrust System	No	7.5
Raymond Fault	Yes	7
San Andreas Fault	Yes	8

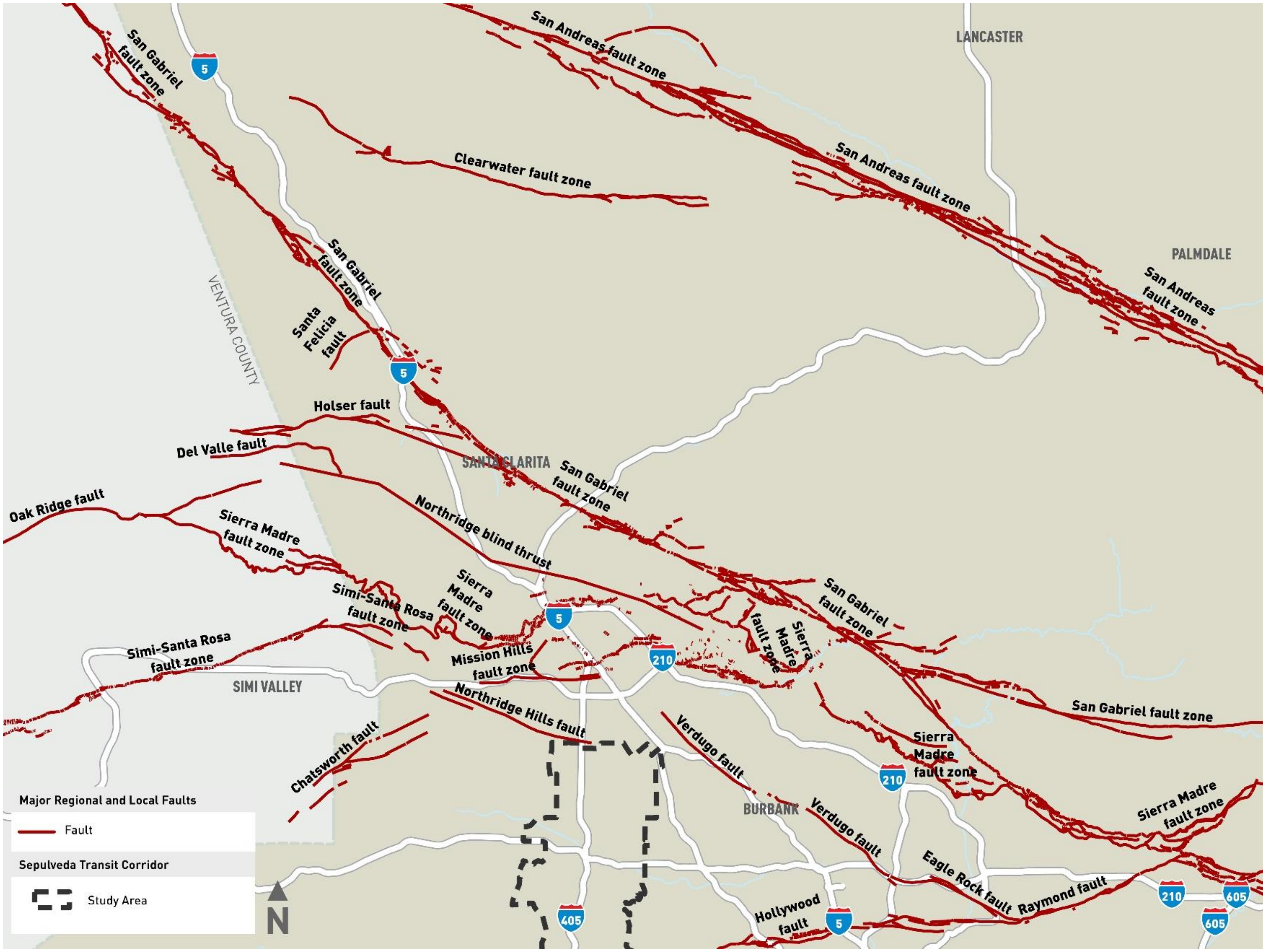
Fault Name	Alquist-Priolo Earthquake Fault Zone	Maximum Moment Magnitude (M_w)
San Gabriel Fault	Yes	7
Santa Felicia Fault	No	—
Santa Monica Fault	Yes	7
Sierra Madre Fault	Yes	7
Simi-Santa Rosa Fault	Yes	6.7
Verdugo Fault	No	6.8

Source: CGS, 2023; USGS, 2017a, 2017b, 2017c, 2017d, 2023; SCEDC, 2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2023g, 2023h, 2023i, 2023j, 2023k, 2023l, 2023m, 2023n, 2023o, 2023p, 2023q, and 2023r; and Shaw et al., 2022.

Figure 5-2. No Project Alternative: Major Regional and Local Faults – South

Source: CGS, 2023; HTA, 2024

Figure 5-3. No Project Alternative: Major Regional and Local Faults – North



Source: CGS, 2023; HTA, 2024

5.1.4.1 Charnock Fault

The Charlock fault is located south of the southern portion of the No Project Alternative. Charnock fault extends southeast from near Venice Boulevard to the City of Gardena and runs parallel to the axis of the Gardena syncline for most of its length. The northeastern side of the fault is downthrown relative to the southwestern side (CDWRSD, 1961). Faulted rocks of late Quaternary age (between present day and 700,000 years ago) is present along this fault (USGS, 1981). The Charnock fault runs underneath the LAX runway.

5.1.4.2 Chatsworth Fault

The Chatsworth fault is located northwest from the northern portion of the No Project Alternative. The Chatsworth fault is 12.4 miles long and is classified as a late Quaternary (between present day and 700,000 years ago). The Chatsworth fault has a probable magnitude of M_w 6.0 to M_w 6.8. The Chatsworth fault is a reverse fault, where the displacement is predominantly vertical. This fault is north-dipping, and the slip rate is currently unknown (SCEDC, 2023a).

5.1.4.3 Clearwater Fault Zone

The Clearwater fault is located north from the northern portion of the No Project Alternative. The Clearwater fault is 19.9 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Clearwater fault varies from north-dipping to vertical (SCEDC, 2023b).

5.1.4.4 Del Valle Fault

The Del Valle fault is located northwest from the northern portion of the No Project Alternative. The Del Valle fault is classified as late Quaternary (between present day and 700,000 years ago). The Del Valle fault is a south-dipping reverse fault, and it contains the prominent tectonic geomorphic features. (Yeats et al., 1985).

5.1.4.5 Eagle Rock Fault

The Eagle Rock fault is located southeast from the mid-section of the No Project Alternative. The Eagle Rock fault is 6.8 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Eagle Rock fault is a thrust fault, which is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much, if not all, of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an obvious sign of compressional tectonics (SCEDC, 2023c, 2023s). The slip rate for Eagle Rock fault is probably less than 0.1 mm/year. The possibility of simultaneous rupture with the Verdugo fault is uncertain. The Eagle Rock fault dips to the northeast (SCEDC, 2023c).

5.1.4.6 Hollywood Fault

The Hollywood fault is located northeast from the mid-section of the No Project Alternative. The Hollywood fault is 9.3 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023d, 2023s). The Hollywood fault is a left-reverse fault and has a probable magnitude between M_w 5.8 and M_w 6.5. There is a potential for the probable magnitude to be larger if rupture is simultaneous with an adjacent fault. The slip rate for the Hollywood fault is between 0.33 and 0.75 mm/year. The Hollywood fault could be considered a westward extension of the Raymond fault and is roughly parallel to the Santa Monica fault (SCEDC, 2023d). The Hollywood fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act.

5.1.4.7 Holser Fault

The Holser fault is located northwest from the northern portion of the No Project Alternative. The Holser fault is 12.4 miles long and is classified as a late Quaternary (between present day and 700,000 years ago). The Holser fault is a reverse fault with a slip rate of 0.4 mm/year; the displacement is predominantly vertical, and the dip is to the south (SCEDC, 2023e).

5.1.4.8 Malibu Coast Fault

The Malibu Coast fault is located southwest from the mid-section of the No Project Alternative. The Malibu Coast fault is 21.1 miles long with several parallel strands. The Malibu Coast fault is classified as Holocene (from about 10,000 years ago to the present) in part; otherwise, the fault is classified as late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023f, 2023s). The Malibu Coast fault is a reverse fault with a slip rate of 0.3 mm/year. The Malibu Coast fault is a north-dipping fault. The slip rate may be higher at its eastern end, where it meets the Santa Monica fault and develops left-reverse motion (SCEDC, 2023f). The Malibu Coast fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

5.1.4.9 Mission Hills Fault

The Mission Hills fault is located north from the northern portion of the No Project Alternative. The Mission Hills fault is 6.2 miles long. The Mission Hills fault is classified as late Quaternary (between present day and 700,000 years ago) and possibly Holocene (from about 10,000 years ago to the present) (SCEDC, 2023g, 2023s). The Mission Hills fault is a reverse fault, where the displacement is predominantly vertical. The Mission Hills fault has a slip rate of 0.5 mm/year (SCEDC, 2023g).

5.1.4.10 Newport-Inglewood-Rose Canyon Fault

The Newport-Inglewood-Rose Canyon fault is located east from the southern portion of the No Project Alternative. The Newport-Inglewood-Rose Canyon fault is 55.9 miles long. The Newport-Inglewood-Rose Canyon fault is mostly classified as Quaternary (geologic time starting 1.6 million years ago and continuing to the present day) and in part classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023h, 2023s). The Newport-Inglewood-Rose Canyon fault is a right-lateral fault, which is a fault that slips in such a way that the two sides move with a predominantly lateral motion (with respect to each other). The Newport-Inglewood-Rose Canyon fault has a probable magnitude of between M_W 6.0 and M_W 7.2 and a slip rate between 0.8 and 2.1 mm/year (SCEDC, 2023h). The Newport-Inglewood-Rose Canyon fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

5.1.4.11 Northridge Blind Thrust Fault

The Northridge Blind Thrust fault is located north from the northern portion of the No Project Alternative. The Northridge Blind Thrust fault is part of the Oak Ridge fault system (SCEDC, 2023j). At its eastern end, the Oak Ridge Thrust fault is progressively more difficult to trace and is buried, or also known as *blind*. The Northridge Blind Thrust fault has a probable magnitude of M_w 6.5 to M_w 7.5. The slip rate for the Northridge Blind Thrust fault is between 3.5 and 6 mm/year (SCEDC, 2023j). The Northridge Blind Thrust fault, as part of the Oak Ridge fault system, is classified mostly as late Quaternary (between present day and 700,000 years ago) and in part as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023j, 2023s). The Northridge Blind Thrust fault is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much, if not all, of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an

obvious sign of compressional tectonics (SCEDC, 2023j, 2023s). This blind thrust fault is assumed to be part of the fault system responsible for the 1994 Northridge earthquake.

5.1.4.12 Northridge Hills Fault

The Northridge Hills fault is located north from the northern portion of the No Project Alternative. The Northridge Hills fault is not the fault on which the 1994 Northridge earthquake occurred. The Northridge Hills fault is classified as late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023i, 2023s). The Northridge Hills fault is 15.5 miles long and is a reverse fault, where the displacement is predominantly vertical. The dip for the Northridge Hills fault is probably to the north (SCEDC, 2023i).

5.1.4.13 Overland Avenue Fault

The northern tip of the Overland Avenue fault is located within the southern portion of the Project Study Area. The Overland Avenue fault trends northwest and extends from Santa Monica Boulevard to the northwestern flank of Baldwin Hills. Displacement of the fault is believed to be vertical, with a magnitude of approximately 30 feet (CDWRSD, 1961). Faulted rocks of late Quaternary age (between present day and 700,000 years ago) is present along this fault (USGS, 1981). The northeastern side of the fault is raised relative to the southwestern side (CDWRSD, 1961).

5.1.4.14 Oak Ridge Fault

The Oak Ridge fault is located northwest from the northern portion of the No Project Alternative. The Oak Ridge fault system is connected to the 1994 Northridge earthquake. The Oak Ridge fault is approximately 55.9 miles in length (SCEDC, 2023j) The Oak Ridge fault has a probable magnitude of M_w 6.5 to M_w 7.5. The slip rate for Oak Ridge fault is between 3.5 and 6 mm/year (SCEDC, 2023j). The Oak Ridge fault system is classified mostly as late Quaternary (between present day and 700,000 years ago) and in part as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023j, 2023s). The Oak Ridge fault is a thrust fault, which is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much, if not all, of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an obvious sign of compressional tectonics (SCEDC, 2023j, 2023s). This fault dips to the south at a fairly shallow (less than 45 degrees) angle. Thus, epicenters of earthquakes on this (and any other thrust) fault may appear far removed from the surface trace. The surface trace of the Oak Ridge fault forms a ridge (hence its name) to the south of its trace; at its eastern end, the Oak Ridge fault becomes progressively more difficult to trace (SCEDC, 2023j). The Oak Ridge fault appears to be overthrust by the *Santa Susana* fault, becoming a *blind thrust fault* that includes the Northridge Blind Thrust fault.

5.1.4.15 Palos Verdes Fault

The Palos Verdes fault is located south from the southern portion of the No Project Alternative. The Palos Verdes fault is 49.7 miles long and is classified as Holocene (from about 10,000 years ago to the present) offshore and as late Quaternary (between present day and 700,000 years ago) onshore (SCEDC, 2023k, 2023s). The Palos Verdes fault is a right-reverse fault and has a probable magnitude between 6.0 M_w and 7.0 M_w. The slip rate is between 0.1 and 3.0 mm/year (SCEDC, 2023k).

5.1.4.16 Puente Hills Blind Thrust Fault

The Puente Hills Blind Thrust fault is located southeast from the southern portion of the No Project Alternative. The Puente Hills Blind Thrust fault is 24.9 miles long. In 1987, the Puente Hills Blind Thrust fault produced an M_w 5.9 earthquake in Whittier. In March 2014, the Puente Hills Blind Thrust fault produced an M_w 5.1 earthquake with over 100 aftershocks (KCAL News, 2014). The Puente Hills Blind

Thrust fault has a probable magnitude between M_w 6.5 and M_w 6.6 for frequency of a single segment and a probable magnitude of M_w 7.1 for multi-segment rupture scenarios. The slip rates on the ramp segments range from 0.44 to 1.7 mm/year, with preferred rates between 0.62 and 1.28 mm/year (Shaw et al., 2022).

5.1.4.17 Raymond Fault

The Raymond fault is located northeast from the mid-section of the No Project Alternative. The Raymond fault is 16.2 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023l, 2023s). The Raymond fault is a left-reverse fault and has a probable magnitude between M_w 6.0 and M_w 7.0. The slip rate is between 0.10 and 0.22 mm/year (SCEDC, 2023l). The Raymond fault dips at about 75 degrees to the north. There is evidence that at least eight surface-rupturing events have occurred along this fault in the last 36,000 years. The exact nature of the slip along the Raymond fault has been a subject of debate for quite some time. In late 1988, the *Pasadena earthquake* occurred on the Raymond fault, and the motion of this earthquake was predominantly left-lateral, with a reverse component of only about 1/15 the size of the lateral component. If the Raymond fault is indeed primarily a left-lateral fault, it could be responsible for transferring slip southward from the *Sierra Madre* Fault Zone to other fault systems (SCEDC, 2023l). The Raymond fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

5.1.4.18 San Andreas Fault

The San Andreas fault is located northeast from the northern portion of the No Project Alternative. The San Andreas fault is 745.6 miles long. The San Andreas fault has a probable magnitude between M_w 6.8 and M_w 8.0. The interval between major ruptures averages about 140 years on the Mojave segment, and the recurrence interval varies greatly from under 20 years (at Parkfield only) to over 300 years. The slip rate is between 20 and 35 mm/year (SCEDC, 2023m). The last major rupture of the San Andreas fault occurred on January 9, 1857 at the Mojave segment and on April 18, 1906 at the northern segment. The San Andreas fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

5.1.4.19 San Gabriel Fault

The San Gabriel fault is located northeast from the northern portion of the No Project Alternative. The San Gabriel fault is 87 miles long. The San Gabriel fault is primarily a right-lateral strike slip fault, which is a fault where the slip motion is parallel to the direction, or trend, of the line marking the intersection of a fault plane (or another planar geologic feature) with the horizontal. The San Gabriel fault is classified as late Quaternary (between present day and 700,000 years ago) west of the intersection with the Sierra Madre Fault Zone, Quaternary (1.6 million years ago and continuing to the present day) east of that intersection, and Holocene (from about 10,000 years ago to the present) between Saugus and Castaic. The slip rate is between 1 and 5 mm/year (SCEDC, 2023n). The slip rate and reoccurrence interval vary significantly along the length of the San Gabriel fault. The western half is more active than the eastern half, and the dip is generally steep and to the north. The San Gabriel fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

5.1.4.20 Santa Felicia Fault

The Santa Felicia fault is located northwest from the northern portion of the No Project Alternative. The Santa Felicia fault is a fault that is less well understood. The Santa Felicia fault is classified as late Quaternary (between present day and 700,000 years ago). The Santa Felicia fault apparently overrides the youngest strand of the San Gabriel fault. The Santa Felicia fault is a south-dipping reverse fault. The Santa Felicia fault has no recognized tectonic geomorphic features, although it follows the Santa Felicia Canyon for part of its length (Yeats et al., 1985).

5.1.4.21 Santa Monica Fault

The Santa Monica fault would cross the No Project Alternative approximately north of Massachusetts Avenue and I-405. The Santa Monica fault is 14.9 miles long. The Santa Monica fault has a probable magnitude between M_w 6.0 and M_w 7.0. The Santa Monica fault is classified as late Quaternary (between present day and 700,000 years ago) and is a left-reverse fault. The Santa Monica fault is a north-dipping fault, and the slip rate may be greatest at its western end. The slip rate is between 0.27 and 0.39 mm/year (SCEDC, 2023o). In 2015, the Santa Monica Fault Zone was evaluated for the Alquist-Priolo Earthquake Fault Zoning program (Olson, 2015). Currently, the Santa Monica Fault Zone is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023). The guideway for the No Project Alternative falls within the Alquist-Priolo Earthquake Fault Zone. No habitable structures would be located within the Alquist-Priolo Earthquake Fault Zone for the No Project Alternative.

5.1.4.22 Sierra Madre Fault

The Sierra Madre fault is located north from the northern portion of the No Project Alternative. The Sierra Madre fault is 46.6 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023p, 2023s). The Sierra Madre fault is a reverse fault, where the displacement is predominantly vertical. The Sierra Madre fault has a probable magnitude between M_w 6.0 and M_w 7.0. The slip rate is between 0.36 and 4.0 mm/year (SCEDC, 2023k). The Sierra Madre fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

5.1.4.23 Simi-Santa Rosa Fault

The Simi-Santa Rosa fault is located northwest from the northern portion of the No Project Alternative. The Simi-Santa Rosa fault is 24.9 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023q, 2023s). The Simi-Santa Rosa fault is a reverse fault, where the displacement is predominantly vertical. This fault dips to the north. The Simi-Santa Rosa fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

5.1.4.24 Verdugo Fault

The Verdugo fault is located east from the mid-section of the No Project Alternative. The Verdugo fault is 13 miles long and is classified as Holocene (from about 10,000 years ago to the present) and late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023r, 2023s). The Verdugo fault is a reverse fault and has a probable magnitude of between M_w 6.0 and M_w 6.8. The slip rate is roughly 0.5 mm/year (SCEDC, 2023r). The Verdugo fault dips to the northeast.

5.1.5 Geological Hazards

5.1.5.1 Fault Rupture

Faults are geologic zones of weakness. Surface rupture occurs when movement on a fault deep in the earth breaks through to the ground surface. Surface ruptures associated with the 1994 Northridge earthquake began as a rupture at a depth of about 10.9 miles beneath the San Fernando Valley. For 8 seconds following the initial break, the rupture propagated upward and northwestward along the fault plan at a rate of about 1.9 miles per second. The size of the rupture covered an area of approximately 9.3 by 12.4 miles (USGS, 2013). Not all earthquakes result in surface rupture; however, due to the proximity of known active faults, fault ruptures and the subsequent hazard posed by seismic activity are potentially high. An earthquake could cause major damage and not have the fault trace break at the ground surface. Fault rupture almost always follows preexisting faults, which are zones of weakness. Rupture may occur suddenly during an earthquake or slowly in the form of fault creep. Sudden displacements are more damaging to structures because they are accompanied by shaking.

5.1.5.2 Ground Shaking

A major cause of structural damage that results from earthquakes is ground shaking. The amount of motion can vary from “zero to forceful,” depending upon the distance to the fault, the magnitude of the earthquake, and the local geology. Greater movement can be expected at sites located on poorly consolidated material such as alluvium located near the source of the earthquake epicenter or in response to an earthquake of great magnitude. Strong ground shaking can damage large freeway overpasses and unreinforced masonry buildings. It can also trigger a variety of secondary hazards such as liquefaction, landslides, fire, and dam failure.

The amount of damage to a building does not depend solely on how hard it is shaken. In general, smaller buildings such as houses are damaged more by stronger earthquakes and houses must be relatively close to the epicenter to be severely damaged. Larger structures such as high-rise buildings can be susceptible to damage from weaker earthquakes and will be more noticeably affected by the largest earthquakes, even at considerable distances.

Damage as a result of ground shaking is not limited to aboveground structures. Seismic waves generated by the earthquake cause the ground to move, leading to dynamic forces on underground structures. This shaking can induce ground deformation and displacements, and can potentially damage the structural integrity of tunnels, basements, and other underground facilities.

The intensity of ground motion expected at a particular site depends upon the magnitude of the earthquake, the distance to the epicenter, and the geology of the area between the epicenter and the property. Another factor affecting structural damage due to ground shaking is the quality and condition of the existing structure, which is influenced by whether it adheres to current or past building codes. Greater movement can be expected at sites on poorly consolidated material, such as loose alluvium, in proximity to the causative fault, or in response to an event of great magnitude. The general area is susceptible to earthquakes of M_w 6.0 to M_w 8.0. Due to the proximity of known active faults, the hazard posed by seismic shaking is potentially high.

5.1.6 Dry Sand Settlement

Settlement is defined as areas that are prone to rates of ground-surface collapse and densification (soil particle compaction) that are greater than those of the surrounding area. Such areas are often underlain by sediments that differ laterally in composition or degree of existing density. Differential settlement refers to areas that have more than one rate of settlement. Settlement can damage structures, pipelines, and other subsurface entities.

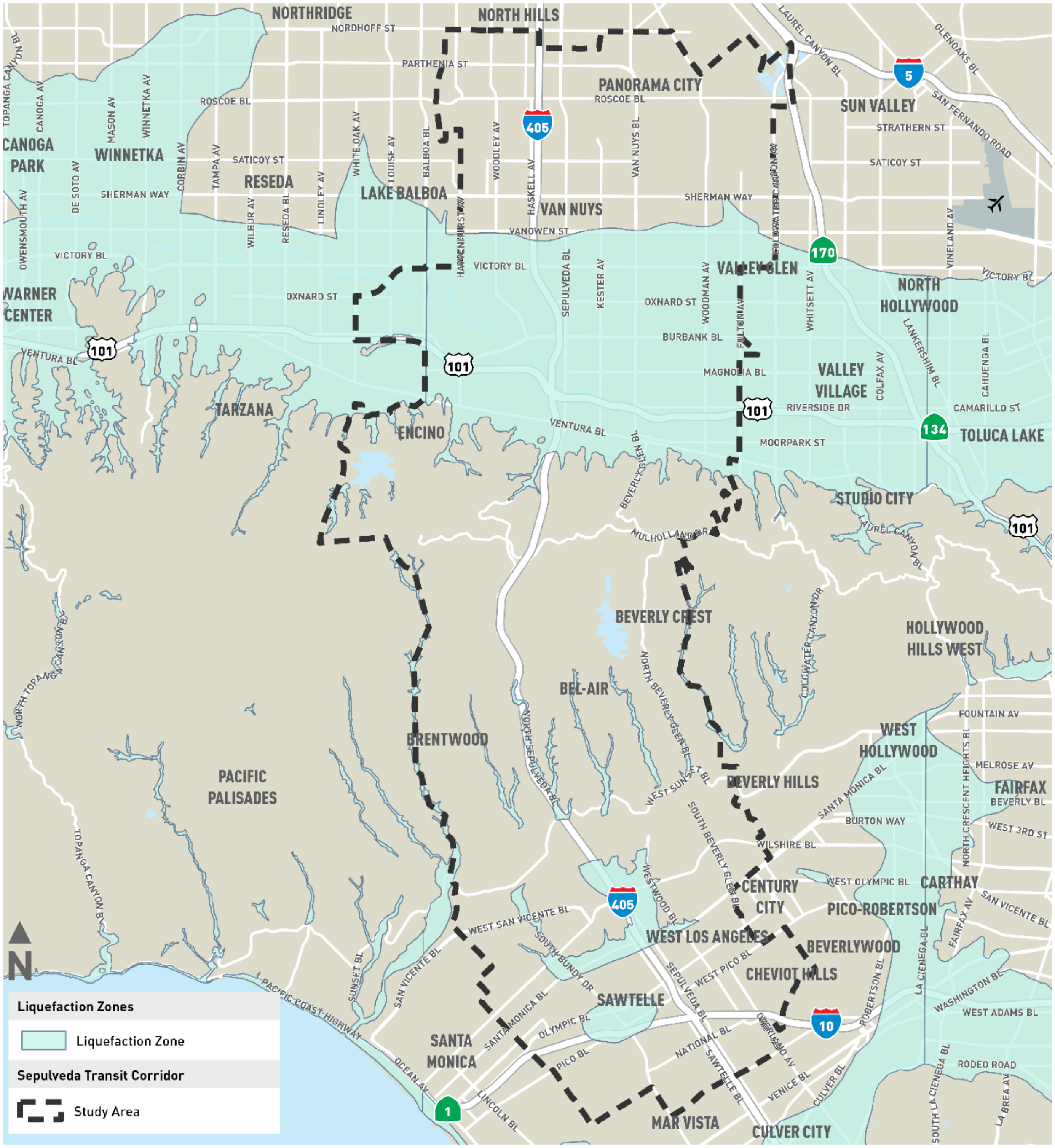
Strong ground shaking can cause soil settlement by vibrating sediment particles into more tightly compacted configurations, thereby reducing pore space. Unconsolidated, loosely packed alluvial deposits and sand (unsaturated or saturated) are especially susceptible to this phenomenon. Poorly compacted artificial fills may experience seismically induced settlement. Due to the presence of alluvial deposits in the Project Study Area, the hazard posed by seismically induced settlement is potentially high.

5.1.7 Liquefaction

Liquefaction involves a sudden loss in strength of a saturated, cohesionless, uniformly particle-sized soil, that is typically caused by ground-shaking activities, which causes temporary transformation of the soil to a fluid mass. In rare instances, ground-borne vibrations can cause liquefaction from activities such as pile driving or tunnel boring. If the liquefying layer is near the ground surface, the effects may resemble those of quicksand. If the layer is deep below the ground surface, it may provide a sliding surface for the material above it and/or cause differential settlement of the ground surface, which may damage building foundations by altering weight-bearing characteristics.

During a liquefaction event, soils behave similarly to liquids, losing bearing strength. Structures built on these soils may tilt or settle when the soils liquefy. Liquefaction occurs more often in earthquake-prone areas that are underlain by young sandy alluvium where the groundwater table is less than 50 feet below ground surface (Metro, 2023a). Per the County of Los Angeles, liquefaction zones identify where the stability of foundation soils must be investigated, and countermeasures undertaken in the design and construction of buildings for human occupancy (LA County Planning, 2022a). As shown on Figure 5-4, Liquefaction Zones exist within the Project Study Area, and the potential for liquefaction event is relatively high for the mapped areas shown (California Department of Conservation, 1998).

Figure 5-4. No Project Alternative: Liquefaction Zones



Source: County of Los Angeles, Enterprise GIS (eGIS), 2022; HTA, 2024

5.1.8 Subsidence

Subsidence involves a sudden sinking or gradual settling and compaction of soil and other surface material with little or no horizontal motion. This is typically caused by the removal of groundwater, oil, or natural gas, or by natural processes like the compaction of soil. This can lead to structural damage to buildings and infrastructure. The Los Angeles Basin is vulnerable to subsidence, particular due to groundwater and oil extraction. Over-extraction of groundwater can be concerning because as the groundwater table drops, the soil compacts, leading to subsidence that can damage infrastructure, buildings, and roads. Subsidence typically impact surface level soils. Although the alignment is entirely aerial, all stations have surface level elements. Moreover, alluvial deposits are susceptible to subsidence, especially when they consist of loose, unconsolidated sediments. As shown on Figure 5-1, alluvial deposits are found within the Project Study Area; the hazard posed by subsidence is potentially high at those locations.

5.1.9 Expansive Soils

Expansive soils have a significant amount of clay particles that can give up water (shrink) or take on water (swell). The change in volume exerts stress on buildings and other loads placed on these soils. The occurrence of these soils is often associated with geologic units having marginal stability. Expansive soils can be dispersed widely and can be found in hillside areas as well as low-lying areas in alluvial basins. Municipal grading and building codes require routine soils testing to identify expansive characteristics and appropriate remediation measures. Specific treatments to eliminate expansion of soils at building sites include, but are not limited to, grouting (cementing the soil particles together), re-compaction (watering and compressing the soils), and replacement with non-expansive material (excavation of unsuitable soil followed by filling with suitable material), all of which are common practice in California. Due to the presence of alluvial deposits in the Project Study Area, the hazard posed by expansive soils is potentially high at those locations.

5.1.10 Collapsible Soils

Collapsible soils undergo a rearrangement of their grains and a loss of cementation, resulting in substantial and rapid settlement under relatively low loads. Collapsible soils occur predominantly at the base of mountain ranges where Holocene-age alluvial fan and wash sediments have been deposited during rapid runoff events. Soils prone to collapse are commonly associated with human-made fill, wind-laid sands and silts, and alluvial fan and mudflow sediments that are deposited during flash floods. Additionally, desert soils are commonly associated with hydro-compression and collapse associated with wetting. Examples of common problems associated with collapsible soils include tilting and sagging floors, cracking or separation in structures, sagging floors, and nonfunctional windows and doors. Collapsible soils typically impact earth at surface levels. Due to the presence of alluvial deposits in the Project Study Area, the hazard posed by collapsible soils is potentially high at those locations.

5.1.11 Lateral Spreading

Lateral spread is the finite, lateral displacement of sloping ground (0.1 to < 6 percent) as a result of pore pressure buildup or liquefaction in a shallow, underlying soil deposit during an earthquake. Lateral spreading, as a result of liquefaction, occurs when a soil mass slides laterally on a liquefied layer, and gravitational and inertial forces cause the layer, and the overlying non-liquefied material to move in a downslope direction. Due to the presence of mountainside areas in the Project Study Area, the hazard posed by lateral spreading is potentially high at those locations.

5.1.12 Slope Stability

Slope failures include many phenomena that involve the downslope displacement of material, which is triggered by static (i.e., gravity) or dynamic (i.e., earthquake) forces such as landslides, rock-falls, debris slides, and soil creeps. Slope stability can depend on complex variables, including the geology, structure, and amount of groundwater present, as well as external processes such as climate, topography, slope geometry, and human activity. Landslides and other slope failures may occur on slopes of 15 percent or less; however, the probability is greater on steeper slopes that exhibit old landslide features such as scarps, slanted vegetation, and offset surfaces. Due to the presence of slopes (of 15 percent greater) in the Project Study Area, particularly in the hilly Santa Monica Mountain communities of Bel-Air, Beverly Crest, and Brentwood, the hazard posed by slope failures is potentially high at those locations.

5.1.13 Landslides

Landslides are the downhill movement of a mass of earth and rock. Landslides are a geological phenomenon that includes a wide range of ground movements, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary cause of a landslide, the following other factors contribute:

- Erosion by rivers, glaciers, or ocean waves
- Human-made excavations and fills
- Rock and soil slopes that are weakened through saturation by snowmelt or heavy rains
- Earthquakes that create stresses such that weak slopes fail
- Volcanic eruptions that produce loose ash deposits, heavy rain, and/or debris flows
- Vibrations from machinery, traffic, blasting, and even thunder
- Excess weight from accumulation of rain or snow, stockpiling of rock or ore from waste piles, or from human-made structures

As shown on Figure 5-5, the potential landslide hazard for the No Project Alternative is focused within the Santa Monica Mountains portion of the Project Study Area.

Figure 5-5. No Project Alternative: Landslide Hazard Zones

Source: County of Los Angeles, eGIS, 2022; HTA, 2024

5.1.14 Soil Erosion

Soil erosion is the process by which soil particles are removed from a land surface by wind, water, or gravity. Most natural erosion occurs at slow rates; however, the rate of erosion increases when land is cleared of vegetation or structures or otherwise altered and left in a disturbed condition. Erosion can occur as a result of, and can be accelerated by, site preparation activities associated with development. Vegetation and topsoil removal in pervious landscaped areas could reduce soil cohesion, as well as the buffer provided by vegetation from wind, water, and surface disturbance, which could render the exposed soils more susceptible to erosive forces.

Excavation or grading may result in erosion during construction activities, irrespective of whether hardscape previously existed at the construction site, because bare soils would be exposed and could be eroded by wind or water. The effects of erosion are intensified with an increase in slope (as water moves faster, it gains momentum to carry more debris), and the narrowing of runoff channels (which increases the velocity of water). Surface structures, such as paved roads and buildings, decrease the potential for erosion. Once covered, soil is no longer exposed to the elements, and erosion generally does not occur.

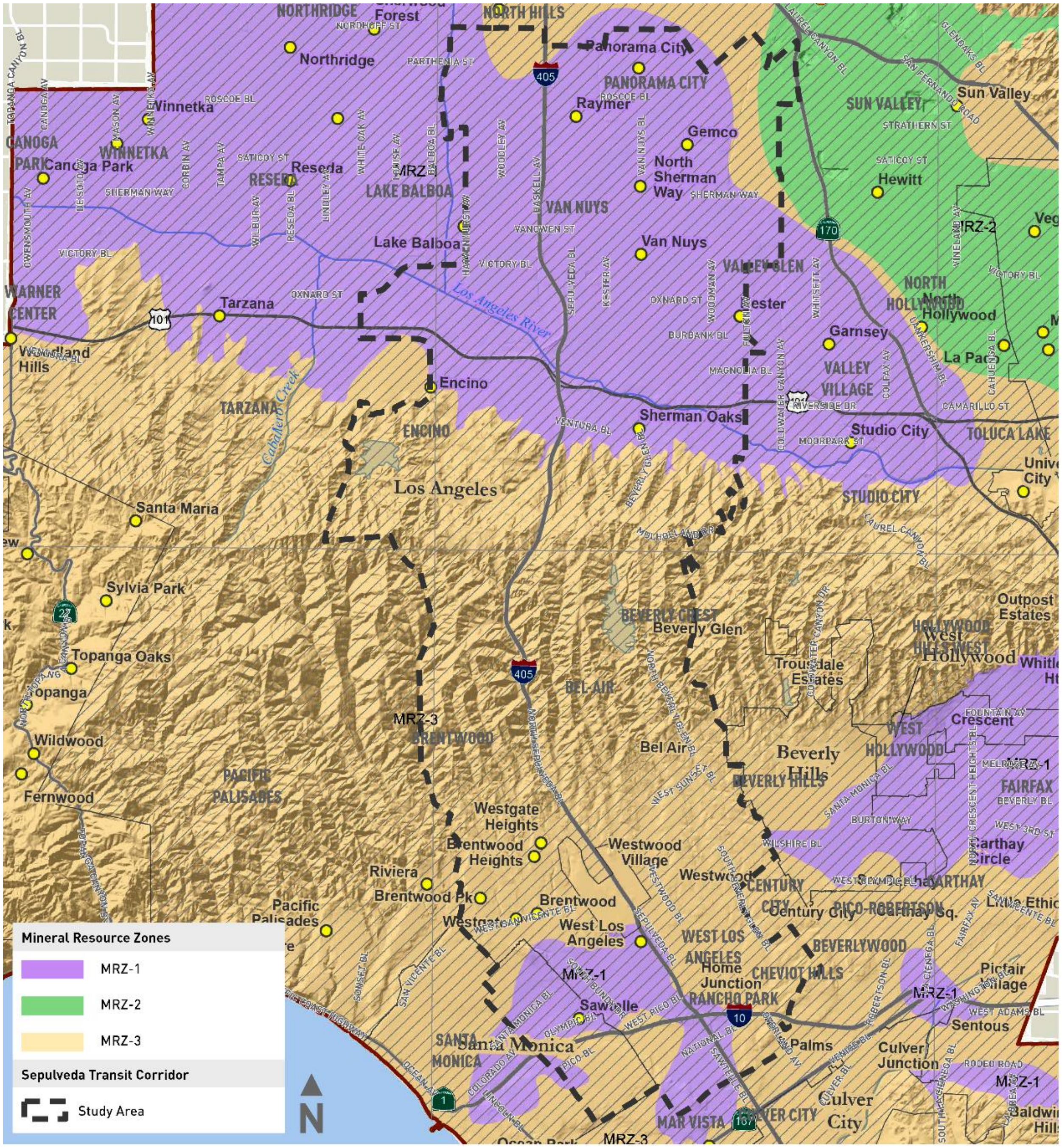
5.2 Mineral Resources

Mineral resource areas are identified according to the Surface Mining and Reclamation Act of 1975 and the following criteria for Mineral Resource Zones (MRZs), Scientific Resource Zones (SZs), and Identified Resource Areas. The MRZ and SZ categories used by the State Geologist in classifying the state’s lands, the geologic and economic data, and the substantiation of which each unit MRZ or SZ assignment is based on land classification information provided by the State Geologist to the Board of Supervisors for the following areas:

- **MRZ-1:** Adequate information indicates that no significant mineral deposits are present or little likelihood exists for their presence. This zone shall be applied where well-developed lines of reasoning, based on economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is nil or slight.
- **MRZ-2:** Adequate information indicates that significant mineral deposits are present or a high likelihood for their presence exists. This zone shall be applied to known mineral deposits or where well-developed lines of reasoning, based on economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is high.
- **MRZ-3:** Areas containing deposits whose significance cannot be evaluated from available data.
- **MRZ-4:** Available information is inadequate for assignment to any other MRZ zone.
- **SZ Areas:** Areas containing unique or rare occurrences of rocks, minerals, or fossils that are of outstanding scientific significance shall be classified in this zone.

The No Project Alternative contains areas designated as MRZ-1 and MRZ-3 (Figure 5-6). The California Department of Conservation, Division of Mines and Geology has classified areas of regional significance as MRZ-2 (CGS, 2021). The Project Study Area is not located within an area designated as MRZ-2. The No Project Alternative is largely located within areas designated as MRZ-3, which contain deposits whose significance cannot be evaluated from available data. The No Project Alternative would be located within areas designated as MRZ-1 in the northern portion of the Project Study Area in the Valley, as well as the southern portion near West Los Angeles. MRZ-1-designated areas indicate that no significant mineral deposits are present or little likelihood exists for their presence.

Figure 5-6. No Project Alternative: Mineral Resources



Source: CGS, 2021; HTA, 2024

5.3 Paleontological Resources

A paleontological records search from the Natural History Museum of Los Angeles County revealed a fossil locality (LACM VP 1681) recorded within the Resource Study Area (RSA). The fossil locality is located in the central portion of the RSA just west of the I-405 Sepulveda freeway cut, adjacent to where Royal Ridge Road ends. LACM VP 1681 indicated a fossil Pipefish (*Syngnathus avus*) from within the

Miocene Modelo Formation. Pipefish are considered rare in the fossil record, are indicators of paleoenvironmental conditions, and thus increase the scientific importance of this locality. Paleontologists have previously sampled the locality, and subsequent construction activities (i.e., I-405) have effectively removed the locality, but it is still indicative of the fossiliferous nature of the Modelo Formation (Society of Vertebrate Paleontology [SVP], 1995; Bell, 2023). Additionally, 14 other fossil localities are located within 5 miles of the RSA that produced fossil vertebrates and invertebrates.

Paleontological sensitivity refers to the paleontological potential for a geologic unit to contain fossil remains, traces, and fossil-collecting localities. The following sensitivity ratings indicate the potential for containing significant paleontological resources.

- High paleontological sensitivity indicates that geologic units have a history of or are considered to have a high potential for paleontological resources (i.e., fossil remains).
- Moderate paleontological sensitivity indicates that fossil remains or traces have been found but are in poor condition, are a common paleontological resource, or do not have scientific significance.
- Low paleontological sensitivity indicates a low potential for containing fossil paleontological resources.
- No paleontological sensitivity indicates areas that are not conducive to significant paleontological resources due to environmental conditions.

For this Project, it is difficult to quantify the number of sensitive formations and their sensitivity level with precision due to a blanket of soil that covers the entire RSA underground and current construction in the area. Appendix A to this technical report, the stand-alone Paleontological Technical Memorandum, contains a detailed analysis of paleontological resources.

5.4 Impact Evaluation

5.4.1 Impact GEO-1: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map, issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.

5.4.1.1 Operational Impacts

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. In absence of the Project, the reasonably foreseeable transit improvement within the Project Study Area would be the rerouting of the existing Metro Line 761. Rerouting Metro Line 761 would not present new seismic risks because the bus route is an existing route which would be rerouted along existing streets and highways. Other than potential for new bus shelters, no habitable structures would be constructed as part of the No Project Alternative. These activities do not have the potential to disturb geological processes such as faults. Therefore, impacts associated with the No Project Alternative associated with loss, injury, or death involving the Alquist-Priolo Earthquake Fault Zone would have no impact during operations.

5.4.1.2 Construction Impacts

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. The No Project Alternative would include any construction activities associated with the rerouting of Metro Line 761. Construction associated with rerouting Metro Line 761 would be minimal and consist primarily of installing potentially new bus stops and potentially minor curb revisions. Construction activities for the No Project Alternative would not directly or indirectly exacerbate rupture of a known earthquake fault causing substantial adverse effects, including the risk of loss, injury, or death because these elements do not reach a depth or be of an intensity that would affect geological processes such as faults. Therefore, construction impacts associated with loss, injury, or death involving the Alquist-Priolo Earthquake Fault Zone would have no impact.

5.4.2 Impact GEO-2: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking and/or seismic-related ground failure, including liquefaction?

5.4.2.1 Operational Impacts

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. In absence of the Project, the reasonably foreseeable transit improvement within the Project Study Area consists of rerouting the existing Metro Line 761. Other than potential for new bus stops, no habitable structures would be constructed as part of the No Project Alternative. While the No Project Alternative would be located in a seismically active region and may be subject to the effects of ground shaking, operations of the No Project Alternative would not directly or indirectly cause strong seismic ground shaking including liquefaction. Therefore, No Project Alternative would have a less than significant impact related to liquefaction during operations.

5.4.2.2 Construction Impacts

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. Any projects associated with the No Project Alternative would located in a seismically active area. In addition, the No Project Alternative would include any construction activities associated with the rerouting of Metro Line 761. Construction associated with rerouting Metro Line 761 would be minimal and consist primarily of installing potentially new bus stops and potentially minor curb revisions. However, construction of the No Project Alternative would not have the potential to cause liquefaction because construction would not produce seismic ground shaking such that loose granular soils below the groundwater table become to liquefy. Therefore, impacts associated with construction activities related to the No Project Alternative are less than significant.

5.4.3 Impact GEO-3: Would the Project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides?

5.4.3.1 Operational Impacts

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. The Study Area for the No Project Alternative would be located in areas susceptible to landslides. Portions of I-405 along the bus route are located within designated landslide zones; however, the existing Metro Line 761 already operates along the same stretch of I-405. These operational activities do not have the potential to cause landslides and impacts would be less than significant during operations.

5.4.3.2 Construction Impacts

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. The CBC*,* County of Los Angeles, and City of Los Angeles guidelines as well as by Cal/OSHA contains site-specific slope-stability design standards as requirements for stabilization. No construction activities associated with the rerouting of Metro Line 761 would occur within a landslide zone. These construction activities do not have the potential to cause landslides and impacts associated with landslides and/or slope instability during construction activities would be less than significant.

5.4.4 Impact GEO-4: Would the project result in substantial soil erosion or the loss of topsoil?

5.4.4.1 Operational Impacts

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. The Study Area for the No Project Alternative would be located in areas where there may be erosion or loss of topsoil. Metro Line 761 would be rerouted along existing streets and highways that do not involve exposed soils, though erosion does occur within portions of the Sepulveda Pass where the bus would operate. Compliance with Section J110 of the CBC would result in a less than significant impact to soil erosion during operations. Section 2.2.2 provides further information about the CBC.

5.4.4.2 Construction Impacts

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. The rerouted Metro Line 761 would not involve construction activities in areas with exposed soil such that construction-related soil erosion may occur. Compliance with existing regulations would minimize any potential effects from erosion and ensure consistency with the *Regional Water Quality Control Board Water Quality Control Plan*. By adhering to these requirements, the rerouted Metro Line 761 would have a less than significant impact associated with soil erosion or loss of topsoil during construction activities.

5.4.5 Impact GEO-5: Would the project be located on a geographic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?

5.4.5.1 Operational Impacts

Section 5.4.2 addresses impacts related to liquefaction, and Section 5.4.3 addresses impacts related to landslides.

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. In absence of the Project, the reasonably foreseeable transit improvement within the Project Study Area consists of rerouting the existing Metro Line 761. Rerouting of Metro Line 761 would not present new seismic risks because the bus route is an existing route which would simply be rerouted along existing streets and highways. Other than potential for new bus stops, no habitable structures would be constructed as part of the No Project Alternative. During operations, the projects associated with the No Project Alternative would experience earthquake-induced ground-shaking activity because of their proximity to known active faults. The No Project Alternative would be located in a seismically active region and may be subject to the effects of ground shaking. Therefore, No Project Alternative would probably experience moderate to high ground shaking from these fault zones, as well as some background shaking from other seismically active areas of the Southern California region.

Earthquakes are prevalent within Southern California, and there is no practicable way to avoid ground shaking when it occurs. The CBC includes measures to minimize the risk of loss, injury, and death from the effects of earthquakes and ground shaking on buildings, with specific provisions for seismic design. The development that would be part of the No Project Alternative would be required to resist seismic ground shaking in accordance with the CBC Chapter 16 design parameters identified in the CBC. With adherence to the provisions listed in the CBC, potential impacts related to ground shaking would be less than significant during operations.

During severe ground shaking, loose granular soils below the groundwater table may liquefy. Projects associated with the No Project Alternative would, upon completion of construction, have complied with applicable standards, requirements, and building codes related to seismic ground shaking and possible ground failure, such as liquefaction. With adherence to the provisions listed in the CBC, the potential impacts related to liquefaction would be less than significant during operations.

Using unsuitable materials for fill and/or foundation support would have the potential to create future heaving, subsidence, spreading, or collapse problems, which would lead to building settlement and/or utility line and pavement disruption. Using such materials exclusively for landscaping would not cause these problems. Rerouting Metro Line 761 would not use fill or foundation support, because new structures associated with the bus route would be limited to typical bus stop facilities such as signage and potentially street furniture. The No Project Alternative would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils during operations.

5.4.5.2 Construction Impacts

Section 5.4.2 addresses impacts related to liquefaction, and Section 5.4.3 addresses impacts related to landslides.

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. Using unsuitable materials for fill and/or foundation support would have the potential to create future heaving, subsidence, spreading, or collapse problems, which would lead to building settlement and/or utility line and pavement disruption. Rerouting Metro Line 761 would not use fill or foundation support because new structures associated with the bus route would be limited to typical bus stop facilities such as signage and potentially street furniture.

Adherence to existing regulations and policies would ensure the maximum practicable protection available for users of buildings and infrastructure and associated trenches, slopes, and foundations. Therefore, the No Project Alternative would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils.

5.4.6 Impact GEO-6: Would the project be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property?

5.4.6.1 Operational Impacts

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. In absence of the Project, the only reasonably foreseeable transit improvement in the Project Study Area would involve changes to Metro Line 761. Rerouting

Metro Line 761 would not involve placing infrastructure in any areas with expansive soil as the bus would operate on existing streets and highways. Changes to the Metro Line 761 would not result in any new habitable structures and the structures anticipated to be required would be small structures common to Metro bus stops. These operational activities do not create substantial direct or indirect risks to life or property as it relates to being located on expansive. As such, impacts would be less than significant.

5.4.6.2 Construction Impacts

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. The No Project Alternative would be required to comply with applicable provisions of the CBC with regard to soil hazard-related design. The County of Los Angeles Building Code and City of Los Angeles Building Code require a site-specific foundation investigation and report for each construction site that identifies potentially unsuitable soil conditions and contains appropriate recommendations for foundation type and design criteria that conform to the analysis and implementation criteria described in the County of Los Angeles Building Code and the City of Los Angeles Building Code. Regulations exist to address weak soils issues, including expansion. The No Project Alternative would adhere to existing regulations and would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils.

5.4.7 Impact GEO-7: Would the project have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?

5.4.7.1 Operational Impacts

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. In absence of the Project, the only reasonably foreseeable transit improvement in the Project Study Area would involve changes to Metro Line 761. It is expected that the No Project Alternative would have no impact associated with soils incapable of adequately supporting such systems during operations.

5.4.7.2 Construction Impacts

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. In absence of the Project, the only reasonably foreseeable transit improvement in the Project Study Area would involve changes to Metro Line 761. The No Project Alternative would have no impact associated with soils incapable of adequately supporting such systems during construction activities.

5.4.8 Impact GEO-8: Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

5.4.8.1 Operational Impacts

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. In absence of the Project, the only reasonably foreseeable transit improvement in the Project Study Area would involve changes to Metro Line 761. Operations of the projects associated with the No Project Alternative does not include activities that involve ground disturbance other than bus stop facilities associated with the rerouting of Metro Line 761. Therefore, there would be no operational impacts related to paleontological resources.

5.4.8.2 Construction Impacts

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. The only reasonably foreseeable transportation project under the No Project Alternative is a set of improvements to Metro Line 761, including bus stop facility updates. Bus stop facilities associated with the rerouting of Metro Line 761 would require minor ground disturbance at shallow depths within existing fill and does not involve excavation or use TBM construction. The No Project Alternative would undergo its own environmental evaluation and mitigation measures may be included to reduce impacts related to paleontological resources. Standard paleontological resources mitigation would reduce impacts related to excavation from the surface level. Therefore, the No Project Alternative for construction impacts would result in a less than significant impact.

5.4.9 Impact GEO-9: Would the project result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state or an important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?

5.4.9.1 Operational Impacts

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. In absence of the Project, the only reasonably foreseeable transit improvement in the Project Study Area would involve changes to Metro Line 761. Operation of the projects associated with the No Project Alternative would not require excavation that may affect mineral resources. Therefore, the projects associated with the No Project Alternative would have no operational impacts related to the loss of availability of a known mineral resource or an important mineral resource recovery site.

5.4.9.2 Construction Impacts

The No Project Alternative would not include construction and operation of the Project, and impacts associated with the Project would not occur. The only reasonably foreseeable transportation project under the No Project Alternative is a set of improvements to Metro Line 761, including bus stop facility updates. Bus stop facilities associated with the rerouting of Metro Line 761 would require minor ground disturbance at shallow depths within existing fill and does not involve major excavation or use TBM construction. However, the area that the No Project Alternative encompasses is not known to have mineral resources. Therefore, the projects associated with the No Project Alternative would have no construction impacts related to the loss of availability of a known mineral resource or an important mineral resource recovery.

6 ALTERNATIVE 1

6.1 Alternative Description

Alternative 1 is an entirely aerial monorail alignment that would run along the Interstate 405 (I-405) corridor and would include eight aerial monorail transit (MRT) stations and a new electric bus route from the Los Angeles County Metropolitan Transportation Authority's (Metro) D Line Westwood/VA Hospital Station to the University of California, Los Angeles (UCLA) Gateway Plaza via Wilshire Boulevard and Westwood Boulevard. This alternative would provide transfers to five high-frequency fixed guideway transit and commuter rail lines, including the Metro E, Metro D, and Metro G Lines, the East San Fernando Valley Light Rail Transit Line, and the Metrolink Ventura County Line. The length of the alignment between the terminus stations would be approximately 15.1 miles. The length of the bus route would be 1.5 miles.

The eight aerial MRT stations and three bus stops would be as follows:

1. Metro E Line Expo/Sepulveda Station (aerial)
2. Santa Monica Boulevard Station (aerial)
3. Wilshire Boulevard/Metro D Line Station (aerial)
    a. Wilshire Boulevard/VA Medical Center bus stop
    b. Westwood Village bus stop
    c. UCLA Gateway Plaza bus stop
4. Getty Center Station (aerial)
5. Ventura Boulevard/Sepulveda Boulevard Station (aerial)
6. Metro G Line Sepulveda Station (aerial)
7. Sherman Way Station (aerial)
8. Van Nuys Metrolink Station (aerial)

6.1.1 Operating Characteristics

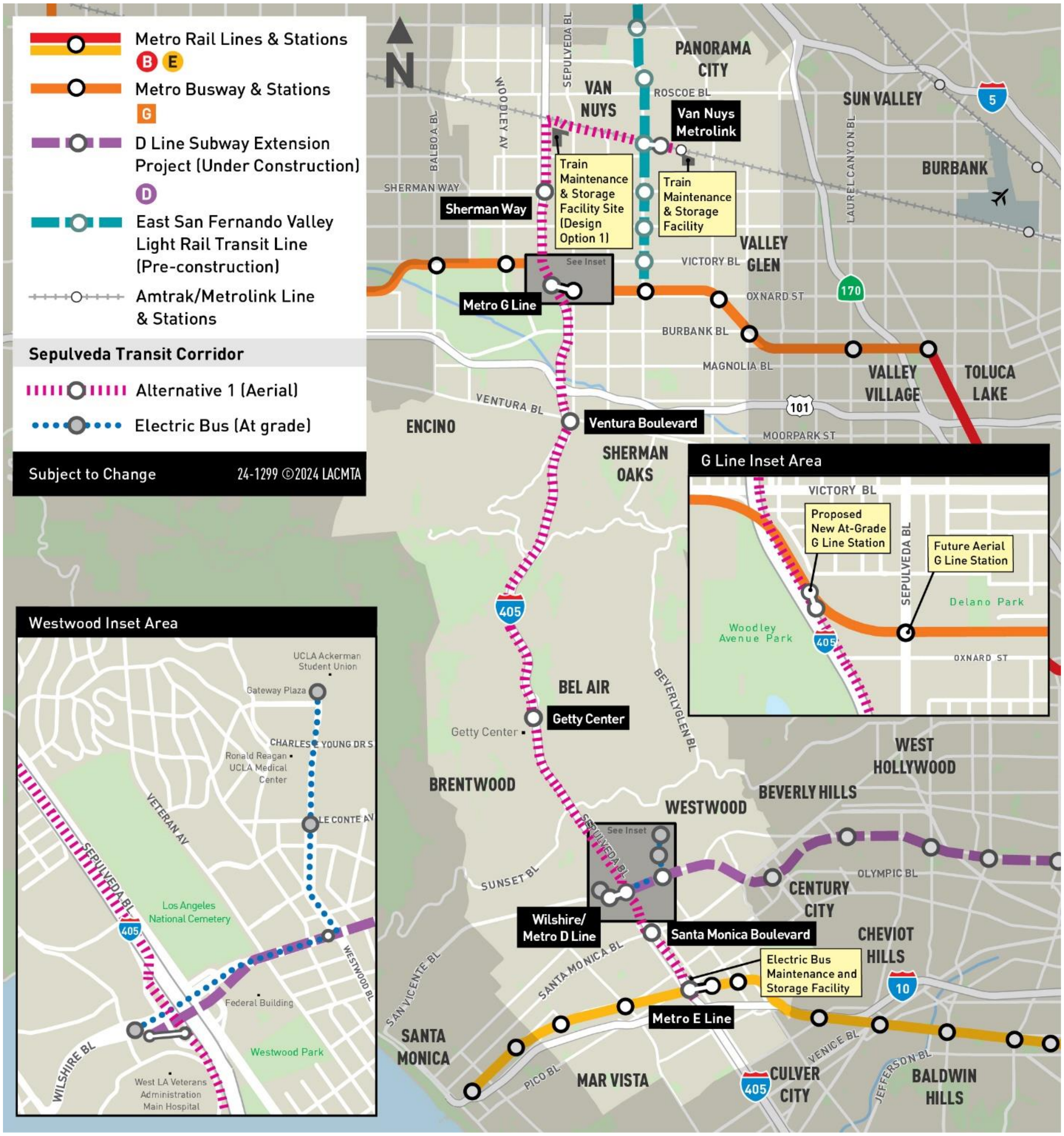
6.1.1.1 Alignment

As shown on Figure 6-1, from its southern terminus at the Metro E Line Expo/Sepulveda Station, the alignment of Alternative 1 would generally follow I-405 to the Los Angeles-San Diego-San Luis Obispo (LOSSAN) rail corridor near the alignment's northern terminus at the Van Nuys Metrolink Station. At several points, the alignment would transition from one side of the freeway to the other or to the median. North of U.S. Highway 101 (US-101), the alignment would be on the east side of the I-405 right-of-way and would then curve eastward along the south side of the LOSSAN rail corridor to Van Nuys Boulevard.

The proposed southern terminus station would be located west of the existing Metro E Line Expo/Sepulveda Station and east of I-405 between Pico Boulevard and Exposition Boulevard. Tail tracks would extend just south of the station adjacent to the eastbound Interstate 10 to northbound I-405 connector over Exposition Boulevard. North of the Metro E Line Expo/Sepulveda Station, a storage track would be located off the main alignment north of Pico Boulevard between I-405 and Cotner Avenue. The alignment would continue north along the east side of I-405 until just south of Santa Monica Boulevard, where a proposed station would be located between the I-405 northbound travel lanes and Cotner Avenue. The alignment would cross over the northbound and southbound freeway lanes north of Santa Monica Boulevard and travel along the west side of I-405, before reaching a proposed station within the

I-405 southbound-to-eastbound loop off-ramp to Wilshire Boulevard, near the Metro D Line Westwood/VA Hospital Station.

Figure 6-1. Alternative 1: Alignment



Source: LASRE, 2024; HTA, 2024

An electric bus would serve as a shuttle between the Wilshire Boulevard/Metro D Line Station and UCLA Gateway Plaza. From the Wilshire Boulevard/Metro D Line Station, the bus would travel east on Wilshire Boulevard and turn north on Westwood Boulevard to UCLA Gateway Plaza and make an intermediate stop in Westwood Village near the intersection of Le Conte Avenue and Westwood Boulevard.

North of Wilshire Boulevard, the monorail alignment would transition over the southbound I-405 freeway lanes to the freeway median, where it would continue north over the Sunset Boulevard overcrossing. The alignment would remain in the median to Getty Center Drive, where it would cross over the southbound freeway lanes to the west side of I-405, just north of the Getty Center Drive undercrossing, to the proposed Getty Center Station located north of the Getty Center tram station. The alignment would return to the median for a short distance before curving back to the west side of I-405, south of the Sepulveda Boulevard undercrossing north of the Getty Center Drive interchange. After crossing over Bel Air Crest Road and Skirball Center Drive, the alignment would return to the median and run under the Mulholland Drive Bridge, then continue north within the I-405 median to descend into the San Fernando Valley (Valley).

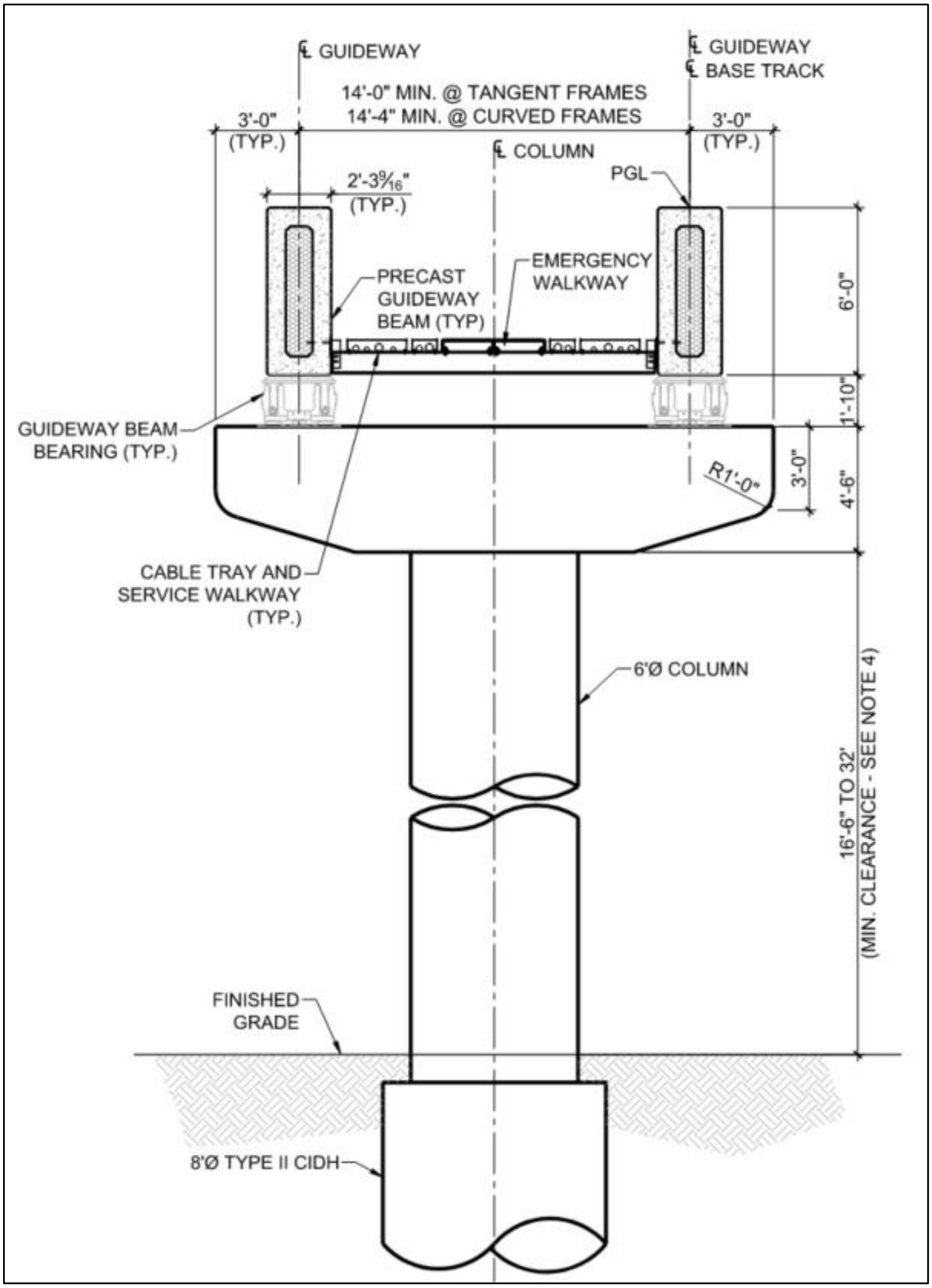
Near Greenleaf Street, the alignment would cross over the northbound freeway lanes and northbound on-ramps toward the proposed Ventura Boulevard Station on the east side of I-405. This station would be located above a transit plaza and would replace an existing segment of Dickens Street adjacent to I-405, just south of Ventura Boulevard. Immediately north of the Ventura Boulevard Station, the alignment would cross over northbound I-405 to the US-101 connector and continue north between the connector and the I-405 northbound travel lanes. The alignment would continue north along the east side of I-405—crossing over US-101 and the Los Angeles River—to a proposed station on the east side of I-405 near the Metro G Line Busway. A new at-grade station on the Metro G Line would be constructed for Alternative 1 adjacent to the proposed monorail station. These proposed stations are shown on the Metro G Line inset area on Figure 6-1.

The alignment would then continue north along the east side of I-405 to the proposed Sherman Way Station. The station would be located inside the I-405 northbound loop off-ramp to Sherman Way. North of the station, the alignment would continue along the eastern edge of I-405, then curve to the southeast parallel to the LOSSAN rail corridor. The alignment would remain aerial along Raymer Street east of Sepulveda Boulevard and cross over Van Nuys Boulevard to the proposed terminus station adjacent to the Van Nuys Metrolink/Amtrak Station. Overhead utilities along Raymer Street would be undergrounded where they would conflict with the guideway or its supporting columns. Tail tracks would be located southeast of this terminus station.

6.1.1.2 Guideway Characteristics

The monorail alignment of Alternative 1 would be entirely aerial, utilizing straddle-beam monorail technology, which allows the monorail vehicle to straddle a guide beam that both supports and guides the vehicle. Northbound and southbound trains would travel on parallel beams supported by either a single-column or a straddle-bent structure. Figure 6-2 shows a typical cross-section of the aerial monorail guideway.

Figure 6-2. Typical Monorail Guideway Cross-Section

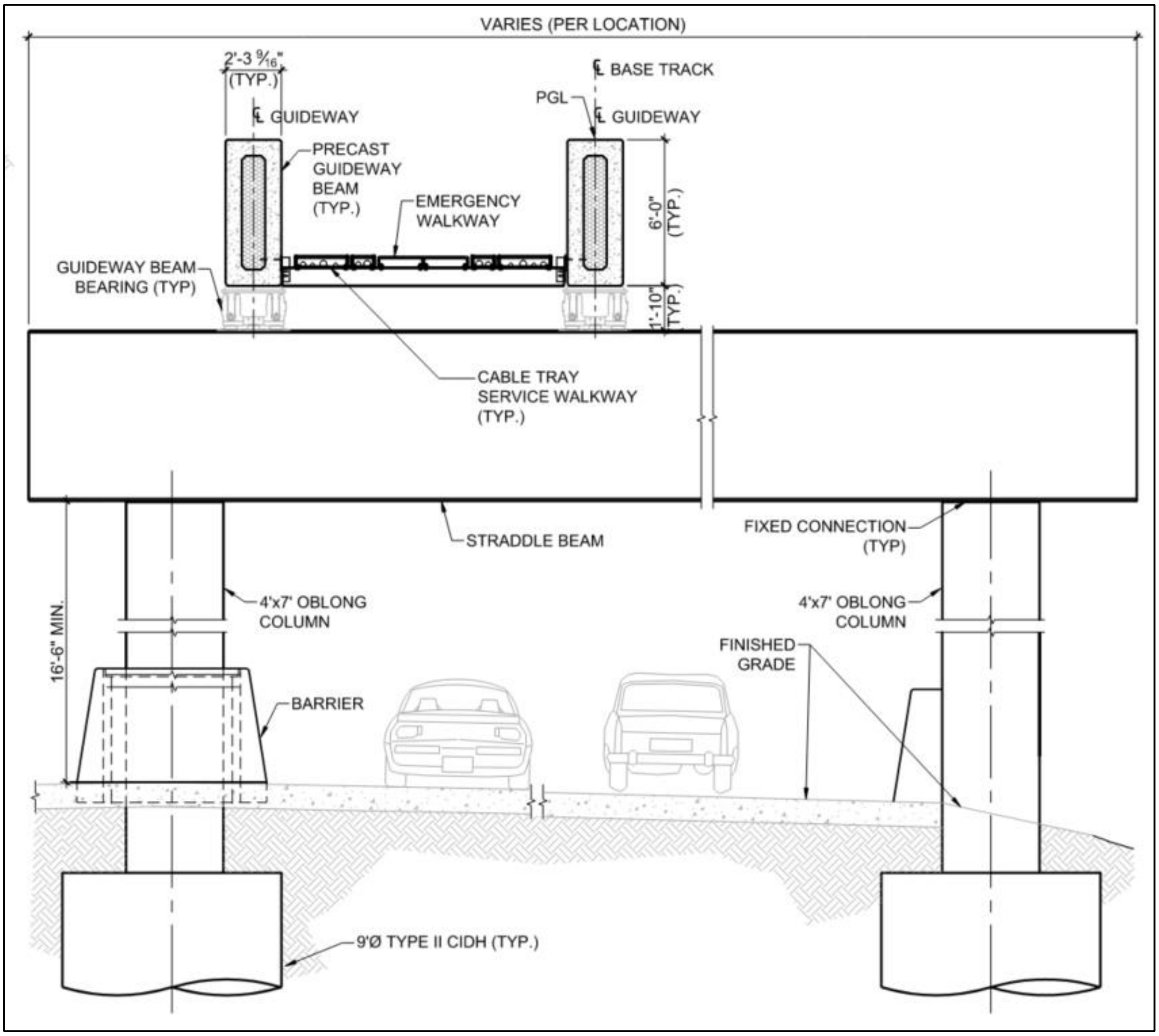


Source: LASRE, 2024

On a typical guideway section (i.e., not at a station), guide beams would rest on 20-foot-wide column caps (i.e., the structure connecting the columns and the guide beams), with typical spans (i.e., the distance between columns) ranging from 70 to 190 feet. The bottom of the column caps would typically be between 16.5 feet and 32 feet above ground level.

Over certain segments of roadway and freeway facilities, a straddle-bent configuration, as shown on Figure 6-3, consisting of two concrete columns constructed outside of the underlying roadway would be used to support the guide beams and column cap. Typical spans for these structures would range between 65 and 70 feet. A minimum 16.5-foot clearance would be maintained between the underlying roadway and the bottom of the column caps.

Figure 6-3. Typical Monorail Straddle-Bent Cross-Section



Source: LASRE, 2024

Structural support columns would vary in size and arrangement by alignment location. Columns would be 6 feet in diameter along main alignment segments adjacent to I-405 and be 4 feet wide by 6 feet long in the I-405 median. Straddle-bent columns would be 4 feet wide by 7 feet long. At stations, six rows of dual 5-foot by 8-foot columns would support the aerial guideway. Beam switch locations and long-span structures would also utilize different sized columns, with dual 5-foot columns supporting switch locations and 9-foot- or 10-foot-diameter columns supporting long-span structures. Crash protection barriers would be used to protect the columns. Columns would have a cast-in-drilled-hole (CIDH) pile foundation extending 1 foot in diameter beyond the column width with varying depths for appropriate geotechnical considerations and structural support.

6.1.1.3 Vehicle Technology

Alternative 1 would utilize straddle-beam monorail technology, which allows the monorail vehicle to straddle a guide beam that both supports and guides the vehicle. Rubber tires would sit both atop and on each side of the guide beam to provide traction and guide the train. Trains would be automated and powered by power rails mounted to the guide beam, with planned peak-period headways of 166 seconds and off-peak-period headways of 5 minutes. Monorail trains could consist of up to eight cars. Alternative 1 would have a maximum operating speed of 56 miles per hour; actual operating speeds would depend on the design of the guideway and distance between stations.

Monorail train cars would be 10.5 feet wide, with two double doors on each side. End cars would be 46.1 feet long with a design capacity of 97 passengers, and intermediate cars would be 35.8 feet long and have a design capacity of 90 passengers.

The electric bus connecting the Wilshire Boulevard/Metro D Line Station, Westwood Village, and UCLA Gateway Plaza would be a battery electric, low-floor transit bus, either 40 or 60 feet in length. The buses would run with headways of 2 minutes during peak periods. The electric bus service would operate in existing mixed-flow travel lanes.

6.1.1.4 Stations

Alternative 1 would include eight aerial MRT stations with platforms approximately 320 feet long, elevated 50 feet to 75 feet above the existing ground level. The Metro E Line Expo/Sepulveda, Santa Monica Boulevard, Ventura Boulevard/Sepulveda Boulevard, Sherman Way, and Van Nuys Metrolink Stations would be center-platform stations where passengers would travel up to a shared platform that would serve both directions of travel. The Wilshire Boulevard/Metro D Line, Getty Center, and Metro G Line Sepulveda Stations would be side-platform stations where passengers would select and travel up to one of two station platforms, depending on their direction of travel. Each station, regardless of whether it has side or center platforms, would include a concourse level prior to reaching the train platforms. Each station would have a minimum of two elevators, two escalators, and one stairway from ground level to the concourse.

Station platforms would be approximately 320 feet long and would be supported by six rows of dual 5-foot by 8-foot columns. Station platforms would be covered, but not enclosed. Side-platform stations would be 61.5 feet wide to accommodate two 13-foot-wide station platforms with a 35.5-foot-wide intermediate gap for side-by-side trains. Center-platform stations would be 49 feet wide, with a 25-foot-wide center platform.

Monorail stations would include automatic, bi-parting fixed doors along the edges of station platforms. These doors would be integrated into the automatic train control system and would not open unless a train is stopped at the platform.

The following information describes each station, with relevant entrance, walkway, and transfer information. Bicycle parking would be provided at each station.

Metro E Line Expo/Sepulveda Station

- This aerial station would be located near the existing Metro E Line Expo/Sepulveda Station, just east of I-405 between Pico Boulevard and Exposition Boulevard.
- A transit plaza and station entrance would be located on the east side of the station.
- An off-street passenger pick-up/drop-off loop would be located south of Pico Boulevard west of Cotner Avenue.
- An elevated pedestrian walkway would connect the concourse level of the proposed station to the Metro E Line Expo/Sepulveda Station within the fare paid zone.
- Passengers would be able to park at the existing Metro E Line Expo/Sepulveda Station parking facility, which provides 260 parking spaces. No additional automobile parking would be provided at the proposed station.

Santa Monica Boulevard Station

- This aerial station would be located just south of Santa Monica Boulevard, between the I-405 northbound travel lanes and Cotner Avenue.
- Station entrances would be located on the southeast and southwest corners of Santa Monica Boulevard and Cotner Avenue. The entrance on the southeast corner of the intersection would be connected to the station concourse level via an elevated pedestrian walkway spanning Cotner Avenue.
- No dedicated station parking would be provided at this station.

Wilshire Boulevard/Metro D Line Station

- This aerial station would be located west of I-405 and south of Wilshire Boulevard within the southbound I-405 loop off-ramp to eastbound Wilshire Boulevard.
- An elevated pedestrian walkway spanning the adjacent I-405 ramps would connect the concourse level of the proposed station to a station plaza adjacent to the Metro D Line Westwood/VA Hospital Station within the fare paid zone. The station plaza would be the only entrance to the proposed station.
- The station plaza would include an electric bus stop and provide access to the Metro D Line Station via a new station entrance and concourse constructed using a knock-out panel provided in the Metro D Line Station.
- The passenger pick-up/drop-off facility at the Metro D Line Station would be reconfigured, maintaining the original capacity.
- No dedicated station parking would be provided at this station.

Getty Center Station

- This aerial station would be located on the west side of I-405 near the Getty Center, approximately 1,000 feet north of the Getty Center tram station.
- An elevated pedestrian walkway would connect the concourse level of the proposed station to the Getty Center tram station. The proposed connection would occur outside the fare paid zone.
- The pedestrian walkway would provide the only entrance to the proposed station.

- No dedicated station parking would be provided at this station.

Ventura Boulevard/Sepulveda Boulevard Station

- This aerial station would be located east of I-405, just south of Ventura Boulevard.
- A transit plaza, including two station entrances, would be located on the east side of the station. The plaza would require the closure of a 0.1-mile segment of Dickens Street between Sepulveda Boulevard and Ventura Boulevard, with a passenger pick-up/drop-off loop and bus stops provided south of the station, off Sepulveda Boulevard.
- No dedicated station parking would be provided at this station.

Metro G Line Sepulveda Station

- This aerial station would be located near the Metro G Line Sepulveda Station, between I-405 and the Metro G Line Busway.
- Entrances to the MRT station would be located on both sides of a proposed new Metro G Line bus rapid transit (BRT) station.
- An elevated pedestrian walkway would connect the concourse level of the proposed station to the proposed new Metro G Line BRT station outside of the fare paid zone.
- Passengers would be able to park at the existing Metro G Line Sepulveda Station parking facility, which has a capacity of 1,205 parking spaces. Currently, only 260 parking spaces are used for transit parking. No additional automobile parking would be provided at the proposed station.

Sherman Way Station

- This aerial station would be located inside the I-405 northbound loop off-ramp to Sherman Way.
- A station entrance would be located on the north side of Sherman Way.
- An on-street passenger pick-up/drop-off area would be provided on the north side of Sherman Way west of Firmament Avenue.
- No dedicated station parking would be provided at this station.

Van Nuys Metrolink Station

- This aerial station would be located on the east side of Van Nuys Boulevard, just south of the LOSSAN rail corridor, incorporating the site of the current Amtrak ticket office.
- A station entrance would be located on the east side of Van Nuys Boulevard just south of the LOSSAN rail corridor. A second entrance would be located north of the LOSSAN rail corridor with an elevated pedestrian walkway connecting to both the concourse level of the proposed station and the platform of the Van Nuys Metrolink/Amtrak Station.
- Existing Metrolink station parking would be reconfigured, maintaining approximately the same number of spaces, but 180 parking spaces would be relocated north of the LOSSAN rail corridor. Metrolink parking would not be available to Metro transit riders.

6.1.1.5 Station-to-Station Travel Times

Table 6-1 presents the station-to-station distance and travel times for Alternative 1. The travel times include both run time and dwell time. Dwell time is 30 seconds per station. Northbound and southbound travel times vary slightly because of grade differentials and operational considerations at end-of-line stations.

Table 6-1. Alternative 1: Station-to-Station Travel Times and Station Dwell Times

From Station	To Station	Distance (miles)	Northbound Station-to-Station Travel Time (seconds)	Southbound Station-to-Station Travel Time (seconds)	Dwell Time (seconds)
Metro E Line Station					*30*
Metro E Line	Santa Monica Boulevard	0.9	122	98	—
Santa Monica Boulevard Station					*30*
Santa Monica Boulevard	Wilshire/Metro D Line	0.7	99	104	—
Wilshire/Metro D Line Station					*30*
Wilshire/Metro D Line	Getty Center	2.9	263	266	—
Getty Center Station					*30*
Getty Center	Ventura Boulevard	4.7	419	418	—
Ventura Boulevard Station					*30*
Ventura Boulevard	Metro G Line	2.0	177	184	—
Metro G Line Station					*30*
Metro G Line	Sherman Way	1.5	135	134	—
Sherman Way Station					*30*
Sherman Way	Van Nuys Metrolink	2.4	284	284	—
Van Nuys Metrolink Station					*30*

Source: LASRE, 2024

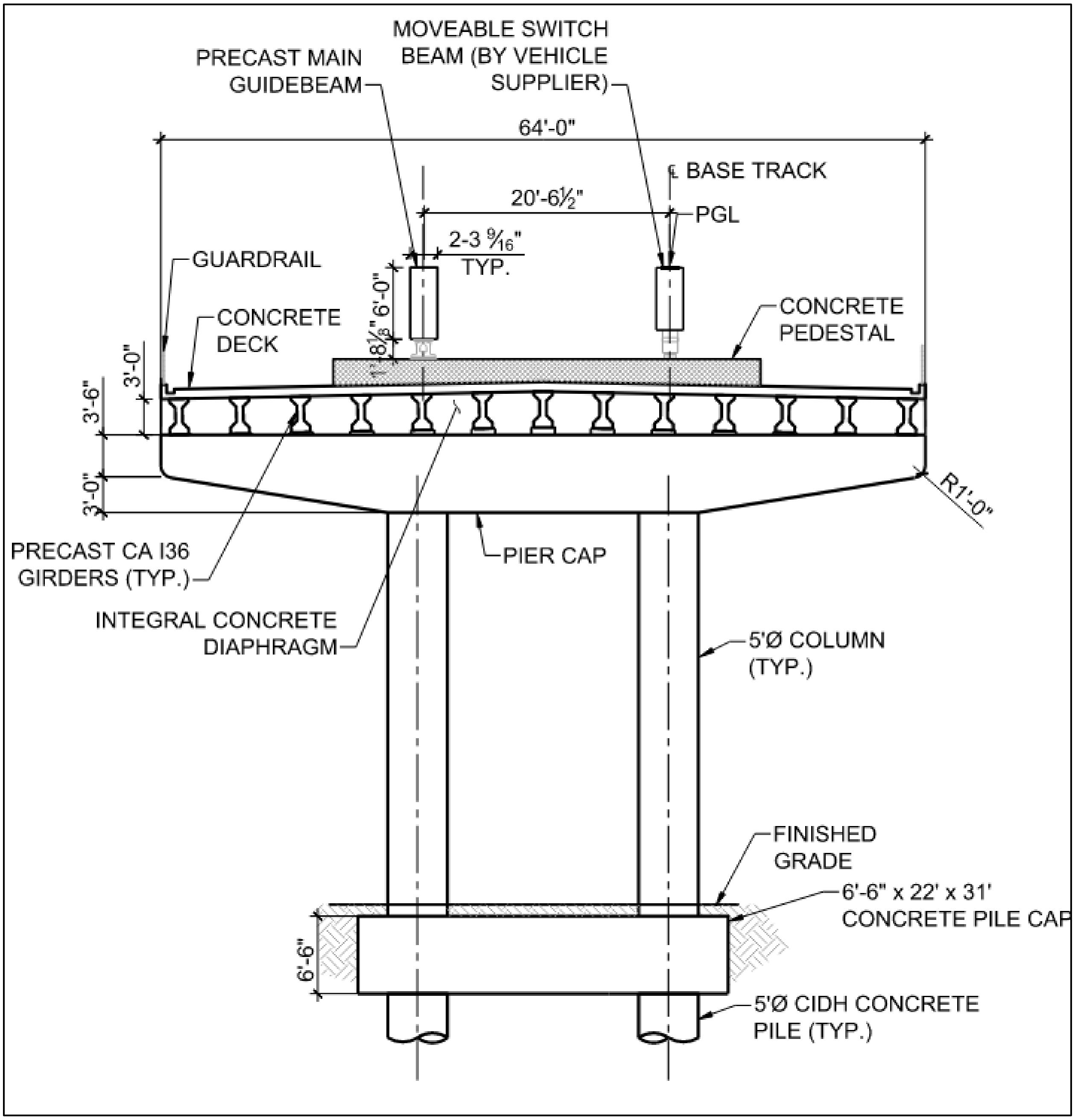
— = no data

6.1.1.6 Special Trackwork

Alternative 1 would include five pairs of beam switches to enable trains to cross over to the opposite beam. From south to north, the first pair of beam switches would be located just north of the Metro E Line Expo/Sepulveda Station. The second pair of beam switches would be located near the Wilshire Boulevard/Metro D Line Station on the north side of Wilshire Boulevard, within the Wilshire Boulevard westbound to I-405 southbound loop on-ramp. A third pair of beam switches would be located in the Sepulveda Pass, just south of Mountaingate Drive and Sepulveda Boulevard. A fourth pair of beam switches would be located south of the Metro G Line Station, between the I-405 northbound lanes and the Metro G Line Busway. The final pair would be located near the Van Nuys Metrolink Station.

At beam switch locations, the typical cross-section of the guideway would increase in column and column cap width. The column cap at these locations would be 64 feet wide, with dual 5-foot-diameter columns. Underground pile caps for additional structural support would also be required at beam switch locations. Figure 6-4 shows a typical cross-section of the monorail beam switch.

Figure 6-4. Typical Monorail Beam Switch Cross-Section



Source: LASRE, 2024

6.1.1.7 Monorail Maintenance and Storage Facility

MSF Base Design

In the maintenance and storage facility (MSF) Base Design for Alternative 1, the MSF would be located on City of Los Angeles Department of Water and Power (LADWP) property east of the Van Nuys Metrolink Station. The MSF Base Design site would be approximately 18 acres and would be designed to accommodate a fleet of 208 monorail vehicles. The site would be bounded by the LOSSAN rail corridor to the north, Saticoy Street to the south, and property lines extending north of Tyrone and Hazeltine Avenues to the east and west, respectively.

Monorail trains would access the site from the main alignment's northern tail tracks at the northwest corner of the site. Trains would travel parallel to the LOSSAN rail corridor before curving southeast to maintenance facilities and storage tracks. The guideway would remain in an aerial configuration within the MSF Base Design, including within maintenance facilities.

The site would include the following facilities:

- Primary entrance with guard shack
- Primary maintenance building that would include administrative offices, an operations control center, and a maintenance shop and office
- Train car wash building
- Emergency generator
- Traction power substation (TPSS)
- Maintenance-of-way (MOW) building
- Parking area for employees

MSF Design Option 1

In the MSF Design Option 1, the MSF would be located on industrial property, abutting Orion Avenue, south of the LOSSAN rail corridor. The MSF Design Option 1 site would be approximately 26 acres and would be designed to accommodate a fleet of 224 monorail vehicles. The site would be bounded by I-405 to the west, Stagg Street to the south, the LOSSAN rail corridor to the north, and Orion Avenue and Raymer Street to the east. The monorail guideway would travel along the northern edge of the site.

Monorail trains would access the site from the monorail guideway east of Sepulveda Boulevard, requiring additional property east of Sepulveda Boulevard and north of Raymer Street. From the northeast corner of the site, trains would travel parallel to the LOSSAN rail corridor before turning south to maintenance facilities and storage tracks parallel to I-405. The guideway would remain in an aerial configuration within the MSF Design Option 1, including within maintenance facilities.

The site would include the following facilities:

- Primary entrance with guard shack
- Primary maintenance building that would include administrative offices, an operations control center, and a maintenance shop and office
- Train car wash building
- Emergency generator
- TPSS
- MOW building
- Parking area for employees

Figure 6-5 shows the locations of the MSF Base Design and MSF Design Option 1 for Alternative 1.

Figure 6-5. Alternative 1: Maintenance and Storage Facility Options

Source: LASRE, 2024; HTA, 2024

6.1.1.8 Electric Bus Maintenance and Storage Facility

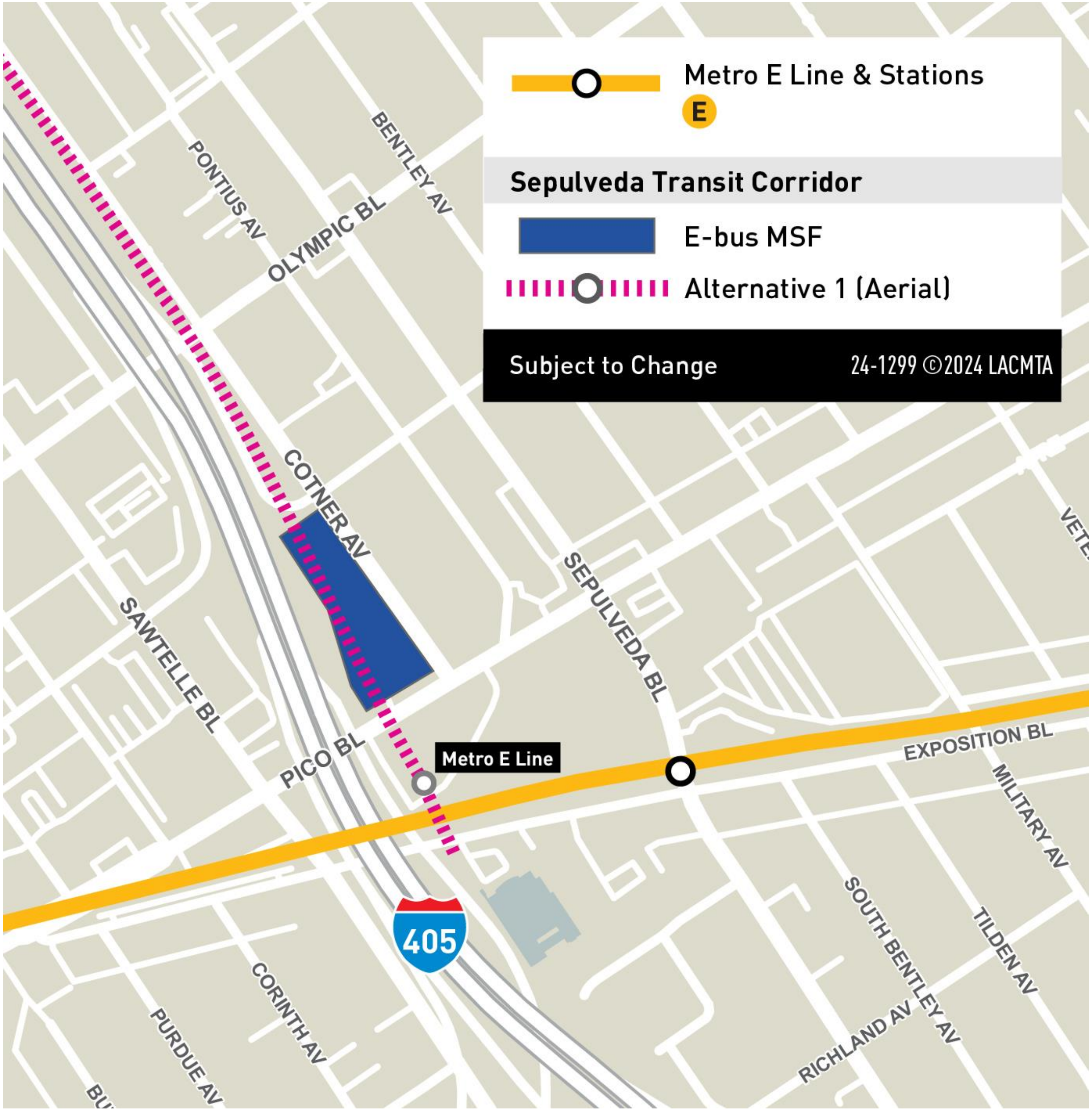
An electric bus MSF would be located on the northwest corner of Pico Boulevard and Cotner Avenue and would be designed to accommodate 14 electric buses. The site would be approximately 2 acres and would comprise six parcels bounded by Cotner Avenue to the east, I-405 to the west, Pico Boulevard to the south, and the I-405 northbound on-ramp to the north.

The site would include approximately 45,000 square feet of buildings and include the following facilities:

- Maintenance shop and bay
- Maintenance office
- Operations center
- Bus charging equipment
- Parts storeroom with service areas
- Parking area for employees

Figure 6-6 shows the location of the proposed electric bus MSF.

Figure 6-6. Alternative 1: Electric Bus Maintenance and Storage Facility



Source: LASRE, 2024; HTA, 2024

6.1.1.9 Traction Power Substations

TPSSs transform and convert high voltage alternating current supplied from power utility feeders into direct current suitable for transit operation. A TPSS on a site of approximately 8,000 square feet would be located approximately every 1 mile along the alignment. Table 6-2 lists the TPSS locations proposed for Alternative 1.

Figure 6-7 shows the TPSS locations along the Alternative 1 alignment.

Table 6-2. Alternative 1: Traction Power Substation Locations

TPSS No.	TPSS Location Description	Configuration
1	TPSS 1 would be located east of I-405, just south of Exposition Boulevard and the monorail guideway tail tracks.	At-grade
2	TPSS 2 would be located west of I-405, just north of Wilshire Boulevard, inside the Westbound Wilshire Boulevard to I-405 Southbound Loop On-Ramp.	At-grade
3	TPSS 3 would be located west of I-405, just north of Sunset Boulevard, inside the Church Lane to I-405 Southbound Loop On-Ramp.	At-grade
4	TPSS 4 would be located east of I-405 and Sepulveda Boulevard, just north of the Getty Center Station.	At-grade
5	TPSS 5 would be located west of I-405, just east of the intersection between Promontory Road and Sepulveda Boulevard.	At-grade
6	TPSS 6 would be located between I-405 and Sepulveda Boulevard, just north of the Skirball Center Drive Overpass.	At-grade
7	TPSS 7 would be located east of I-405, just south of Ventura Boulevard Station, between Sepulveda Boulevard and Dickens Street.	At-grade
8	TPSS 8 would be located east of I-405, just south of the Metro G Line Sepulveda Station.	At-grade
9	TPSS 9 would be located east of I-405, just east of the Sherman Way Station, inside the I-405 Northbound Loop Off-Ramp to Sherman Way westbound.	At-grade
10	TPSS 10 would be located east of I-405, at the southeast quadrant of the I-405 overcrossing with the LOSSAN rail corridor.	At-grade
11	TPSS 11 would be located east of I-405, at the southeast quadrant of the I-405 overcrossing with the LOSSAN rail corridor.	At-grade (within MSF Design Option)
12	TPSS 12 would be located between Van Nuys Boulevard and Raymer Street, south of the LOSSAN rail corridor.	At-grade
13	TPSS 13 would be located south of the LOSSAN rail corridor, between Tyrone Avenue and Hazeltine Avenue.	At-grade (within MSF Base Design)

Source: LASRE, 2024; HTA, 2024

Figure 6-7. Alternative 1: Traction Power Substation Locations

Source: LASRE, 2024; HTA, 2024

6.1.1.10 Roadway Configuration Changes

Table 6-3 lists the roadway changes necessary to accommodate the guideway of Alternative 1. Figure 6-8 shows the location of these roadway changes in the Sepulveda Transit Corridor Project (Project) Study Area, except for I-405 configuration changes, which would occur throughout the corridor.

Table 6-3. Alternative 1: Roadway Changes

Location	From	To	Description of Change
Cotner Avenue	Nebraska Avenue	Santa Monica Boulevard	Roadway realignment to accommodate aerial guideway columns and station access
Beloit Avenue	Massachusetts Avenue	Ohio Avenue	Roadway narrowing to accommodate aerial guideway columns
I-405 Southbound On-Ramp, Southbound Off-Ramp, and Northbound On-Ramp at Wilshire Boulevard	Wilshire Boulevard	I-405	Ramp realignment to accommodate aerial guideway columns and I-405 widening
Sunset Boulevard	Gunston Drive	I-405 Northbound Off-Ramp at Sunset Boulevard	Removal of direct eastbound to southbound on-ramp to accommodate aerial guideway columns and I-405 widening. Widening of Sunset Boulevard bridge with additional westbound lane
I-405 Southbound On-Ramp and Off-Ramp at Sunset Boulevard and North Church Lane	Sunset Boulevard	Not Applicable	Ramp realignment to accommodate aerial guideway columns and I-405 widening
I-405 Northbound On-Ramp and Off-Ramp at Sepulveda Boulevard near I-405 Exit 59	Sepulveda Boulevard near I-405 Northbound Exit 59	Sepulveda Boulevard / I-405 Undercrossing (near Getty Center)	Ramp realignment to accommodate aerial guideway columns and I-405 widening
Sepulveda Boulevard	I-405 Southbound Skirball Center Drive Ramps (north of Mountaingate Drive)	Skirball Center Drive	Roadway realignment into existing hillside to accommodate aerial guideway columns and I-405 widening
I-405 Northbound On-Ramp at Mulholland Drive	Mulholland Drive	Not Applicable	Roadway realignment into the existing hillside between the Mulholland Drive Bridge pier and abutment to accommodate aerial guideway columns and I-405 widening
Dickens Street	Sepulveda Boulevard	Ventura Boulevard	Vacation and permanent removal of street for Ventura Boulevard Station construction. Pick-up/drop-off area would be provided along Sepulveda Boulevard at the truncated Dickens Street
Sherman Way	Haskell Avenue	Firmament Avenue	Median improvements, passenger drop-off and pick-up areas, and bus pads within existing travel lanes
Raymer Street	Sepulveda Boulevard	Van Nuys Boulevard	Curb extensions and narrowing of roadway width to accommodate aerial guideway columns
I-405	Sunset Boulevard	Bel Terrace	I-405 widening to accommodate aerial guideway columns in the median

Location	From	To	Description of Change
I-405	Sepulveda Boulevard Northbound Off-Ramp (Getty Center Drive interchange)	Sepulveda Boulevard Northbound On-Ramp (Getty Center Drive interchange)	I-405 widening to accommodate aerial guideway columns in the median
I-405	Skirball Center Drive	I-405 Northbound On-Ramp at Mulholland Drive	I-405 widening to accommodate aerial guideway columns in the median

Source: LASRE, 2024; HTA, 2024

Figure 6-8. Alternative 1: Roadway Changes

Source: LASRE, 2024; HTA, 2024

In addition to the changes made to accommodate the guideway, as listed in Table 6-3, roadways and sidewalks near stations would be reconstructed, which would result in modifications to curb ramps and driveways.

6.1.1.11 Fire/Life Safety – Emergency Egress

Continuous emergency evacuation walkways would be provided along the guideway. The walkways would typically consist of structural steel frames anchored to the guideway beams to support non-slip walkway panels. The walkways would be located between the two guideway beams for most of the alignment; however, where the beams split apart, such as entering center-platform stations, short portions of the walkway would be located on the outside of the beams.

6.1.2 Construction Activities

Construction activities for Alternative 1 would include constructing the aerial guideway and stations, widening I-405, and constructing ancillary facilities. Construction of the transit through substantial completion is expected to have a duration of 6½ years. Early works, such as site preparation, demolition, and utility relocation, could start in advance of construction of the transit facilities.

Aerial guideway construction would begin at the southern and northern ends of the alignment and connect in the middle. Constructing the guideway would require a combination of freeway and local street lane closures throughout the work limits to provide sufficient work area. The first stage of I-405 widening would include a narrowing of adjacent freeway lanes to a minimum width of 11 feet (which would eliminate shoulders) and placing K-rail on the outside edge of the travel lanes to create outside work areas. Within these outside work zones, retaining walls, drainage infrastructure, and outer pavement widenings would be constructed to allow for I-405 widening. The reconstruction of on- and off-ramps would be the final stage of I-405 widening.

A median work zone along I-405 for the length of the alignment would be required for erection of the guideway structure. In the median work zone, demolition of the existing median and drainage infrastructure would be followed by the installation of new K-rail and installation of guideway structural components, which would include full directional freeway closures when guideway beams must be transported into the median work areas during late-night hours. Additional night and weekend directional closures would be required for installation of long-span structures over I-405 travel lanes where the guideway would transition from the median.

Aerial station construction is anticipated to last the duration of construction activities for Alternative 1 and would include the following general sequence of construction:

- Site clearing
- Utility relocation
- Construction fencing and rough grading
- CIDH pile drilling and installation
- Elevator pit excavation
- Soil and material removal
- Pile cap and pier column construction
- Concourse level and platform level falsework for cast-in-place structural concrete
- Guideway beam installation
- Elevator and escalator installation
- Completion of remaining concrete elements such as pedestrian bridges
- Architectural finishes and mechanical, electrical, and plumbing installation

Alternative 1 would require construction of a concrete casting facility for columns and beams associated with the elevated guideway. A specific site has not been identified; however, it is expected that the facility would be located on industrially zoned land adjacent to a truck route in either the Antelope Valley or Riverside County. When a site is identified, the contractor would obtain all permits and approvals necessary from the relevant jurisdiction, the appropriate air quality management entity, and other regulatory entities.

TPSS construction would require additional lane closures. Large equipment, including transformers, rectifiers, and switchgears would be delivered and installed through prefabricated modules, where possible, in at-grade TPSSs. The installation of transformers would require temporary lane closures on Exposition Boulevard, Beloit Avenue, Sepulveda Boulevard just north of Cashmere Street, and the I-405 northbound on-ramp at Burbank Boulevard.

Table 6-4 and Figure 6-9 show the potential construction staging areas for Alternative 1. Staging areas would provide the necessary space for the following activities:

- Contractors' equipment
- Receiving deliveries
- Storing materials
- Site offices
- Work zone for excavation
- Other construction activities (including parking and change facilities for workers, location of construction office trailers, storage, staging and delivery of construction materials and permanent plant equipment, and maintenance of construction equipment)

Table 6-4. Alternative 1: Construction Staging Locations

No.	Location Description
1	Public Storage between Pico Boulevard and Exposition Boulevard, east of I-405
2	South of Dowlen Drive and east of Greater LA Fisher House
3	At 1400 N Sepulveda Boulevard
4	At 1760 N Sepulveda Boulevard
5	East of I-405 and north of Mulholland Drive Bridge
6	Inside of I-405 Northbound to US-101 Northbound Loop Connector, south of US-101
7	ElectroRent Building south of Metro G Line Busway, east of I-405
8	Inside the I-405 Northbound Loop Off-Ramp at Victory Boulevard
9	Along Cabrito Road, east of Van Nuys Boulevard

Source: LASRE, 2024; HTA, 2024

Figure 6-9. Alternative 1: Construction Staging Locations

Source: LASRE, 2024; HTA, 2024

6.2 Existing Conditions

6.2.1 Regional Geology

Alternative 1 would pass through the northwestern portion of the Los Angeles Basin, through the Santa Monica Mountains, and then continue into the south and central portions of the San Fernando Valley, with an electric bus connection to UCLA. The northern portion of Alternative 1 would traverse the San Fernando Valley and continue south through the Santa Monica Mountains into the Los Angeles Basin (Metro, 2023a).

Alternative 1 would be within two geologic provinces:

- The northern portion of Alternative 1 would be located within the Transverse Ranges geomorphic province.
- The southern portion of Alternative 1 would be located within the Los Angeles Basin, which is the northern-most basin of the Peninsular Ranges geomorphic province.

6.2.1.1 Transverse Ranges Geomorphic Province

The Transverse Ranges geomorphic province is composed of several mountain ranges oriented in an east–west direction and extends over 320 miles from the Mojave and Colorado Desert Provinces to Point Arguello at the Pacific Ocean. Included within the Transverse Ranges are portions of Riverside, San Bernardino, Los Angeles, and Ventura Counties. Acting as a northern boundary, the Transverse Ranges truncate the northwest-trending structural grain of the Peninsular Ranges geomorphic province. Most active faults in the Transverse Ranges are east–west-trending faults. Rock types in this province include gneiss, granitic rocks, and sedimentary rocks. Volcanic rocks are found in the Santa Monica Mountains. Alluvial sediments are typically in canyon bottoms and valleys, with broad alluvial fans at the mouths of steep canyons (City of Los Angeles, 2018).

6.2.1.2 Peninsular Ranges Geomorphic Province

The Peninsular Ranges geomorphic province, composed of multiple mountain ranges and valleys, extends southward 775 miles past the United States-Mexico border. The Peninsular Ranges geomorphic province extends southward from the southern edge of the Transverse Ranges geomorphic province to the tip of Baja California in Mexico. The Peninsular Ranges are characterized by northwest–southeast-trending hills and valleys that are separated by similarly trending faults. Most active faults in the Peninsular Ranges province are northwest trending. Rock types in this province in the Los Angeles region generally include schist and sedimentary rocks. Surface materials in canyon bottoms and basins generally consist of alluvium (City of Los Angeles, 2018).

6.2.1.3 San Fernando Valley

The San Fernando Valley is a triangular east–west-trending structural depression located within the Transverse Ranges geomorphic province. The Transverse Ranges province trends east–west from the offshore Channel Islands (e.g. Santa Rosa, Santa Cruz, and Anacapa) to the eastern Mojave Desert. The province is characterized by east–west-trending mountain ranges (such as the Santa Monica Mountains, San Gabriel Mountains, and San Bernardino Mountains) separated by similar trending intermontane valleys. The San Fernando Valley is bordered on the east by the Verdugo Mountains, on the north by the San Gabriel and Santa Susana Mountains, on the west by the Simi Hills, and on the south by the Santa Monica Mountains. The mountains that bound the San Fernando Valley are actively deforming anticlinal ranges bounded by thrust faults. Because the ranges have risen and deformed, the valley has subsided and accumulated sediment to create the elongated basin (Metro, 2023a).

6.2.1.4 Santa Monica Mountains

The Santa Monica Mountains are an east–west-trending linear mountain range within the western Transverse Ranges geomorphic province. Major east-trending folds, reverse faults, and left-lateral, strike-slip faults reflect regional north–south compression and are characteristic of the Transverse Ranges. The Santa Monica Mountains are being actively uplifted along a series of segmented frontal reverse faults (Malibu Coast fault, Santa Monica fault, and Raymond fault) on the south side of the range that extend from Arroyo Sequit in the west to Glendale in the east. This fault system is aligned with the Santa Cruz Island fault. The Los Angeles Basin on the southern side of the range is one of a series of basins forming a transition zone between the Transverse Ranges and the northwest–southeast-trending Peninsular Ranges geomorphic province to the south (Metro, 2023a).

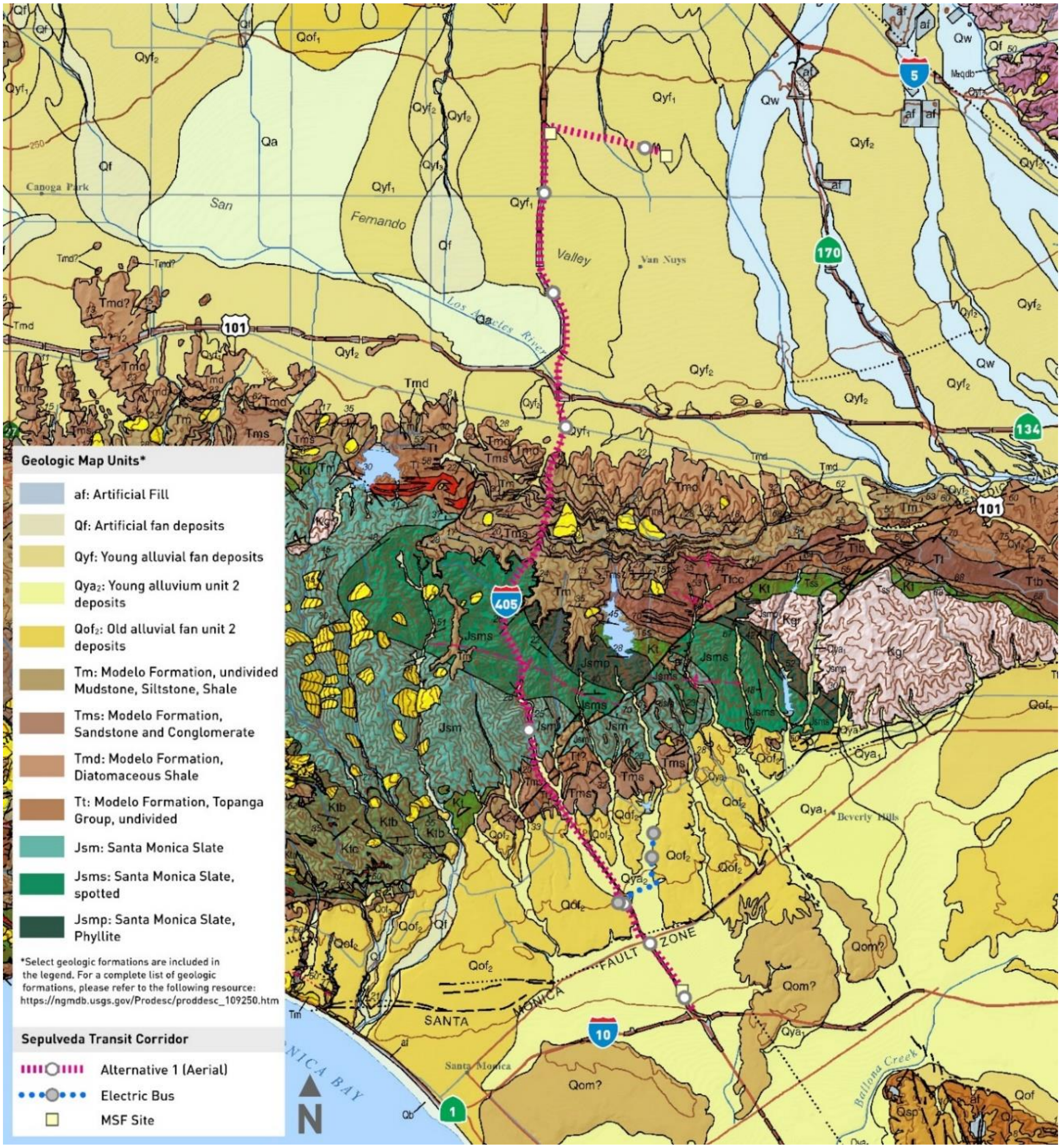
6.2.1.5 Los Angeles Basin

The Los Angeles Basin is a large low-lying coastal plain bordered by the Santa Monica Mountains on the north, the Repetto and Puente Hills on the northeast, the Santa Ana Mountains on the east, and the San Joaquin Hills on the south. The western margin of the basin is open to the Pacific Ocean except for one prominent hill: the Palos Verdes Peninsula. The floor of the Los Angeles Basin is a relatively flat surface that rises gently from sea level along the coastline to an apron of uplifted terrain along the base of the surrounding mountains, which rise abruptly to a few thousand feet above the plain. The flat basin floor is interrupted in a few localities by small hills, the most prominent of which are a northwest–southeast-trending alignment of hills and mesas that extend from the Newport Beach area on the south to the Beverly Hills area on the north (Metro, 2023a).

6.2.2 Project Site Soil Types and Characteristics

Figure 6-10 shows the geologic features of Alternative 1. Alternative 1 would be generally underlain by nearly horizontal Quaternary sediments overlying Tertiary-age sediments and sedimentary rocks. All the geologic units within Alternative 1 have been deformed into folds and offset by faults. The sedimentary strata lap onto the Santa Monica slate that forms the core of the Santa Monica Mountains; bedrock units on the south flank generally dip southerly and bedrock units on the north flank generally dip northerly. Along the higher elevations within Alternative 1, particularly through the Santa Monica Mountains, sedimentary and metamorphic bedrock are exposed at the surface with some localized colluvial and alluvial soils within tributary valleys (Metro, 2023a).

Figure 6-10. Alternative 1: Geologic Units



Source: USGS 2016; HTA, 2024

Alluvial deposits are found in the valley/basin portions of Alternative 1, including the areas north and south of the Santa Monica Mountains. The San Fernando Valley to the north is underlain by up to 2,000 feet of alluvial sediment, with Cretaceous-aged crystalline bedrock below the alluvium (Metro, 2023a).

The southern portion of Alternative 1 would extend into the Los Angeles Basin. This area of Alternative 1 would be directly underlain by unconsolidated, Quaternary-age, sandy sediments. The soil could be subdivided into loose, unconsolidated, Holocene-age sediments, which cover the bulk of the basin, and late-Pleistocene materials, which comprise the surface over much of the uplifts of the Newport Inglewood Structural Zone and the marginal plains. Lithified and crystalline rocks occur only in the mountains surrounding the basins and at depths ranging from about 5,000 feet to as much as 30,000 feet in the deepest part of the central basin.

The lithologic units exposed along Alternative 1 include artificial fill, landslide debris, young and old alluvium, and bedrock most commonly associated with the Modelo Formation and Santa Monica Slate. Much of I-405 and associated improvements are underlain by artificial fill associated with the construction of I-405. Young and old alluvial fan and stream deposits are found predominantly along the northern and southern sides of the Santa Monica Mountains. These surficial units are generally composed of unconsolidated to poorly to moderately consolidated sediments of Holocene to Pleistocene ages and are found either at the surface or buried under the fill associated with I-405 (Metro, 2023a).

6.2.2.1 Artificial Fill

Artificial fill (af) is comprised of silty sand, a mixture of moist, brown and gray, silty sand of fine-grained to coarse-grained composure. Some clay or gray pockets may be observed. The most commonly observed lithology for the No Project Alternative along the alignment is typically at the ground surface (Metro, 2023a).

6.2.2.2 Modelo Formation

The Modelo Formation (Tm, Tms, Tmd) is a late Miocene-age sedimentary bedrock that generally consists of gray to brown, thinly bedded mudstone, and shale and siltstone, with interbeds of very fine-grained to coarse-grained sandstone. The most commonly observed lithology for Alternative 1 is near I-405, with thinly bedded shale to shaley siltstone with interbeds of fine sandstone. Additionally, localized diatomaceous shale and siltstone with interbeds of bentonite and fine sandstone are within the formation (Metro, 2023a).

6.2.2.3 Old Alluvial Fan Deposits

Older (Late to middle Pleistocene) alluvial fan deposits (Qof), which form the Santa Monica Plain, are mapped along the southern edge of the Santa Monica Mountains. They continue in the subsurface in the Los Angeles Basin. These sediments were deposited by stream channels that had flowed southward from the Santa Monica Mountains during the late Pleistocene. They consist of a thick series of alluvial fans that spread out southward from the mountain front toward the ocean. These deposits are described by Campbell et al. (2016) as moderately consolidated, silt, sand, and gravel deposits on alluvial fans.

6.2.2.4 Santa Susana Formation

The Paleocene Santa Susana Formation (Tss), which underlies the Topanga Formation, is exposed in the slopes bordering the west side of the Stone Canyon Reservoir (SCR). Campbell et al. (2016) described the formation as consisting predominantly of fine- to medium-grained sandstone with some interbeds of gray clay shale, mudstone and siltstone, and some lenses of pebble-cobble conglomerate. Shale beds commonly contain indurated limestone concretions.

6.2.2.5 Santa Monica Slate

The Santa Monica Slate (Jsm, Jsms, Jsmp) is a Jurassic-age metamorphic rock that generally consists of black slate and, to a lesser degree, meta-siltstone and fine-grained meta-graywacke. The rock is generally sheared and intensely jointed due to the localized folding and faulting within the Santa Monica Mountains. The Santa Monica Slate is exposed throughout the southern side of the Santa Monica Mountains, with exposures generally highly fractured with small surficial slides within the fractured rock (Metro, 2023a).

6.2.2.6 Topanga Formation

In the Project Study Area, the middle Miocene Topanga Formation (Tt and Tb) unconformably underlies the Modelo Formation. The Topanga Formation is exposed in slopes that are adjacent to the east side of the SCR and Upper Stone Canyon Reservoir (USCR). Campbell et al. (2016) described the Topanga Formation as a heterogenous sequence of sedimentary and volcanic rocks containing marine facies. Campbell et al. (2016) subdivided the Topanga Formation into undifferentiated sedimentary rocks (Regional Geologic Map Symbol: Tt) or volcanic rocks (Regional Geologic Map symbol: Tb). Sedimentary rock lithologies include interbedded gray, micaceous claystone, clay shale, and siltstone; semi-friable to well cemented arkosic sandstone; and locally includes gravely sandstone and lenses of pebble to cobble conglomerate. In general, the lower portion of the Topanga Formation (toward the south) commonly contains the coarser-grained lithologies (sandstones and conglomerates), and the upper portion contains fine-grained sandstone, siltstone, and shales. Volcanic rocks within the Topanga Formation (Tb) include extrusive flows, intrusive sills, tuffs, and volcanic breccias.

6.2.2.7 Tuna Canyon Formation

The Cretaceous Tuna Canyon Formation (Kt), which underlies the Santa Susana Formation, is exposed in the slopes bordering SCR. Campbell et al. (2014) described the formation as consisting of marine sandstone, siltstone, and conglomerate. The sandstones range from thinly to very thickly bedded and locally contain abundant fragments of black slate. LADWP (1998) reported that the formation, as exposed in roadcuts along the west side of SCR, includes very thick to massive conglomerate beds that contain weak to extremely strong cobble to boulder-sized granitic, metavolcanic, and quarzitic clasts up to 18-inches in diameter.

6.2.2.8 Younger Alluvial Fan Deposits

The younger alluvial units (QyF and Qya) along both the northern and southern sides of the Santa Monica Mountains consist of sand, silt, silty clay, silty sand, and clayey sand with some interbedded units of gravel to cobble-size clasts. The gravel units are composed of slate and are scattered through the alluvium along the southern side of the mountains; while along the northern side, the gravel transitions to sandstone and is less frequent and abundant. The younger alluvium generally varies in thickness from a few feet to over 50 feet or more in some areas along Alternative 1 (Metro, 2023a).

6.2.3 Seismicity

The entire Southern California region is seismically active. A network of major regional faults and minor local faults crisscrosses the region. The faulting and seismicity are dominated by the San Andreas fault system, which separates two of the major tectonic plates that comprise the earth’s crust. The Pacific Plate lies west of the San Andreas fault system. This plate is moving in a northwesterly direction relative to the North American Plate, which lies east of the San Andreas fault system. This relative movement between the two plates is the driving force of fault ruptures in western California. The San Andreas fault generally trends northwest–southeast; however, north of the Transverse Ranges province, the fault trends more in an east–west direction, causing a north–south compression between the two plates. North–south compression in Southern California has been estimated from 5 millimeters per year (mm/year) to 20 mm/year. This compression has produced rapid uplift of many of the mountain ranges in Southern California (Metro, 2023a).

In addition to the San Andreas fault, numerous faults in Southern California are categorized as active, potentially active, and inactive. A fault is classified as active if it has either moved during the Holocene epoch (from about 11,700 years to the present) or is included in an Alquist-Priolo Earthquake Fault Zone (as established by California Geological Survey [CGS]). A fault is classified as potentially active if it has experienced movement within the Quaternary period (geologic time starting 1.6 million years ago and continuing to the present day). Faults that have not moved in the last 1.8 million years generally are considered inactive. Surface displacement can be recognized by the existence of cliffs in alluvium, terraces, offset stream courses, fault troughs, and saddles, the alignment of depressions, sag ponds, and the existence of steep mountain fronts.

Generally defined, an earthquake is an abrupt release of accumulated energy in the form of seismic waves that are created when movement occurs along a fault plane. The severity of an earthquake is generally expressed in two ways: magnitude and intensity. The energy released, measured on the Moment Magnitude (M_w) scale, represents the “size” of an earthquake. The Richter Magnitude (M) scale has been replaced in most modern building codes by the M_W scale because the M_W scale provides more useful information to design engineers. Alternative 1 is subject to earthquakes of M_W 6.0 to M_W 8.0 by the surrounding faults (CGS, 2023; USGS, 2017a, 2017b, 2017c, 2017d, 2023; SCEDC, 2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2023g, 2023h, 2023i, 2023j, 2023k, 2023l, 2023m, 2023n, 2023o, 2023p, 2023q, 2023r; and Shaw et al., 2022).

The intensity of an earthquake is measured by the Modified Mercalli Intensity (MMI) scale, which emphasizes the current seismic environment at a particular site and measures ground-shaking severity according to damage done to structures, changes in the earth surface, and personal accounts. Table 6-5 identifies the level of intensity according to the MMI scale and describes that intensity with respect to how it would be received or sensed by its receptors.

Table 6-5. Alternative 1: Modified Mercalli Intensity Scale

Intensity	Shaking	Description/Damage
I	Not Felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration is similar to the passing of a truck. Duration is estimated.
IV	Light	Felt indoors by many and outdoors by few during the day. At night, some are awakened. Dishes, windows, doors are disturbed; walls make cracking sound. Sensation is like a heavy truck striking a building. Standing motor cars are rocked noticeably.
V	Moderate	Felt by nearly everyone; many are awakened. Some dishes and windows are broken. Unstable objects are overturned. Pendulum clocks may stop.
VI	Strong	Felt by all; many are frightened. Some heavy furniture is moved; there are a few instances of fallen plaster. Damage is slight.
VII	Very Strong	Damage is negligible in buildings of good design and construction, slight to moderate in well-built ordinary structures, and considerable in poorly built structures; some chimneys are broken.
VIII	Severe	Damage is slight in specially designed structures, considerable in ordinary substantial buildings with partial collapse, and great in poorly built structures. Chimneys, factory stacks, columns, monuments, and walls fall. Heavy furniture is overturned.

Intensity	Shaking	Description/Damage
IX	Violent	Damage is considerable in specially designed structures; well-designed frame structures are thrown out of plum. Damage is great in substantial buildings, with partial collapse. Buildings are shifted off foundations.
X	Extreme	Some well-built wooden structures are destroyed; most masonry and frame structures are destroyed with foundations. Rails are bent.

Source: USGS, 2022

Ground motions also are reported in terms of a percentage of the acceleration of gravity (percent g, where g equals 32 feet per second). One hundred percent of gravity (1g) is the acceleration a skydiver would experience during free-fall. An acceleration of 0.4g is equivalent to accelerating from 0 to 60 miles per hour in about 7 seconds.

Ground motions are also reported in terms of a percentage of the acceleration of gravity (percent g, where g equals 32 feet per second). One hundred percent of gravity (1g) is the acceleration a skydiver would experience during free-fall. An acceleration of 0.4g is equivalent to accelerating from 0 to 60 miles per hour in about 7 seconds.

Over the past 54 years, Southern California has experienced three significant earthquakes: the 1971 San Fernando earthquake (also known as the Sylmar earthquake, on the Sierra Madre Fault), which registered as M_W 6.6; the 1987 Whittier Narrows earthquake, which registered as M_W 5.9; and the Northridge earthquake, which occurred in January 1994 and registered as M_W 6.7.

6.2.4

6.2.5 Regional and Local Faults

Major regional and local faults are identified in Table 6-6 and are shown on **Error! Reference source not found.**Figure 6-11 and Figure 6-12.

Table 6-6. Alternative 1: Major Regional and Local Faults

Fault Name	Approximate Closest Distance from Alternative 1 to the Fault (miles)	Compass Direction	Alquist-Priolo Earthquake Fault Zone	Maximum Moment Magnitude (Mw)
Santa Monica Fault	Crosses Alternative 1 north of Massachusetts Avenue and I-405	North	Yes	7.0
Overland Avenue Fault	0.8	Southeast	No	6.6
Northridge Hills Fault	1.3	North	No	—
Hollywood Fault	1.9	Northeast	Yes	6.5
Newport-Inglewood-Rose Canyon Fault	1.9	East	Yes	7.2
Charnock Fault	3.2	Southeast	No	6.5
Mission Hills Fault	4.2	North	No	—
Sierra Madre Fault	4.7	North	Yes	7.0
Verdugo Fault	6.9	East	No	6.8
Chatsworth Fault	7.3	Northwest	No	6.8
Puente Hills Blind Thrust System	7.3	Southeast	No	7.5
Northridge Blind Thrust Fault	8.3	North	No	6.9

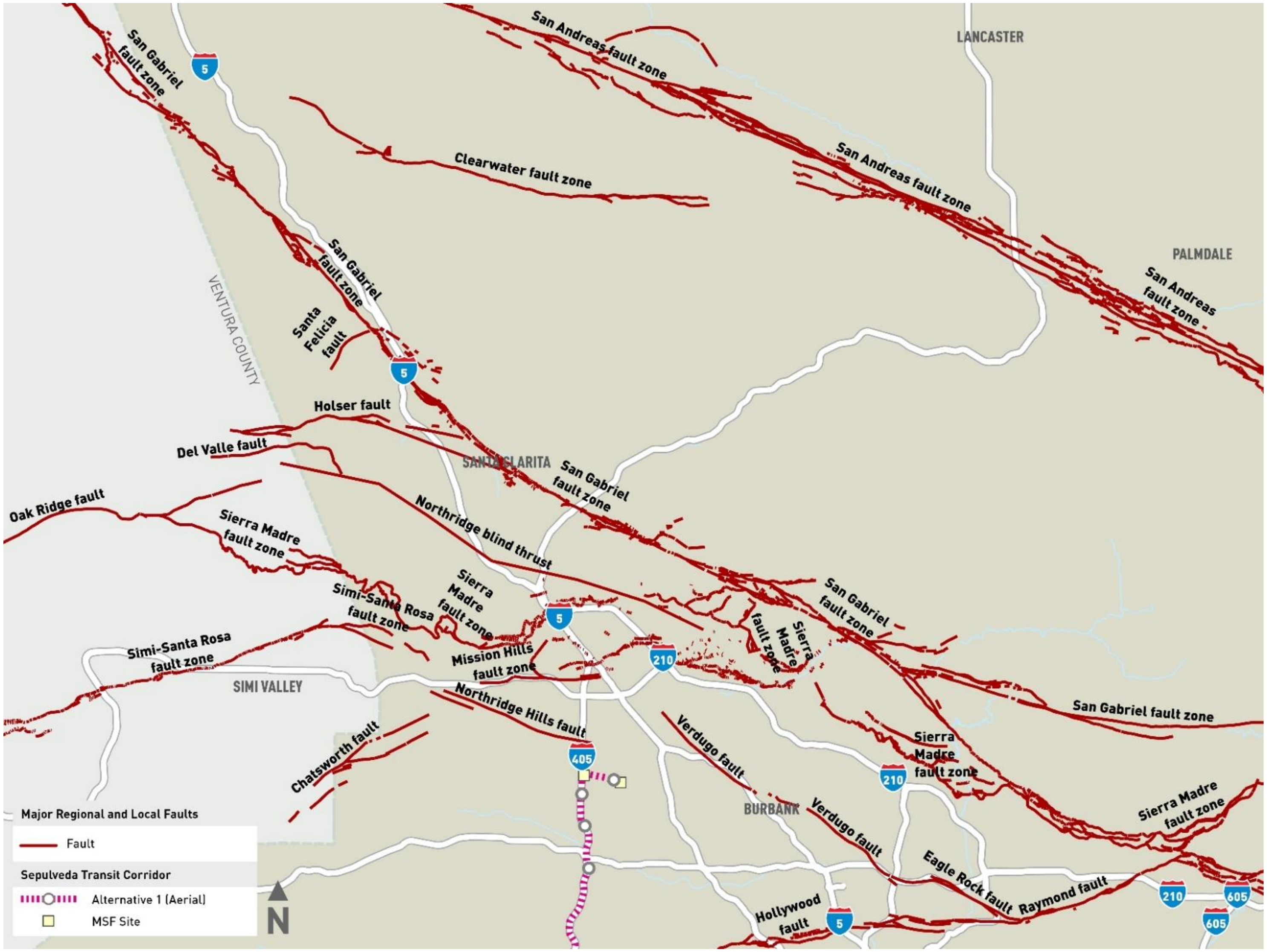
Fault Name	Approximate Closest Distance from Alternative 1 to the Fault (miles)	Compass Direction	Alquist-Priolo Earthquake Fault Zone	Maximum Moment Magnitude (Mw)
Simi-Santa Rosa Fault	8.5	Northwest	Yes	6.7
San Gabriel Fault	10.4	Northeast	Yes	7.0
Malibu Coast Fault	10.7	Southwest	Yes	6.7
Raymond Fault	13.2	Northeast	Yes	7.0
Eagle Rock Fault	13.4	Southeast	No	—
Holser Fault	14.2	Northwest	No	6.5
Palos Verdes Fault	15.2	South	No	7.1
Del Valle Fault	17.3	Northwest	No	—
Oak Ridge Fault	19.5	Northwest	No	7.5
Santa Felicia Fault	21.5	Northwest	No	—
Clearwater Fault	26.0	North	No	—
San Andreas Fault	29.5	Northeast	Yes	8.0

Source: CGS, 2023; USGS, 2017a, 2017b, 2017c, 2017d, 2023; SCEDC, 2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2023g, 2023h, 2023i, 2023j, 2023k, 2023l, 2023m, 2023n, 2023o, 2023p, 2023q, and 2023r; and Shaw et al., 2022

Figure 6-11. Alternative 1: Major Regional and Local Faults – South

Source: CGS, 2023; HTA, 2024

Figure 6-12. Alternative 1: Major Regional and Local Faults – North



Source: CGS, 2023; HTA, 2024

6.2.5.1 Charnock Fault

The Charlock fault is located approximately 3.2 miles southeast from the southern portion of Alternative 1. Charnock fault extends southeast from near Venice Boulevard to the City of Gardena and runs parallel to the axis of the Gardena syncline for most of its length. The northeastern side of the fault is downthrown relative to the southwestern side (CDWRSD, 1961). Faulted rocks of late Quaternary age (between present day and 700,000 years ago) are present along this fault (USGS, 1981). The Charnock fault runs underneath the Los Angeles International Airport (LAX) runway.

6.2.5.2 Chatsworth Fault

The Chatsworth fault is located approximately 7.3 miles northwest from the northern portion of Alternative 1. The Chatsworth fault is 12.4 miles long and is classified as a late Quaternary (between present day and 700,000 years ago). The Chatsworth fault has a probable magnitude of M_w 6.0 to M_w 6.8. The Chatsworth fault is a reverse fault, where the displacement is predominantly vertical. This fault is north-dipping, and the slip rate is currently unknown (SCEDC, 2023a).

6.2.5.3 Clearwater Fault Zone

The Clearwater fault is located approximately 26 miles north from the northern portion of Alternative 1. The Clearwater fault is 19.9 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Clearwater fault varies from north-dipping to vertical (SCEDC, 2023b).

6.2.5.4 Del Valle Fault

The Del Valle fault is located approximately 17.3 miles northwest from the northern portion of Alternative 1. The Del Valle fault is classified as late Quaternary (between present day and 700,000 years ago). The Del Valle fault is a south-dipping reverse faults, and it contains the prominent tectonic geomorphic features. (Yeats et al., 1985).

6.2.5.5 Eagle Rock Fault

The Eagle Rock fault is located approximately 13.4 miles southeast from the mid-section of Alternative 1. The Eagle Rock fault is 6.8 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Eagle Rock fault is a thrust fault, which is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much, if not all, of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an obvious sign of compressional tectonics (SCEDC, 2023c, 2023s). The slip rate for Eagle Rock fault is probably less than 0.1 mm/year. The possibility of simultaneous rupture with the Verdugo fault is uncertain. The Eagle Rock fault dips to the northeast (SCEDC, 2023c).

6.2.5.6 Hollywood Fault

The Hollywood fault is located approximately 1.9 miles northeast from the mid-section of Alternative 1. The Hollywood fault is 9.3 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023d, 2023s). The Hollywood fault is a left-reverse fault and has a probable magnitude between M_w 5.8 and M_w 6.5. There is a potential for the probable magnitude to be larger if rupture is simultaneous with an adjacent fault. The slip rate for the Hollywood fault is between 0.33 and 0.75 mm/year. The Hollywood fault could be considered a westward extension of the Raymond fault and is roughly parallel to the Santa Monica fault (SCEDC, 2023d). The Hollywood fault is a designated Alquist-Priolo- Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act.

6.2.5.7 Holser Fault

The Holser fault is located approximately 14.2 miles northwest from the northern portion of Alternative 1. The Holser fault is 12.4 miles long and is classified as a late Quaternary (between present day and 700,000 years ago). The Holser fault is a reverse fault with a slip rate of 0.4 mm/year; the displacement is predominantly vertical, and the dip is to the south (SCEDC, 2023e).

6.2.5.8 Malibu Coast Fault

The Malibu Coast fault is located approximately 10.7 miles southwest from the mid-section of Alternative 1. The Malibu Coast fault is 21.1 miles long with several parallel strands. The Malibu Coast fault is classified as Holocene (from about 10,000 years ago to the present) in part; otherwise, the fault is classified as late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023f, 2023s). The Malibu Coast fault is a reverse fault with a slip rate of 0.3 mm/year. The Malibu Coast fault is a north-dipping fault. The slip rate may be higher at its eastern end, where it meets the Santa Monica fault and develops left-reverse motion (SCEDC, 2023f). The Malibu Coast fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

6.2.5.9 Mission Hills Fault

The Mission Hills fault is located approximately 4.2 miles north from the northern portion of Alternative 1. The Mission Hills fault is 6.2 miles long. The Mission Hills fault is classified as late Quaternary (between present day and 700,000 years ago) and possibly Holocene (from about 10,000 years ago to the present) (SCEDC, 2023g, 2023s). The Mission Hills fault is a reverse fault, where the displacement is predominantly vertical. The Mission Hills fault has a slip rate of 0.5 mm/year (SCEDC, 2023g).

6.2.5.10 Newport-Inglewood-Rose Canyon Fault

The Newport-Inglewood-Rose Canyon fault is located approximately 1.9 miles east from the southern portion of Alternative 1. The Newport-Inglewood-Rose Canyon fault is 55.9 miles long. The Newport-Inglewood-Rose Canyon fault is mostly classified as Quaternary (geologic time starting 1.6 million years ago and continuing to the present day) and in part classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023h, 2023s). The Newport-Inglewood-Rose Canyon fault is a right-lateral fault, which is a fault that slips in such a way that the two sides move with a predominantly lateral motion (with respect to each other). The Newport-Inglewood-Rose Canyon fault has a probable magnitude of between M_W 6.0 and M_W 7.2 and a slip rate between 0.8 and 2.1 mm/year (SCEDC, 2023h). The Newport-Inglewood-Rose Canyon fault is a designated Alquist-Priolo- Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

6.2.5.11 Northridge Blind Thrust Fault

The Northridge Blind Thrust fault is located approximately 8.3 miles north from the northern portion of Alternative 1. The Northridge Blind Thrust fault is part of the Oak Ridge fault system (SCEDC, 2023j). At its eastern end, the Oak Ridge Thrust fault is progressively more difficult to trace and is buried, or also known as *blind*. The Northridge Blind Thrust fault has a probable magnitude of M_w 6.5 to M_w 7.5. The slip rate for the Northridge Blind Thrust fault is between 3.5 and 6 mm/year (SCEDC, 2023j). The Northridge Blind Thrust fault, as part of the Oak Ridge fault system, is classified mostly as late Quaternary (between present day and 700,000 years ago) and in part as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023j, 2023s). The Northridge Blind Thrust fault is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much, if not all, of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an

obvious sign of compressional tectonics (SCEDC, 2023j, 2023s). This blind thrust fault is assumed to be part of the fault system responsible for the 1994 Northridge earthquake.

6.2.5.12 Northridge Hills Fault

The Northridge Hills fault is located approximately 1.3 miles north from the northern portion of Alternative 1. The Northridge Hills fault is not the fault on which the 1994 Northridge earthquake occurred. The Northridge Hills fault is classified as late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023i, 2023s). The Northridge Hills fault is 15.5 miles long and is a reverse fault, where the displacement is predominantly vertical. The dip for the Northridge Hills fault is probably to the north (SCEDC, 2023i).

6.2.5.13 Overland Avenue Fault

The Overland Avenue fault is located approximately 0.8 miles southeast from the southern portion of Alternative 1. The Overland Avenue fault trends northwest and extends from Santa Monica Boulevard to the northwestern flank of the Baldwin Hills. Displacement of the fault is believed to be vertical, with a magnitude of approximately 30 feet (CDWRSD, 1961). Faulted rocks of late Quaternary age (between present day and 700,000 years ago) is present along this fault (USGS, 1981). The northeastern side of the fault is raised relative to the southwestern side (CDWRSD, 1961).

6.2.5.14 Oak Ridge Fault

The Oak Ridge fault is located approximately 19.5 miles northwest from the northern portion of Alternative 1. The Oak Ridge fault system is connected to the 1994 Northridge earthquake. The Oak Ridge fault is approximately 55.9 miles in length (SCEDC, 2023j). The Oak Ridge fault has a probable magnitude of M_w 6.5 to M_w 7.5. The slip rate for Oak Ridge fault is between 3.5 and 6 mm/year (SCEDC, 2023j). The Oak Ridge fault system is classified mostly as late Quaternary (between present day and 700,000 years ago) and in part as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023j, 2023s). The Oak Ridge fault is a thrust fault, which is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much, if not all, of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an obvious sign of compressional tectonics (SCEDC, 2023j, 2023s). This fault dips to the south at a fairly shallow (less than 45 degrees) angle. Thus, epicenters of earthquakes on this (and any other thrust) fault may appear far removed from the surface trace. The surface trace of the Oak Ridge fault forms a ridge (hence its name) to the south of its trace; at its eastern end, the Oak Ridge fault becomes progressively more difficult to trace (SCEDC, 2023j). The Oak Ridge fault appears to be overthrust by the *Santa Susana* fault, becoming a *blind thrust fault* that includes the Northridge Blind Thrust fault.

6.2.5.15 Palos Verdes Fault

The Palos Verdes fault is located approximately 15.2 miles south from the southern portion of Alternative 1. The Palos Verdes fault is 49.7 miles long and is classified as Holocene (from about 10,000 years ago to the present) offshore and as late Quaternary (between present day and 700,000 years ago) onshore (SCEDC, 2023k, 2023s). The Palos Verdes fault is a right-reverse fault and has a probable magnitude between 6.0 M_w and 7.0 M_w. The slip rate is between 0.1 and 3.0 mm/year (SCEDC, 2023k).

6.2.5.16 Puente Hills Blind Thrust Fault

The Puente Hills Blind Thrust fault is located approximately 18.9 miles southeast from the southern portion of Alternative 1. The Puente Hills Blind Thrust fault is 24.9 miles long. In 1987, the Puente Hills Blind Thrust fault produced an M_w 5.9 earthquake in Whittier. In March 2014, the Puente Hills Blind

Thrust fault produced an M_w 5.1 earthquake with over 100 aftershocks (KCAL News, 2014). The Puente Hills Blind Thrust fault has a probable magnitude between M_w 6.5 and M_w 6.6 for frequency of a single segment and a probable magnitude of M_w 7.1 for multi-segment rupture scenarios. The slip rates on the ramp segments range from 0.44 to 1.7 mm/year, with preferred rates between 0.62 and 1.28 mm/year (Shaw et al., 2022).

6.2.5.17 Raymond Fault

The Raymond fault is located approximately 13.2 miles northeast from the mid-section of Alternative 1. The Raymond fault is 16.2 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023l, 2023s). The Raymond fault is a left-reverse fault and has a probable magnitude between M_w 6.0 and M_w 7.0. The slip rate is between 0.10 and 0.22 mm/year (SCEDC, 2023l). The Raymond fault dips at about 75 degrees to the north. There is evidence that at least eight surface-rupturing events have occurred along this fault in the last 36,000 years. The exact nature of the slip along the Raymond fault has been a subject of debate for quite some time. In late 1988, the *Pasadena earthquake* occurred on the Raymond fault, and the motion of this earthquake was predominantly left-lateral, with a reverse component of only about 1/15 the size of the lateral component. If the Raymond fault is indeed primarily a left-lateral fault, it could be responsible for transferring slip southward from the *Sierra Madre* Fault Zone to other fault systems (SCEDC, 2023l). The Raymond fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

6.2.5.18 San Andreas Fault

The San Andreas fault is located approximately 29.5 miles northeast from the northern portion of Alternative 1. The San Andreas fault is 745.6 miles long. The San Andreas fault has a probable magnitude between M_w 6.8 and M_w 8.0. The interval between major ruptures averages about 140 years on the Mojave segment, and the recurrence interval varies greatly from under 20 years (at Parkfield only) to over 300 years. The slip rate is between 20 and 35 mm/year (SCEDC, 2023m). The last major rupture of the San Andreas fault occurred on January 9, 1857 at the Mojave segment and on April 18, 1906 at the northern segment. The San Andreas fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

6.2.5.19 San Gabriel Fault

The San Gabriel fault is located approximately 10.4 miles northeast from the northern portion of Alternative 1. The San Gabriel fault is 87 miles long. The San Gabriel fault is primarily a right-lateral strike slip fault, which is a fault where the slip motion is parallel to the direction, or trend, of the line marking the intersection of a fault plane (or another planar geologic feature) with the horizontal. The San Gabriel fault is classified as late Quaternary (between present day and 700,000 years ago) west of the intersection with the Sierra Madre Fault Zone, Quaternary (1.6 million years ago and continuing to the present day) east of that intersection, and Holocene (from about 10,000 years ago to the present) between Saugus and Castaic. The slip rate is between 1 and 5 mm/year (SCEDC, 2023n). The slip rate and reoccurrence interval vary significantly along the length of the San Gabriel fault. The western half is more active than the eastern half, and the dip is generally steep and to the north. The San Gabriel fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

6.2.5.20 Santa Felicia Fault

The Santa Felicia fault is located approximately 21.5 miles northwest from the northern portion of Alternative 1. The Santa Felicia fault is a fault that is less well understood. The Santa Felicia fault is classified as late Quaternary (between present day and 700,000 years ago). The Santa Felicia fault apparently overrides the youngest strand of the San Gabriel fault. The Santa Felicia fault is a south-dipping reverse fault. The Santa Felicia fault has no recognized tectonic geomorphic features, although it follows the Santa Felicia Canyon for part of its length (Yeats et al., 1985).

6.2.5.21 Santa Monica Fault

The Santa Monica fault would cross Alternative 1 approximately north of Massachusetts Avenue and I-405. The Santa Monica fault is 14.9 miles long. The Santa Monica fault has a probable magnitude between M_w 6.0 and M_w 7.0. The Santa Monica fault is classified as late Quaternary (between present day and 700,000 years ago) and is a left-reverse fault. The Santa Monica fault is a north-dipping fault, and the slip rate may be greatest at its western end. The slip rate is between 0.27 and 0.39 mm/year (SCEDC, 2023o). In 2015, the Santa Monica Fault Zone was evaluated for the Alquist-Priolo Earthquake Fault Zoning program (Olson, 2015). Currently, the Santa Monica Fault Zone is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023). The guideway for Alternative 1 would fall within the Alquist-Priolo Earthquake Fault Zone. No habitable structures would be located within the Alquist-Priolo Earthquake Fault Zone for Alternative 1.

6.2.5.22 Sierra Madre Fault

The Sierra Madre fault is located approximately 4.7 miles north from the northern portion of Alternative 1. The Sierra Madre fault is 46.6 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023p, 2023s). The Sierra Madre fault is a reverse fault, where the displacement is predominantly vertical. The Sierra Madre fault has a probable magnitude between M_w 6.0 and M_w 7.0. The slip rate is between 0.36 and 4.0 mm/year (SCEDC, 2023k). The Sierra Madre fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

6.2.5.23 Simi-Santa Rosa Fault

The Simi-Santa Rosa fault is located approximately 8.5 miles northwest from the northern portion of Alternative 1. The Simi-Santa Rosa fault is 24.9 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023q, 2023s). The Simi-Santa Rosa fault is a reverse fault, where the displacement is predominantly vertical. This fault dips to the north. The Simi-Santa Rosa fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

6.2.5.24 Verdugo Fault

The Verdugo fault is located approximately 6.9 miles east from the mid-section of Alternative 1. The Verdugo fault is 13 miles long and is classified as Holocene (from about 10,000 years ago to the present) and late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023r, 2023s). The Verdugo fault is a reverse fault and has a probable magnitude of between M_w 6.0 and M_w 6.8. The slip rate is roughly 0.5 mm/year (SCEDC, 2023r). The Verdugo fault dips to the northeast.

6.2.6 Geological Hazards

6.2.6.1 Fault Rupture

Faults are geologic zones of weakness. Surface rupture occurs when movement on a fault deep in the earth breaks through to the ground surface. Surface ruptures associated with the 1994 Northridge earthquake began as a rupture at a depth of about 10.9 miles beneath the San Fernando Valley. For 8 seconds following the initial break, the rupture propagated upward and northwestward along the fault plan at a rate of about 1.9 miles per second. The size of the rupture covered an area of approximately 9.3 by 12.4 miles (USGS, 2013). Not all earthquakes result in surface rupture; however, due to the proximity of known active faults, fault ruptures and the subsequent hazard posed by seismic activity are potentially high. An earthquake could cause major damage and not have the fault trace break at the ground surface. Fault rupture almost always follows preexisting faults, which are zones of weakness. Rupture may occur suddenly during an earthquake or slowly in the form of fault creep. Sudden displacements are more damaging to structures because they are accompanied by shaking.

6.2.6.2 Ground Shaking

A major cause of structural damage that results from earthquakes is ground shaking. The amount of motion can vary from “zero to forceful,” depending upon the distance to the fault, the magnitude of the earthquake, and the local geology. Greater movement can be expected at sites located on poorly consolidated material such as alluvium located near the source of the earthquake epicenter or in response to an earthquake of great magnitude. Strong ground shaking can damage large freeway overpasses and unreinforced masonry buildings. It can also trigger a variety of secondary hazards such as liquefaction, landslides, fire, and dam failure.

The amount of damage to a building does not depend solely on how hard it is shaken. In general, smaller buildings such as houses are damaged more by stronger earthquakes, and houses must be relatively close to the epicenter to be severely damaged. Larger structures such as high-rise buildings are damaged more by weaker earthquakes and will be more noticeably affected by the largest earthquakes, even at considerable distances.

Damage as a result of ground shaking is not limited to aboveground structures. Seismic waves generated by the earthquake cause the ground to move, leading to dynamic forces on underground structures. This shaking can induce ground deformation and displacements, and can potentially damage the structural integrity of tunnels, basements, and other underground facilities.

The intensity of ground motion expected at a particular site depends upon the magnitude of the earthquake, the distance to the epicenter, and the geology of the area between the epicenter and the property. Another factor affecting structural damage due to ground shaking is the quality and condition of the existing structure, which is influenced by whether it adheres to current or past building codes. Greater movement can be expected at sites on poorly consolidated material, such as loose alluvium, in proximity to the causative fault, or in response to an event of great magnitude. The general area is susceptible to earthquakes of M_w 6.0 to M_w 8.0. Due to the proximity of known active faults, the hazard posed by seismic shaking is potentially high.

6.2.6.3 Difficult Ground Conditions for Excavating or Drilling

Difficult drilling conditions may be encountered due to the presence of shallow bedrock in the Santa Monica Mountain areas. Drilling in this area is anticipated to be slow, casing (if used) installation into these materials will also be difficult. Hard drilling should be anticipated.

6.2.7 Dry Sand Settlement

Settlement is defined as areas that are prone to rates of ground-surface collapse and densification (soil particle compaction) that are greater than those of the surrounding area. Such areas are often underlain by sediments that differ laterally in composition or degree of existing compaction. Differential settlement refers to areas that have more than one rate of settlement. Settlement can damage structures, pipelines, and other subsurface entities.

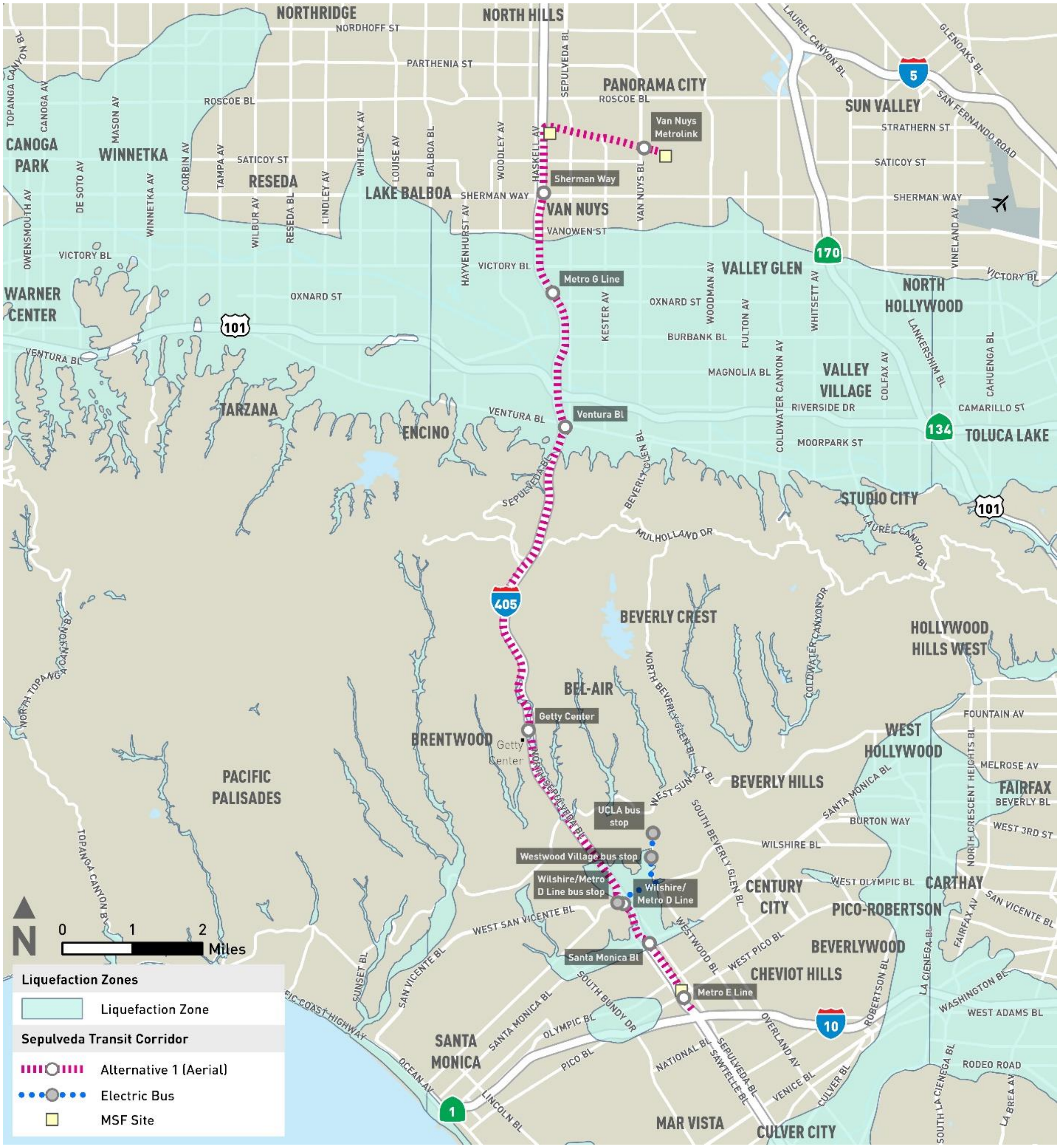
Strong ground shaking can cause soil settlement by vibrating sediment particles into more tightly compacted configurations, thereby reducing pore space. Unconsolidated, loosely packed alluvial deposits and sand (unsaturated or saturated) are especially susceptible to this phenomenon. Poorly compacted artificial fills may experience seismically induced settlement. Due to the presence of alluvial deposits in the Project Study Area, the hazard posed by seismically induced settlement is potentially high.

6.2.8 Liquefaction

Liquefaction involves a sudden loss in strength of a saturated, cohesionless, uniformly particle-sized soil, that is typically caused by ground-shaking activities, which causes temporary transformation of the soil to a fluid mass. In rare instances, ground-borne vibrations can cause liquefaction from activities such as pile driving or tunnel boring. If the liquefying layer is near the ground surface, the effects may resemble those of quicksand. If the layer is deep below the ground surface, it may provide a sliding surface for the material above it and/or cause differential settlement of the ground surface, which may damage building foundations by altering weight-bearing characteristics.

During a liquefaction event, soils behave similarly to liquids, losing bearing strength. Structures built on these soils may tilt or settle when the soils liquefy. Liquefaction occurs more often in earthquake-prone areas that are underlain by young sandy alluvium where the groundwater table is less than 50 feet below ground surface (Metro, 2023a). Per the County of Los Angeles, liquefaction zones identify where the stability of foundation soils must be investigated, and countermeasures undertaken in the design and construction of buildings for human occupancy (LA County Planning, 2022a). As shown on Figure 6-13, the alignment of Alternative 1 would traverse a Liquefaction Zone, and the potential for a liquefaction event is relatively high for the mapped areas shown (California Department of Conservation, 1998). Site-specific liquefaction potential would be evaluated in more detail based on future site-specific subsurface investigation data.

Figure 6-13. Alternative 1: Liquefaction Zones



Source: County of Los Angeles, Enterprise GIS (eGIS) 2022; HTA, 2024

6.2.9 Subsidence

Subsidence involves a sudden sinking or gradual settling and compaction of soil and other surface material with little or no horizontal motion. This is typically caused by the removal of groundwater, oil, or natural gas, or by natural processes like the compaction of soil. This can lead to structural damage to buildings and infrastructure. The Los Angeles Basin is vulnerable to subsidence, particular due to

groundwater and oil extraction. Over-extraction of groundwater can be concerning because as the groundwater table drops, the soil compacts, leading to subsidence that can damage infrastructure, buildings, and roads. Information relating to groundwater conditions can be found in the *Sepulveda Transit Corridor Project Water Resources Technical Report* (Metro, 2025).

Subsidence typically impacts surface level soils. Although the alignment is entirely aerial, all stations have surface level elements. Moreover, alluvial deposits are susceptible to subsidence, especially when they consist of loose, unconsolidated sediments. As shown on Figure 6-10, alluvial deposits are at all of Alternative 1's stations, except for the Getty Center Station and, as such, the hazard posed by subsidence is potentially high at those locations.

6.2.10 Expansive Soils

Expansive soils have a significant amount of clay particles that can give up water (shrink) or take on water (swell). The change in volume exerts stress on buildings and other loads placed on these soils. The occurrence of these soils is often associated with geologic units having marginal stability. Expansive soils can be dispersed widely and can be found in hillside areas as well as low-lying areas in alluvial basins. Municipal grading and building codes require routine soils testing to identify expansive characteristics and appropriate remediation measures. Specific treatments to eliminate expansion of soils at building sites include, but are not limited to, grouting (cementing the soil particles together), re-compaction (watering and compressing the soils), and replacement with non-expansive material (excavation of unsuitable soil followed by filling with suitable material), all of which are common practice in California. Expansive soils typically impact surface level soils. Although the alignment is entirely aerial, all stations have surface level elements. As shown on Figure 6-10, alluvial deposits are at all of Alternative 1's stations, except for the Getty Center Station and, as such, the hazard posed by expansive soils is potentially high at those locations.

6.2.11 Collapsible Soils

Collapsible soils undergo a rearrangement of their grains and a loss of cementation, resulting in substantial and rapid settlement under relatively low loads. Collapsible soils occur predominantly at the base of mountain ranges where Holocene-age alluvial fan and wash sediments have been deposited during rapid runoff events. Soils prone to collapse are commonly associated with human-made fill, wind-laid sands and silts, and alluvial fan and mudflow sediments deposited during flash floods. Additionally, desert soils are commonly associated with hydro-compression and collapse associated with wetting. Examples of common problems associated with collapsible soils include tilting and sagging floors, cracking or separation in structures, sagging floors, and nonfunctional windows and doors. Collapsible soils typically impact earth at surface levels. Although the alignment is entirely aerial, all stations have surface level elements. As shown on Figure 6-10, alluvial deposits are at all of Alternative 1's stations, except for the Getty Center Station and, as such, the hazard posed by collapsible soils is potentially high at those locations.

6.2.12 Lateral Spreading

Lateral spread is the finite, lateral displacement of sloping ground (0.1 to < 6 percent) as a result of pore pressure buildup or liquefaction in a shallow, underlying soil deposit during an earthquake. Lateral spreading, as a result of liquefaction, occurs when a soil mass slides laterally on a liquefied layer, and gravitational and inertial forces cause the layer, and the overlying non-liquefied material to move in a downslope direction. Due to the presence of mountainside areas in the Project Study Area, the hazard posed by lateral spreading is potentially high at those locations.

6.2.13 Slope Stability

Slope failures include many phenomena that involve the downslope displacement of material, which is triggered by static (i.e., gravity) or dynamic (i.e., earthquake) forces such as landslides, rock-falls, debris slides, and soil creeps. Slope stability can depend on complex variables, including the geology, structure, and amount of groundwater present, as well as external processes such as climate, topography, slope geometry, and human activity. Landslides and other slope failures may occur on slopes of 15 percent or less; however, the probability is greater on steeper slopes that exhibit old landslide features such as scarps, slanted vegetation, and offset surfaces. Due to the presence of slopes (of 15 percent greater) in the Project Study Area, particularly in the hilly Santa Monica Mountain communities of Bel-Air, Beverly Crest, and Brentwood, the hazard posed by slope failures is potentially high at those locations.

6.2.14 Landslides

Landslides are the downhill movement of a mass of earth and rock. Landslides are a geological phenomenon that includes a wide range of ground movements, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary cause of a landslide, the following other factors contribute:

- Erosion by rivers, glaciers, or ocean waves
- Rock and soil slopes that are weakened through saturation by snowmelt or heavy rains
- Earthquakes that create stresses such that weak slopes fail
- Volcanic eruptions that produce loose ash deposits, heavy rain, and/or debris flows
- Vibrations from machinery, traffic, blasting, and even thunder
- Excess weight from accumulation of rain or snow, stockpiling of rock or ore from waste piles, or from human-made structures

As shown on Figure 6-14, the potential landslide hazard for Alternative 1 is focused within the Santa Monica Mountains portion of the alternative.

Figure 6-14. Alternative 1: Landslide Hazard Zones

Source: County of Los Angeles, eGIS, 2022; HTA, 2024

6.2.15 Soil Erosion

Soil erosion is the process by which soil particles are removed from a land surface by wind, water, or gravity. Most natural erosion occurs at slow rates; however, the rate of erosion increases when land is cleared of vegetation or structures or otherwise altered and left in a disturbed condition. Erosion can occur as a result of, and can be accelerated by, site preparation activities associated with development.

Vegetation removal in pervious landscaped areas could reduce soil cohesion, as well as the buffer provided by vegetation from wind, water, and surface disturbance, which could render the exposed soils more susceptible to erosive forces.

Excavation or grading may result in erosion during construction activities, irrespective of whether hardscape previously existed at the construction site, because bare soils would be exposed and could be eroded by wind or water. The effects of erosion are intensified with an increase in slope (as water moves faster, it gains momentum to carry more debris), and the narrowing of runoff channels (which increases the velocity of water). Surface structures, such as paved roads and buildings, decrease the potential for erosion. Once covered, such as with a paved road, soil is no longer exposed to the elements, and erosion generally does not occur.

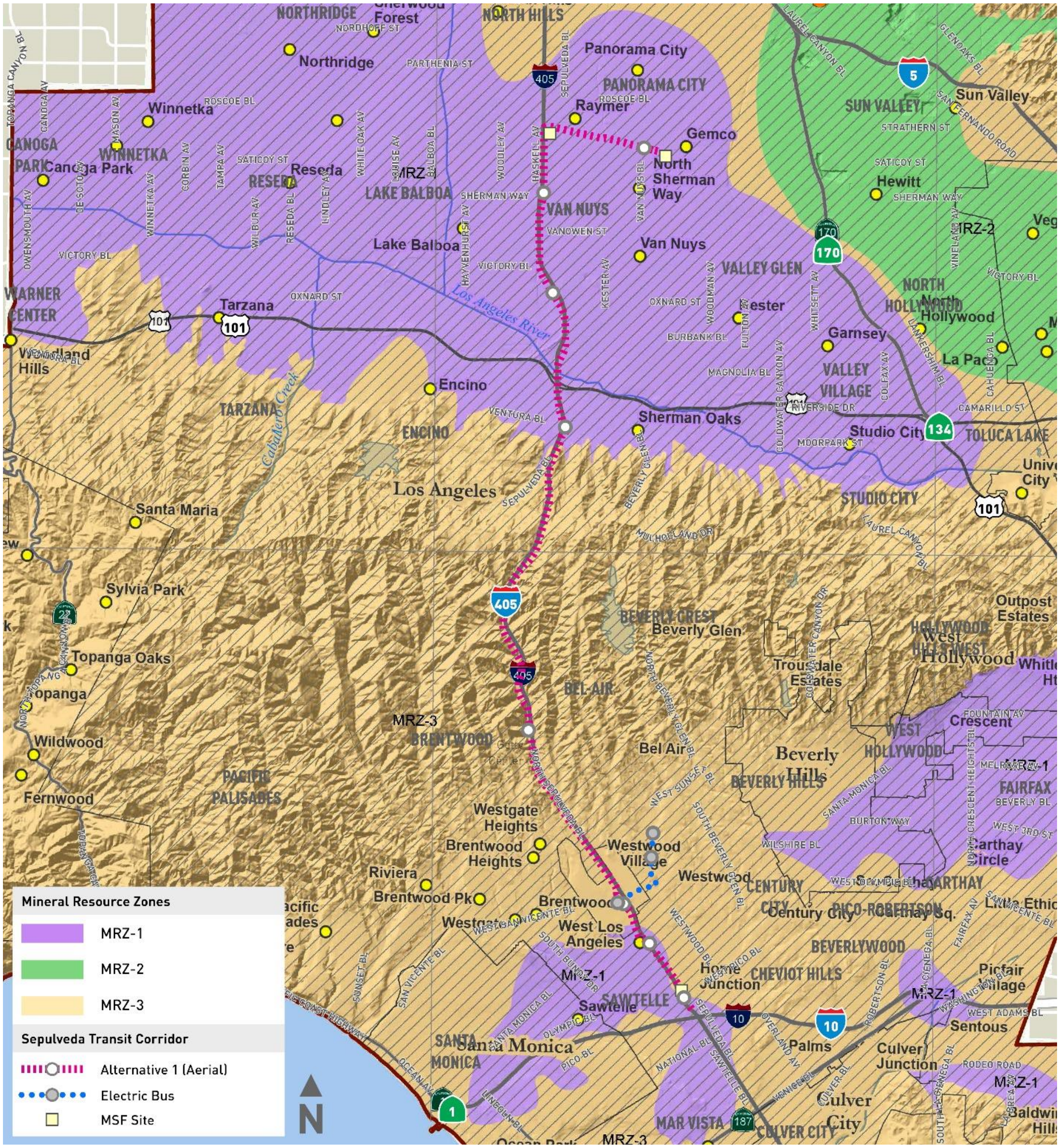
6.3 Mineral Resources

Mineral resource areas are identified according to the Surface Mining and Reclamation Act of 1975 and the following criteria for Mineral Resource Zones (MRZs), Scientific Resource Zones (SZs), and Identified Resource Areas. The MRZ and SZ categories used by the State Geologist in classifying the state's lands, the geologic and economic data, and the substantiation of which each unit MRZ or SZ assignment is based on land classification information provided by the State Geologist to the Board of Supervisors for the following areas:

- **MRZ-1:** Adequate information indicates that no significant mineral deposits are present or little likelihood exists for their presence. This zone shall be applied where well-developed lines of reasoning, based on economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is nil or slight.
- **MRZ-2:** Adequate information indicates that significant mineral deposits are present or a high likelihood for their presence exists. This zone shall be applied to known mineral deposits or where well-developed lines of reasoning, based on economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is high.
- **MRZ-3:** Containing deposits whose significance cannot be evaluated from available data.
- **MRZ-4:** Available information is inadequate for assignment to any other MRZ zone.
- **SZ Areas:** Areas containing unique or rare occurrences of rocks, minerals, or fossils that are of outstanding scientific significance shall be classified in this zone.

Alternative 1 would be located in areas designated as MRZ-1 and MRZ-3 (Figure 6-15). The California Department of Conservation, Division of Mines and Geology has classified areas of regional significance as MRZ-2 (CGS, 2021). Alternative 1 would not be located within an area designated as MRZ-2. Alternative 1 would be largely located within areas designated as MRZ-3, which contain deposits whose significance cannot be evaluated from available data. Alternative 1 would be located within areas designated as MRZ-1 in the northern portion of the Project in the Valley, as well as the southern portion of the Project near West Los Angeles. MRZ-1-designated areas indicate that no significant mineral deposits are present or little likelihood exists for their presence.

Figure 6-15. Alternative 1: Mineral Resources



Source: CGS, 2021; HTA, 2024

6.4 Paleontological Resources

A paleontological records search from the Natural History Museum of Los Angeles County (NHMLAC) revealed a fossil locality (LACM VP 1681) recorded within the Resource Study Area (RSA), indicating a high paleontological sensitivity in the area. The fossil locality is located in the central portion of the RSA just west of the I-405 Sepulveda freeway cut, adjacent to where Royal Ridge Road ends. LACM VP 1681 indicated a fossil Pipefish (*Syngnathus avus*) from within the Miocene Modelo Formation. Pipefish are considered rare in the fossil record, are indicators of paleoenvironmental conditions, and thus increase the scientific importance of this locality. Paleontologists have previously sampled the locality, and subsequent construction activities (i.e., I-405) have effectively removed the locality, but it is still indicative of the fossiliferous nature of the Modelo Formation (SVP, 1995; Bell, 2023). Additionally, 14 other fossil localities are located within 5 miles of the RSA that produced fossil vertebrates and invertebrates.

Paleontological sensitivity refers to the paleontological potential for a geologic unit to contain fossil remains, traces, and fossil-collecting localities. The following sensitivity ratings indicate the potential for containing significant paleontological resources.

- High paleontological sensitivity indicates that geologic units have a history of or are considered to have a high potential for paleontological resources (i.e., fossil remains).
- Moderate paleontological sensitivity indicates that fossil remains or traces have been found but are in poor condition, are a common paleontological resource, or do not have scientific significance.
- Low paleontological sensitivity indicates a low potential for containing fossil paleontological resources.
- No paleontological sensitivity indicates areas that are not conducive to significant paleontological resources due to environmental conditions.

For this Project, it is difficult to quantify the number of sensitive formations and their sensitivity level with precision due to a blanket of soil that covers the entire RSA underground and current construction in the area. Appendix A to this technical report, the stand-alone Paleontological Technical Memorandum, contains a detailed analysis of paleontological resources.

6.5 Impacts Evaluation

6.5.1 Impact GEO-1: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map, issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.

6.5.1.1 Operational Impacts

Alternative 1 traverses the Santa Monica Fault at approximately north of Massachusetts Avenue and the I-405 median, north of Santa Monica Boulevard. The next nearest Alquist-Priolo Earthquake Fault Zones to Alternative 1 are the Hollywood Fault, located approximately two miles northeast from its mid-section of Alternative 1, and the Newport-Inglewood-Rose Canyon Fault, located approximately two miles east of the southern portion of Alternative 1.

The Alquist-Priolo Earthquake Fault Zoning Act prohibits the construction of structures for human occupancy (i.e., houses, apartments, offices, stations, etc.) on the surface trace of active faults. However, the Alquist-Priolo Earthquake Fault Zoning Act does not prohibit the construction of non-habitable structures (i.e., not suitable to be lived in such as carport, roads, train tracks, bridges, etc.). Alternative 1 would include an entirely aerial monorail alignment that would traverse the I-405 corridor and include eight aerial monorail transit (MRT) stations and traction power substation (TPSS) sites.

Alternative 1's alignment would include a fixed guideway within the Alquist-Priolo Earthquake Fault Zone. Alternative 1 would also include the operation of an electric bus which would serve as a shuttle between the Wilshire Boulevard/Metro D Line and UCLA Gateway Plaza Stations.

Operation of Alternative 1 including the electric bus would not directly or indirectly cause the rupture of a fault because its elements are entirely aerial or at-grade for the electric bus. Neither component involves ground-disturbing activities or habitable structures directly on or near fault traces. Furthermore, Alternative 1 would be designed to comply with current seismic safety standards, including structural engineering measures to account for the potential impacts of seismic activity, as discussed in detail in Section 2 Regulatory and Policy Framework. As such, the operational components of Alternative 1 would not exacerbate fault rupture risks or contribute to the potential for loss, injury, or death associated with known earthquake.

While operational activities of Alternative 1 would not exacerbate fault rupture risks, Alternative 1 would be constructed in a way that would reduce the risk of loss, injury, or death *as a result* of a fault rupture through compliance and adherence to existing regulations as described in Section 2 Regulatory and Policy Framework. Construction of Alternative 1 would also incorporate earthquake-resistant design recommendations provided during final geotechnical engineering. Therefore, operational impacts associated with substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault would be less than significant.

6.5.1.2 Construction Impacts

Construction of Alternative 1 would occur within the Santa Monica Fault zone, north of Santa Monica Boulevard and along I-405. This construction would involve installing cast-in-drilled-hole (CIDH) piles, precast beams, and precast bent caps within the I-405 ROW. These elements would not reach a depth or involve an intensity of activity that would affect geological processes such as faults. As detailed in Section 2 Regulatory and Policy Framework, compliance with applicable seismic and geotechnical regulations would ensure that construction activities are conducted in a manner that accounts for the presence of active faults. The CIDH piles, for instance, would be engineered to remain stable under seismic conditions without triggering or exacerbating fault activity. Because the depth and intensity of construction activities would not be sufficient to influence geological processes such as fault rupture, and due to adherence to strict safety and design standards, construction of Alternative 1 would not directly or indirectly exacerbate rupture of a known earthquake fault in a manner that could result in substantial adverse effects, including the risk of loss, injury, or death. Therefore, construction impacts related to fault rupture would be less than significant.

Alternative 1 would be located in an earthquake-prone area (Southern California). Construction activities would be carried out in compliance with the regulatory requirements as defined in Project Measure (PM) GEO-1 and Section 2, to account for the potential effects of ground shaking and the portion of Alternative 1 within the Santa Monica Fault. Moreover, while temporary structures such as office trailers and staging areas would be located throughout the alignment, no habitable structures associated with construction activities would be located within the Alquist-Priolo Earthquake Fault Zone.

6.5.1.3 Maintenance and Storage Facilities

MSF Base Design

The proposed MSF Base Design would be located west of Hazeltine Avenue and south of the LOSSAN rail corridor ROW. The proposed MSF Base Design would not be within an Alquist-Priolo Earthquake Fault Zone. The closest Alquist-Priolo Earthquake Fault Zone is the Hollywood fault located approximately 8.5

miles southeast from the proposed MSF Base Design. Therefore, there are no impacts related to loss, injury, or death involving the rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map during operations or construction.

MSF Design Option 1

The proposed MSF Design Option 1 would be located east of the I-405 overpass and south of the LOSSAN rail corridor ROW. The proposed MSF Design Option 1 would not be within an Alquist-Priolo Earthquake Fault Zone. The closest Alquist-Priolo Earthquake Fault Zone is the Hollywood fault located approximately 9.5 miles southeast from the proposed MSF Design Option 1. Therefore, there are no impacts related to loss, injury, or death involving the rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map during operations or construction.

Electric Bus MSF

The proposed Electric Bus MSF would be located west of Cotner Avenue and north of Pico Boulevard, which are adjacent to I-405. The proposed Electric Bus MSF would not be within an Alquist-Priolo Earthquake Fault Zone. The closest Alquist-Priolo Earthquake Fault Zone is the Santa Monica fault located approximately 0.9 mile north from the proposed Electric Bus MSF. Therefore, there are no impacts related to loss, injury, or death involving the rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map during operations or construction.

6.5.2 Impact GEO-2: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking and/or seismic-related ground failure, including liquefaction?

6.5.2.1 Operational Impacts

Seismic-related ground failures include liquefaction, post-liquefaction settlements, and landslides. Hazards related to landslides is discussed in Section 6.5.3.

As previously discussed, Alternative 1 would include an entirely aerial monorail alignment that would traverse the I-405 corridor and include eight aerial monorail transit (MRT) stations and TPSS sites. As shown on Figure 6-13, the alignment of Alternative 1 would traverse a Liquefaction Zone. Liquefaction occurs when a mass of saturated soil loses significant strength and stiffness due to applied stress, usually from an earthquake.

Alternative 1, during operation activities, would experience earthquake-induced ground shaking activity because of its proximity to known active faults as listed in Table 6-6 and shown on Figure 6-11 and Figure 6-12. However, while Alternative 1 would be located in a seismically active region and may be subject to the effects of ground shaking, operational activities associated with Alternative 1 would not directly or indirectly cause strong seismic ground shaking including liquefaction. This is because operational activities, such as the movement of monorail vehicles along the guideway and electric bus operations, would not involve ground-disturbing activities or the application of forces that could affect geological processes. As described in Section 2 Regulatory and Policy Framework, the design and construction of Alternative 1 would comply with applicable seismic and geotechnical regulations, which require infrastructure in liquefaction-prone areas to incorporate engineering measures, such as reinforced foundations for the elevated guideway, to ensure that the design is capable of withstanding seismic forces during operation. Therefore, Alternative 1 would have a less than significant impact related to liquefaction during operations.

6.5.2.2 Construction Impacts

Liquefaction occurs when a mass of saturated soil loses significant strength and stiffness due to applied stress, usually from an earthquake. Liquefaction is more likely to happen where groundwater is moderate to shallow and the stratigraphy consists of loose, unconsolidated soils like fill and young alluvial deposits. Liquefaction is generally considered possible when the depth to groundwater is within about 50 feet from the ground surface. Much of the portion of the corridor within the Santa Monica Mountains is not considered to be liquefiable as soil coverage is relatively thin and much of the area is underlain by bedrock. However, as shown on Figure 6-13, Alternative 1 traverses several Liquefaction Zones both within the San Fernando Valley and the Los Angeles Basin.

Construction of Alternative 1 would occur within the Santa Monica Fault zone, north of Santa Monica Boulevard and along I-405. This construction would involve installing CIDH piles, precast beams, and precast bent caps within the I-405 ROW. Construction activities for Alternative 1 would not reach a depth or involve ground disturbances of sufficient intensity to trigger liquefaction or affect geological processes such as faults. As a result, construction would not directly or indirectly cause strong seismic ground shaking or seismic-related ground failure. As such, impacts related to seismic ground shaking including liquefaction would be less than significant during construction activities.

The following information is purely informational as it has been determined that impacts related to seismic ground shaking including liquefaction would be less than significant during Alternative 1’s construction activities. While Alternative 1’s construction activities would not directly or indirectly cause strong seismic shaking resulting in seismic-related ground failures, Alternative 1 would be located in southern California, a seismically active area. As such, hazards on Alternative 1 during construction by a seismic shaking, including liquefaction are considered. A seismic event during construction could result in safety hazards to construction workers. Standard measures that would protect the public from risk of loss, injury, or death are not yet in place. Risk at a construction site increases because the equipment, tools, and materials on-site could become projectiles. Unfinished structures and buildings could potentially collapse. Excavation and trenching are among the most hazardous construction operations. Seismic events could result in uneven surfaces, cave-ins, and flooding from groundwater intrusion. OSHA’s Excavation and Trenching standard (Title 29 of the Code of Federal Regulations, Part 1926.650) covers requirements for excavation and trenching operations. OSHA requires that all excavations in which employees could potentially be exposed to cave-ins be protected by sloping or benching the sides of the excavation, supporting the sides of the excavation, or placing a shield between the side of the excavation and the work area. In California, Cal/OSHA has responsibility for implementing federal rules relevant to worker safety, including slope protection during construction excavations. Cal/OSHA’s requirements are more restrictive and protective than federal OSHA standards.

6.5.2.3 Maintenance and Storage Facilities

MSF Base Design

The proposed MSF Base Design would be located west of Hazeltine Avenue and south of the LOSSAN rail corridor ROW. The site would include the following facilities:

- Primary maintenance building that would include administrative offices, operations control center and maintenance shop and office
- Train car wash building
- Emergency generator

- TPSS
- Maintenance-of-way (MOW) building
- Parking area for employees

Operation and construction of the proposed MSF Base Design do not involve extensive excavation and do not reach a depth or be of an intensity that would affect geological processes such as faults. As such, impacts related to seismic ground shaking including liquefaction would be less than significant during operation and construction.

MSF Design Option 1

The proposed MSF Design Option 1 would be located east of the I-405 overpass and south of the LOSSAN rail corridor ROW.

The site would include the following facilities:

- Primary entrance with guard shack
- Primary maintenance building that would include administrative offices, an operations control center, and a maintenance shop and office
- Train car wash building
- Emergency generator
- TPSS
- MOW building
- Parking area for employees

Operation and construction of the proposed MSF Design Option 1 do not involve extensive excavation and do not reach a depth or be of an intensity that would affect geological processes such as faults. As such, impacts related to seismic ground shaking including liquefaction would be less than significant during operation and construction.

Electric Bus MSF

An electric bus MSF would be located on the northwest corner of Pico Boulevard and Cotner Avenue and would be designed to accommodate 14 electric buses. The site would be approximately 2 acres and would comprise six parcels bounded by Cotner Avenue to the east, I-405 to the west, Pico Boulevard to the south, and the I-405 northbound on-ramp to the north.

The site would include approximately 45,000 square feet of buildings and include the following facilities:

- Maintenance shop and bay
- Maintenance office
- Operations center
- Parts storeroom with service areas
- Parking area for employees

Operation and construction of the proposed electric bus MSF do not involve extensive excavation and do not reach a depth or be of an intensity that would affect geological processes such as faults. As such, impacts related to seismic ground shaking including liquefaction would be less than significant during operation and construction.

6.5.3 Impact GEO-3: Would the Project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides?

6.5.3.1 Operational Impacts

As shown on Figure 6-14, Alternative 1 would traverse the Santa Monica Mountains, which are within a designated potential Landslide Hazard Zone (LHZ) and are areas prone to landslides. The segments for the aerial alignment and stations extending along the west side of I-405 between Getty Center Drive and Bel Air Crest Road, and the east side of I-405 into the Bel Air community along the south side of the Santa Monica Mountains have a potential for seismic-induced landslides where ground surfaces consist of steep slopes. The *Sepulveda Transit Corridor Project, Detailed Geotechnical Exploration Plan* has identified that the elevated guideway structure would be predominately located within the I-405 ROW and generally stay above the top of the existing slopes extending along the west side of I-405 (Metro, 2023a). As a result, the guideway would generally not interact with the slopes themselves, thereby minimizing the risk of slope instability and interference with the existing topography.

Concentrated storm runoff can result in severe slope erosion leading to a loss of structural support and catastrophic failure. Perched groundwater and infiltration from irrigation, rainfall, or snowmelt frequently cause landslides. However, as discussed in Section 6.5.4, impacts related to topsoil erosion and water infiltration are managed separately and would not directly influence the operational impacts related to landslides.

Earthquake-induced landslides are slope failures/movements that occur from shaking during an earthquake event. Operational activities associated with Alternative 1 would not directly or indirectly cause strong seismic ground shaking including landslides as these activities would not involve interaction with geological processes such as faults or the alteration of natural slopes.

Certain human activities can cause landslides. They are commonly a result of building roads and structures without adequate grading of slopes, poorly planned alteration of drainage patterns, and disturbing old landslides. However, operational activities for Alternative 1 would not involve grading of slopes, modification of drainage systems, or disturbance of existing landslides. Additionally, the design of Alternative 1 would minimize interaction with natural slopes by employing an elevated guideway positioned above steep terrain and avoiding direct contact with unstable areas. The design would also incorporate drainage and erosion control measures to prevent water-related slope instability and comply with applicable geotechnical and engineering standards described in Section2 Regulatory and Policy Framework. Therefore, Alternative 1 would have a less than significant impact related to landslides during operations.

6.5.3.2 Construction Impacts

The Santa Monica Mountains are within a designated potential LHZ (Figure 6-14). Alternative 1 would include an entirely aerial monorail alignment that would traverse the I-405 corridor and include eight aerial MRT stations and TPSS sites. Areas that affect the existing slope along I-405 and increase landslides would be further investigated consistent with local requirements for slope stability during the design phase when site-specific data and final geometry of improvements are available. The foundation types would be determined as part of the required geotechnical investigation conducted during the final design phase and would ensure that the potential for landslides would not cause potential for substantial adverse effects, including the risk of loss, injury, or death.

Construction activities for Alternative 1 would include widening the freeway and demolishing and rebuilding the retaining walls that hold back the mountains. Retaining-wall construction would occur in the Sepulveda Pass at the proposed reconfigured northbound I-405 Getty On-Ramp and require the excavation of existing hills and slopes within the Santa Monica Mountains. Temporary engineering structures, such as shoring or bracing, would be erected to support the retaining walls while excavation is underway. However, because these activities would occur within a designated LHZ, there is a heighted risk of landslides, particularly during periods of heavy rainfall or seismic activity. Such landslides could result in the destabilization of the slopes, potentially leading to injury or death of construction workers and substantial damage to the infrastructure under construction.

To address these risks, all grading and construction activities would be carried out in compliance with the regulatory requirements defined in Section 2, including state regulations and the equivalent seismic design criteria such as the MRDC, to account for the portion of Alternative 1 that would be within a landslide zone. The final design of the retaining walls and the temporary engineering required to construct them would abide with structural engineering standards set forth in the provisions listed in the CBC.

Alternative 1 shall comply with the regulatory requirements as defined in PM GEO-1 through PM GEO-3. PM GEO-1 requires a site-specific slope-stability design, and a design to address landslide potentials as required by the standards contained in the CBC and County of Los Angeles and City of Los Angeles guidelines, as well as by Cal/OSHA requirements for stabilization. Alternative 1 would include manufactured slopes in the retention basins, which would occur mostly on the perimeter of the sites. PM GEO-2 would recommend site-specific evaluations of unstable soil conditions and also provides recommendations for necessary ground preparation in conformance with CBC and other applicable regulations. Finally, PM GEO-3 would require that the alternative demonstrate that the design complies with all applicable provisions including the CBC.

Provisions provided in the CBC relating to the construction and design of the retaining walls include requirements for foundation and soil investigations, excavation, grading, fill-allowable, and load-bearing values of soils. Section 1810 of the CBC also includes regulations related to the design of footings, foundations, and slope clearances, retaining walls, and pier, pile, driven, and CIP foundation support systems. Chapter 33 of the CBC includes requirements for safeguards at work sites to ensure stable excavations and cut or fill slopes. CBC Appendix J includes grading requirements for the design of excavations and fills (Sections J106 and J107) and for erosion control (Section J110). Construction activities are subject to occupational safety standards for excavation, shoring, and trenching as specified in Cal/OSHA regulations (CCR Title 8).

In terms of temporary slopes, excavation activities at Alternative 1 could occur in unstable soils. In general, the risk of slope failure is considered higher for temporary slopes due to generally steeper gradients versus permanent, manufactured slopes. Similar to the construction of permanent slopes, temporary slopes would be required to adhere to the Cal/OSHA and CBC requirements for shoring and stabilization. The design and construction of Alternative 1 would be compliant with the regulatory requirements as defined in PM GEO-1, PM GEO-2, and PM GEO-3 as integral components of the project. These measures would provide site-specific slope stability designs, evaluations of unstable soil conditions, and necessary ground preparation to address landslide potentials and slope stability. Combined with adherence to applicable regulatory standards, including the CBC and Cal/OSHA requirements, these project measure ensure that impacts associated with landslides and/or slope instability during construction activities would be less than significant.

6.5.3.3 Maintenance and Storage Facilities

MSF Base Design

The proposed MSF Base Design would be located west of Hazeltine Avenue and south of the LOSSAN rail corridor ROW. The proposed MSF Base Design would not be located on land designated as an LHZ (Figure 6-14); the closest LHZ is located 4.16 miles south from the proposed MSF Base Design site. Therefore, the proposed MSF Base Design would not directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides, and no impact would occur.

MSF Design Option 1

The proposed MSF Design Option 1 would abut Orion Avenue west of Sepulveda Boulevard and south of the LOSSAN rail corridor ROW. The proposed MSF Design Option 1 would not be located on land designated as an LHZ (Figure 6-14); the closest LHZ is located 4.14 miles south from the proposed MSF Design Option 1. Therefore, the proposed MSF Design Option 1 would not directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides, and no impact would occur.

Electric Bus MSF

The proposed Electric Bus MSF would be located on the northwest corner of Pico Boulevard and Cotner Avenue. The proposed Electric Bus MSF would not be located on land designated as an LHZ (Figure 6-14); the closest LHZ is located 3.08 miles north from the proposed Electric Bus MSF site. Therefore, the proposed Electric Bus MSF would not directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides, and no impact would occur.

6.5.4 Impact GEO-4: Would the project result in substantial soil erosion or the loss of topsoil?

6.5.4.1 Operational Impacts

Implementation of Alternative 1 would not result in substantial soil erosion or the loss of topsoil during operations. Topsoil is the uppermost layer of soil—usually the top 6 to 8 inches—which has the highest concentration of organic matter and micro-organisms and is where most biological soil activity occurs. Plants generally concentrate their roots in, and obtain most of their nutrients from, this layer. Topsoil erosion is of concern when the topsoil layer is blown or washed away, which makes plant life or agricultural production impossible. In addition, significant erosion typically occurs on steep slopes where stormwater and high winds can carry topsoil down hillsides.

Within the Project Study Area, pervious surfaces are associated with the open space areas within the adjacent Santa Monica Mountain region and a minimal extent of setbacks and residential yards along the Alternative 1 RSA. Alternative 1 would include an entirely aerial monorail alignment that would traverse the I-405 corridor and would include eight aerial MRT stations and a new electric bus route. Operation of Alternative 1 would not result in substantial ground disturbance or an increase in the amount of exposed soil as compared to existing conditions and would not change the amount of erosion and spreading grounds within the Santa Monica Mountains and residential yards along the Alternative 1 RSA as compared to existing conditions.

As described in the *Sepulveda Transit Corridor Project Water Resources Technical Report* (Metro, 2025), Alternative 1 would increase existing impervious areas resulting from the following components: Metro E Line Station, Santa Monica Boulevard Station, Wilshire Boulevard/Metro D Line Station, Getty Center

Station, Sherman Way Station TPSS, and proposed MSF as well as I-405 modifications required to operate Alternative 1. Total net impervious surface area created by Alternative 1 elements would total to 252,003 square feet and 1,459,260 square feet for I-405 modifications.

The proposed stations would not result in a significant increase in impervious surfaces, because most of the land surfaces in the Project Study Area are currently developed and covered by existing impervious surfaces. The footprints of the proposed Alternative 1 stations are nominal when compared to the area of the watershed and groundwater basin. However, the TPSSs and I-405 freeway modifications that include new or relocated ramps, expanded shoulders, column locations, and retaining walls would result in a greater increase in impervious surface areas. As a result of the TPSSs and freeway modifications, runoff would be expected to increase due to the increase in impervious surface area. Further details on new impervious surfaces and their impact on erosion resulting from Alternative 1 can be found in the *Sepulveda Transit Corridor Project Water Resources Technical Report* (Metro, 2025).

Alternative 1 would be designed to incorporate several sustainability features, such as native landscaping, rainwater cisterns for capture and reuse, permeable surfaces, soil improvements, increased vegetation, and on-site retention, in compliance with the *Low Impact Development Standards Manual* (LACDPW, 2014), which would serve to reduce impervious area and limit runoff that may cause erosion. Alternative 1 would comply with post-construction measures in applicable National Pollutant Discharge Elimination System (NPDES) permits and Low Impact Development (LID) standards required by Los Angeles County and other local jurisdictions, which aim to minimize erosion impacts from development projects. With adherence to existing regulations, Alternative 1 would result in a less than significant impact related to substantial soil erosion or the loss of topsoil during operations.

6.5.4.2 Construction Impacts

Ground-disturbing activities occurring during construction would temporarily expose surficial soils to wind and water erosion and have the potential to temporarily increase erosion and loss of topsoil. Construction work that would involve ground-disturbing activities include installation of CIDH piles for the MRT aerial guideway, I-405 widening, street and reconstruction, installation of TPSS sites, utility relocations, and grading relating to these activities. In the Sepulveda Pass area, adjacent to the Santa Monica Mountains, areas of pervious surfaces could be particularly susceptible to erosion. Retaining-wall installation would be required to accommodate the reconfiguration of Sepulveda Boulevard and Getty Center on- and off-ramps. Such construction would involve considerable earth-moving activities, including the partial excavation of the Santa Monica Mountains to increase the setback of the retaining walls. However, construction activities would be required to comply with existing regulatory requirements, as described in Section 2, including implementation of best management practices and other erosion and sedimentation control measures that would ensure grading, excavation, and other earth-moving activities would avoid a significant impact.

Metro would be required to prepare a *Stormwater Pollution Prevention Plan*, and a site-specific *Standard Urban Storm Water Mitigation Plan* (SUSMP), which is part of the NPDES Municipal General Permit. Preparation of the site-specific SUSMP would describe the minimum required best management practices to be incorporated into Alternative 1 design and on-going operation of the facilities. Prior to the initiation of grading activities associated with implementation of Alternative 1, Metro would submit a site-specific SUSMP to reduce the discharge of pollutants to the maximum extent practical using best management practices, control techniques and systems, design and engineering methods, and other provisions that are appropriate during construction activities. All development activities associated with Alternative 1 would comply with the site-specific SUSMP.

Preparation of a site-specific SUSMP and adherence to existing regulations would ensure the maximum practicable protection available for soils excavated during the construction of buildings and associated infrastructure. Compliance with existing regulations would minimize effects from erosion through repair and rehabilitation of topsoil post-construction and ensure consistency with the *Regional Water Quality Control Board Water Quality Control Plan*. In view of these requirements, Alternative 1 would have a less than significant impact associated with soil erosion or loss of topsoil during construction activities.

6.5.4.3 Maintenance and Storage Facilities

MSF Base Design

Operation of the proposed MSF Base Design would include the maintenance, cleaning, and storage of monorail vehicles. The proposed MSF Base Design site would be located within an urbanized area that is primarily impervious with no exposed soil. Operation of the proposed MSF Base Design would not result in ground disturbance or a change in the amount of exposed soil as compared to existing conditions and would adhere to existing regulations. The proposed MSF Base Design would comply with post-construction measures in applicable NPDES permits and LID standards required by Los Angeles County and the City of Los Angeles that aim to minimize erosion impacts from development projects. Therefore, the proposed MSF Base Design would result in a less than significant impact related to substantial soil erosion or the loss of topsoil during operations and construction.

MSF Design Option 1

Operation of the proposed MSF Design Option 1 would include the maintenance, cleaning, and storage of monorail vehicles. The proposed MSF Design Option 1 site would be located within an urbanized area that is primarily impervious with no exposed soil. Operation of the proposed MSF Design Option 1 would not result in ground disturbance or a change in the amount of exposed soil as compared to existing conditions and would adhere to existing regulations. The proposed MSF Design Option 1 would comply with post-construction measures in applicable NPDES permits and LID standards required by Los Angeles County and the City of Los Angeles that aim to minimize erosion impacts from development projects. Therefore, the proposed MSF Design Option 1 would result in a less than significant impact related to substantial soil erosion or the loss of topsoil during operations and construction.

Electric Bus MSF

Operation of the proposed Electric Bus MSF would include the maintenance, cleaning, and storage of the proposed electric bus fleet. The proposed Electric Bus MSF site would be located within an urbanized area that is primarily impervious with no exposed soil. Operation of the proposed Electric Bus MSF would not result in ground disturbance or a change in the amount of exposed soil as compared to existing conditions and would adhere to existing regulations. The proposed Electric Bus MSF would comply with post-construction measures in applicable NPDES permits and LID standards required by Los Angeles County and the City of Los Angeles that aim to minimize erosion impacts from development projects. Therefore, the proposed Electric Bus MSF would result in a less than significant impact related to substantial soil erosion or the loss of topsoil during operations and construction.

6.5.5 Impact GEO-5: Would the project be located on a geographic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?

6.5.5.1 Operational Impacts

Section 6.5.2 addresses impacts related to liquefaction, and Section 6.5.3 addressed impacts related to landslides. The analysis in this section addresses impacts related to unstable soils as a result of subsidence, differential settlement, lateral spreading, or collapse. The aerial segments of Alternative 1 would not be located on a geographic unit or soil that is unstable, or that would become unstable, potentially resulting in lateral spreading, subsidence, liquefaction, or collapse.

Collapsible soils and the potential for lateral spreading to affect the Project is low because most of the areas with liquefaction potential are along relatively flat terrain, and liquefiable layers are below the groundwater table as identified in the *Sepulveda Transit Corridor Project, Detailed Geotechnical Exploration Plan* (Metro, 2023a). However, a lateral spreading hazard may exist along I-405 and the Santa Monica Mountains due to liquefiable soils and steep slope topography for the aerial alignment, stations, and TPSS sites. Additionally, ground shaking leading to liquefaction of saturated soil could result in lateral spreading where the soil undergoes a temporary loss of strength, and if the liquefied soil is not contained laterally, it may result in deformation or translation of the slope.

Using unsuitable materials for fill and/or foundation support would have the potential to create future heaving, subsidence, spreading, or collapse problems, which would lead to building settlement and/or utility line and pavement disruption. Structural engineering standards to address geological conditions are part of standard construction requirements and standard construction practices. Alternative 1 would be designed in accordance with and equivalent to MRDC Section 5, Structural; Metro's Supplemental Seismic Design Criteria (2017); and the California Seismic Hazards Mapping Act. Furthermore, Alternative 1 would be designed in accordance with recommendations developed in a detailed geotechnical report prepared during final design, which would provide site-specific information pertaining to the depths and areal extents of lateral spreading, subsidence, or collapse.

During the design process, if it is determined that these conditions identified in the geotechnical report could result in an unacceptable soil or structural response (to be defined during final design and dependent on the type of structure), the resulting final geotechnical engineering would include recommendations that would be incorporated into the final design plans, consistent with standard practice to address any unstable geologic and related conditions present along the alignment. Recommendations may include deep foundations and/or ground improvements such as dynamic compaction, stone columns, jet grouting, and cement deep soil mixing and compaction grouting.

Given compliance with these regulatory and design requirements, Alternative 1 would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils as a result of subsidence, differential settlement, lateral spreading, or collapse during operations.

6.5.5.2 Construction Impacts

Section 6.5.2 addresses impacts related to liquefaction and Section 6.5.3 addresses impacts related to landslides. The analysis addresses impacts related to unstable soils as a result of subsidence, differential settlement, lateral spreading, or collapse. Construction activities for Alternative 1 would involve foundation support installation and earthwork along the alignment. Certain construction activities, such as CIDH drilling for the aerial guideway and excavation and erection of the temporary engineering of the retaining walls along the Santa Monica Mountains in the Sepulveda Pass, could affect soil stability leading to ground movements (both lateral movements and settlements) or subsidence. Additionally, the use of unsuitable materials for fill and/or foundation support could have the potential to create future heaving, subsidence, spreading, or collapse problems leading to foundation or roadway settlement. However, Alternative 1 be in compliance with the regulatory requirements as defined in PM GEO-2 as defined in Section 6.6. Under PM GEO-2, Alternative 1 shall provide a site-specific evaluation of soil conditions that shall contain recommendations for ground preparation, earthwork, and compaction specification based on the geological conditions specific to the site.

As described in Section 6.6, MM GEO-1 through MM GEO-5 would be implemented as part of Alternative 1. MM GEO-3 ensures compliance with the recommendations of the final soils and geotechnical report, which would provide site-specific information pertaining to the depths and areal extents of lateral spreading, subsidence, or collapse. Prior to construction, MM GEO-5 specifies that Metro shall prepare a *Construction Management Plan* (CMP) detailing how to address geologic constraints and minimize or avoid impacts to geologic hazards during construction.

Adherence to existing regulations and policies and implementation of MM GEO-1 through MM GEO-5 would ensure the maximum practicable protection available for users of buildings and infrastructure and associated trenches, slopes, and foundations. With the implementation of these mitigation measures, Alternative 1 would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils.

6.5.5.3 Maintenance and Storage Facilities

MSF Base Design

As addressed in Section 6.5.2 and Section 6.5.3, the proposed MSF Base Design would be located on stable soils where no liquefaction or landslide zones are present. Construction and operations would not occur on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed MSF Base Design, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse. The proposed MSF Base Design would be designed in compliance with applicable local, state, or federal laws or regulations, including recommendations on engineering and design considerations, as described in Section 6.5.5.1 and Section 6.5.5.2, and identified in MM GEO-1 through MM GEO-5. Thus, operation and construction of the proposed MSF Base Design would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

MSF Design Option 1

As addressed in Section 6.5.2 and Section 6.5.3, the proposed MSF Design Option 1 would be located on stable soils where no liquefaction or landslide zones are present. Construction and operations would not occur on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed MSF Design Option 1, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse. The proposed MSF Design Option 1 would be designed in compliance with applicable local, state, or federal laws or regulations, including recommendations on engineering and design considerations, as described in Section 6.5.5.1 and Section 6.5.5.2, and identified in MM GEO-1 through MM GEO-5. Thus, operation and construction of the proposed MSF Design Option 1 would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

Electric Bus MSF

As addressed in Section 6.5.2 and Section 6.5.3, the proposed Electric Bus MSF would be located on stable soils where no liquefaction or landslide zones are present. Construction and operations would not occur on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed Electric Bus MSF, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse. The proposed Electric Bus MSF would be designed in compliance with applicable local, state, or federal laws or regulations, including recommendations on engineering and design considerations, as described in Section 6.5.5.1 and Section 6.5.5.2, and identified in MM GEO-1 through MM GEO-5. Thus, operation and construction of the proposed Electric Bus MSF would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

6.5.6 Impact GEO-6: Would the project be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property?

6.5.6.1 Operational Impacts

Based on researched data for the Project Study Area, the majority of fine-grained soil and rock encountered in the previous consultant data exhibited low plasticity with very low to medium expansion potential (Metro, 2023a). Expansive soils can be found almost anywhere, particularly in coastal plains and low-lying valleys such as the Los Angeles Basin and San Fernando Valley. Expansive clays can be found in weathered bedrock along the Santa Monica Mountains. Much of the northern section of the Santa Monica Mountains is in the Modelo Formation. Clay-rich soils may exist locally within alluvial soils present along Alternative 1 that could swell and shrink with wetting and drying. The change in soil volume is capable of exerting enough force on structures to damage foundations, structures, and underground utilities. Damage can also occur as these soils dry out and contract. As part of PM GEO-2 during construction, a California-registered geologist and geotechnical engineer would submit to and conduct a site-specific evaluation of unstable soil conditions to confirm the existence of expansive soils.

While expansive soils could have an impact on project elements, operational activities of Alternative 1 do not directly or indirectly cause risks of life or property as operations would not involve wetting or drying of expansive soils. Therefore, impacts related to expansive soils are less than significant during operations.

6.5.6.2 Construction Impacts

Construction activities associated with Alternative 1 primarily pertain to the construction of the aerial guideway, and aerial stations. Construction of the guideway would take place within the median along I-405 and local street lanes. Aerial station construction related to groundwork includes drilling and installation of CIDH piles, pile cap, and pier column construction, and excavation of elevator pits.

Expansive soils can be found almost anywhere including the Los Angeles Basin and San Fernando Valley. Expansive soils could have an impact on project elements, including the proposed aerial stations, guideway, and TPSS sites. Though construction is primarily on developed land, since the construction of Alternative 1 includes excavation and surface ground disturbances, if expansive soils do exist, construction activities have the potential to create substantial direct or indirect risks to life or property. As such, impacts related to construction activities could be potentially significant.

To reduce these risks, Alternative 1 would be designed in accordance with the equivalent seismic design criteria such as the MRDC equivalent, Los Angeles County and other applicable local building codes, and the CBC. This includes compliance with equivalent MRDC Section 5 (or equivalent seismic design criteria), which requires preparation of a geotechnical investigation during final design (refer to Section 2 Regulatory and Policy Framework for additional information). This design-level geotechnical investigation must include a detailed evaluation of geologic hazards, including the depths and areal extents of liquefaction, soil expansiveness, lateral spread, and seismically induced settlement. This investigation would include collecting soil samples and performing tests to assess the potential for corrosion, consolidation, expansion, and collapse. Based on the investigation and test results, specific design recommendations, including potential remediation of expansive soils, would be developed to address any identified issues. Expansive soil remediation could include soil removal and replacement, chemical treatment, or structural enhancements.

Alternative 1 would be in compliance with the regulatory requirements as defined in PM GEO-2 which calls for a California-registered geologist and geotechnical engineer to submit to and conduct a site-specific evaluation of unstable soil conditions to confirm the existence of expansive soils. The evaluation would also provide recommendations for ground preparation and earthwork activities specific to the site.

Moreover, Alternative 1 would be required to demonstrate compliance with applicable provisions of the CBC and MRDC regarding soil hazard-related design, as described by PM GEO-3. The MRDC equivalent and the County of Los Angeles and City of Los Angeles building codes require site-specific investigations and reports for each construction site. The reports must identify any unsuitable soil conditions and provide recommendations for foundation type and design criteria consistent with the analysis and building code standards. Regulations exist to address weak soil issues, including expansion. As part of PM GEO-3, as described in Section 6.6, Alternative 1 would comply with applicable local, state, or federal laws or regulations.

Finally, prior to construction, the Project shall implement MM GEO-5, which requires preparation of a CMP which addresses geologic hazards such as soils with shrink-swell potential (expansive soils) and outlines strategies to minimize or avoid impacts.

With compliance with the regulatory requirements as defined in PM GEO 2, PM GEO-3, and implementation of MM GEO-5, Alternative 1 would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils during construction.

6.5.6.3 Maintenance and Storage Facilities

MSF Base Design

The proposed MSF Base Design would be required to comply with applicable provisions of the MRDC, Los Angeles County and other applicable local building codes, and the CBC with regard to soil hazard-related design.

The County of Los Angeles Building Code and City of Los Angeles Building Code require a site-specific foundation investigation and report for each construction site that identifies potentially unsuitable soil conditions and contains appropriate recommendations for foundation type and design criteria that conform to the analysis and implementation criteria described in the County of Los Angeles Building Code and the City of Los Angeles Building Code. Regulations exist to address weak soils issues, including expansion.

With compliance with the regulatory requirements as defined in PM GEO-3, as discussed in Section 6.5.6.2, and adherence to existing regulations, the proposed MSF Base Design would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils.

MSF Design Option 1

Operations related to the proposed MSF Design Option 1 do not involve grading, excavation, or other ground disturbances. Therefore, impacts related to operational activities are less than significant.

Construction of the proposed MSF Design Option 1 may involve grading, excavation, or other ground disturbances. If expansive soils exist at these sites, construction activities have the potential to create substantial direct or indirect risks to life or property. As such, impacts related to construction activities could be potentially significant.

The proposed MSF Design Option 1 would be in compliance with the regulatory requirements as defined in PM GEO-2 which calls for a California-registered geologist and geotechnical engineer to submit to and conduct a site-specific evaluation of unstable soil conditions to confirm the existence of expansive soils. The evaluation would also provide recommendations for ground preparation and earthwork activities specific to the site. Moreover, the proposed MSF Design Option 1 would be required to comply with applicable provisions of the CBC and an MRDC equivalent with regard to soil hazard-related design, as described by PM GEO-3. Finally, prior to construction, the proposed MSF Design Option 1 shall implement MM GEO-5, which requires the preparation of a CMP which addresses geologic hazards such as soils with shrink-swell potential (expansive soils) and outlines strategies to minimize or avoid impacts.

With compliance with the regulatory requirements as defined in PM GEO-2, PM GEO-3, and implementation of MM GEO-5, the proposed MSF Design Option 1 would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils during construction.

Electric Bus MSF

Operations related to the proposed Electric Bus MSF do not involve grading, excavation, or other ground disturbances. Therefore, impacts related to operational activities are less than significant.

Construction of the proposed Electric Bus MSF may involve grading, excavation, or other ground disturbances. If expansive soils exist at these sites, construction activities have the potential to create substantial direct or indirect risks to life or property. As such, impacts related to construction activities could be potentially significant.

The proposed Electric Bus MSF would be in compliance with the regulatory requirements as defined in PM GEO-2 which calls for a California-registered geologist and geotechnical engineer to submit to and conduct a site-specific evaluation of unstable soil conditions to confirm the existence of expansive soils. The evaluation would also provide recommendations for ground preparation and earthwork activities specific to the site. Moreover, the proposed Electric Bus MSF would be required to comply with applicable provisions of the CBC and an MRDC equivalent with regard to soil hazard-related design, as described by PM GEO-3. Finally, prior to construction, the proposed Electric Bus MSF shall implement MM GEO-5, which requires the preparation of a CMP which addresses geologic hazards such as soils with shrink-swell potential (expansive soils) and outlines strategies to minimize or avoid impacts.

With compliance with the regulatory requirements as defined in PM GEO-2, PM GEO-3, and implementation of MM GEO-5, the proposed Electric Bus MSF would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils during construction.

6.5.7 Impact GEO-7: Would the Project have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?

6.5.7.1 Operational Impacts

No septic systems or alternative wastewater disposal systems are proposed for Alternative 1. As described previously, Metro would be required to prepare a site-specific SUSMP, which is part of the NPDES Municipal General Permit.

Preparation of the site-specific SUSMP would describe the minimum required best management practices to be incorporated into Alternative 1 design and on-going operation of the facilities. All development activities associated with Alternative 1 would comply with the site-specific SUSMP.

Preparation of a site-specific SUSMP and adherence to existing regulations would ensure the maximum practicable protection available for soils excavated during the construction of buildings and associated infrastructure. Compliance with existing regulations would minimize effects from erosion and ensure consistency with the *Los Angeles Regional Water Quality Control Board Water Quality Control Plan*. In view of these requirements, Alternative 1 would have no impacts associated with soils incapable of adequately supporting such systems during operations.

6.5.7.2 Construction Impacts

No septic systems or alternative wastewater disposal systems are proposed for Alternative 1. Alternative 1 would have no impact associated with soils incapable of adequately supporting such systems during construction activities.

6.5.7.3 Maintenance and Storage Facilities

MSF Base Design

No septic systems or alternative wastewater disposal systems are proposed for the proposed MSF Base Design. Therefore, the proposed MSF Base Design would have no impact associated with soils incapable of adequately supporting such systems during operations.

MSF Design Option 1

No septic systems or alternative wastewater disposal systems are proposed for the proposed MSF Design Option 1. Therefore, the proposed MSF Design Option 1 would have no impact associated with soils incapable of adequately supporting such systems during operations.

Electric Bus MSF

No septic systems or alternative wastewater disposal systems are proposed for the proposed Electric Bus MSF. Therefore, the proposed Electric Bus MSF would have no impact associated with soils incapable of adequately supporting such systems during operations.

6.5.8 Impact GEO-8: Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

6.5.8.1 Operational Impacts

Operations of Alternative 1 would not include on-going activities that would involve ground disturbance. Therefore, there would be no operational impacts related to paleontological resources.

6.5.8.2 Construction Impacts

Construction impacts to the ground surface associated with Alternative 1 would include providing the access, staging, and laydown areas needed for the construction of the foundations and columns required for the monorail. These impacts would include an 8-foot-wide work area required along each guideway beam, an 8-foot-wide work area required on each side of concrete straddle beam, and an 8-foot-wide work area at each column/foundation. Additionally, the construction impact areas would extend along the I-405 corridor to provide construction access and staging/laydown areas within and adjacent to Caltrans ROW.

Alternative 1 would have eight proposed aerial monorail stations and three bus stops. At the monorail station in Wilshire Boulevard, there would be an electric bus shuttle that would operate on the street and connect people to the Metro D Line Westwood/VA station. Construction impacts specific to Alternative 1 would be the electric-bus connection that would extend to the roadway limits of Wilshire and Westwood Boulevards (or Kinross Avenue) to accommodate new electric -bus stops and to the limits of the Metro Division 7 property.

Most of the impacts from Alternative 1 would result from the construction of the foundation columns for the MRT alignment and the foundations needed for the aerial MRT stations, switch locations, and long-span structures. The columns involved in Alternative 1 would range from 6 feet in diameter in the main alignment with a 7-foot-diameter foundation; 4-foot to 7-foot columns with an 8-foot-wide foundation at the I-405 median; 5-foot to 8-foot columns with a 9-foot foundation at the aerial MRT stations; 5-foot-diameter column with a 6-foot foundation at the switch locations; and lastly 10 feet in diameter columns with a foundation 11 feet in diameter for the long-span structures. The CIDH method will be used during the construction of the foundations for the columns. This method does not allow for careful monitoring as it grinds the sediments. Consequently, this method would cause potentially significant impacts to paleontological resources when utilized in paleontologically sensitive geologic formations.

Because of the uncertainty regarding the depth of sensitive sediments and the potential for encountering unique paleontological resources during ground disturbance, the impact would be significant. To address this significant impact, MM GEO-6 through MM GEO-9 would be implemented. These measures include the use of onsite paleontological monitors who can quickly identify and protect resources until any discovered localities can be safely removed. These mitigation measures are designed to minimize impacts to paleontological resources by ensuring that any discoveries are properly documented, evaluated, and protected during construction activities. With the implementation of MM GEO-6 through MM GEO-9, impacts to paleontological resources would be reduced to less than significant (Scott and Springer, 2003; Bell, 2023; Duke Cultural Resources Management, 2023).

6.5.8.3 Maintenance and Storage Facilities

MSF Base Design

The impacts involved with the MSF Base Design would include all administrative buildings, maintenance buildings, wash facilities, drive aisles, storage tracks, and the columns for the aerial MSF. The surface rocks in the underground portions of the proposed MSF Base Design are mapped as young alluvial, unit 2 (Qya2), defined by USGS as older surfaces not yet old enough to establish plant life (USGS, 2009), but may be more paleontologically sensitive (older) than indicated, at depth. Construction in these formations defined as Qya2 could potentially cause significant impacts to paleontological resources. Implementation of MM GEO-6 through MM GEO-9 would reduce impacts to less than significant.

MSF Design Option 1

The impacts involved with the MSF Design Option 1 would include all administrative buildings, maintenance buildings, wash facilities, drive aisles, storage tracks, and the columns for the aerial MSF. The surface rocks in the underground portions of the proposed MSF Design Option 1 are mapped as Qya2 but may be more paleontologically sensitive (older) than indicated, at depth. Construction in these formations defined as Qya2 could potentially cause significant impacts to paleontological resources. Implementation of MM GEO-6 through MM GEO-9 would reduce impacts to less than significant.

Electric Bus MSF

The type of buildings and uses in the Electric Bus MSF would not likely require deep excavation. Therefore, no impacts related to paleontological resources would occur.

6.5.9 Impact GEO-9: Would the project result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state or result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?

6.5.9.1 Operational Impacts

Operation of Alternative 1 would not require excavation that may affect mineral resources. No mining operations are present within the Alternative 1 Resource Study Area, so operation of Alternative 1 would not disrupt mining operations. Therefore, Alternative 1 would have no operational impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

6.5.9.2 Construction Impacts

Construction of Alternative 1 would require excavation for columns, but Alternative 1 would not be located in an area with known mineral deposits. As mentioned in Section 6.3, Alternative 1 is located in areas designated as MRZ-1 and MRZ-3. The California Department of Conservation, Division of Mines and Geology has classified areas of regional significance as MRZ-2 (CGS, 2021). Alternative 1 would not be located within an area designated as MRZ-2. Alternative 1 would be located within areas designated as MRZ-1 in the northern portion of the Project in the Valley as well as the southern portion of the Project near West Los Angeles. MRZ-1 designated areas indicate that no significant mineral deposits are present or little likelihood exists for their presence. No mining operations are present within the Alternative 1 RSA, so construction of Alternative 1 would not disrupt mining operations. Therefore, Alternative 1 would have no construction impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

6.5.9.3 Maintenance and Storage Facilities

MSF Base Design

Operation of the MSF Base Design would not require excavation that may affect mineral resources. No mining operations are present within or in the vicinity of the MSF Base Design, so operation of the MSF Base Design would not disrupt mining operations. Therefore, the MSF Base Design would have no operational impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

Construction of the MSF Base Design would require excavation for columns, but the MSF Base Design would not be located in an area with known mineral deposits. No mining operations are present within or in the vicinity of MSF Base Design, so construction of the MSF Base Design would not disrupt mining operations. Therefore, the MSF Base Design would have no construction impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

MSF Design Option 1

Operation of the MSF Design Option 1 would not require excavation that may affect mineral resources. No mining operations are present within or in the vicinity of MSF Design Option 1, so operation of MSF Design Option 1 would not disrupt mining operations. Therefore, the MSF Design Option 1 would have no operational impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

Construction of the MSF Design Option 1 would require excavation for columns, but the MSF Design Option 1 would not be located in an area with known mineral deposits. No mining operations are present within or in the vicinity of the MSF Design Option 1, so construction of the MSF Design Option 1 would not disrupt mining operations. Therefore, the MSF Design Option 1 would have no construction impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

Electric Bus MSF

Operation and construction of the Electric Bus MSF would not require excavation that may affect mineral resources. No mining operations are present within or in the vicinity of the Electric Bus MSF, so operation of the Electric Bus MSF would not disrupt mining operations. Therefore, the Electric Bus MSF would have no operational or construction impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

6.6 Project and Mitigation Measures

6.6.1 Operational Impacts

No mitigation measures are required.

6.6.2 Construction Impacts

Alternative 1 would implement the following project and mitigation measures to ensure that impacts to the geology, soils, and seismicity remain less than significant during construction activities:

PM GEO-1: *The Project shall demonstrate to the County of Los Angeles and the City of Los Angeles that the design of the Project complies with all applicable provisions of the California Building Code with respect to seismic design. Compliance shall include the following:*

- *California Building Code Seismic Zone 4 Standards as the minimum seismic-resistant design for all proposed facilities*
- *Seismic-resistant earthwork and construction design criteria (i.e., for the construction of the tunnel below ground surface, liquefaction, landslide, etc.), based on the site-specific recommendations of a California Registered Geologist in cooperation with the Project Engineers.*
- *An engineering analysis to characterize site specific performance of alluvium or fill where either forms part or all of the support.*

PM GEO-2: *A California-registered geologist and geotechnical engineer shall submit to and have approval by the Project a site specific evaluation of unstable soil conditions, including recommendations for ground preparation and earthwork activities specific to the site and in conformance with City of Los Angeles Building Code, County of Los Angeles Building Code, the California Building Code, Metro Rail Design Criteria (as applicable), and Caltrans Structure Seismic Design Criteria.*

PM GEO-3: *The Project shall demonstrate that the design of the Project complies with all applicable provisions of the County of Los Angeles Building Code and City of Los Angeles Building Code.*

MM GEO-1: *The Project's design shall include integration and installation of early warning system to detect and respond to strong ground motion associated with ground rupture. Known active fault(s) (i.e., Santa Monica Fault) shall be monitored. Linear monitoring systems such as time domain reflectometers or equivalent or more effective technology shall be installed along fixed guideway in the zone of potential ground rupture.*

MM GEO-2: *Where excavations are made for the construction of the below surface tunnel, the Project shall either shore excavation walls with shoring designed to withstand additional loads or reduce the slope of the excavation walls to a shallower gradient. Excavation spoils shall not be placed immediately adjacent to excavation walls unless the excavation wall is shored to support the added load. Spoils should be stored at a safe distance from the excavation site to prevent undue pressure on the walls.*

MM GEO-3: *The Project shall comply with the recommendations of the final soils and geotechnical report. These recommendations shall be implemented in the design of the Project, including but not limited to measures associated with site preparation, fill placement, temporary shoring and permanent dewatering, groundwater seismic design features, excavation stability, foundations, soil stabilization, establishment of deep foundations, concrete slabs and pavements, surface drainage, cement type and corrosion measures, erosion control, shoring and internal bracing, and plan review.*

MM GEO-4: *In locations where soils have a potential to be corrosive to steel and concrete, the soils shall be removed, and buried structures shall be designed for corrosive conditions, and corrosion-protected materials shall be used in infrastructure.*

MM GEO-5: *Prior to construction, the Project shall prepare a Construction Management Plan (CMP) that addresses geologic constraints and outlines strategies to minimize or avoid impacts to geologic hazards during construction. The plan shall address the* *following geological and geotechnical constraints/resources and incorporate standard mitigation measures (shown in parentheses):*

- *Groundwater withdrawal (using dewatering pumps and proper disposal of contaminated groundwater according to legal requirements)*
- *Risk of ground failure from unstable soils (retaining walls and inserting soil stabilizers)*
- *Subsidence (retaining walls and shoring)*
- *Erosion control methods (netting on slopes, bioswales, sediment basins, re-vegetation)*
- *Soils with shrink-swell potential (inserting soil stabilizers)*
- *Soils with corrosive potential (protective coatings and protection for metal, steel or concrete structures, soil treatment, removal of corrosive soils and proper disposal of any corrosive soils)*
- *Impact to topsoils (netting, and dust control)*
- *The recommendations of the CMP would be incorporated into the project plans and specifications.*

MM GEO-6: *The potential to avoid impacts to previously unrecorded paleontological resources shall be avoided by having a qualified Paleontologist or Archaeologist cross-trained in paleontology, meeting the Society of Vertebrate Paleontology Standards retained as the project paleontologist, with a minimum of a bachelor's degree (B.S./B.A.) in geology, or related discipline with an emphasis in paleontology and demonstrated experience and competence in paleontological research, fieldwork, reporting, and curation. A paleontological monitor, under the guidance of the project paleontologist, shall be present as required by the type of earth-moving activities in the Project, specifically in areas south of Ventura Boulevard that have been deemed areas of high sensitivity for paleontological resources. The monitor shall be a trained paleontological monitor with experience and knowledge of sediments, geologic formations, and the identification and treatment of fossil resources.*

MM GEO-7: *A Paleontological Resources Impact Mitigation Program (PRIMP) shall be prepared by a qualified paleontologist. The PRIMP shall include guidelines for developing and implementing mitigation efforts, including minimum requirements, general fieldwork, and laboratory methods, threshold for assessing paleontological resources, threshold for excavation and documentation of significant or unique paleontological resources, reporting requirements, considerations for the curation of recovered paleontological resources into a relevant institution, and process of documents to Metro and peer review entities.*

MM GEO-8: *The project paleontologist or paleontological monitor shall perform a Workers Environmental Awareness Program training session for each worker on the project site to familiarize the worker with the procedures in the event a paleontological resource is discovered. Workers hired after the initial Workers Environmental Awareness Program training conducted at the pre-grade meeting shall be required to* *take additional Workers Environmental Awareness Program training as part of their site orientation.*

MM GEO-9: *To prevent damage to unanticipated paleontological resources, a paleontological monitor shall observe ground-disturbing activities including but not limited to grading, trenching, drilling, etc. Paleontological monitoring shall start at full time for geological units deemed to have "High" paleontological sensitivity. Geological units deemed to have "Low" paleontological sensitivity shall be monitored by spot checks. No monitoring is required for geologic units identified as having "No" paleontological sensitivity. "Unknown" paleontological sensitivity is assigned to the less metamorphosed portions of the Santa Monica Slate, as detailed below.*

- *The monitor shall be empowered to temporarily halt or redirect construction efforts if paleontological resources are discovered. The paleontological monitor shall flag an area 50 feet around the discovery and notify the construction crew immediately. No further disturbance in the flagged area shall occur until the qualified paleontologist has cleared the area. In consultation with the qualified paleontologist, the monitor shall quickly assess the nature and significance of the find. If the specimen is not significant, it shall be quickly removed, and the area cleared. In the event paleontological resources are discovered and deemed by the project paleontologist to be scientifically important, the paleontological resources shall be recovered by excavation (i.e., salvage and bulk sediment sample) or immediate removal if the resource is small enough and can be removed safely in this fashion without damage to the paleontological resource. If the discovery is significant, the qualified paleontologist shall notify Metro immediately. In consultation with Metro, the qualified paleontologist shall develop a plan of mitigation, which will likely include salvage excavation and removal of the find, removal of sediment from around the specimen (in the laboratory), research to identify and categorize the find, curation of the find in a local qualified repository, and preparation of a report summarizing the find.*
- *Generally, geologic units that have endured metamorphic processes (i.e., extreme heat and pressure over long periods of time) do not contain paleontological resources. The Santa Monica Slate, originally a fossiliferous shale, has been subjected to various levels of metamorphism and thus, in areas of "low-grade metamorphism," paleontological resources may be discovered. Due to the rarity of paleontological resources dating to the Mesozoic (between approximately 65.5 to 252 million years ago) of Southern California, any such materials have high importance to the paleontology of the region. When encountered, the project paleontologist shall assess the levels of metamorphism that portion of the Santa Monica Slate has experienced. The Santa Monica Slate shall be monitored part time where the project paleontologist has determined lower levels of metamorphism have taken place and the preservation of paleontological resources is possible. If exposures of the Santa Monica Slate have been subjected to high levels of metamorphism (i.e., phyllite components of Jsmp), paleontological monitoring in that portion of the formation is not necessary.*

- *Recovered paleontological resources shall be prepared, identified to the lowest taxonomic level possible, and curated into a recognized repository (i.e., Natural History Museum of Los Angeles County). Bulk sediment samples, if collected, shall be "screen-washed" to recover the contained paleontological resources, which will then be identified to the lowest taxonomic level possible, and curated (as above). The report and all relevant field notes shall be accessioned along with the paleontological resources.*

6.6.3 Impacts After Mitigation

Adherence to existing regulations and implementation of PM GEO-1 and MM GEO-1 would result in a less than significant impact associated with exposing people or structures to seismic ground shaking, including effects related to seismic-related ground failure during construction activities.

Adherence to existing regulations and implementation of PM GEO-1, would ensure that Alternative 1 has a less than significant impact with the exposure of people or structures to liquefaction during construction activities.

With adherence to existing regulations, Alternative 1 would have a less than significant impact associated with landslides and/or slope instability during construction activities.

Adherence to existing regulations and policies and with implementation of PM GEO-2 and MM GEO-3 through MM GEO-5 would ensure the maximum practicable protection available for users of buildings and infrastructure and associated trenches, slopes, and foundations. Therefore, Alternative 1 would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils.

With implementation of PM GEO-3 and adherence to existing regulations, Alternative 1 would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils.

When grading and trenching activities are employed, observation of MM GEO-6 through MM GEO-9 would reduce the impact to paleontological resources to less than significant.

7 ALTERNATIVE 3

7.1 Alternative Description

Alternative 3 is an aerial monorail alignment that would run along the Interstate 405 (I-405) corridor and would include seven aerial monorail transit (MRT) stations and an underground tunnel alignment between the Getty Center and Wilshire Boulevard with two underground stations. This alternative would provide transfers to five high-frequency fixed guideway transit and commuter rail lines, including the Los Angeles County Metropolitan Transportation Authority's (Metro) E, Metro D, and Metro G Lines, the East San Fernando Valley Light Rail Transit Line, and the Metrolink Ventura County Line. The length of the alignment between the terminus stations would be approximately 16.1 miles, with 12.5 miles of aerial guideway and 3.6 miles of underground configuration.

The seven aerial and two underground MRT stations would be as follows:

1. Metro E Line Expo/Sepulveda Station (aerial)
2. Santa Monica Boulevard Station (aerial)
3. Wilshire Boulevard/Metro D Line Station (underground)
4. UCLA Gateway Plaza Station (underground)
5. Getty Center Station (aerial)
6. Ventura Boulevard/Sepulveda Boulevard Station (aerial)
7. Metro G Line Sepulveda Station (aerial)
8. Sherman Way Station (aerial)
9. Van Nuys Metrolink Station (aerial)

7.1.1 Operating Characteristics

7.1.1.1 Alignment

As shown on Figure 7-1, from its southern terminus at the Metro E Line Expo/Sepulveda Station, the alignment of Alternative 3 would generally follow I-405 to the Los Angeles-San Diego-San Luis Obispo (LOSSAN) rail corridor, except for an underground segment between Wilshire Boulevard and the Getty Center.

The proposed southern terminus station would be located west of the existing Metro E Line Expo/Sepulveda Station, east of I-405 between Pico Boulevard and Exposition Boulevard. Tail tracks would extend just south of the station adjacent to the eastbound Interstate 10 to northbound I-405 connector over Exposition Boulevard. North of the Metro E Line Expo/Sepulveda Station, a storage track would be located off of the main alignment north of Pico Boulevard, between I-405 and Cotner Avenue. The alignment would continue north along the east side of I-405 until just south of Santa Monica Boulevard, where a proposed station would be located between the I-405 northbound travel lanes and Cotner Avenue. The alignment would cross over the northbound and southbound freeway lanes north of Santa Monica Boulevard and travel along the west side of I-405. Once adjacent to the U.S. Department of Veterans Affairs (VA) Hospital site, the alignment would cross back over the I-405 lanes and Sepulveda Boulevard, before entering an underground tunnel south of the Federal Building parking lot.

Figure 7-1. Alternative 3: Alignment

Source: LASRE, 2024; HTA, 2024

The alignment would proceed east underground and turn north under Veteran Avenue toward the proposed Wilshire Boulevard/Metro D Line Station located under the University of California, Los Angeles (UCLA) Lot 36 on the east side of Veteran Avenue north of Wilshire Boulevard. North of this station, the underground alignment would curve northeast parallel to Weyburn Avenue before curving north and traveling underneath Westwood Plaza at Le Conte Avenue. The alignment would follow Westwood Plaza until the underground UCLA Gateway Plaza Station in front of the Luskin Conference

Center. The alignment would then continue north under the UCLA campus until Sunset Boulevard, where the tunnel would curve northwest for approximately 2 miles to rejoin I-405.

The Alternative 3 alignment would transition from an underground configuration to an aerial guideway structure after exiting the tunnel portal located at the northern end of the Leo Baeck Temple parking lot. The alignment would cross over Sepulveda Boulevard and the I-405 lanes to the proposed Getty Center Station on the west side of I-405, just north of the Getty Center tram station. The alignment would return to the median for a short distance before curving back to the west side of I-405 south of the Sepulveda Boulevard undercrossing north of the Getty Center Drive interchange. After crossing over Bel Air Crest Road and Skirball Center Drive, the alignment would again return to the median and run under the Mulholland Drive Bridge, then continue north within the I-405 median to descend into the San Fernando Valley (Valley).

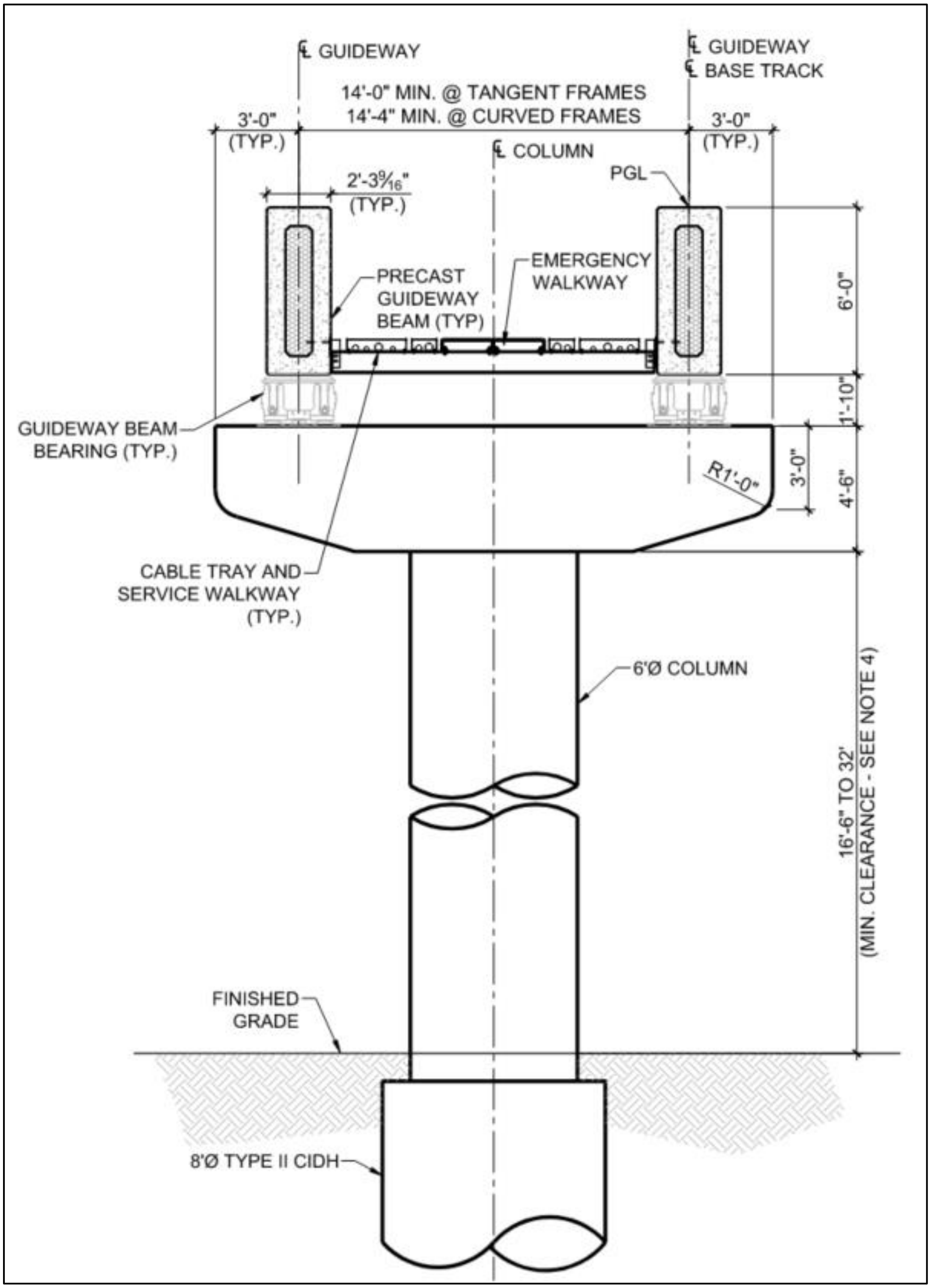
Near Greenleaf Street, the alignment would cross over the northbound freeway lanes and on-ramps toward the proposed Ventura Boulevard Station on the east side of I-405. This station would be located above a transit plaza and replace an existing segment of Dickens Street adjacent to I-405, just south of Ventura Boulevard. Immediately north of the Ventura Boulevard Station, the alignment would cross over the northbound I-405 to U.S. Highway 101 (US-101) connector and continue north between the connector and the I-405 northbound travel lanes. The alignment would continue north along the east side of I-405—crossing over US-101 and the Los Angeles River—to a proposed station on the east side of I-405 near the Metro G Line Busway. A new at-grade station on the Metro G Line would be constructed for Alternative 3 adjacent to the proposed station. These proposed stations are shown on the Metro G Line inset area on Figure 7-1.

The alignment would then continue north along the east side of I-405 to the proposed Sherman Way Station. The station would be located inside the I-405 northbound loop off-ramp to Sherman Way. North of the station, the alignment would continue along the eastern edge of I-405, then curve to the southeast parallel to the LOSSAN rail corridor. The alignment would run elevated along Raymer Street, east of Sepulveda Boulevard, and cross over Van Nuys Boulevard to the proposed terminus station adjacent to the Van Nuys Metrolink/Amtrak Station. Overhead utilities along Raymer Street would be undergrounded where they would conflict with the guideway or its supporting columns. Tail tracks would be located southeast of this terminus station.

7.1.1.2 Guideway Characteristics

Alternative 3 would utilize straddle-beam monorail technology, which allows the monorail vehicle to straddle a guide beam that both supports and guides the vehicle. Alternative 3 would operate on aerial and underground guideways with dual-beam configurations. Northbound and southbound trains would travel on parallel beams either in the same tunnel or supported by a single-column or straddle-bent aerial structure. Figure 7-2 shows a typical cross-section of the aerial monorail guideway.

Figure 7-2. Typical Aerial Monorail Guideway Cross-Section

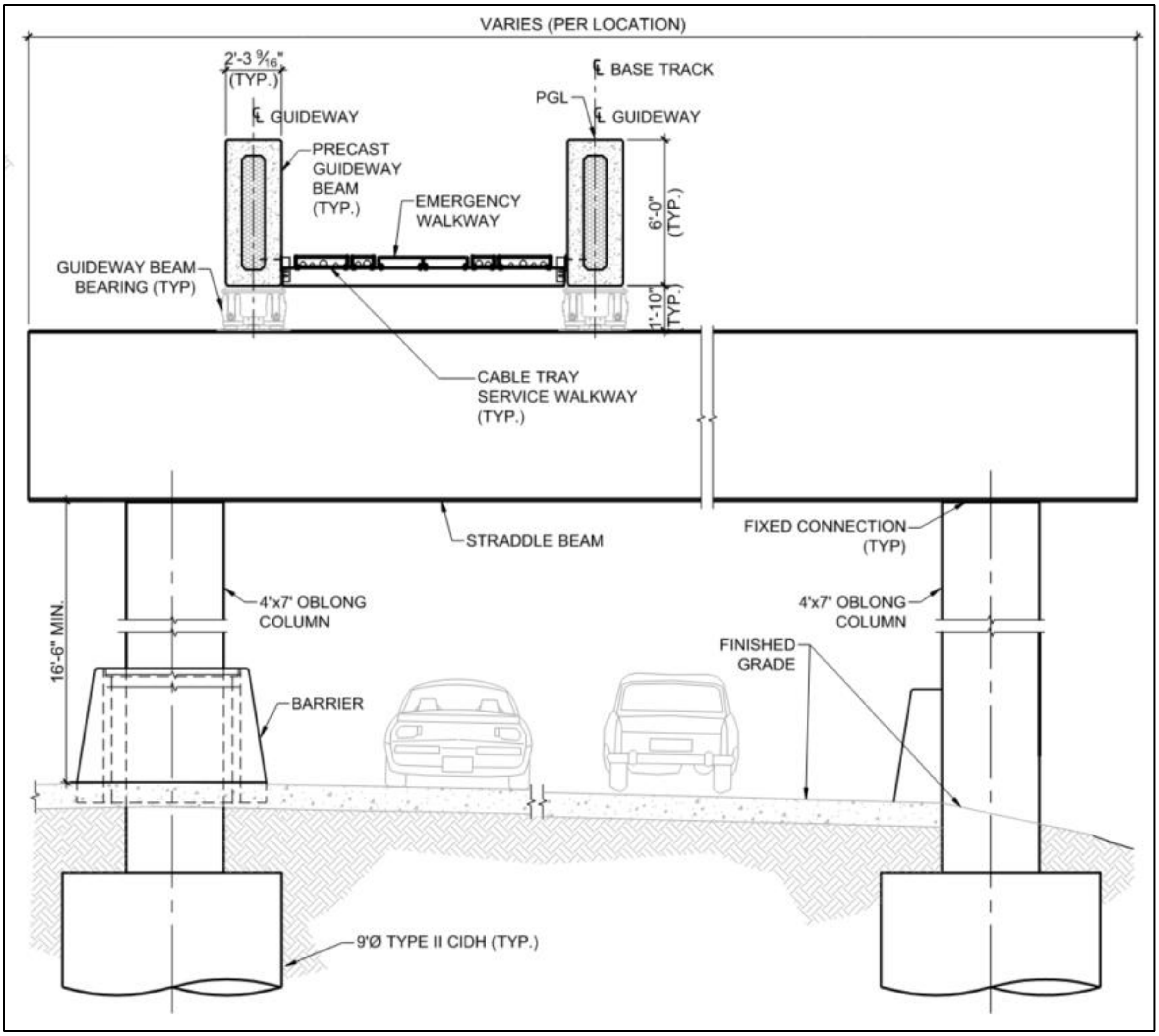


Source: LASRE, 2024

On a typical guideway section (i.e., not at a station), guide beams would rest on 20-foot-wide column caps (i.e., the structure connecting the columns and the guide beams), with typical spans (i.e., the distance between columns) ranging from 70 to 190 feet. The bottom of the column caps would typically be between 16.5 feet and 32 feet above ground level.

Over certain segments of roadway and freeway facilities, a straddle-bent configuration, as shown on Figure 7-3, consisting of two concrete columns constructed outside of the underlying roadway would be used to support the guide beams and column cap. Typical spans for these structures would range between 65 and 70 feet. A minimum 16.5-foot clearance would be maintained between the underlying roadway and the bottom of the column caps.

Figure 7-3. Typical Monorail Straddle-Bent Cross-Section

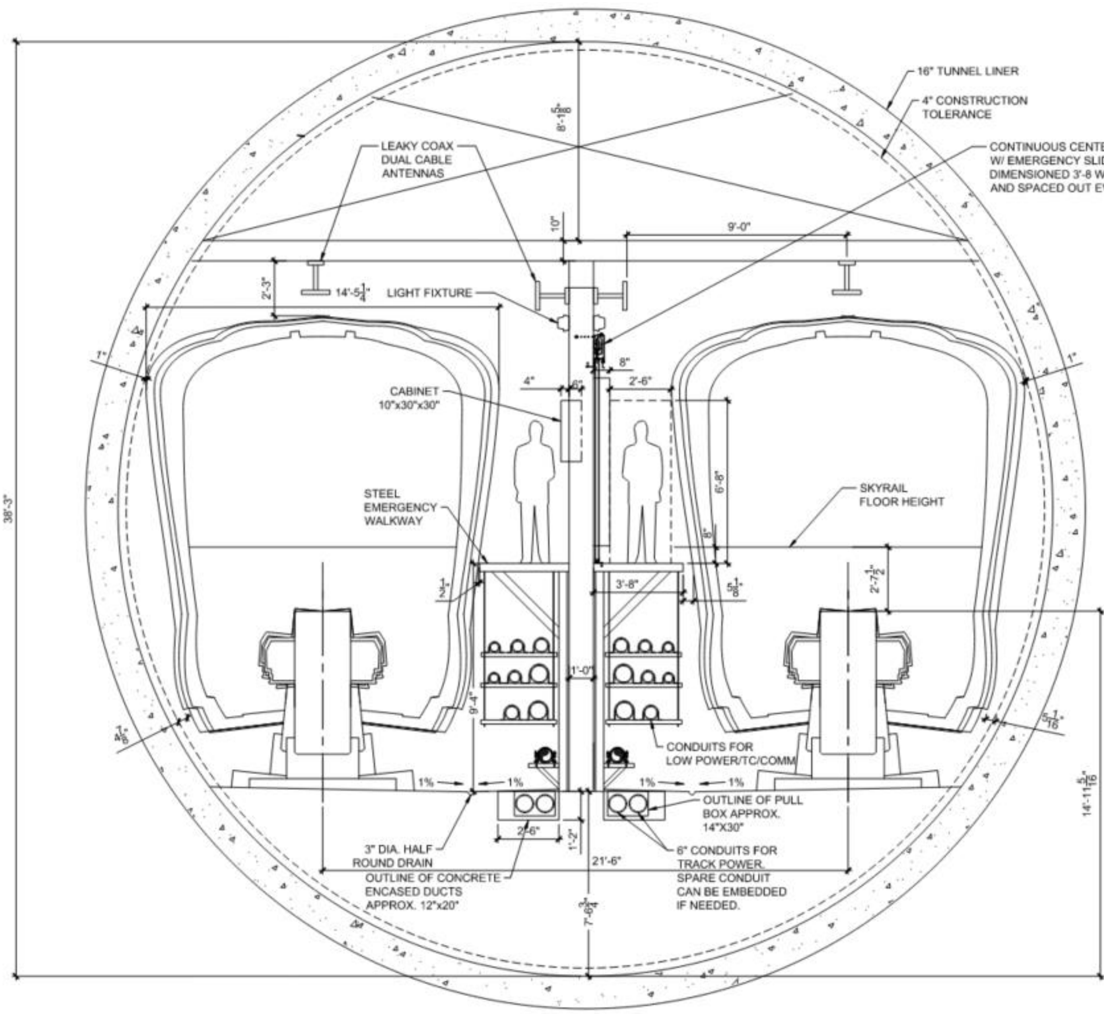


Source: LASRE, 2024

Structural support columns would vary in size and arrangement by alignment location. Columns would be 6 feet in diameter along main alignment segments adjacent to I-405 and be 4 feet wide by 6 feet long in the I-405 median. Straddle-bent columns would be 4 feet wide by 7 feet long. At stations, six rows of dual 5-foot by-8-foot columns would support the aerial guideway. Beam switch locations and long-span structures would also utilize different sized columns, with dual 5-foot columns supporting switch locations and either 9-foot or 10-foot-diameter columns supporting long-span structures. Crash protection barriers would be used to protect the columns. All columns would have a cast-in-drilled-hole (CIDH) pile foundation extending 1 foot in diameter beyond the column width, with varying depths for appropriate geotechnical considerations and structural support.

For underground sections, a single 40-foot-diameter tunnel would be needed to accommodate dual-beam configuration. The tunnel would be divided by a 1-foot-thick center wall dividing two compartments with a 14.5-foot-wide space for trains and a 4-foot-wide emergency evacuation walkway. The center wall would include emergency sliding doors placed every 750 to 800 feet. A plenum within the crown of the tunnel, measuring 8 feet tall from the top of the tunnel, would allow for air circulation and ventilation. Figure 7-4 illustrates these components at a typical cross-section of the underground monorail guideway.

Figure 7-4. Typical Underground Monorail Guideway Cross-Section



Source: LASRE, 2024

7.1.1.3 Vehicle Technology

Alternative 3 would utilize straddle-beam monorail technology, which allows the monorail vehicle to straddle a guide beam that both supports and guides the vehicle. Rubber tires would sit both atop and on each side of the guide beam to provide traction and guide the train. Trains would be automated and powered by power rails mounted to the guide beam, with planned peak-period headways of 166 seconds and off-peak-period headways of 5 minutes. Monorail trains could consist of up to eight cars. Alternative 3 would have a maximum operating speed of 56 miles per hour; actual operating speeds would depend on the design of the guideway and distance between stations.

Monorail train cars would be 10.5 feet wide, with two double doors on each side. End cars would be 46.1 feet long with a design capacity of 97 passengers, and intermediate cars would be 35.8 feet long and have a design capacity of 90 passengers.

7.1.1.4 Stations

Alternative 3 would include seven aerial and two underground MRT stations with platforms approximately 320 feet long. Aerial stations would be elevated 50 feet to 75 feet above the ground level, and underground stations would be 80 feet to 110 feet underneath the existing ground level. The Metro E Line Expo/Sepulveda, Santa Monica Boulevard, Ventura Boulevard/Sepulveda Boulevard, Sherman Way, and Van Nuys Metrolink Stations would be center-platform stations where passengers would travel up to a shared platform that would serve both directions of travel. The Wilshire Boulevard/Metro D Line, UCLA Gateway Plaza, Getty Center, and Metro G Line Sepulveda Stations would be side-platform stations where passengers would select and travel up or down to station platforms, depending on their direction of travel. Each station, regardless of whether it has side or center platforms, would include a concourse level prior to reaching the train platforms. Each station would have a minimum of two elevators, two escalators, and one stairway from ground level to the concourse.

Aerial station platforms would be approximately 320 feet long and would be supported by six rows of dual 5-foot by 8-foot columns. The platforms would be covered, but not enclosed. Side-platform stations would be 61.5 feet wide to accommodate two 13-foot-wide station platforms with a 35.5-foot-wide intermediate gap for side-by-side trains. Center-platform stations would be 49 feet wide, with a 25-foot-wide center platform.

Underground side platforms would be 320 feet long and 26 feet wide, separated by a distance of 31.5 feet for side-by-side trains.

Monorail stations would include automatic, bi-parting fixed doors along the edges of station platforms. These doors would be integrated into the automatic train control system and would not open unless a train is stopped at the platform.

The following information describes each station, with relevant entrance, walkway, and transfer information. Bicycle parking would be provided at each station.

Metro E Line Expo/Sepulveda Station

- This aerial station would be located near the existing Metro E Line Expo/Sepulveda Station, just east of I-405 between Pico Boulevard and Exposition Boulevard.
- A transit plaza and station entrance would be located on the east side of the station.
- An off-street passenger pick-up/drop-off loop would be located south of Pico Boulevard, west of Cotner Avenue.
- An elevated pedestrian walkway would connect the concourse level of the proposed station to the Metro E Line Expo/Sepulveda Station within the fare paid zone.

- Passengers would be able to park at the existing Metro E Line Expo/Sepulveda Station parking facility, which provides 260 parking spaces. No additional automobile parking would be provided at the proposed station.

Santa Monica Boulevard Station

- This aerial station would be located just south of Santa Monica Boulevard, between the I-405 northbound travel lanes and Cotner Avenue.
- Station entrances would be located on the southeast and southwest corners of Santa Monica Boulevard and Cotner Avenue. The entrance on the southeast corner of the intersection would be connected to the station concourse level via an elevated pedestrian walkway spanning Cotner Avenue.
- No dedicated station parking would be provided at this station.

Wilshire Boulevard/Metro D Line Station

- This underground station would be located under UCLA Lot 36 on the east side of Veteran Avenue, north of Wilshire Boulevard.
- A station entrance would be located on the northeast corner of the intersection of Veteran Avenue and Wilshire Boulevard.
- An underground pedestrian walkway would connect the concourse level of the proposed station to the Metro D Line Westwood/UCLA Station using a knock-out panel provided in the Metro D Line Station box. This connection would occur within the fare paid zone.
- No dedicated station parking would be provided at this station.

UCLA Gateway Plaza Station

- This underground station would be located beneath Gateway Plaza.
- Station entrances would be located on the northern end and southeastern end of the plaza.
- No dedicated station parking would be provided at this station.

Getty Center Station

- This aerial station would be located on the west side of I-405 near the Getty Center, approximately 1,000 feet north of the Getty Center tram station.
- An elevated pedestrian walkway would connect the proposed station's concourse level with the Getty Center tram station. The proposed connection would occur outside the fare paid zone.
- An entrance to the walkway above the Getty Center's parking lot would be the proposed station's only entrance.
- No dedicated station parking would be provided at this station.

Ventura Boulevard/Sepulveda Boulevard Station

- This aerial station would be located east of I-405, just south of Ventura Boulevard.
- A transit plaza, including two station entrances, would be located on the east side of the station. The plaza would require the closure of a 0.1-mile segment of Dickens Street between Sepulveda

Boulevard and Ventura Boulevard, with a passenger pick-up/drop-off loop and bus stops provided south of the station, off Sepulveda Boulevard.

- No dedicated station parking would be provided at this station.

Metro G Line Sepulveda Station

- This aerial station would be located near the Metro G Line Sepulveda Station, between I-405 and the Metro G Line Busway.
- Entrances to the MRT station would be located on both sides of the new proposed Metro G Line bus rapid transit (BRT) station.
- An elevated pedestrian walkway would connect the concourse level of the proposed station to the proposed new Metro G Line BRT station outside of the fare paid zone.
- Passengers would be able to park at the existing Metro G Line Sepulveda Station parking facility, which has a capacity of 1,205 parking spaces. Currently, only 260 parking spaces are used for transit parking. No additional automobile parking would be provided at the proposed station.

Sherman Way Station

- This aerial station would be located inside the I-405 northbound loop off-ramp to Sherman Way.
- A station entrance would be located on the north side of Sherman Way, directly across the street from the I-405 northbound off-ramp to Sherman Way East.
- An on-street passenger pick-up/drop-off area would be provided on the north side of Sherman Way, west of Firmament Avenue.
- No dedicated station parking would be provided at this station.

Van Nuys Metrolink Station

- This aerial station would be located on the east side of Van Nuys Boulevard, just south of the LOSSAN rail corridor, incorporating the site of the current Amtrak ticket office.
- A station entrance would be located on the east side of Van Nuys Boulevard just south of the LOSSAN rail corridor. A second entrance would be located to the north of the LOSSAN rail corridor with an elevated pedestrian walkway connecting to both the concourse level of the proposed station and the platform of the Van Nuys Metrolink/Amtrak Station.
- Existing Metrolink Station parking would be reconfigured, maintaining approximately the same number of spaces, but 180 parking spaces would be relocated north of the LOSSAN rail corridor. Metrolink parking would not be available to Metro transit riders.

7.1.1.5 Station-to-Station Travel Times

Table 7-1 presents the station-to-station distance and travel times for Alternative 3. The travel times include both running time and dwelling time. The travel times differ between northbound and southbound trips because of grade differentials and operational considerations at end-of-line stations.

Table 7-1. Alternative 3: Station-to-Station Travel Times and Station Dwell Times

From Station	To Station	Distance (miles)	Northbound Station-to-Station Travel Time (seconds)	Southbound Station-to-Station Travel Time (seconds)	Dwell Time (seconds)
Metro E Line Station					*30*
Metro E Line	Santa Monica Boulevard	0.9	123	97	—
Santa Monica Boulevard Station					*30*
Santa Monica Boulevard	Wilshire/Metro D Line	1.1	192	194	—
Wilshire/Metro D Line Station					*30*
Wilshire/Metro D Line	UCLA Gateway Plaza	0.9	138	133	—
UCLA Gateway Plaza Station					*30*
UCLA Gateway Plaza	Getty Center	2.6	295	284	—
Getty Center Station					*30*
Getty Center	Ventura Boulevard	4.7	414	424	—
Ventura Boulevard Station					*30*
Ventura Boulevard	Metro G Line	2.0	179	187	—
Metro G Line Station					*30*
Metro G Line	Sherman Way	1.5	134	133	—
Sherman Way Station					*30*
Sherman Way	Van Nuys Metrolink	2.4	284	279	—
Van Nuys Metrolink Station					*30*

Source: LASRE, 2024

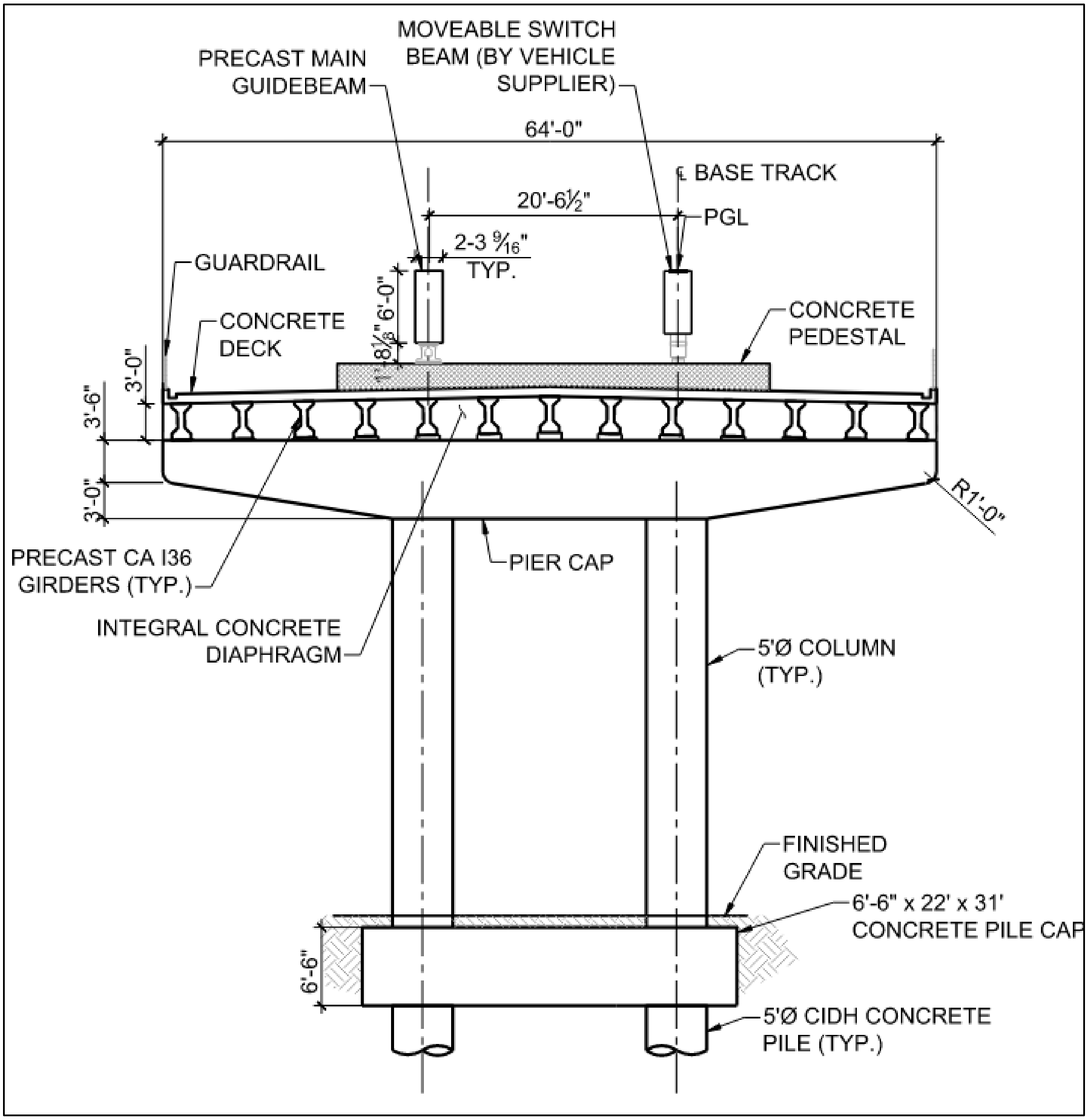
— = no data

7.1.1.6 Special Trackwork

Alternative 3 would include five pairs of beam switches to enable trains to cross over and reverse direction on the opposite beam. All beam switches would be located on aerial portions of the alignment of Alternative 3. From south to north, the first pair of beam switches would be located just north of the Metro E Line Expo/Sepulveda Station. A second pair of beam switches would be located on the west side of I-405, directly adjacent to the VA Hospital site, south of the Wilshire Boulevard/Metro D Line Station. A third pair of beam switches would be located in the Sepulveda Pass just south of Mountaingate Drive and Sepulveda Boulevard. A fourth pair of beam switches would be located south of the Metro G Line Station between the I-405 northbound lanes and the Metro G Line Busway. The final pair would be located near the Van Nuys Metrolink Station.

At beam switch locations, the typical cross-section of the guideway would increase in column and column cap width. The column cap width at these locations would be 64 feet, with dual 5-foot-diameter columns. Underground pile caps for additional structural support would also be required at these locations. Figure 7-5 shows a typical cross-section of the monorail beam switch.

Figure 7-5. Typical Monorail Beam Switch Cross-Section



Source: LASRE, 2024

7.1.1.7 Maintenance and Storage Facility

MSF Base Design

In the maintenance and storage facility (MSF) Base Design for Alternative 3, the MSF would be located on City of Los Angeles Department of Water and Power (LADWP) property east of the Van Nuys Metrolink Station. The MSF Base Design site would be approximately 18 acres and would be designed to accommodate a fleet of 208 monorail vehicles. The site would be bounded by the LOSSAN rail corridor to the north, Saticoy Street to the south, and property lines extending north of Tyrone and Hazeltine Avenues to the east and west, respectively.

Monorail trains would access the site from the main alignment's northern tail tracks at the northwest corner of the site. Trains would travel parallel to the LOSSAN rail corridor before curving southeast to maintenance facilities and storage tracks. The guideway would remain in an aerial configuration within the MSF Base Design, including within maintenance facilities.

The site would include the following facilities:

- Primary entrance with guard shack
- Primary maintenance building that would include administrative offices, an operations control center, and a maintenance shop and office
- Train car wash building
- Emergency generator
- Traction power substation (TPSS)
- Maintenance-of-way (MOW) building
- Parking area for employees

MSF Design Option 1

In the MSF Design Option 1, the MSF would be located on industrial property, abutting Orion Avenue, south of the LOSSAN rail corridor. The MSF Design Option 1 site would be approximately 26 acres and would be designed to accommodate a fleet of 224 monorail vehicles. The site would be bounded by I-405 to the west, Stagg Street to the south, the LOSSAN rail corridor to the north, and Orion Avenue and Raymer Street to the east. The monorail guideway would travel along the northern edge of the site.

Monorail trains would access the site from the monorail guideway east of Sepulveda Boulevard, requiring additional property east of Sepulveda Boulevard and north of Raymer Street. From the northeast corner of the site, trains would travel parallel to the LOSSAN rail corridor before turning south to maintenance facilities and storage tracks parallel to I-405. The guideway would remain in an aerial configuration within the MSF Design Option 1, including within maintenance facilities.

The site would include the following facilities:

- Primary entrance with guard shack
- Primary maintenance building that would include administrative offices, an operations control center, and a maintenance shop and office
- Train car wash building
- Emergency generator
- TPSS
- MOW building
- Parking area for employees

Figure 7-6 shows the locations of the MSF Base Design and MSF Design Option 1 for Alternative 3.

Figure 7-6. Alternative 3: Maintenance and Storage Facility Options

Source: LASRE, 2024; HTA, 2024

7.1.1.8 Traction Power Substations

TPSSs transform and convert high voltage alternating current supplied from power utility feeders into direct current suitable for transit operation. A TPSS on a site of approximately 8,000 square feet would be located approximately every 1 mile along the alignment. Table 7-2 lists the TPSS locations proposed for Alternative 3.

Figure 7-7 shows the TPSS locations along the Alternative 3 alignment.

Table 7-2. Alternative 3: Traction Power Substation Locations

TPSS No.	TPSS Location Description	Configuration
1	TPSS 1 would be located east of I-405, just south of Exposition Boulevard and the monorail guideway tail tracks.	At-grade
2	TPSS 2 would be located east of I-405 and Sepulveda Boulevard, just north of the Getty Center Station.	At-grade
3	TPSS 3 would be located west of I-405, just east of the intersection between Promontory Road and Sepulveda Boulevard.	At-grade
4	TPSS 4 would be located between I-405 and Sepulveda Boulevard, just north of the Skirball Center Drive Overpass.	At-grade
5	TPSS 5 would be located east of I-405, just south of Ventura Boulevard Station, between Sepulveda Boulevard and Dickens Street.	At-grade
6	TPSS 6 would be located east of I-405, just south of the Metro G Line Sepulveda Station.	At-grade
7	TPSS 7 would be located east of I-405, just east of the Sherman Way Station, inside the I-405 Northbound Loop Off-Ramp to Sherman Way westbound.	At-grade
8	TPSS 8 would be located east of I-405, at the southeast quadrant of the I-405 overcrossing with the LOSSAN rail corridor.	At-grade
9	TPSS 9 would be located east of I-405, at the southeast quadrant of the I-405 overcrossing with the LOSSAN rail corridor.	At-grade (within MSF Design Option)
10	TPSS 10 would be located between Van Nuys Boulevard and Raymer Street, south of the LOSSAN rail corridor.	At-grade
11	TPSS 11 would be located south of the LOSSAN rail corridor, between Tyrone Avenue and Hazeltine Avenue.	At-grade (within MSF Base Design)
12	TPSS 12 would be located southwest of Veteran Avenue at Wellworth Avenue.	Underground
13	TPSS 13 would be located within the Wilshire Boulevard/Metro D Line Station.	Underground (adjacent to station)
14	TPSS 14 would be located underneath UCLA Gateway Plaza.	Underground (adjacent to station)

Source: LASRE, 2024; HTA, 2024

Figure 7-7. Alternative 3: Traction Power Substation Locations

Source: LASRE, 2024; HTA, 2024

7.1.1.9 Roadway Configuration Changes

Table 7-3 lists the roadway changes necessary to accommodate the guideway of Alternative 3. Figure 7-8 shows the location of these roadway changes in the Sepulveda Transit Corridor Project (Project) Study Area, except for the I-405 configuration changes, which occur throughout the corridor.

Table 7-3. Alternative 3: Roadway Changes

Location	From	To	Description of Change
Cotner Avenue	Nebraska Avenue	Santa Monica Boulevard	Roadway realignment to accommodate aerial guideway columns
Beloit Avenue	Massachusetts Avenue	Ohio Avenue	Roadway narrowing to accommodate aerial guideway columns
Sepulveda Boulevard	Getty Center Drive	Not Applicable	Southbound right turn lane to Getty Center Drive shortened to accommodate aerial guideway columns
I-405 Northbound On-Ramp and Off-Ramp at Sepulveda Boulevard near I-405 Exit 59	Sepulveda Boulevard near I-405 Northbound Exit 59	Sepulveda Boulevard/I-405 Undercrossing (near Getty Center)	Ramp realignment to accommodate aerial guideway columns and I-405 widening
Sepulveda Boulevard	I-405 Southbound Skirball Center Drive Ramps (north of Mountaingate Drive)	Skirball Center Drive	Roadway realignment into existing hillside to accommodate aerial guideway columns and I-405 widening
I-405 Northbound On-Ramp at Mulholland Drive	Mulholland Drive	Not Applicable	Roadway realignment into the existing hillside between the Mulholland Drive Bridge pier and abutment to accommodate aerial guideway columns and I-405 widening
Dickens Street	Sepulveda Boulevard	Ventura Boulevard	Permanent removal of street for Ventura Boulevard Station construction Pick-up/drop-off area would be provided along Sepulveda Boulevard at the truncated Dickens Street
Sherman Way	Haskell Avenue	Firmament Avenue	Median improvements, passenger drop-off and pick-up areas, and bus pads within existing travel lanes
Raymer Street	Sepulveda Boulevard	Van Nuys Boulevard	Curb extensions and narrowing of roadway width to accommodate aerial guideway columns
I-405	Sepulveda Boulevard Northbound Off-Ramp (Getty Center Drive interchange)	Sepulveda Boulevard Northbound On-Ramp (Getty Center Drive interchange)	I-405 widening to accommodate aerial guideway columns in the median
I-405	Skirball Center Drive	U.S. Highway 101	I-405 widening to accommodate aerial guideway columns in the median

Source: LASRE, 2024; HTA, 2024

Figure 7-8. Alternative 3: Roadway Changes

Source: LASRE, 2024; HTA, 2024

In addition to the changes made to accommodate the guideway, as listed in Table 7-3, roadways and sidewalks near stations would be reconstructed, which would result in modifications to curb ramps and driveways.

7.1.1.10 Ventilation Facilities

For ventilation of the monorail's underground portion, a plenum within the crown of the tunnel would provide a separate compartment for air circulation and allow multiple trains to operate between stations. Vents would be located at the southern portal near the Federal Building parking lot, Wilshire/Metro D Line Station, UCLA Gateway Plaza Station, and at the northern portal near the Leo Baeck Temple parking lot. Emergency ventilation fans would be located at the UCLA Gateway Plaza Station and at the northern and southern tunnel portals.

7.1.1.11 Fire/Life Safety – Emergency Egress

Continuous emergency evacuation walkways would be provided along the guideway. Walkways along the alignment's aerial portions would typically consist of structural steel frames anchored to the guideway beams to support non-slip walkway panels. The walkways would be located between the two guideway beams for most of the aerial alignment; however, where the beams split apart, such as entering center-platform stations, short portions of the walkway would be located on the outside of the beams. For the underground portion of Alternative 3, 3.5-foot-wide emergency evacuation walkways would be located on both sides of the beams. Access to tunnel segments for first responders would be through stations.

7.1.2 Construction Activities

Construction activities for Alternative 3 would include constructing the aerial guideway and stations, underground tunnel and stations, and ancillary facilities, and widening I-405. Construction of the transit facilities through substantial completion is expected to have a duration of 8 ½ years. Early works, such as site preparation, demolition, and utility relocation, could start in advance of construction of the transit facilities.

Aerial guideway construction would begin at the southern and northern ends of the alignment and connect in the middle. Constructing the guideway would require a combination of freeway and local street lane closures throughout the working limits to provide sufficient work area. The first stage of I-405 widening would include a narrowing of adjacent freeway lanes to a minimum width of 11 feet (which would eliminate shoulders) and placing K-rail on the outside edge of the travel lanes to create outside work areas. Within these outside work zones, retaining walls, drainage, and outer pavement widenings would be constructed to allow for I-405 widening. The reconstruction of on- and off-ramps would be the final stage of I-405 widening.

A median work zone along I-405 for the length of the alignment would be required for erection of the guideway structure. In the median work zone, demolition of existing median and drainage infrastructure would be followed by the installation of new K-rails and installation of guideway structural components, which would include full directional freeway closures when guideway beams must be transported into the median work areas during late-night hours. Additional night and weekend directional closures would be required for installation of long-span structures over I-405 travel lanes where the guideway would transition from the median.

Aerial station construction is anticipated to last the duration of construction activities for Alternative 3 and would include the following general sequence of construction:

- Site clearing
- Utility relocation
- Construction fencing and rough grading
- CIDH pile drilling and installation
- Elevator pit excavation
- Soil and material removal

- Pile cap and pier column construction
- Concourse level and platform level falsework and cast-in-place structural concrete
- Guideway beam installation
- Elevator and escalator installation
- Completion of remaining concrete elements such as pedestrian bridges
- Architectural finishes and mechanical, electrical, and plumbing installation

Underground stations, including the Wilshire Boulevard/Metro D Line Station and the UCLA Gateway Plaza Station, would use a "cut-and-cover" construction method whereby the station structure would be constructed within a trench excavated from the surface that is covered by a temporary deck and backfilled during the later stages of station construction. Traffic and pedestrian detours would be necessary during underground station excavation until decking is in place and the appropriate safety measures are taken to resume cross traffic.

A tunnel boring machine (TBM) would be used to construct the underground segment of the guideway. The TBM would be launched from a staging area on Veteran Avenue south of Wilshire Boulevard, and head north toward an exit portal location north of Leo Baeck Temple. The southern portion of the tunnel between Wilshire Boulevard and the Bel Air Country Club would be at a depth between 80 to 110 feet from the surface to the top of the tunnel. The UCLA Gateway Plaza Station would be constructed using cut-and-cover methods. Through the Santa Monica Mountains, the tunnel would range between 30 to 300 feet deep.

Alternative 3 would require construction of a concrete casting facility for columns and beams associated with the elevated guideway. A specific site has not been identified; however, it is expected that the facility would be located on industrially zoned land adjacent to a truck route in either the Antelope Valley or Riverside County. When a site is identified, the contractor would obtain all permits and approvals necessary from the relevant jurisdiction, the appropriate air quality management entity, and other regulatory entities.

TPSS construction would require additional lane closures. Large equipment, including transformers, rectifiers, and switchgears would be delivered and installed through prefabricated modules where possible in at-grade TPSSs. The installation of transformers would require temporary lane closures on Exposition Boulevard, Beloit Avenue, and the I-405 northbound on-ramp at Burbank Boulevard.

Table 7-4 and Figure 7-9 show the potential construction staging areas for Alternative 3. Staging areas would provide the necessary space for the following activities:

- Contractors' equipment
- Receiving deliveries
- Storing materials
- Site offices
- Work zone for excavation
- Other construction activities (including parking and change facilities for workers, location of construction office trailers, storage, staging and delivery of construction materials and permanent plant equipment, and maintenance of construction equipment)

Table 7-4. Alternative 3: Construction Staging Locations

No.	Location Description
1	Public Storage between Pico Boulevard and Exposition Boulevard, east of I-405
2	South of Dowlen Drive and east of Greater LA Fisher House
3	Federal Building Parking Lot
4	Kinross Recreation Center and UCLA Lot 36
5	North end of the Leo Baeck Temple Parking Lot (tunnel boring machine retrieval)
6	At 1400 N Sepulveda Boulevard
7	At 1760 N Sepulveda Boulevard
8	East of I-405 and north of Mulholland Drive Bridge
9	Inside of I-405 Northbound to US-101 Northbound Loop Connector, south of US-101
10	ElectroRent Building, south of G Line Busway, east of I-405
11	Inside the I-405 Northbound Loop Off-Ramp at Victory Boulevard
12	Along Cabrito Road, east of Van Nuys Boulevard

Source: LASRE, 2024; HTA, 2024

Figure 7-9. Alternative 3: Construction Staging Locations

Source: LASRE, 2024; HTA, 2024

7.2 Existing Conditions

7.2.1 Regional Geology

Alternative 3 would pass through the northwestern portion of the Los Angeles Basin, through the Santa Monica Mountains, and then continue into the south and central portions of the San Fernando Valley, with a tunnel connection to UCLA Gateway Plaza. The northern portion of Alternative 3 would traverse the San Fernando Valley and would continue south through the Santa Monica Mountains into the Los Angeles Basin.

Alternative 3 would be within two geologic provinces (City of Los Angeles, 2018):

- The northern portion of Alternative 3 would be located within the Transverse Ranges geomorphic provinces.
- The southern portion of Alternative 3 would be located within the Los Angeles Basin, which is the northern-most basin of the Peninsular Ranges geomorphic provinces.

7.2.1.1 Transverse Ranges Geomorphic Province

The Transverse Ranges geomorphic province is composed of several mountain ranges oriented in an east–west direction and extends over 320 miles from the Mojave and Colorado Desert Provinces to Point Arguello at the Pacific Ocean. Included within the Transverse Ranges are portions of Riverside, San Bernardino, Los Angeles, and Ventura Counties. Acting as a northern boundary, the Transverse Ranges truncate the northwest-trending structural grain of the Peninsular Ranges geomorphic province. Most active faults in the Transverse Ranges are east–west-trending faults. Rock types in this province include gneiss, granitic rocks, and sedimentary rocks. Volcanic rocks are found in the Santa Monica Mountains. Alluvial sediments are typically in canyon bottoms and valleys, with broad alluvial fans at the mouths of steep canyons (City of Los Angeles, 2018).

7.2.1.2 Peninsular Ranges Geomorphic Province

The Peninsular Ranges geomorphic province, composed of multiple mountain ranges and valleys, extends southward 775 miles past the United States-Mexico border. The Peninsular Ranges geomorphic province extends southward from the southern edge of the Transverse Ranges geomorphic province to the tip of Baja California in Mexico. The Peninsular Ranges are characterized by northwest–southeast-trending hills and valleys that are separated by similarly trending faults. Most active faults in the Peninsular Ranges province are northwest trending. Rock types in this province in the Los Angeles region generally include schist and sedimentary rocks. Surface materials in canyon bottoms and basins generally consist of alluvium (City of Los Angeles, 2018).

7.2.1.3 San Fernando Valley

The San Fernando Valley is a triangular east–west-trending structural depression located within the Transverse Ranges geomorphic province. The Transverse Ranges province trends east–west from the offshore Channel Islands (Santa Rosa, Santa Cruz, Anacapa, etc.) to the eastern Mojave Desert. The province is characterized by east–west trending mountain ranges (such as the Santa Monica Mountains, San Gabriel Mountains, and San Bernardino Mountains) separated by similar trending intermontane valleys. The San Fernando Valley is bordered on the east by the Verdugo Mountains, on the north by the San Gabriel and Santa Susana Mountains, on the west by the Simi Hills, and on the south by the Santa Monica Mountains. The mountains that bound the San Fernando Valley are actively deforming anticlinal ranges bounded by thrust faults. Because the ranges have risen and deformed, the valley has subsided and accumulated sediment to create the elongated basin (Metro, 2023a).

7.2.1.4 Santa Monica Mountains

The Santa Monica Mountains are an east–west-trending linear mountain range within the western Transverse Ranges geomorphic province. Major east-trending folds, reverse faults, and left-lateral, strike-slip faults reflect regional north–south compression and are characteristic of the Transverse Ranges. The Santa Monica Mountains are being actively uplifted along a series of segmented frontal reverse faults (Malibu Coast fault, Santa Monica fault, and Raymond fault) on the south side of the range that extend from Arroyo Sequit in the west to Glendale in the east. This fault system is aligned with the Santa Cruz Island fault. The Los Angeles Basin on the southern side of the range is one of a series of basins forming a transition zone between the Transverse Ranges and the northwest–southeast-trending Peninsular Ranges geomorphic province to the south (Metro, 2023a).

7.2.1.5 Los Angeles Basin

The Los Angeles Basin is a large low-lying coastal plain bordered by the Santa Monica Mountains on the north, the Repetto and Puente Hills on the northeast, the Santa Ana Mountains on the east, and the San Joaquin Hills on the south. The western margin of the basin is open to the Pacific Ocean except for one prominent hill: the Palos Verdes Peninsula. The floor of the Los Angeles Basin is a relatively flat surface that rises gently from sea level along the coastline to an apron of uplifted terrain along the base of the surrounding mountains, which rise abruptly to a few thousand feet above the plain. The flat basin floor is interrupted in a few localities by small hills, the most prominent of which are a northwest–southeast-trending alignment of hills and mesas that extend from the Newport Beach area on the south to the Beverly Hills area on the north (Metro, 2023a).

7.2.2 Project Site Soil Types and Characteristics

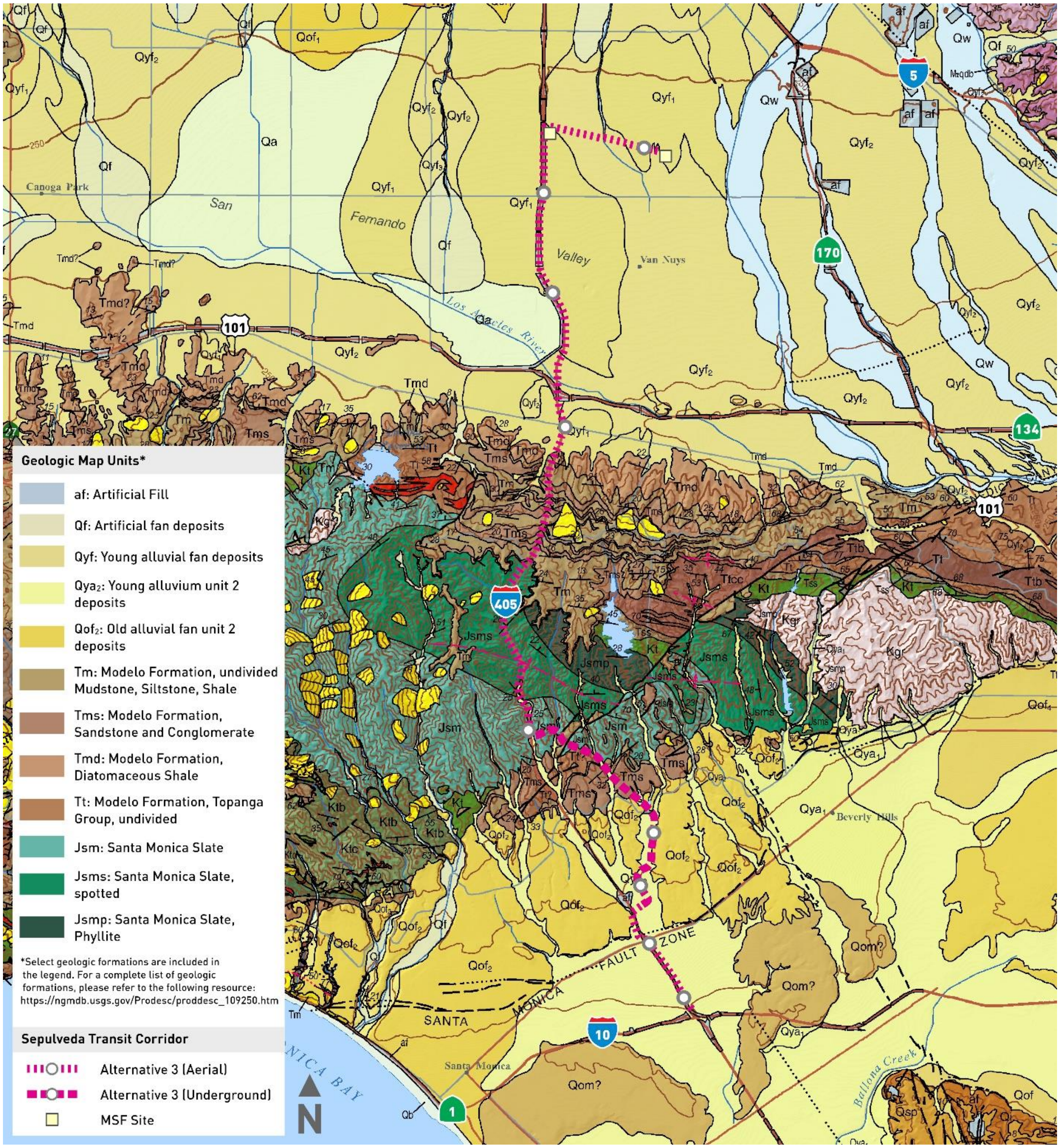
Figure 7-10 shows the geologic features of Alternative 3. Alternative 3 would be generally underlain by nearly horizontal Quaternary sediments overlying Tertiary-age sediments and sedimentary rocks. All the geologic units within Alternative 3 have been deformed into folds and offset by faults. The sedimentary strata lap onto the Santa Monica slate that forms the core of the Santa Monica Mountains; bedrock units on the south flank generally dip southerly and bedrock units on the north flank generally dip northerly. Along the higher elevations within Alternative 3, particularly through the Santa Monica Mountains, sedimentary and metamorphic bedrock are exposed at the surface with some localized colluvial and alluvial soils within tributary valleys (Metro, 2023a).

Alluvial deposits are found in the valley/basin portions of Alternative 3, including the areas north and south of the Santa Monica Mountains. The Valley to the north is underlain by up to 2,000 feet of alluvial sediment, with Cretaceous-aged crystalline bedrock below the alluvium (Metro, 2023a).

The southern portion of Alternative 3 would extend into the Los Angeles Basin. This area of Alternative 3 would be directly underlain by unconsolidated, Quaternary-age, sandy sediments. The soils generally could be subdivided into loose unconsolidated Holocene-age sediments, which cover the bulk of the basin, and late-Pleistocene materials, which comprise the surface over much of the uplifts of the Newport Inglewood Structural Zone and the marginal plains. Hard rocks occur only in the mountains surrounding the basins and at depths ranging from about 5,000 feet to as much as 30,000 feet in the deepest part of the central basin.

The lithologic units exposed along the entire Alternative 3 includes artificial fill, landslide debris, young and old alluvium, and bedrock most commonly associated with the Modelo Formation and Santa Monica Slate. Much of I-405 and associated improvements are underlain by artificial fill associated with the construction of I-405. Young and old alluvial fan and stream deposits are found predominantly along the northern and southern sides of the Santa Monica Mountains. These surficial units are generally composed of unconsolidated to poorly to moderately consolidated sediments of Holocene to Pleistocene ages and are found either at the surface or buried under the fill associated with I-405 (Metro, 2023a).

Figure 7-10. Alternative 3: Geologic Units



Source: USGS 2016; HTA, 2024

7.2.2.1 Artificial Fill

Artificial fill (af) is comprised of silty sand, a mixture of moist, brown and gray, silty sand of fine-grained to coarse-grained composure. Some clay or gray pockets may be observed. The most commonly observed lithology for the No Project Alternative is along the alignment typically at the ground surface. (Metro, 2023a).

7.2.2.2 Modelo Formation

The Modelo Formation (Tm, Tms, Tmd) is a late Miocene-age sedimentary bedrock that generally consists of gray to brown, thinly bedded mudstone, shale and siltstone, with interbeds of very fine-grained to coarse-grained sandstone. The most commonly observed lithology for Alternative 3 is near I-405, with thinly bedded shale to shaley siltstone with interbeds of fine sandstone. Additionally, localized diatomaceous shale and siltstone with interbeds of bentonite and fine sandstone are within the formation (Metro, 2023a).

7.2.2.3 Old Alluvial Fan Deposits

Older (Late to middle Pleistocene) alluvial fan deposits (Qof), which form the Santa Monica Plain, are mapped along the southern edge of the Santa Monica Mountains. They continue in the subsurface in the Los Angeles Basin. These sediments were deposited by stream channels that had flowed southward from the Santa Monica Mountains during the late Pleistocene. They consist of a thick series of alluvial fans that spread out southward from the mountain front toward the ocean. These deposits are described by Campbell et al. (2016) as moderately consolidated, silt, sand, and gravel deposits on alluvial fans.

7.2.2.4 Santa Susana Formation

The Paleocene Santa Susana Formation (Tss), which underlies the Topanga Formation, is exposed in the slopes bordering the west side of the Stone Canyon Reservoir (SCR). Campbell et al. (2016) described the formation as consisting predominantly of fine- to medium-grained sandstone, with some interbeds of gray clay shale, mudstone and siltstone, and some lenses of pebble-cobble conglomerate. Shale beds commonly contain indurated limestone concretions.

7.2.2.5 Santa Monica Slate

The Santa Monica Slate (Jsm, Jsms, Jsmp) is a Jurassic-age metamorphic rock that generally consists of black slate and, to a lesser degree, meta-siltstone and fine-grained meta-graywacke. The rock is generally sheared and intensely jointed due to the localized folding and faulting within the Santa Monica Mountains. The Santa Monica Slate is exposed throughout the southern side of the Santa Monica Mountains, with exposures generally highly fractured with small surficial slides within the fractured rock (Metro, 2023a).

7.2.2.6 Topanga Formation

In the Project Study Area, the middle Miocene Topanga Formation (Tt and Tb) unconformably underlies the Modelo Formation. The Topanga Formation is exposed in slopes that are adjacent to the east side of SCR and Upper Stone Canyon Reservoir (USCR). Campbell et al. (2016) described the Topanga Formation as a heterogenous sequence of sedimentary and volcanic rocks containing marine facies. Campbell et al., (2016) subdivided the Topanga Formation into undifferentiated sedimentary rocks (Regional Geologic Map Symbol: Tt) or volcanic rocks (Regional Geologic Map symbol: Tb). Sedimentary rock lithologies include interbedded gray, micaceous claystone, clay shale, and siltstone; semi-friable to well cemented arkosic sandstone; and locally includes gravely sandstone and lenses of pebble to cobble conglomerate. In general, the lower portion of the Topanga Formation (toward the south) commonly contains the coarser-grained lithologies (sandstones and conglomerates), and the upper portion contains fine-grained sandstone, siltstone, and shales. Volcanic rocks within the Topanga Formation (Tb) include extrusive flows, intrusive sills, tuffs, and volcanic breccias.

7.2.2.7 Tuna Canyon Formation

The Cretaceous Tuna Canyon Formation (Kt), which underlies the Santa Susana Formation, is exposed in the slopes bordering SCR. Campbell et al. (2014) described the formation as consisting of marine sandstone, siltstone, and conglomerate. The sandstones range from thinly to very thickly bedded and locally contain abundant fragments of black slate. LADWP (1998) reported that the formation, as exposed in roadcuts along the west side of SCR, includes very thick to massive conglomerate beds that contain weak to extremely strong cobble to boulder-sized granitic, metavolcanic, and quarzitic clasts up to 18 inches in diameter.

7.2.2.8 Younger Alluvial Fan Deposits

The younger alluvial units (QyF and Qya) along both the northern and southern side of the Santa Monica Mountains consist of sand, silt, silty clay, silty sand, and clayey sand with some interbedded units of gravel to cobble-size clasts. The gravel units are composed of slate and are scattered through the alluvium along the southern side of the mountains; while along the northern side, the gravel transitions to sandstone and is less frequent and abundant. The younger alluvium generally varies in thickness from a few feet to over 50 feet or more in some areas along Alternative 3 (Metro, 2023a).

7.2.3 Seismicity

The entire Southern California region is seismically active. A network of major regional faults and minor local faults crisscrosses the region. The faulting and seismicity are dominated by the San Andreas fault system, which separates two of the major tectonic plates that comprise the earth's crust. The Pacific Plate lies west of the San Andreas fault system. This plate is moving in a northwesterly direction relative to the North American Plate, which lies east of the San Andreas fault system. This relative movement between the two plates is the driving force of fault ruptures in western California. The San Andreas fault generally trends northwest–southeast; however, north of the Transverse Ranges province, the fault trends more in an east–west direction, causing a north–south compression between the two plates. North–south compression in Southern California has been estimated from 5 millimeters per year (mm/year) to 20 mm/year. This compression has produced rapid uplift of many of the mountain ranges in Southern California (Metro, 2023a).

In addition to the San Andreas fault, numerous faults in Southern California are categorized as active, potentially active, and inactive. A fault is classified as active if it has either moved during the Holocene epoch (from about 11,700 years to the present) or is included in an Alquist-Priolo Earthquake Fault Zone (as established by California Geological Survey [CGS]). A fault is classified as potentially active if it has experienced movement within the Quaternary period (during the last 1.6 million years). Faults that have not moved in the last 1.8 million years generally are considered inactive. Surface displacement can be recognized by the existence of cliffs in alluvium, terraces, offset stream courses, fault troughs and saddles, the alignment of depressions, sag ponds, and the existence of steep mountain fronts.

Generally defined, an earthquake is an abrupt release of accumulated energy in the form of seismic waves that are created when movement occurs along a fault plane. The severity of an earthquake is generally expressed in two ways: magnitude and intensity. The energy released, measured on the Moment Magnitude (M_w) scale, represents the "size" of an earthquake. The Richter Magnitude (M) scale has been replaced in most modern building codes by the M_W scale because the M_W scale provides more useful information to design engineers. The Alternative 3 site is subject to earthquakes of M_W 6.0 to M_W 8.0 by the surrounding faults (CGS, 2023; USGS, 2017a, 2017b, 2017c, 2017d, 2023; SCEDC, 2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2023g, 2023h, 2023i, 2023j, 2023k, 2023l, 2023m, 2023n, 2023o, 2023p, 2023q, 2023r; and Shaw et al., 2022).

The intensity of an earthquake is measured by the Modified Mercalli Intensity (MMI) scale, which emphasizes the current seismic environment at a particular site and measures ground shaking severity according to damage done to structures, changes in the earth surface, and personal accounts. Table 7-5 identifies the level of intensity according to the MMI scale and describes that intensity with respect to how it would be received or sensed by its receptors.

Table 7-5. Alternative 3: Modified Mercalli Intensity Scale

Intensity	Shaking	Description/Damage
I	Not Felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration is similar to the passing of a truck. Duration is estimated.
IV	Light	Felt indoors by many and outdoors by few during the day. At night, some are awakened. Dishes, windows, doors are disturbed; walls make cracking sound. Sensation is like a heavy truck striking a building. Standing motor cars are rocked noticeably.
V	Moderate	Felt by nearly everyone; many are awakened. Some dishes and windows are broken. Unstable objects are overturned. Pendulum clocks may stop.
VI	Strong	Felt by all; many are frightened. Some heavy furniture is moved; there are a few instances of fallen plaster. Damage is slight.
VII	Very Strong	Damage is negligible in buildings of good design and construction, slight to moderate in well-built ordinary structures, and considerable in poorly built structures; some chimneys are broken.
VIII	Severe	Damage is slight in specially designed structures, considerable in ordinary substantial buildings with partial collapse, and great in poorly built structures. Chimneys, factory stacks, columns, monuments, and walls fall. Heavy furniture is overturned.
IX	Violent	Damage is considerable in specially designed structures; well-designed frame structures are thrown out of plum. Damage is great in substantial buildings, with partial collapse. Buildings are shifted off foundations.
X	Extreme	Some well-built wooden structures are destroyed; most masonry and frame structures are destroyed with foundations. Rails are bent.

Source: USGS, 2022

Ground motions also are reported in terms of a percentage of the acceleration of gravity (percent g, where g equals 32 feet per second). One hundred percent of gravity (1g) is the acceleration a skydiver would experience during free-fall. An acceleration of 0.4g is equivalent to accelerating from 0 to 60 miles per hour in about 7 seconds.

Over the past 54 years, Southern California has experienced three significant earthquakes: the 1971 San Fernando earthquake (also known as the Sylmar earthquake, on the Sierra Madre Fault), which registered as M_W 6.6; the 1987 Whittier Narrows earthquake, which registered as M_W 5.9; and the Northridge earthquake, which occurred in January 1994 and registered as M_W 6.7.

7.2.4 Regional and Local Faults

Major regional and local faults are identified in Table 7-6 and are shown on **Error! Reference source not found.**Figure 7-11 and Figure 7-12.

Table 7-6. Alternative 3: Major Regional and Local Faults

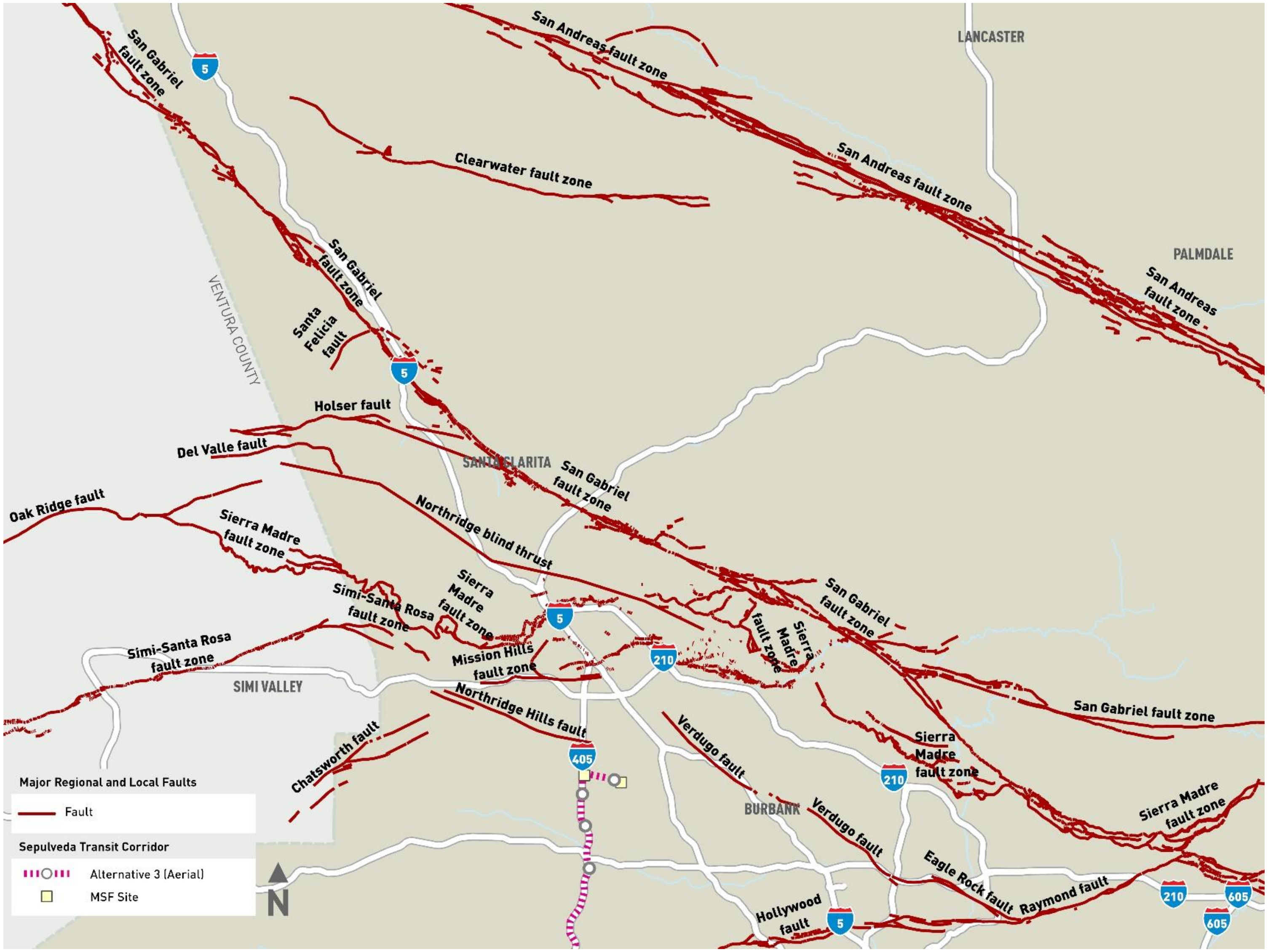
Fault Name	Approximate Closest Distance from Alternative 3 to the Fault (miles)	Compass Direction	Alquist-Priolo Earthquake Fault Zone	Maximum Moment Magnitude (M_w)
Santa Monica Fault	Crosses Alternative 3 north of Massachusetts Avenue and I-405	North	Yes	7.0
Overland Avenue Fault	0.8	Southeast	No	6.6
Northridge Hills Fault	1.3	North	No	—
Hollywood Fault	1.8	Northeast	Yes	6.5
Newport-Inglewood-Rose Canyon Fault	1.8	East	Yes	7.2
Charnock Fault	3.2	Southeast	No	6.5
Mission Hills Fault	4.2	North	No	—
Sierra Madre Fault	4.7	North	Yes	7.0
Verdugo Fault	6.9	East	No	6.8
Chatsworth Fault	7.3	Northwest	No	6.8
Puente Hills Blind Thrust System	7.3	Southeast	No	—
Northridge Blind Thrust Fault	8.3	North	No	7.5
Simi-Santa Rosa Fault	8.5	Northwest	Yes	6.9
San Gabriel Fault	10.4	Northeast	Yes	6.7
Malibu Coast Fault	10.7	Southwest	Yes	7.0
Raymond Fault	13.2	Northeast	Yes	6.7
Eagle Rock Fault	13.4	Southeast	No	7.0
Hosler Fault	14.2	Northwest	No	—
Palos Verdes Fault	15.2	South	No	6.5
Del Valle Fault	17.3	Northwest	No	7.1
Oak Ridge Fault	19.5	Northwest	No	7.5
Santa Felicia Fault	21.5	Northwest	No	—
Clearwater Fault	26.0	North	No	—
San Andreas Fault	29.5	Northeast	Yes	8.0

Source: CGS, 2023; USGS, 2017a, 2017b, 2017c, 2017d, 2023; SCEDC, 2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2023g, 2023h, 2023i, 2023j, 2023k, 2023l, 2023m, 2023n, 2023o, 2023p, 2023q, 2023r; and Shaw et al., 2022.

Figure 7-11. Alternative 3: Major Regional and Local Faults – South

Source: CGS, 2023; HTA, 2024

Figure 7-12. Alternative 3: Major Regional and Local Faults – North



Source: CGS, 2023; HTA, 2024

7.2.4.1 Charnock Fault

The Charlock fault is located approximately 3.2 miles southeast from the southern portion of Alternative 3. Charnock fault extends southeast from near Venice Boulevard to the City of Gardena and runs parallel to the axis of the Gardena syncline for most of its length. The northeastern side of the fault is downthrown relative to the southwestern side (CDWRSD, 1961). Faulted rocks of late Quaternary age (between present day and 700,000 years ago) is present along this fault (USGS, 1981). The Charnock fault runs underneath the Los Angeles International Airport (LAX) runway.

7.2.4.2 Chatsworth Fault

The Chatsworth fault is located approximately 7.3 miles northwest from the northern portion of Alternative 3. The Chatsworth fault is 12.4 miles long and is classified as a late Quaternary (between present day and 700,000 years ago). The Chatsworth fault has a probable magnitude of M_w 6.0 to M_w 6.8. The Chatsworth fault is a reverse fault, where the displacement is predominantly vertical. This fault is north-dipping, and the slip rate is currently unknown (SCEDC, 2023a).

7.2.4.3 Clearwater Fault Zone

The Clearwater fault is located approximately 26 miles north from the northern portion of Alternative 3. The Clearwater fault is 20 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Clearwater fault varies from north-dipping to vertical (SCEDC, 2023b).

7.2.4.4 Del Valle Fault

The Del Valle fault is located approximately 17.3 miles northwest from the northern portion of Alternative 3. The Del Valle fault is classified as late Quaternary (between present day and 700,000 years ago). The Del Valle fault is a south-dipping reverse fault, and it contains the prominent tectonic geomorphic features (Yeats et al., 1985).

7.2.4.5 Eagle Rock Fault

The Eagle Rock fault is located approximately 13.4 miles southeast from the mid-section of Alternative 3. The Eagle Rock fault is 6.8 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Eagle Rock fault is a thrust fault, which is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much, if not all, of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an obvious sign of compressional tectonics (SCEDC, 2023c, 2023s). The slip rate for Eagle Rock fault is probably less than 0.1 mm/year. The possibility of simultaneous rupture with the Verdugo fault is uncertain. The Eagle Rock fault dips to the northeast (SCEDC, 2023c).

7.2.4.6 Hollywood Fault

The Hollywood fault is located approximately 1.8 miles northeast from the mid-section of Alternative 3. The Hollywood fault is 9.3 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023d, 2023s). The Hollywood fault is a left-reverse fault and has a probable magnitude between M_w 5.8 and M_w 6.5. There is a potential for the probable magnitude to be larger if rupture is simultaneous with an adjacent fault. The slip rate for the Hollywood fault is between 0.33 and 0.75 mm/year. The Hollywood fault could be considered a westward extension of the Raymond fault and is roughly parallel to the Santa Monica fault (SCEDC, 2023d). The Hollywood fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act.

7.2.4.7 Holser Fault

The Holser fault is located approximately 14.2 miles northwest from the northern portion of Alternative 3. The Holser fault is 12.4 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Holser fault is a reverse fault with a slip rate of 0.4 mm/year; the displacement is predominantly vertical, and the dip is to the south (SCEDC, 2023e).

7.2.4.8 Malibu Coast Fault

The Malibu Coast fault is located approximately 10.7 miles southwest from the mid-section of Alternative 3. The Malibu Coast fault is 21.1 miles long with several parallel strands. The Malibu Coast fault is classified as Holocene (from about 10,000 years ago to the present) in part; otherwise, the fault is classified as late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023f, 2023s). The Malibu Coast fault is a reverse fault with a slip rate of 0.3 mm/year. The Malibu Coast fault is a north-dipping fault. The slip rate may be higher at its eastern end, where it meets the Santa Monica fault and develops left-reverse motion (SCEDC, 2023f). The Malibu Coast fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

7.2.4.9 Mission Hills Fault

The Mission Hills fault is located approximately 4.2 miles north from the northern portion of Alternative 3. The Mission Hills fault is 6.2 miles long. The Mission Hills fault is classified as late Quaternary (between present day and 700,000 years ago) and possibly Holocene (from about 10,000 years ago to the present) (SCEDC, 2023g, 2023s). The Mission Hills fault is a reverse fault, where the displacement is predominantly vertical. The Mission Hills fault has a slip rate of 0.5 mm/year (SCEDC, 2023g).

7.2.4.10 Newport-Inglewood-Rose Canyon Fault

The Newport-Inglewood-Rose Canyon fault is located approximately 1.2 miles east from the southern portion of Alternative 3. The Newport-Inglewood-Rose Canyon fault is 55.9 miles long. The Newport-Inglewood-Rose Canyon fault is mostly classified as Quaternary (1.6 million years ago and continuing to the present day) and in part classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023h, 2023s). The Newport-Inglewood-Rose Canyon fault is a right-lateral fault, which is a fault that slips in such a way that the two sides move with a predominantly lateral motion (with respect to each other). The Newport-Inglewood-Rose Canyon fault has a probable magnitude between M_w 6.0 and M_w 7.2 and a slip rate between 0.8 and 2.1 mm/year (SCEDC, 2023h). The Newport-Inglewood-Rose Canyon fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

7.2.4.11 Northridge Blind Thrust Fault

The Northridge Blind Thrust fault is located approximately 8.3 miles north from the northern portion of Alternative 3. The Northridge Blind Thrust fault is part of the Oak Ridge fault system (SCEDC, 2023j). At its eastern end, the Oak Ridge Thrust fault is progressively more difficult to trace and is buried, or also known as *blind*. The Northridge Blind Thrust fault has a probable magnitude of M_w 6.5 to M_w7.5. The slip rate for the Northridge Blind Thrust fault is between 3.5 and 6 mm/year (SCEDC, 2023j). The Northridge Blind Thrust fault, as part of the Oak Ridge fault system, is classified mostly as late Quaternary (between present day and 700,000 years ago) and in part as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023j, 2023s). The Northridge Blind Thrust fault is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much, if not all, of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an obvious sign of compressional tectonics (SCEDC, 2023j, 2023s). This blind thrust fault is assumed to be part of the fault system responsible for the 1994 Northridge earthquake.

7.2.4.12 Northridge Hills Fault

The Northridge Hills fault is located approximately 1.3 miles north from the northern portion of Alternative 3. The Northridge Hills fault is not the fault on which the 1994 Northridge earthquake occurred. The Northridge Hills fault is classified as late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023i, 2023s). The Northridge Hills fault is 15.5 miles long, and is a reverse fault, where the displacement is predominantly vertical. The dip for the Mission Hills fault is probably to the north (SCEDC, 2023i).

7.2.4.13 Overland Avenue Fault

The Overland Avenue fault is located approximately 0.8 miles southeast from the southern portion of Alternative 3. The Overland Avenue fault trends northwest and extends from Santa Monica Boulevard to the northwestern flank of the Baldwin Hills. Displacement of the fault is believed to be vertical, with a magnitude of approximately 30 feet. Faulted rocks of late Quaternary age (between present day and 700,000 years ago) is present along this fault (USGS, 1981). The northeastern side of the fault is raised relative to the southwestern side (CDWRSD, 1961).

7.2.4.14 Oak Ridge Fault

The Oak Ridge fault is located approximately 19.5 miles northwest from the northern portion of Alternative 3. The Oak Ridge fault system is connected to the 1994 Northridge earthquake. The Oak Ridge fault is approximately 55.9 miles in length (SCEDC, 2023j). The Oak Ridge fault has a probable magnitude of M_w 6.5 to M_w 7.5. The slip rate for Oak Ridge fault is between 3.5 and 6 mm/year (SCEDC, 2023j). The Oak Ridge fault system is classified mostly as late Quaternary (between present day and 700,000 years ago) and in part as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023j, 2023s). The Oak Ridge fault is thrust fault, which is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much, if not all, of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an obvious sign of compressional tectonics (SCEDC, 2023j, 2023s). This fault dips to the south at a fairly shallow (less than 45 degrees) angle. Thus, epicenters of earthquakes on this (and any other thrust) fault may appear far removed from the surface trace. The surface trace of the Oak Ridge fault forms a ridge (hence its name) to the south of its trace; at its eastern end, the Oak Ridge fault becomes progressively more difficult to trace (SDEDC, 2023j). The Oak Ridge fault appears to be overthrust by the Santa Susana *f*ault, becoming the Northridge Blind Thrust fault.

7.2.4.15 Palos Verdes Fault

The Palos Verdes fault is located approximately 15.2 miles south from the southern portion of Alternative 3. The Palos Verdes fault is 49.7 miles long and is classified as Holocene (from about 10,000 years ago to the present) offshore and as late Quaternary (between present day and 700,000 years ago) onshore (SCEDC, 2023k, 2023s). The Palos Verdes fault is a right-reverse fault and has a probable magnitude between M_w 6.0 and M_w 7.0. The slip rate is between 0.1 and 3.0 mm/year (SCEDC, 2023k).

7.2.4.16 Puente Hills Blind Thrust Fault

The Puente Hills Blind Thrust fault is located approximately 18.9 miles southeast from the southern portion of Alternative 3. The Puente Hills Blind Thrust fault is 24.9 miles long. In 1987, the Puente Hills Blind Thrust fault produced an M_w 5.9 earthquake in Whittier. In March 2014, the Puente Hills Blind

Thrust fault produced an M_w 5.1 earthquake with over 100 aftershocks (KCAL News, 2014). The Puente Hills Blind Thrust fault has a probable magnitude between M_w 6.5 and M_w 6.6 for frequency of a single segment and a probable magnitude of M_w 7.1 for multi-segment rupture scenarios. The slip rates on the ramp segments range from 0.44 to 1.7 mm/year, with preferred rates between 0.62 and 1.28 mm/year (Shaw et al., 2022).

7.2.4.17 Raymond Fault

The Raymond fault is located approximately 13.2 miles northeast from the mid-section of Alternative 3. The Raymond fault is 16.2 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023l, 2023s). The Raymond fault is a left-reverse fault and has a probable magnitude between M_w 6.0 and M_w 7.0. The slip rate is between 0.10 and 0.22 mm/year (SCEDC, 2023l). The Raymond fault dips at about 75 degrees to the north. There is evidence that at least eight surface-rupturing events have occurred along this fault in the last 36,000 years. The exact nature of the slip along the Raymond fault has been a subject of debate for quite some time. In late 1988, the *Pasadena Earthquake* occurred on the Raymond fault, and the motion of this earthquake was predominantly left-lateral, with a reverse component of only about 1/15 the size of the lateral component. If the Raymond fault is indeed primarily a left-lateral fault, it could be responsible for transferring slip southward from the *Sierra Madre* Fault Zone to other fault systems (SCEDC, 2023l). The Raymond fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

7.2.4.18 San Andreas Fault

The San Andreas fault is located approximately 29.5 miles northeast from the northern portion of Alternative 3. The San Andreas fault is 1745.6 miles long. The San Andreas fault has a probable magnitude between M_w 6.8 to M_w 8.0. The interval between major ruptures averages about 140 years on the Mojave segment, and the recurrence interval varies greatly from under 20 years (at Parkfield only) to over 300 years. The slip rate is between 20 and 35 mm/year (SCEDC, 2023m). The last major rupture of the San Andreas fault occurred on January 9, 1857 at the Mojave segment and on April 18, 1906 at the northern segment. The San Andreas fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

7.2.4.19 San Gabriel Fault

The San Gabriel fault is located approximately 10.4 miles northeast from the northern portion of Alternative 3. The San Gabriel fault is 87 miles long. The San Gabriel fault is primarily a right-lateral strike slip, which is a fault where the slip motion is parallel to the direction, or trend, of the line marking the intersection of a fault plane (or another planar geologic feature) with the horizontal. The San Gabriel fault is classified as late Quaternary (between present day and 700,000 years ago) west of the intersection with the Sierra Madre Fault Zone, Quaternary (1.6 million years ago and continuing to the present) east of that intersection, and Holocene (from about 10,000 years ago to the present) between Saugus and Castaic. The slip rate is between 1 and 5 mm/year (SCEDC, 2023n). The slip rate and reoccurrence interval vary significantly along the length of the San Gabriel fault. The western half is more active than the eastern half, and the dip is generally steep and to the north. The San Gabriel fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

7.2.4.20 Santa Felicia Fault

The Santa Felicia fault is located approximately 21.5 miles northwest from the northern portion of Alternative 3. The Santa Felicia fault is a fault that is less well understood. The Santa Felicia fault is classified as late Quaternary (between present day and 700,000 years ago). The Santa Felicia fault apparently overrides the youngest strand of the San Gabriel fault. The Santa Felicia fault is a south-dipping reverse fault. The Santa Felicia fault has no recognized tectonic geomorphic features, although it follows the Santa Felicia Canyon for part of its length (Yeats et al., 1985).

7.2.4.21 Santa Monica Fault

The Santa Monica fault would cross Alternative 3 approximately north of Massachusetts Avenue and I-405. The Santa Monica fault is 14.9 miles long. The Santa Monica fault has a probable magnitude between M_w 6.0 and M_w 7.0. The Santa Monica fault is classified as late Quaternary (between present day and 700,000 years ago) and is a left-reverse fault. The Santa Monica fault is a north-dipping fault, and the slip rate may be greatest at its western end. The slip rate is between 0.27 and 0.39 mm/year (SCEDC, 2023o). In 2015, the Santa Monica Fault Zone was evaluated for the Alquist-Priolo Earthquake Fault Zoning program (Olson, 2015). Currently, the Santa Monica Fault Zone is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023). The guideway for Alternative 3 would fall within the Alquist-Priolo Earthquake Fault Zone. No habitable structures including stations are located within the Alquist-Priolo Earthquake Fault Zone for Alternative 3.

7.2.4.22 Sierra Madre Fault

The Sierra Madre fault is located approximately 4.7 miles north from the northern portion of Alternative 3. The Sierra Madre fault is 46.6 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023p, 2023s). The Sierra Madre fault is a reverse fault, where the displacement is predominantly vertical. The Sierra Madre fault has a probable magnitude between M_w 6.0 and M_w 7.0. The slip rate is between 0.36 and 4.0 mm/year (SCEDC, 2023k). The Sierra Madre fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

7.2.4.23 Simi-Santa Rosa Fault

The Simi-Santa Rosa fault is located approximately 8.5 miles northwest from the northern portion of Alternative 3. The Simi-Santa Rosa fault is 24.9 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023q, 2023s). The Simi-Santa Rosa fault is a reverse fault, where the displacement is predominantly vertical. This fault dips to the north. The Simi-Santa Rosa fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

7.2.4.24 Verdugo Fault

The Verdugo fault is located approximately 6.9 miles east from the mid-section of Alternative 3. The Verdugo fault is 13 miles long and is classified as Holocene (from about 10,000 years ago to the present) and late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023r, 2023s). The Verdugo fault is a reverse fault and has a probable magnitude between M_w 6.0 and M_w 6.8. The slip rate is roughly 0.5 mm/year (SCEDC, 2023r). The Verdugo fault dips to the northeast.

7.2.5 Geological Hazards

7.2.5.1 Fault Rupture

Faults are geologic zones of weakness. Surface rupture occurs when movement on a fault deep in the earth breaks through to the ground surface. Surface ruptures associated with the 1994 Northridge earthquake began as a rupture at a depth of about 10.9 miles beneath the San Fernando Valley. For 8 seconds following the initial break, the rupture propagated upward and northwestward along the fault plan at a rate of about 1.9 miles per second. The size of the rupture covered an area of approximately 9.3 by 12.4 miles (USGS, 2013). Not all earthquakes result in surface rupture; however, due to the proximity of known active faults, fault ruptures and the subsequent hazard posed by seismic activity are potentially high. An earthquake could cause major damage, and not have the fault trace break at the ground surface. Fault rupture almost always follows preexisting faults, which are zones of weakness. Rupture may occur suddenly during an earthquake or slowly in the form of fault creep. Sudden displacements are more damaging to structures because they are accompanied by shaking.

7.2.5.2 Ground Shaking

A major cause of structural damage that results from earthquakes is ground shaking. The amount of motion can vary from “zero to forceful,” depending upon the distance to the fault, the magnitude of the earthquake, and the local geology. Greater movement can be expected at sites located on poorly consolidated material such as alluvium located near the source of the earthquake epicenter or in response to an earthquake of great magnitude. Strong ground shaking can damage large freeway overpasses and unreinforced masonry buildings. It can also trigger a variety of secondary hazards such as liquefaction, landslides, fire, and dam failure.

The amount of damage to a building does not depend solely on how hard it is shaken. In general, smaller buildings such as houses are damaged more by stronger earthquakes, and houses must be relatively close to the epicenter to be severely damaged. Larger structures such as high-rise buildings are damaged more by weaker earthquakes and will be more noticeably affected by the largest earthquakes, even at considerable distances.

Damages as a result of ground shaking is not limited to aboveground structures. Seismic waves generated by the earthquake cause the ground to move, leading to dynamic forces on underground structures. This shaking can induce ground deformation and displacements, and can potentially damage the structural integrity of tunnels, basements, and other underground facilities.

The intensity of ground motion expected at a particular site depends upon the magnitude of the earthquake, the distance to the epicenter, and the geology of the area between the epicenter and the property. Another factor affecting structural damage due to ground shaking is the quality and condition of the existing structure, which is influenced by whether it adheres to current or past building codes. Greater movement can be expected at sites on poorly consolidated material, such as loose alluvium, in proximity to the causative fault, or in response to an event of great magnitude. The general area is susceptible to earthquakes of M_w 6.0 to M_w 8.0. Due to the proximity of known active faults, the hazard posed by seismic shaking is potentially high.

7.2.5.3 Difficult Ground Conditions for Excavating or Drilling

Difficult drilling conditions may be encountered due to the presence of shallow bedrock in the Santa Monica Mountain areas. Drilling in this area is anticipated to be slow, and casing (if used) installation into these materials would also be difficult. Hard drilling should be anticipated.

7.2.6 Dry Sand Settlements

Settlement is defined as areas that are prone to rates of ground-surface collapse and densification (soil particle compaction) that are greater than those of the surrounding area. Such areas are often underlain by sediments that differ laterally in composition or degree of existing compaction. Differential settlement refers to areas that have more than one rate of settlement. Settlement can damage structures, pipelines, and other subsurface entities.

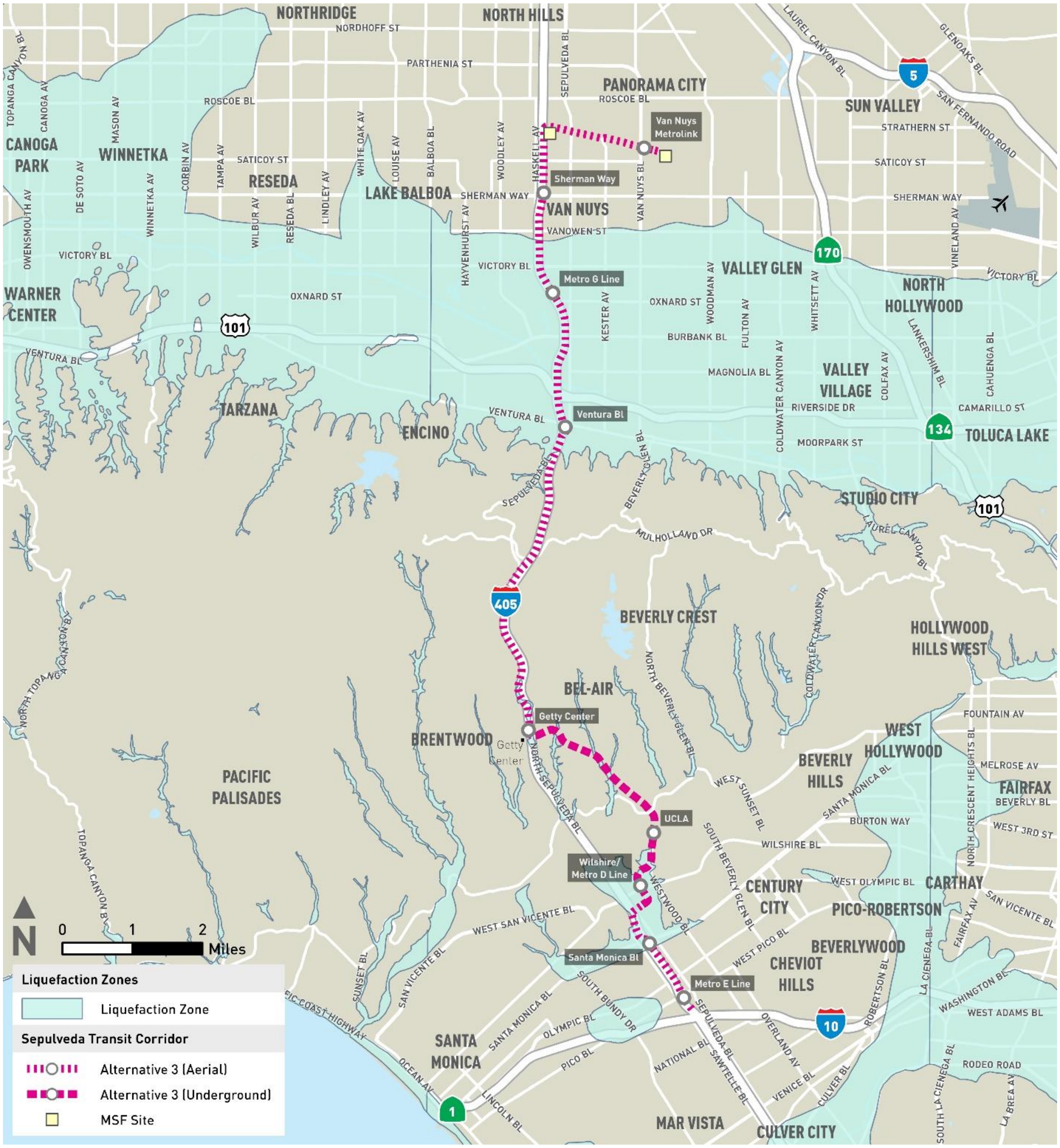
Strong ground shaking can cause soil settlement by vibrating sediment particles into more tightly compacted configurations, thereby reducing pore space. Unconsolidated, loosely packed alluvial deposits and sand (unsaturated or saturated) are especially susceptible to this phenomenon. Poorly compacted artificial fills may experience seismically induced settlement. As shown on Figure 7-10, alluvial deposits are present at all of Alternative 3’s station except the Getty Center Station and as such, the hazard posed by seismically induced settlement is potentially high.

7.2.7 Liquefaction

Liquefaction involves a sudden loss in strength of a saturated, cohesionless, uniformly particle-sized soil, that is typically caused by ground-shaking activities, which causes temporary transformation of the soil to a fluid mass. In rare instances, ground-borne vibrations can cause liquefaction from activities such as pile driving or tunnel boring. If the liquefying layer is near the ground surface, the effects may resemble those of quicksand. If the layer is deep below the ground surface, it may provide a sliding surface for the material above it and/or cause differential settlement of the ground surface, which may damage building foundations by altering weight-bearing characteristics.

During a liquefaction event, soils behave similarly to liquids, losing bearing strength. Structures built on these soils may tilt or settle when the soils liquefy. Liquefaction occurs more often in earthquake-prone areas underlain by young sandy alluvium where the groundwater table is less than 50 feet below ground surface (Metro, 2023a). Per the County of Los Angeles, liquefaction zones identify where the stability of foundation soils must be investigated, and countermeasures undertaken in the design and construction of buildings for human occupancy (LA County Planning, 2022a). As shown on Figure 7-13, Alternative 3 would traverse multiple liquefaction zones, and the potential for a liquefaction event is relatively high for the mapped areas shown (California Department of Conservation, 1998). Site-specific liquefaction potential would be evaluated in more detail based on future site-specific subsurface investigation data.

Figure 7-13. Alternative 3: Liquefaction Zones



Source: County of Los Angeles, Enterprise GIS (eGIS), 2022; HTA, 2024

7.2.8 Subsidence

Subsidence involves a sudden sinking or gradual settling and compaction of soil and other surface material with little or no horizontal motion. This is typically caused by the removal of groundwater, oil, or natural gas, or by natural processes like the compaction of soil. This can lead to structural damage to buildings and infrastructure. The Los Angeles Basin is vulnerable to subsidence, particular due to

groundwater and oil extraction. Over-extraction of groundwater can be concerning because as the groundwater table drops, the soil compacts, leading to subsidence that can damage infrastructure, buildings, and roads. Information relating to groundwater conditions can be found in the *Sepulveda Transit Corridor Project Water Resources Technical Report* (Metro, 2025).

Subsidence typically impacts surface level soils. Although much of the alignment is aerial with segments in a relatively deep subsurface tunnel, all stations have surface level elements. Moreover, alluvial deposits are susceptible to subsidence, especially when they consist of loose, unconsolidated sediments. As shown on Figure 7-10, alluvial deposits are present at each of Alternative 3's stations, except for the Getty Center Station and as such, the hazard posed by subsidence is potentially high at those locations.

7.2.9 Expansive Soils

Expansive soils have a significant amount of clay particles that can give up water (shrink) or take on water (swell). The change in volume exerts stress on buildings and other loads placed on these soils. The occurrence of these soils is often associated with geologic units having marginal stability. Expansive soils can be dispersed widely and can be found in hillside areas as well as low-lying areas in alluvial basins. Municipal grading and building codes require routine soils testing to identify expansive characteristics and appropriate remediation measures. Specific treatments to eliminate expansion of soils at building sites include, but are not limited to, grouting (cementing the soil particles together), re-compaction (watering and compressing the soils), and replacement with non-expansive material (excavation of unsuitable soil followed by filling with suitable material), all of which are common practice in California. Expansive soils typically impact surface level soils. Although the alignment is entirely aerial, all stations have surface level elements. As shown on Figure 7-10, alluvial deposits are present at each of Alternative 3's stations, except for the Getty Center Station and, as such, the hazard posed by expansive soils is potentially high at those locations.

7.2.10 Collapsible Soils

Collapsible soils undergo a rearrangement of their grains and a loss of cementation, resulting in substantial and rapid settlement under relatively low loads. Collapsible soils occur predominantly at the base of mountain ranges where Holocene-age alluvial fan and wash sediments have been deposited during rapid runoff events. Soils prone to collapse are commonly associated with human-made fill, wind-laid sands and silts, and alluvial fan and mudflow sediments deposited during flash floods. Additionally, desert soils are commonly associated with hydro-compression and collapse associated with wetting. Examples of common problems associated with collapsible soils include tilting and sagging floors, cracking or separation in structures, and nonfunctional windows and doors. Collapsible soils typically impact earth at surface levels. Although much of the alignment is aerial with segments in a relatively deep subsurface tunnel, all stations have surface-level elements. As shown on Figure 7-10, alluvial deposits are present at each of Alternative 3's stations, except for the Getty Center Station and, as such, the hazard posed by collapsible soils is potentially high at those locations.

7.2.11 Lateral Spreading

Lateral spread is the finite, lateral displacement of sloping ground (0.1 to < 6 percent) as a result of pore pressure buildup or liquefaction in a shallow, underlying soil deposit during an earthquake. Lateral spreading, as a result of liquefaction, occurs when a soil mass slides laterally on a liquefied layer, and gravitational and inertial forces cause the layer, and the overlying non-liquefied material to move in a downslope direction. Due to the presence of mountainside areas in the Project Study Area, the hazard posed by lateral spreading is potentially high at those locations.

7.2.12 Slope Stability

Slope failures include many phenomena that involve the downslope displacement of material, which is triggered by static (i.e., gravity) or dynamic (i.e., earthquake) forces such as landslides, rock-falls, debris slides, and soil creeps. Slope stability can depend on complex variables, including the geology, structure, and amount of groundwater present, as well as external processes such as climate, topography, slope geometry, and human activity. Landslides and other slope failures may occur on slopes of 15 percent or less; however, the probability is greater on steeper slopes that exhibit old landslide features such as scarps, slanted vegetation, and offset surfaces. Due to the presence of slopes (of 15 percent greater) in the Project Study Area, particularly in the hilly Santa Monica Mountain communities of Bel-Air, Beverly Crest, and Brentwood, the hazard posed by slope failures is potentially high at those locations.

7.2.13 Landslides

Landslides are the downhill movement of a mass of earth and rock. Landslides are a geological phenomenon that includes a wide range of ground movements, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary cause of a landslide, the following other factors contribute:

- Erosion by rivers, glaciers, or ocean waves
- Rock and soil slopes that are weakened through saturation by snowmelt or heavy rains
- Earthquakes that create stresses such that weak slopes fail
- Volcanic eruptions that produce loose ash deposits, heavy rain, and/or debris flows
- Vibrations from machinery, traffic, blasting, and even thunder
- Excess weight from accumulation of rain or snow, stockpiling of rock or ore from waste piles, or from human-made structures.

As shown on Figure 7-14, the potential landslide hazard for Alternative 3 is focused within the Santa Monica Mountains portion of the alternative.

Figure 7-14. Alternative 3: Landslide Hazard Zones

Source: County of Los Angeles, eGIS, 2022; HTA, 2024

7.2.14 Soil Erosion

Soil erosion is the process by which soil particles are removed from a land surface by wind, water, or gravity. Most natural erosion occurs at slow rates; however, the rate of erosion increases when land is cleared of vegetation or structures, or otherwise altered and left in a disturbed condition. Erosion can occur as a result of, and can be accelerated by, site preparation activities associated with development.

Vegetation removal in pervious landscaped areas could reduce soil cohesion, as well as the buffer provided by vegetation from wind, water, and surface disturbance, which could render the exposed soils more susceptible to erosive forces.

Excavation or grading may result in erosion during construction activities, irrespective of whether hardscape previously existed at the construction site, because bare soils would be exposed and could be eroded by wind or water. The effects of erosion are intensified with an increase in slope (as water moves faster, it gains momentum to carry more debris) and the narrowing of runoff channels (which increases the velocity of water). Surface structures, such as paved roads and buildings, decrease the potential for erosion. Once covered, such as with a paved road, soil is no longer exposed to the elements, and erosion generally does not occur.

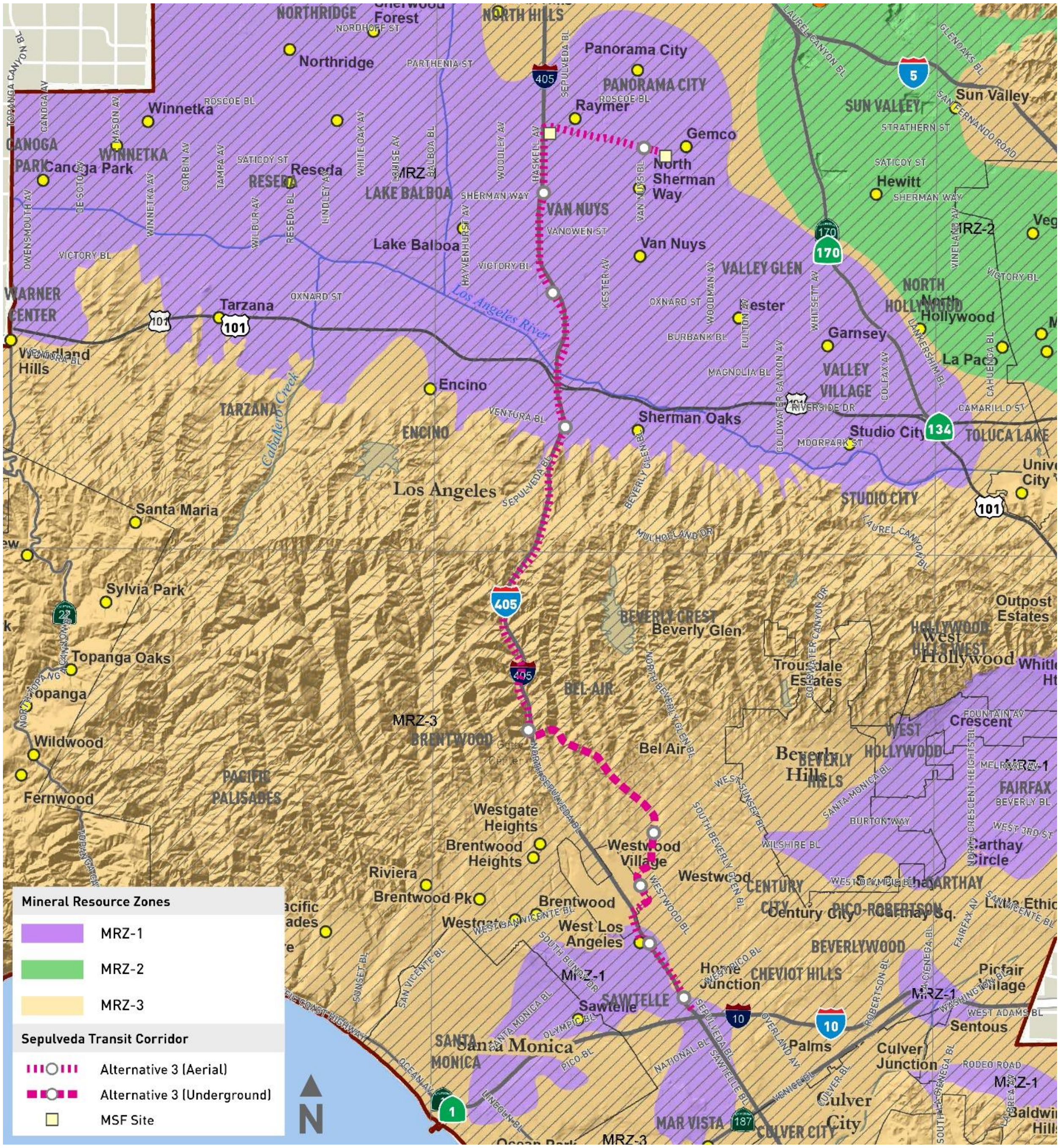
7.3 Mineral Resources

Mineral resource areas are identified according to the Surface Mining and Reclamation Act of 1975 and the following criteria for Mineral Resource Zones (MRZs), Scientific Resource Zones (SZs), and Identified Resource Areas. The MRZ and SZ categories used by the State Geologist in classifying the state's lands, the geologic and economic data, and the substantiation of which each unit MRZ or SZ assignment is based on land classification information provided by the State Geologist to the Board of Supervisors for the following areas:

- **MRZ-1:** Adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence. This zone shall be applied where well-developed lines of reasoning, based on economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is nil or slight.
- **MRZ-2:** Adequate information indicates that significant mineral deposits are present or a high likelihood for their presence exists. This zone shall be applied to known mineral deposits or where well-developed lines of reasoning, based on economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is high.
- **MRZ-3:** Areas containing deposits whose significance cannot be evaluated from available data.
- **MRZ-4:** Available information is inadequate for assignment to any other MRZ zone.
- **SZ Areas:** Areas containing unique or rare occurrences of rocks, minerals, or fossils that are of outstanding scientific significance shall be classified in this zone.

Alternative 3 would contain areas designated as MRZ-1 and MRZ-3 (Figure 7-15). The California Department of Conservation, Division of Mines and Geology has classified areas of regional significance as MRZ-2 (CGS, 2021). Alternative 3 would not be located within an area designated as MRZ-2. Alternative 3 would be largely located within areas designated as MRZ-3, which contains deposits whose significance cannot be evaluated from available data. A portion of Alternative 3 would be located within areas designated as MRZ-1 in the northern portion of the Alternative 3 in the San Fernando Valley, as well as the southern portion of the Alternative 3 near West Los Angeles. MRZ-1 designated areas indicate that no significant mineral deposits are present or little likelihood exists for their presence.

Figure 7-15. Alternative 3: Mineral Resources



Source: CGS, 2021; HTA, 2024

7.4 Paleontological Resources

Alternative 3 has the same footprint as Alternative 1 just north of the Getty Center. However, Alternative 3's footprint transitions below grade just south of Wilshire Boulevard and would return above grade within the I-405 corridor just south of the proposed Getty Center Station. The Alternative 3 footprint impacts the same area where LACM VP 1681 is located, indicating a high paleontological sensitivity in the area. LACM VP 1681 is in the central portion of the Resource Study Area (RSA), just west of the I-405 Sepulveda freeway cut, adjacent to where Royal Ridge Road ends. A fossil Pipefish (*Syngnathus avus*) was recovered from locality LACM VP 1681. The locality was previously sampled by paleontologists and subsequent construction activities (i.e., I-405) have effectively removed the locality, but it is still indicative of the fossiliferous nature of the Modelo Formation (Bell, 2023).

Underground components of Alternative 3 have increased potential to affect paleontological resources. Deeper portions of any paleontologically sensitive unit have potential to produce rare or scientifically important taxa (SVP, 1995).

Additionally, 14 other fossil localities located within 5 miles of the RSA produced fossil vertebrates and invertebrates.

Paleontological sensitivity refers to the paleontological potential for a geologic unit to contain fossil remains, traces, and fossil-collecting localities. The following sensitivity ratings indicate the potential for containing significant paleontological resources.

- High paleontological sensitivity indicates that geologic units have a history of or are considered to have a high potential for paleontological resources (i.e., fossil remains).
- Moderate paleontological sensitivity indicates that fossil remains or traces have been found but are in poor condition, are a common paleontological resource, or do not have scientific significance.
- Low paleontological sensitivity indicates a low potential for containing fossil paleontological resources.
- No paleontological sensitivity indicates areas that are not conducive to significant paleontological resources due to environmental conditions.

For Alternative 3, it is difficult to quantify the number of sensitive formations and their sensitivity level with precision due to a blanket of soil that covers the entire RSA underground and current construction in the area. Appendix A to this technical report, the stand-alone Paleontological Technical Memorandum, contains a detailed analysis of paleontological resources.

7.5 Impacts Evaluation

7.5.1 Impact GEO-1: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map, issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.

7.5.1.1 Operational Impacts

As listed in Table 7-6 and shown on Figure 7-11, Alternative 3 traverses the Santa Monica Fault at approximately north of Massachusetts Avenue and the I-405 median, north of Santa Monica Boulevard. The next closest Alquist-Priolo Earthquake Fault Zones to Alternative 3 are the Hollywood fault, located approximately 2 miles northeast from the mid-section of Alternative 3, and the Newport-Inglewood-Rose Canyon fault, located approximately 2 miles east from the southern portion of Alternative 3.

The Alquist-Priolo Earthquake Fault Zoning Act prohibits the construction of structures for human occupancy (i.e., houses, apartments, offices, stations, etc.) on the surface trace of active faults.

However, the Alquist-Priolo Earthquake Fault Zoning Act does not prohibit the construction of non-habitable structures (i.e., not suitable to be lived in such as carport, roads, train tracks, bridges, etc.). Alternative 3 is an aerial monorail alignment that would run along the Interstate 405 (I-405) corridor and would include seven aerial monorail transit (MRT) stations and an underground tunnel alignment between the Getty Center and Wilshire Boulevard with two underground stations, and TPSS sites. Alternative 3's alignment would include a fixed guideway within the Alquist-Priolo Earthquake Fault Zone.

Operation of Alternative 3 includes both aerial and underground segments. Aerial operations of Alternative 3 would not directly or indirectly cause the rupture of a fault because the monorail vehicles would straddle a guide beam 16.5 feet and 32 feet above ground level. Moreover, underground operations of Alternative 3 similarly involves monorail vehicles straddling a beam guideway ranging between 20 to 300 feet below surface level which would not cause fault rupture. Furthermore, Alternative 3 would be designed to comply with current seismic safety standards, including structural engineering measures to account for the potential impacts of seismic activity, as discussed in detail in Section 2 Regulatory and Policy Framework.

While operational activities of Alternative 3 would not exacerbate fault rupture risks, Alternative 3 would be constructed in a way that would reduce the risk of loss, injury, or death *as a result* of a fault rupture through compliance and adherence to existing regulations as described in Section 2 Regulatory and Policy Framework. Construction of Alternative 3 would also incorporate earthquake-resistant design recommendations provided during final geotechnical engineering. Therefore, operational impacts associated with substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault would be less than significant.

7.5.1.2 Construction Impacts

Construction of Alternative 3 would occur within the Santa Monica Fault zone, north of Santa Monica Boulevard and along I-405. Aerial guideway and station construction would involve installing CIDH piles, precast beams, and precast bent caps within the I-405 ROW. These components would be constructed in compliance with applicable seismic and geotechnical regulatory requirements, as described and Section 2 Regulatory and Policy Framework, and using established engineering practices to minimize ground disturbance and ensure structural stability in areas near active faults. A TBM would be used to construct the underground segment of the guideway. Tunneling depth would range between 20 feet to 300 feet. Underground stations, including the Wilshire Boulevard/Metro D Line Station and the UCLA Gateway Plaza Station, would use a "cut-and-cover" construction method whereby the station structure would be constructed within a trench excavated from the surface that is covered by a temporary deck and backfilled during the later stages of station construction. Construction of Alternative 3 would not directly or indirectly exacerbate rupture of a known earthquake fault causing substantial adverse effects, including the risk of loss, injury, or death because these elements, including the CIDH piles, TBM-excavated tunnels, and cut-and-cover stations, do not reach a depth or be of an intensity that would affect geological processes such as faults. Therefore, construction impacts related to the rupture of a fault are less than significant.

7.5.1.3 Maintenance and Storage Facilities

MSF Base Design

The proposed MSF Base Design would be located west of Hazeltine Avenue and south of the LOSSAN rail corridor ROW. The closest Alquist-Priolo Earthquake Fault Zone is the Hollywood fault located approximately 8.5 miles southeast from the proposed MSF Base Design. Therefore, there are no impacts related to loss, injury, or death involving the rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map during operations or construction.

MSF Design Option 1

The proposed MSF Design Option 1 would be located east of the I-405 overpass and south of the LOSSAN rail corridor ROW. The proposed MSF Design Option 1 would not be within an Alquist-Priolo Earthquake Fault Zone. The closest Alquist-Priolo Earthquake Fault Zone is the Hollywood fault located approximately 9.5 miles southeast from the proposed MSF Design Option 1. Therefore, there are no impacts related to loss, injury, or death involving the rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map during operations or construction.

7.5.2 Impact GEO-2: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking and/or seismic-related ground failure, including liquefaction?

7.5.2.1 Operational Impacts

Seismic-related ground failures include liquefaction, post-liquefaction settlements, and landslides. Hazards related to landslides is discussed in Section 7.5.3. Alternative 3 during operation activities would experience earthquake-induced ground-shaking activity because of its proximity to known active faults as listed in Table 7-6 and shown on Figure 7-11 and Figure 7-12. Alternative 3 would be located in a seismically active region and would be subject to seismic ground shaking that could result in damage to structures or human injury or death. For Alternative 3 this could include damage to aerial and underground structures, stations, and TPSS sites. Seismic ground shaking could also injure humans using or working on the system from falls to the ground or structural collapse and being trapped in the underground tunnel or stations. Therefore, Alternative 3 would experience moderate to high ground shaking from these fault zones, as well as some background shaking from other seismically active areas of the Southern California region.

Earthquakes are prevalent within Southern California, and the potential to experience substantial seismic ground shaking is a common hazard for every project within the region. Alternative 3 would be designed and constructed in conformance with the equivalent design criteria such as the MRDC. Additionally, measures to minimize the risk of loss, injury, and death from the effects of earthquakes and seismic ground shaking for project elements would be designed and constructed in conformance with applicable portions of building and seismic code requirements, including the most recent edition of the CBC with specific provisions for seismic design, Metro’s standard specifications, and industry standards.

On the aerial portions of the Alternative 3 alignment, straddle bents or multicolumn piers with wide column spacing allowing for the passage of a roadway directly below the pier would be used, which would provide increased structural support in the event of seismic activity. Consistent with equivalent design criteria such as the MRDC requirements, project structures and tunnels would be designed to perform in accordance with the two-level seismic evaluation approach based on the maximum design earthquake (MDE) and operating design earthquake (ODE).

Aerial and underground structures would be designed and constructed in accordance with federal, state, and local thresholds for seismicity. Additionally, compliance would be required with equivalent design criteria such as MRDC Section 5, Structural, which dictates that during final design, a geotechnical investigation must be conducted, including a detailed and site-specific evaluation of geotechnical hazards. The resulting final geotechnical engineering recommendations and any additional recommendations that come out of the review process would be incorporated into the final design plans consistent with equivalent design criteria such as the MRDC requirements and standard practice to address any unstable geologic and related conditions present along the alignment. Therefore, compliance with the latest earthquake-resistant building design standards and other seismic safety parameters would substantially reduce potential structural damage and the risk to public safety from seismic events by ensuring that strong seismic ground shaking would not cause potential substantial effects, including the risk of loss, injury, or death.

As shown on Figure 7-13, the alignment of Alternative 3 would traverse a Liquefaction Zone in portions where the alignment exists or enters the underground portion at the Getty Center Station, and the Wilshire/Metro D Line Station. Alternative 3 also includes surface station (UCLA Station and the Wilshire/Metro D Line Station) as well as aerial stations with surface elements (Santa Monica Boulevard Station, Ventura Boulevard Station, and the Metro G Line Station), and there is a potential for liquefaction in these marked areas. As mentioned in Section 7.2.7, liquefaction is considered most likely to occur within the first 50 feet below ground surface. The underground portions of the alignment would be significantly deeper than 50 feet below ground surface; therefore, the potential liquefaction impacts on the tunnel are low. During severe ground shaking, loose granular soils below the groundwater table may liquefy. Seismic-related ground failure and liquefaction could result in damage to structures and human injuries where the soil undergoes a temporary loss of strength. Ground instability could affect structural stability, which in turn could damage structures or injure humans occupying structures on unstable ground. The aerial and underground portions of the proposed alignment and stations would be predominately in the younger alluvium where the potential for adverse impact due to liquefaction is considered moderate to high. However, the aerial portion of the proposed alignment and stations would be supported on a deep foundation system to minimize risk of liquefaction (Metro, 2024b).

Alternative 3 would be designed in accordance with design standards that are specific to ground stability. A geotechnical investigation would be performed during final design, consistent with the equivalent design criteria such as the MRDC; the required design-level geotechnical investigation would provide information pertaining to the depths and areal extents of potential liquefaction and seismically induced settlement. During the design process, if it is determined that these hazards could result in an unacceptable soil or structural response, ground improvements such as dynamic compaction, stone columns, jet grouting, cement deep soil mixing and compaction grouting, or deep foundation support to account for liquefaction or seismically induced settlement potential would be implemented and would be consistent with the recommendations contained in the geotechnical investigation and design standards. Therefore, adherence to the provisions listed in the MRDC, Caltrans Seismic Design Criteria and CBC would substantially reduce potential structural damage and the risk to public safety from seismic events by ensuring that seismic-related ground failure and liquefaction would not cause potential substantial effects, including the risk of loss, injury, or death. As such, the potential impacts related to seismic-related ground failure and liquefaction would be less than significant during operations.

7.5.2.2 Construction Impacts

Alternative 3 would be located in a seismically active area. Active and potentially active faults in Southern California are capable of producing seismic ground shaking, and the Alternative 3 RSA would be anticipated to experience ground acceleration caused by these earthquakes. As stated previously, Alternative 3 would be surrounded by faults capable of generating a characteristic earthquake between

M_W 6.0 and M_W 8.0. To reduce the risks associated with seismically induced ground shaking, which could include the risk of loss, injury, or death, the design of foundations and structures must consider the location and type of subsurface materials underlying Alternative 3. Because Alternative 3 would be located within the CBC, structures would be required to be designed in accordance with applicable parameters of the current CBC.

A seismic event during construction could result in safety hazards to construction workers. Standard measures that would protect the public from risk of loss, injury, or death are not yet in place. Risk at a construction site increases because the equipment, tools, and materials on-site could become projectiles. Unfinished structures and buildings could potentially collapse. Excavation and trenching are among the most hazardous construction operations. Seismic events could result in uneven surfaces, cave-ins, and flooding from groundwater intrusion. OSHA's Excavation and Trenching standard (Title 29 of the Code of Federal Regulations, Part 1926.650) covers requirements for excavation and trenching operations. OSHA requires that all excavations in which employees could potentially be exposed to cave-ins be protected by sloping or benching the sides of the excavation, supporting the sides of the excavation, or placing a shield between the side of the excavation and the work area. In California, Cal/OSHA has responsibility for implementing federal rules relevant to worker safety, including slope protection during construction excavations. Cal/OSHA's requirements are more restrictive and protective than federal OSHA standards.

While construction activities for the underground alignment would involve subsurface work at depths where liquefaction could potentially occur, these activities would not directly or indirectly cause seismic ground shaking or induce liquefaction because the construction processes would not be of sufficient intensity to cause geological processes such as faults or liquefaction. Moreover, as described in Section 2 Regulatory and Policy Framework, the construction of Alternative 3 would adhere to seismic and geotechnical regulations, which would require appropriate engineering measures to ensure that liquefaction risks do not exceed unacceptable levels. Adherence to existing regulations (i.e., the CBC, equivalent design criteria such as the MRDC, and County of Los Angeles Building Code, City of Los Angeles Building Code) would ensure that Alternative 3 remains with a less than significant impact associated with exposing people or structures to seismic ground shaking, including seismic-related ground failure and liquefaction during the construction of tunnels and underground infrastructure.

7.5.2.3 Maintenance and Storage Facilities

MSF Base Design

The proposed MSF Base Design would be located west of Hazeltine Avenue and south of the LOSSAN rail corridor ROW. The site would include the following facilities:

- Primary maintenance building that would include administrative offices, operations control center and maintenance shop and office
- Train car wash building
- Emergency generator
- TPSS
- Maintenance-of-way (MOW) building
- Parking area for employees

Operation and construction of the proposed MSF Base Design do not involve extensive excavation and do not reach a depth or be of an intensity that would affect geological processes such as faults. As such, impacts related to seismic ground shaking including liquefaction would be less than significant during operations and construction.

MSF Design Option 1

The proposed MSF Design Option 1 would be located east of the I-405 overpass and south of the LOSSAN rail corridor ROW. The site would include the following facilities:

- Primary entrance with guard shack
- Primary maintenance building that would include administrative offices, an operations control center, and a maintenance shop and office
- Train car wash building
- Emergency generator
- TPSS
- MOW building
- Parking area for employees

Operation and construction of the proposed MSF Design Option 1 do not involve extensive excavation and do not reach a depth or be of an intensity that would affect geological processes such as faults. As such, impacts related to seismic ground shaking including liquefaction would be less than significant during operations and construction.

7.5.3 Impact GEO-3: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides?

7.5.3.1 Operational Impacts

As shown on Figure 7-14, Alternative 3 would traverse the Santa Monica Mountains, which are within a designated potential Landslide Hazard Zone (LHZ) and are areas prone to landslides. Alternative 3 would consist of an aerial monorail alignment along the I-405 corridor with seven aerial MRT stations and an underground tunnel alignment between the Getty Center and Wilshire Boulevard with two underground stations. The segments for the aerial alignment and stations extending along the west side of I-405 between Getty Center Drive and Bel Air Crest Road, and the east side of I-405 into the Bel Air community along the south side of the Santa Monica Mountains have a high potential for seismic-induced landslides where ground surfaces consist of steep slopes. The *Sepulveda Transit Corridor Project, Detailed Geotechnical Exploration Plan* has identified that the elevated guideway structure would be predominately located within the I-405 ROW and generally stay above the top of the existing slopes extending along the west side of I-405 (Metro, 2023a).

Areas that affect the existing slope along I-405 and increase landslides would be further investigated for slope stability during the design phase when site-specific data and final geometry of improvements are available consistent with local requirements. Operation would not involve grading, excavation, or other actions that could destabilize slopes or exacerbate landslide risks. The foundation types would be determined as part of the required geotechnical investigation conducted during the final design phase and would ensure that the potential for landslides would not cause potential for substantial adverse effects, including the risk of loss, injury, or death. With adherence to existing regulations and the provisions listed in the CBC and equivalent design criteria such as the MRDC that require site-specific geotechnical evaluation during the final design phase that would include specific structural engineering recommendations, the potential impacts related to landslides would be less than significant during operations.

7.5.3.2 Construction Impacts

The Santa Monica Mountains are within a designated a potential LHZ (Figure 7-14). However, Alternative 3 would consist of an aerial monorail alignment along the I-405 corridor with seven aerial MRT stations and an underground tunnel alignment between the Getty Center and Wilshire Boulevard with two underground stations. In addition, construction activities for Alternative 3 would include freeway widening, and the demolition and re-building of the retaining walls that hold back the mountains above the freeway. These activities would be located within a designated potential LHZ and potential landslides during construction could cause injury or death to construction workers. With adherence to the provisions listed in the CBC, the potential impacts related to landslides would remain less than significant.

Alternative 3 would require a site-specific slope-stability design, and design to address landslide potentials as required by the standards contained in the CBC, MRDC, Caltrans, and any County of Los Angeles and City of Los Angeles guidelines, as well as by Cal/OSHA requirements for stabilization. Alternative 3 would include manufactured slopes (using grading techniques) in the retention basins that occur mostly at the perimeter of the sites. Retention basins would be designed with due consideration for slope stability. Therefore, impacts associated with constructed-slope instability are considered less than significant.

The combination of site-specific slope-stability design, compliance with applicable regulatory requirements, and the use of manufactured slopes and retention basins is anticipated to effectively manage constructed-slope instability such that impacts associated with constructed-slope instability, including landslides, are reduced, but may still be potentially significant.

This is particularly true for temporary slopes, as excavation activities for Alternative 3 within Landslide Zones could encounter unstable soils. Temporary slopes generally pose a higher risk of slope failure due to their steeper gradients compared to permanent, manufactured slopes. Similar to permanent slope construction, temporary slopes would be required to comply with Cal/OSHA requirements for shoring and stabilization. To address these significant impacts, MM GEO-2 would be implemented so that any excavations for the construction of the underground segment of Alternative 3 would shore excavation walls or flatten or “lay back” the excavation walls to a shallower gradient as required by applicable local, state, or federal laws or regulations to ensure stability of temporary slopes. With implementation of MM GEO-2, Alternative 3 would have a less than significant impact associated with landslides and/or slope instability during construction activities.

7.5.3.3 Maintenance and Storage Facilities

MSF Base Design

The proposed MSF Base Design would be located west of Hazeltine Avenue and south of the LOSSAN rail corridor ROW. The proposed MSF Base Design would not be located on land designated as an LHZ (Figure 7-14); the closest LHZ is located 4.16 miles south from the proposed MSF Base Design site. Therefore, the proposed MSF Base Design would not directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides, and no impact would occur.

MSF Design Option 1

The proposed MSF Design Option 1 would be located west of Hazeltine Avenue and south of the LOSSAN rail corridor ROW. The proposed MSF Design Option 1 would not be located on land designated as an LHZ (Figure 7-14); the closest LHZ is located 4.14 miles south from the proposed MSF Design Option 1. Therefore, the proposed MSF Design Option 1 would not directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides, and no impact would occur.

7.5.4 Impact GEO-4: Would the project result in substantial soil erosion or the loss of topsoil?

7.5.4.1 Operational Impacts

Implementation of Alternative 3 would not result in substantial soil erosion or the loss of topsoil during operations. Topsoil is the uppermost layer of soil — usually the top 6 to 8 inches — which has the highest concentration of organic matter and micro-organisms, and is where most biological soil activity occurs. Plants generally concentrate their roots in, and obtain most of their nutrients from, this layer. Topsoil erosion is of concern when the topsoil layer is blown or washed away, which makes plant life or agricultural production impossible. In addition, significant erosion typically occurs on steep slopes where stormwater and high winds can carry topsoil down hillsides.

Some areas of pervious surfaces are associated with the open space areas within the adjacent Santa Monica Mountain region and a minimal extent of setbacks and residential yards along the Alternative 3 RSA. Alternative 3 would consist of an aerial monorail alignment along the I-405 corridor with seven aerial MRT stations and an underground tunnel alignment between the Getty Center and Wilshire Boulevard with two underground stations. Operation of Alternative 3 would not result in substantial ground disturbance or an increase in the amount of exposed soil, as compared to existing conditions, and would not change the amount of erosion and spreading grounds within the Santa Monica Mountains and residential yards along the Alternative 3 RSA compared to existing conditions.

As described in the *Sepulveda Transit Corridor Project Water Resources Technical Report* (Metro, 2025), Alternative 3 would increase existing impervious areas resulting from the following components: Metro E Line Station, Santa Monica Boulevard Station, Getty Center Station, Sherman Way Station, TPSS, and proposed MSF. Additionally, freeway modifications required to operate Alternative 3 would increase the existing impervious areas. Seven stations would be in an aerial configuration, so the ground level area that would be impervious would be limited to the column footings, as well as vertical circulation elements such as elevators and stairs. Total net impervious surface area created by Alternative 3 elements would total to 85,928 square feet and 1,241,460 square feet for I-405 modifications.

The proposed stations would not result in a significant increase in impervious surfaces because most of the land surfaces in the Project Study Area are currently developed and covered by existing impervious surfaces. The footprints of the proposed Project stations are nominal when compared to the area of the watershed and groundwater basin. However, the TPSSs and I-405 freeway modification that include new or relocated ramps, expanded shoulders, column locations, and retaining walls, would result in a greater increase in impervious surface areas. As a result of the TPSSs and freeway modifications, runoff would be expected to increase due to the increase in impervious surface area. Further details on new impervious surfaces and its impact on erosion resulting from Alternative 3 can be found in the *Sepulveda Transit Corridor Project Water Resources Technical Report* (Metro, 2025).

Alternative 3 would be designed to incorporate several sustainability features, such as native landscaping, rainwater cisterns for capture and reuse, permeable surfaces, soil improvements, increased vegetation, and on-site retention, in compliance with the *Low Impact Development Standards Manual* (LACDPW, 2014), which would serve to reduce impervious area and limit runoff which may cause erosion. Alternative 3 would comply with post-construction measures in applicable National Pollutant Discharge Elimination System (NPDES) permits and Low Impact Development (LID) standards required by Los Angeles County and other local jurisdictions, which aim to minimize erosion impacts from development projects.

With adherence to existing regulations, Alternative 3 would result in a less than significant impact related to substantial soil erosion or the loss of topsoil during operations.

7.5.4.2 Construction Impacts

Ground-disturbing activities occurring during construction would temporarily expose surficial soils to wind and water erosion and have the potential to temporarily increase erosion and loss of topsoil. Construction work that would involve ground-disturbing activities include installation of cast-in-drilling (CIDH) piles for the MRT aerial guideway, I-405 widening, street and reconstruction, installation of TPSS sites, utility relocations, and grading relating to these activities. The Sepulveda Pass has areas of pervious surfaces within the adjacent Santa Monica Mountain region. Retaining-wall installation would be required to accommodate the reconfiguration of Sepulveda Boulevard and Getty on- and off-ramps. Such construction would involve considerable earth-moving activities, including the partial excavation of the Santa Monica Mountains to increase the setback of the retaining walls.

Alternative 3 includes an underground alignment just before the proposed Wilshire Boulevard/Metro D Line Station continuing north through the Santa Monica Mountains. Alternative 3 alignment would transition from an underground configuration to an aerial guideway structure after exiting the tunnel portal located at the northern end of the Leo Baeck Temple parking lot. The alignment would cross over Sepulveda Boulevard and the I-405 lanes to the proposed Getty Center Station. The southern portion of the tunnel would be at a depth between 20 to 50 feet to connect with the UCLA Gateway Plaza Station, which would be constructed using cut-and-cover methods. As the tunnel extends beneath the University of California, Los Angeles (UCLA) campus and the Bel Air Country Club, it would reach depths between 40 to 60 feet. Through the Santa Monica Mountains, the tunnel would range between 50 to 300 feet deep. The only places where excavation would occur for the construction of the underground alignment would be at the portals to retrieve or drop the TBMs. These activities would not result in substantial soil erosion or the loss of topsoil.

Construction activities would be required to comply with existing regulatory requirements, including implementation of best management practices, and other erosion and sedimentation control measures that would ensure that grading, excavation, and other earth-moving activities would avoid a significant impact.

Metro would be required to prepare a *Stormwater Pollution Prevention Plan*, and a site-specific *Standard Urban Storm Water Mitigation Plan* (SUSMP), which is part of the NPDES Municipal General Permit. Preparation of the site-specific SUSMP would describe the minimum required best management practices to be incorporated into the Alternative 3 design and on-going operation of the facilities. Prior to the initiation of grading activities associated with implementation of Alternative 3, Metro would submit a site-specific SUSMP to reduce the discharge of pollutants to the maximum extent practical using best management practices, control techniques and systems, design and engineering methods, and other provisions that are appropriate during construction activities. All development activities associated with Alternative 3 would comply with the site-specific SUSMP.

Preparation of a site-specific SUSMP and adherence to existing regulations would ensure the maximum practicable protection available for soils excavated during the construction of buildings and associated infrastructure. Compliance with existing regulations would minimize effects from erosion through repair and rehabilitation of topsoil post-construction and ensure consistency with the *Regional Water Quality Control Board Water Quality Control Plan*. In view of these requirements, Alternative 3 would have a less than significant impact associated with soil erosion or loss of topsoil during construction activities.

7.5.4.3 Maintenance and Storage Facilities

MSF Base Design

Operation of the proposed MSF Base Design would include the maintenance, cleaning, and storage of monorail vehicles. The proposed MSF Base Design site would be located within an urbanized area that is primarily impervious with no exposed soil. Operation of the proposed MSF Base Design would not result in ground disturbance or a change in the amount of exposed soil as compared to existing conditions and would adhere to existing regulations. The proposed MSF Base Design would comply with post-construction measures in applicable NPDES permits and LID standards required by Los Angeles County and the City of Los Angeles that aim to minimize erosion impacts from development projects. Therefore, the proposed MSF Base Design would result in a less than significant impact related to substantial soil erosion or the loss of topsoil during operations and construction.

MSF Design Option 1

Operation of the proposed MSF Design Option 1 would include the maintenance, cleaning, and storage of monorail vehicles. The proposed MSF Design Option 1 site would be located within an urbanized area that is primarily impervious with no exposed soil. Operation of the proposed MSF Design Option 1 would not result in ground disturbance or a change in the amount of exposed soil as compared to existing conditions and would adhere to existing regulations. The proposed MSF Design Option 1 would comply with post-construction measures in applicable NPDES permits and LID standards required by Los Angeles County and the City of Los Angeles that aim to minimize erosion impacts from development projects. Therefore, the proposed MSF Design Option 1 would result in a less than significant impact related to substantial soil erosion or the loss of topsoil during operations and construction.

7.5.5 Impact GEO-5: Would the project be located on a geographic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?

7.5.5.1 Operational Impacts

Section 7.5.2 addresses impacts related to liquefaction, and Section 7.5.3 addresses impacts related to landslides. The analysis in this section addresses impacts related to unstable soils as a result of subsidence, differential settlement, lateral spreading, or collapse.

The underground and aerial segments of Alternative 3 would not be located on a geographic unit or soil that is unstable, or that would become unstable, potentially resulting in lateral spreading, subsidence, liquefaction, or collapse. Collapsible soils and the potential for lateral spreading to affect the Project is low because most of the areas with liquefaction potential are along relatively flat terrain and liquefiable layers are below the groundwater table as identified in the *Sepulveda Transit Corridor Project, Detailed Geotechnical Exploration Plan* (Metro, 2023a). However, a lateral spreading hazard may exist along I-405 and the Santa Monica Mountains due to liquefiable soils and steep slope topography for the aerial alignment, stations, and TPSS sites. Additionally, ground shaking leading to liquefaction of saturated soil could result in lateral spreading where the soil undergoes a temporary loss of strength, and if the liquefied soil is not contained laterally, it may result in deformation of the slope. As mentioned in Section 7.2.7, liquefaction is considered most likely to occur within the first 50 feet below ground surface. The underground portions of the alignment would be significantly deeper than 50 feet below ground surface; therefore, the potential liquefaction impacts on the tunnel are low.

Using unsuitable materials for fill and/or foundation support would have the potential to create future heaving, subsidence, spreading, or collapse problems, which would lead to building settlement and/or utility line and pavement disruption. Structural engineering standards to address geological conditions are part of standard construction requirements and standard construction practices. Alternative 3 would be designed in compliance with equivalent design criteria such as MRDC Section 5, Structural; Metro's Supplemental Seismic Design Criteria (2017); and the California Seismic Hazards Mapping Act. Furthermore, Alternative 3 would be designed in accordance with recommendations developed in a detailed geotechnical report prepared during final design, which would provide site-specific information pertaining to the depths and areal extents of lateral spreading, subsidence, or collapse.

During the design process, if it is determined that these conditions identified in the geotechnical report could result in an unacceptable soil or structural response (to be defined during final design and dependent on the type of structure), the resulting final geotechnical engineering would include recommendations that would be incorporated into the final design plans, consistent with standard practice to address any unstable geologic and related conditions present along the alignment. Recommendations may include deep foundations and/or ground improvements such as dynamic compaction, stone columns, jet grouting, and cement deep soil mixing and compaction grouting.

Given compliance with these regulatory and design requirements, Alternative 3 would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils as a result of subsidence, differential settlement, lateral spreading, or collapse during operations.

7.5.5.2 Construction Impacts

Section 7.5.2 addresses impacts related to liquefaction, and Section 7.5.3 addresses impacts related to landslides. The analysis in this section addresses impacts related to unstable soils as a result of subsidence, differential settlement, lateral spreading, or collapse. Construction activities for Alternative 3 would involve foundation support installation and earthwork along the alignment. Certain construction activities, such as CIDH drilling for the aerial guideway and excavation and erection of the temporary engineering of the retaining walls along the Santa Monica Mountains in the Sepulveda Pass, could affect soil stability leading to ground movements (both lateral movements and settlements) or subsidence. Additionally, the use of unsuitable materials for fill and/or foundation support could have the potential to create future heaving, subsidence, spreading, or collapse problems leading to foundation and roadway settlement. Excavation for construction of underground structures, such as station boxes, cut-and-cover tunnels, and tunnel portals, would be reinforced by shoring systems to protect abutting buildings, utilities and other infrastructure. Tunneling using a TBM would result in ground volume loss and potential ground movements. Dewatering, when performed to create a dry work condition for construction of the underground structures, would result in compaction or consolidation of the subsurface soils and thus result in surface settlements.

However, Alternative 3 would be in compliance with the regulatory requirements as defined in project measure (PM) GEO-2 defined in Section 7.6. Under PM GEO-2, a site-specific evaluation of soil conditions that shall contain recommendations for ground preparation, earthwork, and compaction specification based on the geological conditions specific to the site.

In addition, Alternative 3 would implement MM GEO-1 through MM GEO-5 as described in Section 7.6. MM GEO-3 also ensures compliance with the recommendations of the final soils and geotechnical report. Additionally, prior to construction, MM GEO-5 specifies that the Project shall prepare a *Construction Management Plan* (CMP) detailing how to address geologic constraints and minimize or avoid impacts to geologic hazards during construction.

Adherence to existing regulations and policies and implementation of MM GEO-1 through MM GEO-5 would ensure the maximum practicable protection available for users of buildings and infrastructure and associated trenches, slopes, and foundations. Therefore, with the implementation of mitigation measures, Alternative 3 would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils.

MSF Base Design

As addressed in Section 7.5.2 and Section 7.5.3, the proposed MSF Base Design would be located on stable soils where no liquefaction or landslide zones are present. Construction and operations would not occur on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed MSF Base Design, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse. The proposed MSF Base Design would be designed in compliance with applicable local, state, or federal laws or regulations, including recommendations on engineering and design considerations as described in Section 7.5.2.2 and identified in MM GEO-1 through MM GEO-5. Thus, construction and operation of the proposed MSF Base Design would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

MSF Design Option 1

As addressed in Section 7.5.2 and Section 7.5.3, the proposed MSF Design Option 1 would be located on stable soils where no liquefaction or landslide zones are present. Construction and operations would not occur on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed MSF Design Option 1, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse. The proposed MSF Design Option 1 would be designed in compliance with applicable local, state, or federal laws or regulations, including recommendations on engineering and design considerations, as described in Section 7.5.2.2 and identified in MM GEO-1 through MM GEO-5. Thus, construction and operation of the proposed MSF Design Option 1 would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

7.5.6 Impact GEO-6: Would the project be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property?

7.5.6.1 Operational Impacts

Based on researched data for the Project Study Area, the majority of fine-grained soil and rock encountered in the previous consultant data exhibited low plasticity with very low to medium expansion potential (Metro, 2023a). Expansive soils can be found almost anywhere, particularly in coastal plains and low-lying valleys such as the Los Angeles Basin and San Fernando Valley. Expansive clays can be found in weathered bedrock along the Santa Monica Mountains. Much of the northern section of the Santa Monica Mountains is in Modelo Formation. Clay-rich soils may exist locally within alluvial soils present along Alternative 3 that could swell and shrink with wetting and drying. The change in soil volume is capable of exerting enough force on structures to damage foundations, structures, and underground utilities. Damage can also occur as these soils dry out and contract. As part of PM GEO-2 during construction, a California-registered geologist and geotechnical engineer would submit to and conduct a site-specific evaluation of unstable soil conditions to confirm the existence of expansive soils.

While expansive soils could have an impact on project elements, operational activities of Alternative 3 do not directly or indirectly cause risks of life or property as operations would not involve wetting or drying of expansive soils. Therefore, impacts related to expansive soils are less than significant during operations.

7.5.6.2 Construction Impacts

While construction activities for Alternative 3 would primarily take place within the median of I-405, and local streets, the underground alignment of Alternative 3 would travel underground between the Wilshire Boulevard/Metro D Line Station, UCLA Gateway Station, and just before the Getty Center Station. Underground stations, including the Wilshire Boulevard/Metro D Line Station and the UCLA Gateway Plaza Station, would use a “cut-and-cover” construction method whereby the station structure would be constructed within a trench excavated from the surface that is covered by a temporary deck and backfilled during the later stages of station construction. A TBM would be used to construct the underground segment of the guideway.

Expansive soils can be found almost anywhere including the Los Angeles Basin and San Fernando Valley. Expansive soils could have an impact on project elements, including the proposed stations, guideway, and TPSS sites. Construction of Alternative 3 includes excavation and surface ground disturbances, if expansive soils do exist, construction activities have the potential to create substantial direct or indirect risks to life or property. As such, impacts related to construction activities could be potentially significant.

To reduce these risks, Alternative 3 would be designed in accordance with the equivalent seismic design criteria such as the MRDC equivalent, Los Angeles County and other applicable local building codes, and the CBC. This includes compliance with equivalent MRDC Section 5 (or equivalent seismic design criteria), which requires preparation of a geotechnical investigation during final design (refer to Section 2 Regulatory and Policy Framework for additional information). This design-level geotechnical investigation must include a detailed evaluation of geologic hazards, including the depths and areal extents of liquefaction, soil expansiveness, lateral spread, and seismically induced settlement. This investigation would include collecting soil samples and performing tests to assess the potential for corrosion, consolidation, expansion, and collapse. Based on the investigation and test results, specific design recommendations, including potential remediation of expansive soils, would be developed to address any identified issues. Expansive soil remediation could include soil removal and replacement, chemical treatment, or structural enhancements.

Alternative 3 would be in compliance with the regulatory requirements as defined in PM GEO-2 which calls for a California-registered geologist and geotechnical engineer to submit to and conduct a site-specific evaluation of unstable soil conditions to confirm the existence of expansive soils. The evaluation would also provide recommendations for ground preparation and earthwork activities specific to the site and take into consideration both aerial and underground construction.

Moreover, Alternative 3 would be required to comply with applicable provisions of the CBC and MRDC equivalent with regard to soil hazard-related design. The County of Los Angeles Building Code and City of Los Angeles Building Code require a site-specific foundation investigation and report for each construction site that identifies potentially unsuitable soil conditions and contains appropriate recommendations for foundation type and design criteria that conform to the analysis and implementation criteria described in the County of Los Angeles Building Code and the City of Los Angeles Building Code. Regulations exist to address weak soil issues, including expansion. PM GEO-3, as described in Section 7.6.2, would be required, as required by applicable local, state, or federal laws or regulations.

Finally, prior to construction, the Project shall implement MM GEO-5, which requires preparation of a CMP which addresses geologic hazards such as soils with shrink-swell potential (expansive soils) and outlines strategies to minimize or avoid impacts.

With compliance with the regulatory requirements as defined in PM GEO-2, PM GEO-3, and implementation of MM GEO-5, Alternative 3 would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils during construction.

7.5.6.3 Maintenance and Storage Facilities

MSF Base Design

The proposed MSF Base Design would be required to comply with applicable provisions of the equivalent design criteria such as the MRDC, Los Angeles County and other applicable local building codes, and the CBC with regard to soil hazard-related design.

The County of Los Angeles Building Code and City of Los Angeles Building Code require a site-specific foundation investigation and report for each construction site that identifies potentially unsuitable soil conditions and contains appropriate recommendations for foundation type and design criteria that conform to the analysis and implementation criteria described in the County of Los Angeles Building Code and the City of Los Angeles Building Code. Regulations exist to address weak soils issues, including expansion.

With compliance with the regulatory requirements as defined in PM GEO-3, as discussed in Section 7.6.2, and adherence to existing regulations, the proposed MSF Base Design would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils.

MSF Design Option 1

Operations related to the proposed MSF Design Option 1 do not involve grading, excavation, or other ground disturbances. Therefore, impacts related to operational activities are less than significant.

Construction of the proposed MSF Design Option 1 may involve grading, excavation, or other ground disturbances. If expansive soils exist at these sites, construction activities have the potential to create substantial direct or indirect risks to life or property. As such, impacts related to construction activities could be potentially significant.

The proposed MSF Design Option 1 would be in compliance with the regulatory requirements as defined in PM GEO-2 which calls for a California-registered geologist and geotechnical engineer to submit to and conduct a site-specific evaluation of unstable soil conditions to confirm the existence of expansive soils. The evaluation would also provide recommendations for ground preparation and earthwork activities specific to the site. Moreover, the proposed MSF Design Option 1 would be required to comply with applicable provisions of the CBC and an MRDC equivalent with regard to soil hazard-related design, as described by PM GEO-3. Finally, prior to construction, the proposed MSF Design Option 1 shall implement MM GEO-5, which requires the preparation of a CMP which addresses geologic hazards such as soils with shrink-swell potential (expansive soils) and outlines strategies to minimize or avoid impacts.

With compliance with the regulatory requirements as defined in PM GEO-2, PM GEO-3, and implementation of MM GEO-5, the proposed MSF Design Option 1 would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils during construction.

7.5.7 Impact GEO-7: Would the project have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?

7.5.7.1 Operational Impacts

No septic systems or alternative wastewater disposal systems are proposed for Alternative 3. As described previously, Metro would be required to prepare a site-specific Standard Urban Storm Water Mitigation Plan (SUSMP), which is part of the National Pollutant Discharge Elimination System (NPDES) Municipal General Permit.

Preparation of the site-specific SUSMP would describe the minimum required best management practices to be incorporated into Alternative 3 design and on-going operation of the facilities. All development activities associated with Alternative 3 would comply with the site-specific SUSMP.

Preparation of a site-specific SUSMP and adherence to existing regulations would ensure the maximum practicable protection available for soils excavated during the construction of buildings and associated infrastructure. Compliance with existing regulations would minimize effects from erosion and ensure consistency with the *Los Angeles Regional Water Quality Control Board Water Quality Control Plan*. In view of these requirements, Alternative 3 would have no impacts associated with soils incapable of adequately supporting such systems during operations.

7.5.7.2 Construction Impacts

No septic systems or alternative wastewater disposal systems are proposed for Alternative 3. Alternative 3 would have no impacts associated with soils incapable of adequately supporting such systems during construction activities.

7.5.7.3 Maintenance and Storage Facilities

MSF Base Design

No septic systems or alternative wastewater disposal systems are proposed for the proposed MSF Base Design. Therefore, the proposed MSF Base Design would have no impact associated with soils incapable of adequately supporting such systems during operations.

MSF Design Option 1

No septic systems or alternative wastewater disposal systems are proposed for the proposed MSF Design Option 1. Therefore, the proposed MSF Design Option 1 would have no impact associated with soils incapable of adequately supporting such systems during operations.

7.5.8 Impact GEO-8: Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

7.5.8.1 Operational Impacts

Operations of Alternative 3 would not include activities that would involve ground disturbance. Therefore, there would be no operational impacts related to paleontological resources.

7.5.8.2 Construction Impacts

The footprint for Alternative 3 is the same as Alternative 1, north of the Getty Center Station and south of the Wilshire/Metro D Line Station. The portion of Alternative 3 that lies between these two stations would have a 3.7-mile underground alignment and would be located to the east of I-405. The underground alignment would go north of Wilshire Boulevard, and travel underneath Westwood Village and UCLA, before returning to the I-405 corridor just south of the proposed Getty Center Station. The underground alignment would require a 43-foot-wide single-bore tunnel and two 8-foot-wide walkways/drive aisles flanking the tunnel. The tunnel would be a maximum of 440 feet below ground surface level before making its ascent to the surface. Additionally, Alternative 3 would have two underground MRT stations: Wilshire/Metro D Line Station and UCLA Gateway Plaza Station. Construction of the underground MRT stations would involve MRT platforms and all vertical circulation elements required to facilitate pedestrian entrances and connections to the local roadways and Metro D Line subway station. Construction impact areas would also include proposed station entrances that would include modifications to the existing surface at street level. The geologic units that would be disturbed by the tunnel and two MRT stations construction would be young alluvium, unit 2 (Qya2), Modelo Formation sandstone (Tmss), and Topanga Formation (Tt). The units listed are not representative of what can be encountered below the surface level (Campbell et al., 2016). Additionally, it is difficult to say for certain which geologic units would lie beneath old alluvium fan deposits, unit 2 (Qof2), and Qya2. Unit Tmss has a high paleontological sensitivity due to potentially preserved paleontological resources (SVP, 1995).

The subsurface area that would be disturbed under Alternative 3 would be similar to Alternative 1 and involve the access, staging, and laydown areas needed to construct the foundations and columns required for the monorail. These disturbed areas would include an 8-foot-wide work area required along each guideway beam, an 8-foot-wide work area required on each side of concrete straddle beam, and an 8-foot-wide work area at each column/foundation. Additionally, the construction would disturb subsurface areas that extend along the I-405 corridor to provide construction access and staging/laydown areas within and adjacent to Caltrans ROW. Due to unknown subsurface geologic conditions with potential changes to the necessary grading, specific impacts considering excavation depths for the construction of the monorail columns are currently not known. The construction impacts of Alternative 3 to high sensitivity formations total 69.65 acres, and low sensitivity formations total 115.19 acres.

The areas of subsurface that would be specific to Alternative 3 also include the staging areas and activity that would also occur at the two underground portal locations (General Services Administration property and east side of I-405 across from Getty Center), UCLA Gateway Plaza, and within the underground easement proposed for the MRT system.

Most of the impacts from Alternative 3 would result from the construction of the foundation columns for the MRT alignment and the foundations needed for the aerial MRT stations, switch locations, and long-span structures. The columns involved in Alternative 3 would range from 6 feet in diameter in the main alignment with a 7-foot-diameter foundation; 4-foot to 7-foot columns with an 8-foot-wide foundation at the I-405 median; 5-foot to 8-foot columns with a 9-foot foundation at the aerial MRT stations; 5-foot-diameter column with a 6-foot foundation at the switch locations; and lastly 10-foot-diameter columns with a 11-foot-diameter foundation for the long-span structures. The CIDH method would be used during the construction of the foundations for the columns. This method does not allow for careful monitoring as it grinds the soil. Consequently, this method would cause significant and unavoidable impacts to paleontological resources when utilized in paleontologically sensitive geologic formations (*Paleontological Technical Memorandum*, Attachment 1, Figure 5 of this report).

When grading and trenching activities are employed, observation of the Mitigation Measures (Section 7.6) would reduce the impact to paleontological resources to less than significant.

A TBM will be excavating the tunnels for the underground portion of Alternative 3. The TBM will excavate sediments to the dimensions of the finished tunnel, remove the sediments from the forward portion of the TBM via an internal conveyer belt, and erect the segmental, precast concrete tunnel liner. Therefore, the impact to paleontological resources in the tunnels would be significant. The operation of the TBM does not allow the monitor to view the sediments as they are being excavated or the walls of the tunnel following removal of excess sediments and prior to the installation of the tunnel's concrete liner. For these reasons, monitoring paleontological resources adjacent to the TBM is not possible. Thus, in consideration of CEQA, excavations for tunnel construction would result in significant and unavoidable impacts to paleontological resources in paleontologically sensitive geologic units (*Paleontological Technical Memorandum*, Attachment 1, Figure 5 of this report) (SVP, 2010; Scott and Springer, 2003).

When considering Quaternary-aged deposits, deeper (i.e., older) portions of paleontologically sensitive geologic units are generally more sensitive from a scientific point of view. Thus, a mapped geologic unit considered to have low paleontological sensitivity at the surface has the potential to become more sensitive paleontologically at depth. Excavations for launching and extracting the TBM would occur at points along the ROW. Therefore, the impact to paleontological resources at TBM launching and extracting sites would be significant. However, when excavations such as these take place in paleontologically sensitive units (*Paleontological Technical Memorandum*, Attachment 1, Figure 5 of this report), MM GEO-6 through MM GEO-9 shall be implemented to reduce the impact to paleontological resources to less than significant (SVP, 2010; Scott and Springer, 2003).

7.5.8.3 Maintenance and Storage Facilities

MSF Base Design

Subsurface disturbance that would occur under Alternative 3 would be at the locations of administrative buildings, maintenance buildings, wash facilities, drive aisles, storage tracks, and the columns for the aerial MSF. The surface rocks in the underground portions of the proposed MSF Base Design are mapped as Qya2 but may be more paleontologically sensitive (older) than indicated at depth. This impact would be significant and, therefore, mitigation measures are required to ensure that a qualified paleontologist is present to monitor excavation activities. With implementation of MM GEO-6 through MM GEO-9 (Section 7.6), impacts associated with the MSF Base Design would be less than significant.

Further details pertaining to construction impacts to paleontological resources can be found in Appendix A.

MSF Design Option 1

The impacts involved with the MSF Design Option 1 include all administrative buildings, maintenance buildings, wash facilities, drive aisles, storage tracks, and the columns for the aerial MSF. The surface rocks in the underground portions of the proposed MSF Design Option 1 are mapped as Qya2 but may be more paleontologically sensitive (older) than indicated, at depth. There should be a qualified paleontologist to monitor ground disturbance when this unit is encountered (SVP, 1995; Bell, 2023). With implementation of MM GEO-6 through MM GEO-9 (Section 7.6), impacts associated with the MSF Design Option 1 would be less than significant.

Further details pertaining to construction impacts to paleontological resources can be found in Appendix A.

7.5.9 Impact GEO-9: Would the project result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state or result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?

7.5.9.1 Operational Impacts

Operation of Alternative 3 would not require excavation that may affect mineral resources. No mining operations are present within the Alternative 3 RSA, so operation of Alternative 3 would not disrupt mining operations. Therefore, Alternative 3 would have no construction impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

7.5.9.2 Construction Impacts

Construction of Alternative 3 would require excavation for columns and would use a TBM for tunnel construction. However, Alternative 3 would not be located in an area with known mineral deposits. As mentioned in Section 7.3, Alternative 3 is located in areas designated as MRZ-1 and MRZ-3. The California Department of Conservation, Division of Mines and Geology has classified areas of regional significance as MRZ-2 (CGS, 2021). Alternative 3 would not be located within an area designated as MRZ-2. Alternative 3 would be located within areas designated as MRZ-1 in the northern portion of Alternative 3 in the San Fernando Valley as well as the southern portion of Alternative 3 near West Los Angeles. MRZ-1-designated areas indicate that no significant mineral deposits are present or little likelihood exists for their presence. No mining operations are present within the Alternative 3 RSA, so construction of Alternative 3 would not disrupt mining operations. Therefore, Alternative 3 would have no construction impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

7.5.9.3 Maintenance and Storage Facilities

MSF Base Design

Operation of the MSF Base Design would not require excavation that may affect mineral resources. No mining operations are present within or in the vicinity of the MSF Base Design, so operation of the MSF Base Design would not disrupt mining operations. Therefore, the MSF Base Design would have no operational impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

Construction of the MSF Base Design would require excavation for columns, but the MSF Base Design would not be located in an area with known mineral deposits. No mining operations are present within or in the vicinity of MSF Base Design, so construction of the MSF Base Design would not disrupt mining operations. Therefore, the MSF Base Design would have no construction impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

MSF Design Option 1

No known mineral resources that are of value to region or state are located within the proposed MSF Design Option 1. Currently, the proposed MSF Design Option 1 would be entirely developed and occupied by existing land uses. No mining operations are present on-site, and it is unlikely that any future production would occur because the surrounding areas are largely developed and urbanized with no mineral resources of value to the region and the state. Therefore, construction and operation of MSF Design Option 1 would not result in the loss of availability of a known mineral resource, and MSF Design Option 1 would have no impact on known mineral resources or a locally important mineral resource recovery site.

7.6 Project and Mitigation Measures

7.6.1 Operational Impacts

No mitigation measures are required.

7.6.2 Construction Impacts

Alternative 3 would implement the following project and mitigation measures to ensure that impacts to the geology, soils, and seismicity remain less than significant during construction activities:

PM GEO-1: *The Project shall demonstrate to the County of Los Angeles and the City of Los Angeles that the design of the Project complies with all applicable provisions of the California Building Code with respect to seismic design. Compliance shall include the following:*

- *California Building Code Seismic Zone 4 Standards as the minimum seismic-resistant design for all proposed facilities*
- *Seismic-resistant earthwork and construction design criteria (i.e., for the construction of the tunnel below ground surface, liquefaction, landslide, etc.), based on the site-specific recommendations of a California Registered Geologist in cooperation with the Project Engineers.*
- *An engineering analysis to characterize site specific performance of alluvium or fill where either forms part or all of the support.*

PM GEO-2: *A California-registered geologist and geotechnical engineer shall submit to and have approval by the Project a site specific evaluation of unstable soil conditions, including recommendations for ground preparation and earthwork activities specific to the site and in conformance with City of Los Angeles Building Code, County of Los Angeles Building Code, the California Building Code, Metro Rail Design Criteria (as applicable), and Caltrans Structure Seismic Design Criteria.*

PM GEO-3: *The Project shall demonstrate that the design of the Project complies with all applicable provisions of the County of Los Angeles Building Code and City of Los Angeles Building Code.*

MM GEO-1: *The Project's design shall include integration and installation of early warning system to detect and respond to strong ground motion associated with ground rupture. Known active fault(s) (i.e., Santa Monica Fault) shall be monitored. Linear monitoring systems such as time domain reflectometers or equivalent or more effective technology shall be installed along fixed guideway in the zone of potential ground rupture.*

MM GEO-2: *Where excavations are made for the construction of the below surface tunnel, the Project shall either shore excavation walls with shoring designed to withstand additional loads or reduce the slope of the excavation walls to a shallower gradient. Excavation spoils shall not be placed immediately adjacent to excavation walls unless the excavation wall is shored to support the added load. Spoils should be stored at a safe distance from the excavation site to prevent undue pressure on the walls.*

MM GEO-3: *The Project shall comply with the recommendations of the final soils and geotechnical report. These recommendations shall be implemented in the design of the Project, including but not limited to measures associated with site preparation, fill placement, temporary shoring and permanent dewatering, groundwater seismic design features, excavation stability, foundations, soil stabilization, establishment of deep foundations, concrete slabs and pavements, surface drainage, cement type and corrosion measures, erosion control, shoring and internal bracing, and plan review.*

MM GEO-4: *In locations where soils have a potential to be corrosive to steel and concrete, the soils shall be removed, and buried structures shall be designed for corrosive conditions, and corrosion-protected materials shall be used in infrastructure.*

MM GEO-5: *Prior to construction, the Project shall prepare a Construction Management Plan (CMP) that addresses geologic constraints and outlines strategies to minimize or avoid impacts to geologic hazards during construction. The plan shall address the following geological and geotechnical constraints/resources and incorporate standard mitigation measures (shown in parentheses):*

- *Groundwater withdrawal (using dewatering pumps and proper disposal of contaminated groundwater according to legal requirements)*
- *Risk of ground failure from unstable soils (retaining walls and inserting soil stabilizers)*
- *Subsidence (retaining walls and shoring)*
- *Erosion control methods (netting on slopes, bioswales, sediment basins, re-vegetation)*
- *Soils with shrink-swell potential (inserting soil stabilizers)*
- *Soils with corrosive potential (protective coatings and protection for metal, steel or concrete structures, soil treatment, removal of corrosive soils and proper disposal of any corrosive soils)*
- *Impact to topsoils (netting, and dust control)*
- *The recommendations of the CMP would be incorporated into the project plans and specifications.*

MM GEO-6: *The potential to avoid impacts to previously unrecorded paleontological resources shall be avoided by having a qualified Paleontologist or Archaeologist cross-trained in paleontology, meeting the Society of Vertebrate Paleontology Standards retained as the project paleontologist, with a minimum of a bachelor's degree (B.S./B.A.) in geology, or related discipline with an emphasis in paleontology and demonstrated experience and competence in paleontological research, fieldwork, reporting, and curation. A paleontological monitor, under the guidance of the project paleontologist, shall be present as required by the type of earth-moving activities in the Project, specifically in areas south of Ventura Boulevard that have been deemed areas of high sensitivity for paleontological resources. The monitor shall be a trained paleontological monitor with experience and knowledge of sediments, geologic formations, and the identification and treatment of fossil resources.*

MM GEO-7: *A Paleontological Resources Impact Mitigation Program (PRIMP) shall be prepared by a qualified paleontologist. The PRIMP shall include guidelines for developing and implementing mitigation efforts, including minimum requirements, general fieldwork, and laboratory methods, threshold for assessing paleontological resources, threshold for excavation and documentation of significant or unique paleontological resources, reporting requirements, considerations for the curation of recovered paleontological resources into a relevant institution, and process of documents to Metro and peer review entities.*

MM GEO-8: *The project paleontologist or paleontological monitor shall perform a Workers Environmental Awareness Program training session for each worker on the project site to familiarize the worker with the procedures in the event a paleontological resource is discovered. Workers hired after the initial Workers Environmental Awareness Program training conducted at the pre-grade meeting shall be required to take additional Workers Environmental Awareness Program training as part of their site orientation.*

MM GEO-9: *To prevent damage to unanticipated paleontological resources, a paleontological monitor shall observe ground-disturbing activities including but not limited to grading, trenching, drilling, etc. Paleontological monitoring shall start at full time for geological units deemed to have "High" paleontological sensitivity. Geological units deemed to have "Low" paleontological sensitivity shall be monitored by spot checks. No monitoring is required for geologic units identified as having "No" paleontological sensitivity. "Unknown" paleontological sensitivity is assigned to the less metamorphosed portions of the Santa Monica Slate, as detailed below.*

- *The monitor shall be empowered to temporarily halt or redirect construction efforts if paleontological resources are discovered. The paleontological monitor shall flag an area 50 feet around the discovery and notify the construction crew immediately. No further disturbance in the flagged area shall occur until the qualified paleontologist has cleared the area. In consultation with the qualified paleontologist, the monitor shall quickly assess the nature and significance of the find. If the specimen is not significant, it shall be quickly removed, and the area cleared. In the event paleontological resources are discovered and deemed by the project paleontologist to be scientifically important, the paleontological resources shall be recovered by excavation (i.e., salvage and bulk sediment sample) or* *immediate removal if the resource is small enough and can be removed safely in this fashion without damage to the paleontological resource. If the discovery is significant, the qualified paleontologist shall notify Metro immediately. In consultation with Metro, the qualified paleontologist shall develop a plan of mitigation, which will likely include salvage excavation and removal of the find, removal of sediment from around the specimen (in the laboratory), research to identify and categorize the find, curation of the find in a local qualified repository, and preparation of a report summarizing the find.*

- *Generally, geologic units that have endured metamorphic processes (i.e., extreme heat and pressure over long periods of time) do not contain paleontological resources. The Santa Monica Slate, originally a fossiliferous shale, has been subjected to various levels of metamorphism and thus, in areas of "low-grade metamorphism," paleontological resources may be discovered. Due to the rarity of paleontological resources dating to the Mesozoic (between approximately 65.5 to 252 million years ago) of Southern California, any such materials have high importance to the paleontology of the region. When encountered, the project paleontologist shall assess the levels of metamorphism that portion of the Santa Monica Slate has experienced. The Santa Monica Slate shall be monitored part time where the project paleontologist has determined lower levels of metamorphism have taken place and the preservation of paleontological resources is possible. If exposures of the Santa Monica Slate have been subjected to high levels of metamorphism (i.e., phyllite components of Jsmp), paleontological monitoring in that portion of the formation is not necessary.*
- *Recovered paleontological resources shall be prepared, identified to the lowest taxonomic level possible, and curated into a recognized repository (i.e., Natural History Museum of Los Angeles County). Bulk sediment samples, if collected, shall be "screen-washed" to recover the contained paleontological resources, which will then be identified to the lowest taxonomic level possible, and curated (as above). The report and all relevant field notes shall be accessioned along with the paleontological resources.*

7.6.3 Impacts After Mitigation

Adherence to existing regulations and the implementation of PM GEO-1 and, MM GEO-1 would ensure that Alternative 3 would remain with a less than significant impact associated with exposing people or structures to seismic ground shaking, including effects related to seismic-related ground failure during construction activities.

Adherence to existing regulations and implementation of PM GEO-1 would ensure that Alternative 3 would remain with a less than significant impact with the exposure of people or structures to liquefaction during construction activities.

With adherence to existing regulations, Alternative 3 would have a less than significant impact associated with landslides and/or slope instability during construction activities.

Adherence to existing regulations and policies and the implementation of PM GEO-2 and MM GEO-3 through MM GEO-5 would ensure the maximum practicable protection available for users of buildings and infrastructure and associated trenches, slopes, and foundations. Therefore, Alternative 3 would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils.

With implementation of PM GEO-3 and adherence to existing regulations, Alternative 3 would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils.

When grading and trenching activities are employed, observation of the MM GEO-6 through MM GEO-9 would reduce the impact to paleontological resources to less than significant. However, use of the CIDH method and TBM would grind the soil and not allow careful inspection for paleontological resources. Where the CIDH method and TBM are used, impacts would remain significant and unavoidable.

8 ALTERNATIVE 4

8.1 Alternative Description

Alternative 4 is a heavy rail transit (HRT) system with a hybrid underground and aerial guideway track configuration that would include four underground stations and four aerial stations. This alternative would provide transfers to five high-frequency fixed guideway transit and commuter rail lines, including the Los Angeles County Metropolitan Transportation Authority's (Metro) E, Metro D, and Metro G Lines, the East San Fernando Valley Light Rail Transit Line, and the Metrolink Ventura County Line. The length of the alignment between the terminus stations would be approximately 13.9 miles, with 5.7 miles of aerial guideway and 8.2 miles of underground configuration.

The four underground and four aerial HRT stations would be as follows:

1. Metro E Line Expo/Sepulveda Station (underground)
2. Santa Monica Boulevard Station (underground)
3. Wilshire Boulevard/Metro D Line Station (underground)
4. UCLA Gateway Plaza Station (underground)
5. Ventura Boulevard/Sepulveda Boulevard Station (aerial)
6. Metro G Line Sepulveda Station (aerial)
7. Sherman Way Station (aerial)
8. Van Nuys Metrolink Station (aerial)

8.1.1 Operating Characteristics

8.1.1.1 Alignment

As shown on Figure 8-1, from its southern terminus station at the Metro E Line Expo/Sepulveda Station, the alignment of Alternative 4 would run underground north through the Westside of Los Angeles (Westside) and the Santa Monica Mountains to a tunnel portal south of Ventura Boulevard in the San Fernando Valley (Valley). At the tunnel portal, the alignment would transition to an aerial guideway that would generally run above Sepulveda Boulevard before curving eastward along the south side of the Los Angeles-San Diego-San Luis Obispo (LOSSAN) rail corridor to the northern terminus station adjacent to the Van Nuys Metrolink/Amtrak Station.

The proposed southern terminus station would be located underground east of Sepulveda Boulevard, between the existing elevated Metro E Line tracks and Pico Boulevard. Tail tracks for vehicle storage would extend underground south of National Boulevard, east of Sepulveda Boulevard. The alignment would continue north beneath Bentley Avenue before curving northwest to an underground station at the southeast corner of Santa Monica Boulevard and Sepulveda Boulevard. From the Santa Monica Boulevard Station, the alignment would continue and curve eastward toward the Wilshire Boulevard/Metro D Line Station beneath the Metro D Line Westwood/UCLA Station, which is currently under construction as part of the Metro D Line Extension Project. From there, the underground alignment would curve slightly to the northeast and continue beneath Westwood Boulevard before reaching the UCLA Gateway Plaza Station.

Figure 8-1. Alternative 4: Alignment

Source: STCP, 2024; HTA, 2024

From the UCLA Gateway Plaza Station, the alignment would turn to the northwest beneath the Santa Monica Mountains to the east of Interstate 405 (I-405). South of Mulholland Drive, the alignment would curve to the north to reach a tunnel portal at Del Gado Drive, just east of I-405 and south of Sepulveda Boulevard.

The alignment would transition from an underground configuration to an aerial guideway structure after exiting the tunnel portal and would continue northeast to the Ventura Boulevard/Sepulveda Boulevard

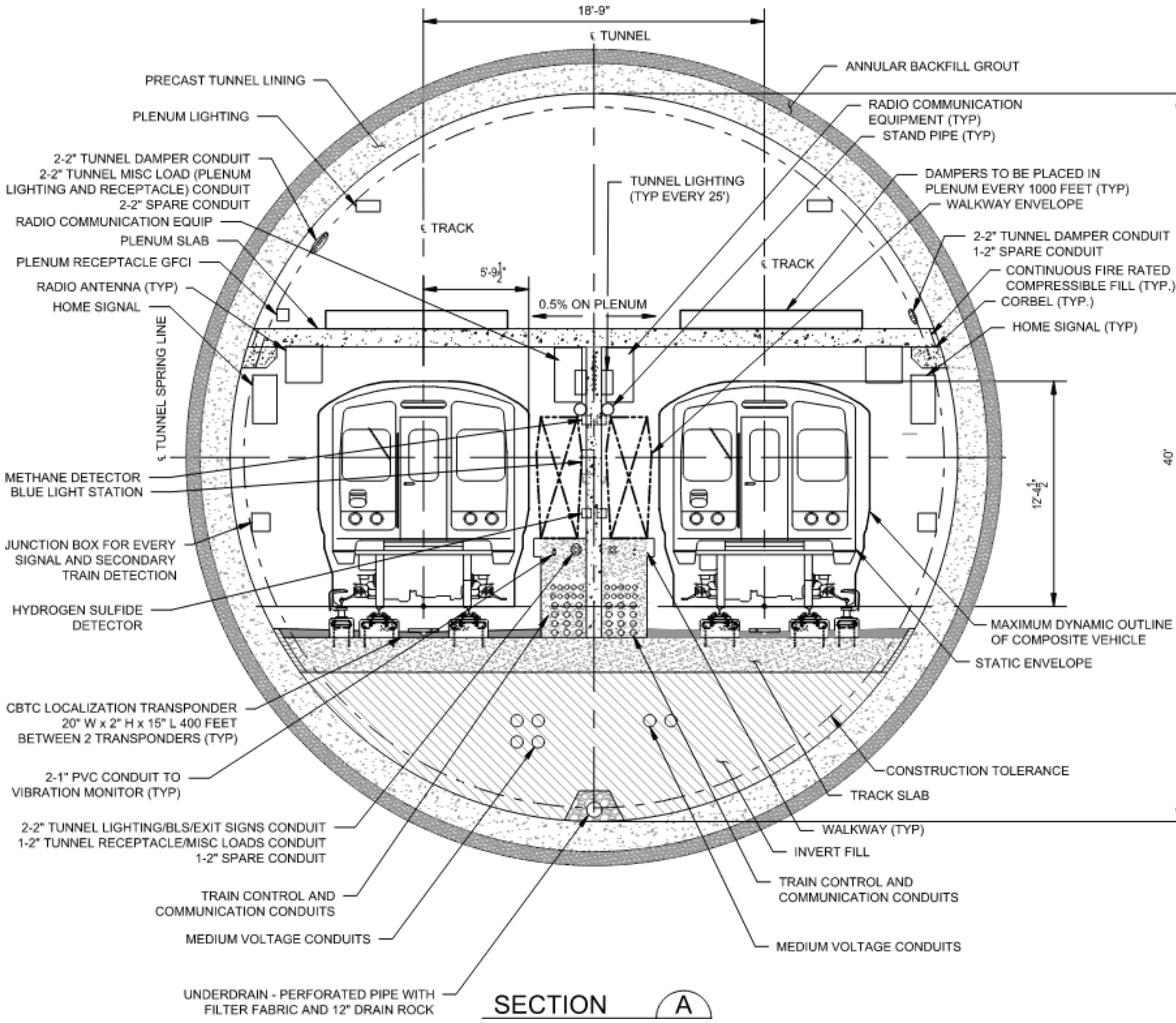
Station located over Dickens Street, immediately west of the Sepulveda Boulevard and Dickens Street intersection. North of the station, the aerial guideway would transition to the center median of Sepulveda Boulevard. The aerial guideway would continue north on Sepulveda Boulevard and cross over U.S. Highway 101 (US-101) and the Los Angeles River before continuing to the Metro G Line Sepulveda Station, immediately south of the Metro G Line Busway. Overhead utilities along Sepulveda Boulevard in the Valley would be undergrounded where they would conflict with the guideway or its supporting columns.

The aerial guideway would continue north above Sepulveda Boulevard, where it would reach the Sherman Way Station just south of Sherman Way. After leaving the Sherman Way Station, the alignment would continue north before curving to the southeast to parallel the LOSSAN rail corridor on the south side of the existing tracks. Parallel to the LOSSAN rail corridor, the guideway would conflict with the existing Willis Avenue Pedestrian Bridge, which would be demolished. The alignment would follow the LOSSAN rail corridor before reaching the proposed northern terminus Van Nuys Metrolink Station located adjacent to the existing Metrolink/Amtrak Station. Tail tracks and yard lead tracks would descend to a proposed at-grade maintenance and storage facility (MSF) east of the northern terminus station. Modifications to the existing pedestrian underpass to the Metrolink platforms to accommodate these tracks would result in reconfiguration of an existing rail spur serving City of Los Angeles Department of Water and Power (LADWP) property.

8.1.1.2 Guideway Characteristics

Alternative 4 would utilize a single-bore tunnel configuration for underground tunnel sections, with an outside diameter of approximately 43.5 feet. The tunnel would include two parallel tracks with 18.75-foot track spacing in tangent sections separated by a continuous central dividing wall throughout the tunnel. Inner walkways would be constructed adjacent to the two tracks. Inner and outer walkways would be constructed within tunnel sections near the track crossovers. At the crown of tunnel, a dedicated air plenum would be provided by constructing a concrete slab above the railway corridor. The air plenum would allow for ventilation throughout the underground portion of the alignment. Figure 8-2 illustrates these components at a typical cross-section of the underground guideway.

Figure 8-2. Typical Underground Guideway Cross-Section

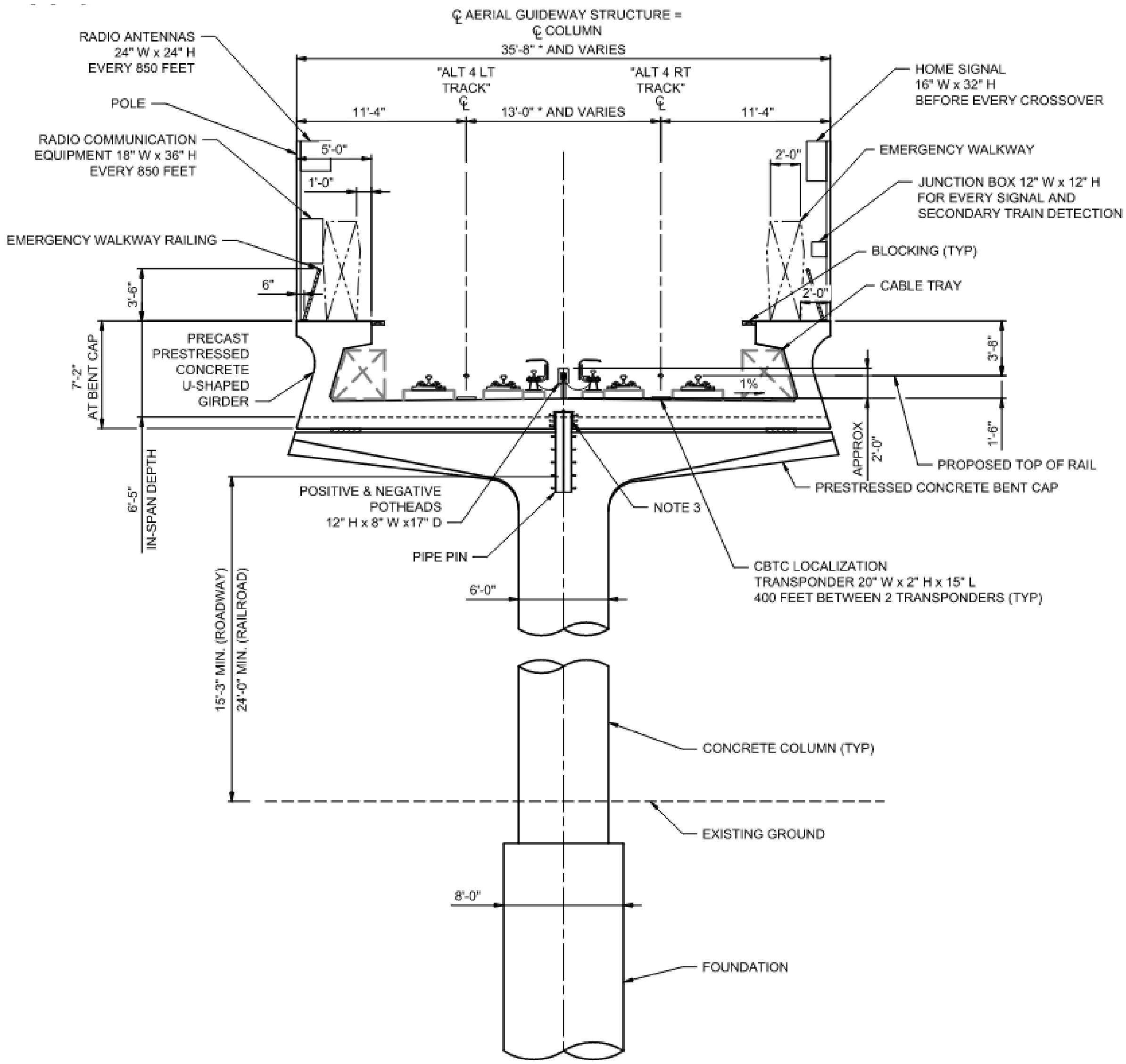


Source: STCP, 2024

In aerial sections, the guideway would be supported by either single columns or straddle-bents. Both types of structures would support a U-shaped concrete girder and the HRT track. The aerial guideway would be approximately 36 feet wide. The track would be constructed on the concrete girders with direct fixation and would maintain a minimum of 13 feet between the centerlines of the two tracks. On the outer side of the tracks, emergency walkways would be constructed with a minimum width of 2 feet.

The single-column pier would be the primary aerial structure throughout the aerial portion of the alignment. Crash protection barriers would be used to protect columns located in the median of Sepulveda Boulevard in the Valley. Figure 8-3 shows a typical cross-section of the single-column aerial guideway.

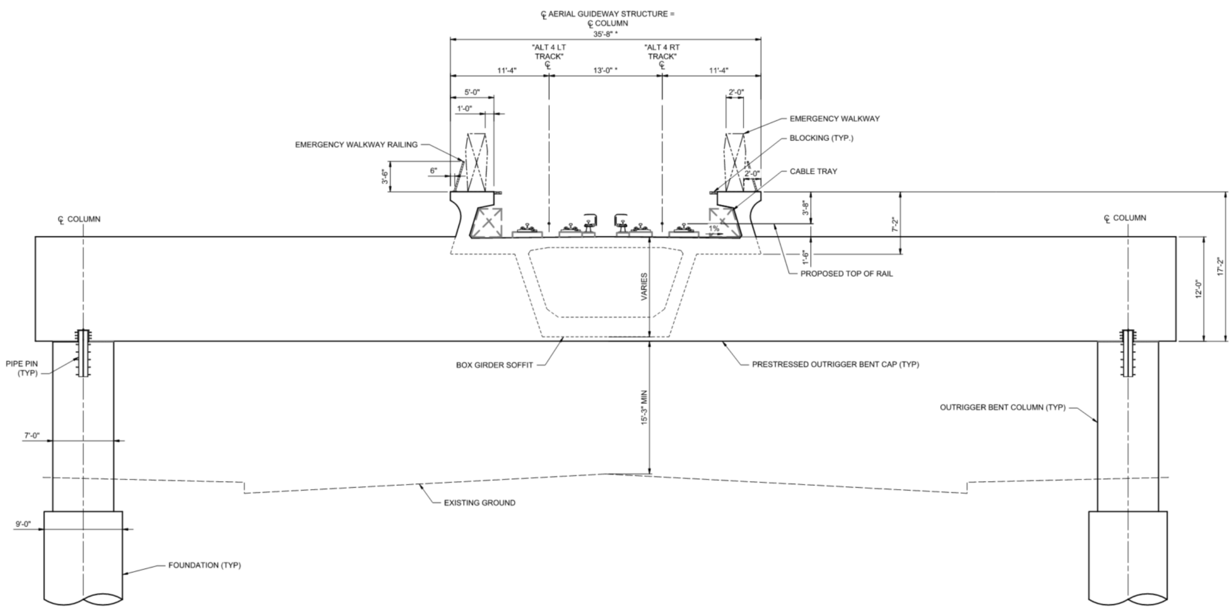
Figure 8-3. Typical Aerial Guideway Cross-Section



Source: STCP, 2024

In order to span intersections and maintain existing turn movements, sections of the aerial guideway would be supported by straddle bents, a concrete straddle-beam placed atop two concrete columns constructed outside of the underlying roadway. Figure 8-4 illustrates a typical straddle-bent configuration.

Figure 8-4. Typical Aerial Straddle-Bent Cross-Section



Source: STCP, 2024

8.1.1.3 Vehicle Technology

Alternative 4 would utilize steel-wheel HRT trains, with automated train operations and planned peak-period headways of 2.5 minutes and off-peak-period headways ranging from 4 to 6 minutes. Each train could consist of three or four cars with open gangways between cars. The HRT vehicle would have a maximum operating speed of 70 miles per hour; actual operating speeds would depend on the design of the guideway and distance between stations. Train cars would be approximately 10 feet wide with three double doors on each side. Each car would be approximately 72 feet long with capacity for 170 passengers. Trains would be powered by a third rail.

8.1.1.4 Stations

Alternative 4 would include four underground stations and four aerial stations with station platforms measuring 280 feet long for both station configurations. The aerial stations would be constructed a minimum of 15.25 feet above ground level, supported by rows of dual columns with 8-foot diameters. The southern terminus station would be adjacent to the Metro E Line Expo/Sepulveda Station, and the northern terminus station would be adjacent to the Van Nuys Metrolink/Amtrak Station.

All stations would be side-platform stations where passengers would select and travel to station platforms depending on their direction of travel. All stations would include 20-foot-wide side platforms separated by 30 feet for side-by-side trains. Aerial station platforms would be covered, but not enclosed. Each underground station would include an upper and lower concourse level prior to reaching the train platforms. Each aerial station, except for the Sherman Way Station, would include a mezzanine level prior to reaching the station platforms. At the Sherman Way Station, separate entrances on opposite sides of the street would provide access to either the northbound or southbound platform with an overhead pedestrian walkway providing additional connectivity across platforms. Each station would have a minimum of two elevators, two escalators, and one stairway from the ground level to the concourse or mezzanine.

Stations would include automatic, bi-parting fixed doors along the edges of station platforms. These platform screen doors would be integrated into the automatic train control system and would not open unless a train is stopped at the platform.

The following information describes each station, with relevant entrance, walkway, and transfer information. Bicycle parking would be provided at each station.

Metro E Line Expo/Sepulveda Station

- This underground station would be located just north of the existing Metro E Line Expo/Sepulveda Station, on the east side of Sepulveda Boulevard.
- A station entrance would be located on the east side of Sepulveda Boulevard, north of the Metro E Line.
- A walkway to transfer to the Metro E Line would be provided at street level within the fare paid zone.
- A 126-space parking lot would be located immediately north of the station entrance, east of Sepulveda Boulevard. Passengers would also be able to park at the existing Metro E Line Expo/Sepulveda Station parking facility, which provides 260 parking spaces.

Santa Monica Boulevard Station

- This underground station would be located under the southeast corner of Santa Monica Boulevard and Sepulveda Boulevard.
- The station entrance would be located on the south side of Santa Monica Boulevard, between Sepulveda Boulevard and Bentley Avenue.
- No dedicated station parking would be provided at this station.

Wilshire Boulevard/Metro D Line Station

- This underground station would be located beneath the Metro D Line tracks and platform under Gayley Avenue, between Wilshire Boulevard and Lindbrook Drive.
- Station entrances would be provided on the northeast corner of Wilshire Boulevard and Gayley Avenue and on the northeast corner of Lindbrook Drive and Gayley Avenue. Passengers would also be able to use the Metro D Line Westwood/UCLA Station entrances to access the station platform.
- A direct internal station transfer to the Metro D Line would be provided at the south end of the station.
- No dedicated station parking would be provided at this station.

UCLA Gateway Plaza Station

- This underground station would be located underneath Gateway Plaza on the University of California, Los Angeles (UCLA) campus.
- Station entrances would be provided on the north side of Gateway Plaza and on the east side of Westwood Boulevard, across from Strathmore Place.
- No dedicated station parking would be provided at this station.

Ventura Boulevard/Sepulveda Boulevard Station

- This aerial station would be located west of Sepulveda Boulevard, spanning over Dickens Street.

- A station entrance would be provided on the west side of Sepulveda Boulevard, south of Dickens Street.
- A 52-space parking lot would be located adjacent to the station entrance on the southwest corner of the Sepulveda Boulevard and Dickens Street intersection, and an additional 40-space parking lot would be located on the northwest corner of the same intersection.

Metro G Line Sepulveda Station

- This aerial station would be located over Sepulveda Boulevard, immediately south of the Metro G Line Busway.
- A station entrance would be provided on the west side of Sepulveda Boulevard, south of the Metro G Line Busway.
- An elevated pedestrian walkway would connect the platform level of the proposed station to the planned aerial Metro G Line Busway platforms within the fare paid zone.
- Passengers would be able to park at the existing Metro G Line Sepulveda Station parking facility, which has a capacity of 1,205 parking spaces. Currently, only 260 parking spaces are used for transit parking. No additional automobile parking would be provided at the proposed station.

Sherman Way Station

- This aerial station would be located over Sepulveda Boulevard between Sherman Way and Gault Street.
- Station entrances would be provided on either side of Sepulveda Boulevard, south of Sherman Way.
- A 46-space parking lot would be located on the northwest corner of the Sepulveda Boulevard and Gault Street intersection, and an additional 76-space parking lot would be located west of the station along Sherman Way.

Van Nuys Metrolink Station

- This aerial station would span Van Nuys Boulevard, just south of the LOSSAN rail corridor.
- The primary station entrance would be located on the east side of Van Nuys Boulevard, just south of the LOSSAN rail corridor. A secondary station entrance would be located between Raymer Street and Van Nuys Boulevard.
- An underground pedestrian walkway would connect the station plaza to the existing pedestrian underpass to the Metrolink/Amtrak platform outside the fare paid zone.
- Existing Metrolink Station parking would be reconfigured, maintaining approximately the same number of spaces, but 66 parking spaces would be relocated west of Van Nuys Boulevard. Metrolink parking would not be available to Metro transit riders.
- Existing at-grade walkway connecting to the underpass would be slightly modified to provide direct access to the Metrolink/Amtrak station.

8.1.1.5 Station-to-Station Travel Times

Table 8-1 presents the station-to-station distance and travel times at peak period for Alternative 4. The travel times include both run time and dwell time. Dwell time is 30 seconds for transfer stations and 20 seconds for other stations. Northbound and southbound travel times vary slightly because of grade differentials and operational considerations at end-of-line stations.

Table 8-1. Alternative 4: Station-to-Station Travel Times and Station Dwell Times

From Station	To Station	Distance (miles)	Northbound Station-to-Station Travel Time (seconds)	Southbound Station-to-Station Travel Time (seconds)	Dwell Time (seconds)
Metro E Line Station					*30*
Metro E Line	Santa Monica Boulevard	0.9	89	86	—
Santa Monica Boulevard Station					*20*
Santa Monica Boulevard	Wilshire/Metro D Line	0.9	91	92	—
Wilshire/Metro D Line Station					*30*
Wilshire/Metro D Line	UCLA Gateway Plaza	0.7	75	68	—
UCLA Gateway Plaza Station					*20*
UCLA Gateway Plaza	Ventura Boulevard	6.1	376	366	—
Ventura Boulevard Station					*20*
Ventura Boulevard	Metro G Line	1.9	149	149	—
Metro G Line Station					*30*
Metro G Line	Sherman Way	1.4	110	109	—
Sherman Way Station					*20*
Sherman Way	Van Nuys Metrolink	1.9	182	180	—
Van Nuys Metrolink Station					*30*

Source: STCP, 2024

— = no data

8.1.1.6 Special Trackwork

Alternative 4 would include 10 double crossovers throughout the alignment, enabling trains to cross over to the parallel track. Each terminus station would include a double crossover immediately north and south of the station. Except for the Santa Monica Boulevard Station, each station would have a double crossover immediately south of the station. The remaining crossovers would be located along the alignment midway between the UCLA Gateway Plaza Station and the Ventura Boulevard Station.

8.1.1.7 Maintenance and Storage Facility

The MSF for Alternative 4 would be located east of the Van Nuys Metrolink Station and would encompass approximately 46 acres. The MSF would be designed to accommodate 184 rail cars and would be bounded by single-family residences to the south, the LOSSAN rail corridor to the north, Woodman Avenue on the east, and Hazeltine Avenue and industrial manufacturing enterprises to the west. Trains would access the site from the fixed guideway's tail tracks at the northwest corner of the site. Trains would then travel southeast to maintenance facilities and storage tracks.

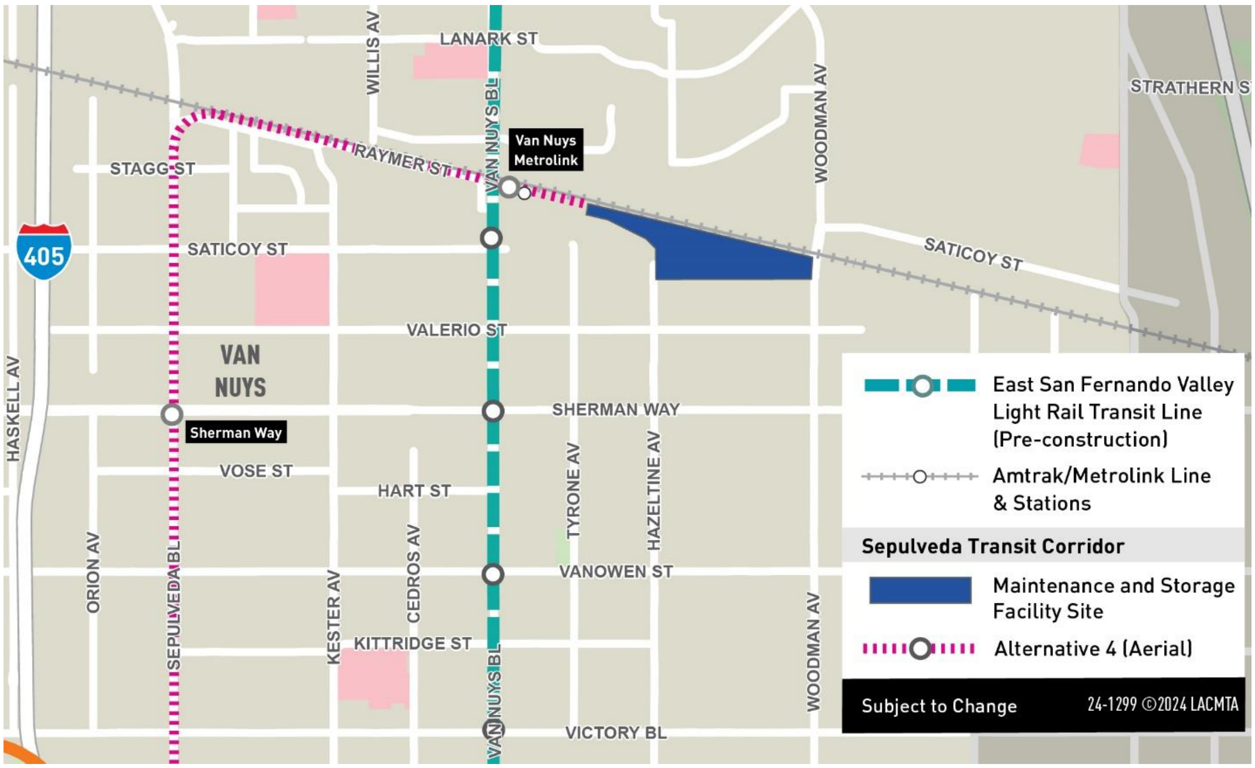
The site would include the following facilities:

- Two entrance gates with guard shacks
- Main shop building
- Maintenance-of-way building
- Storage tracks
- Carwash building
- Cleaning and inspections platforms
- Material storage building
- Hazmat storage locker

- Traction power substation (TPSS) located on the west end of the MSF to serve the mainline
- TPSS located on the east end of the MSF to serve the yard and shops
- Parking area for employees
- Grade-separated access roadway (over the HRT tracks at the east end of the facility, and necessary drainage)

Figure 8-5 shows the location of the MSF site for Alternative 4.

Figure 8-5. Alternative 4: Maintenance and Storage Facility Site



Source: STCP, 2024; HTA, 2024

8.1.1.8 Traction Power Substations

TPSSs transform and convert high voltage alternating current supplied from power utility feeders into direct current suitable for transit operation. Twelve TPSS facilities would be located along the alignment and would be spaced approximately 0.5 to 2.5 miles apart. TPSS facilities would generally be located within the stations, adjacent to the tunnel through the Santa Monica Mountains, or within the MSF. TPSSs would be approximately 2,000 to 3,000 square feet. Table 8-2 lists the TPSS locations for Alternative 4.

Figure 8-6 shows the TPSS locations along the Alternative 4 alignment.

Table 8-2. Alternative 4: Traction Power Substation Locations

TPSS No.	Location Description	Configuration
1	TPSS 1 would be located east of Sepulveda Boulevard and north of the Metro E Line.	Underground (within station)
2	TPSS 2 would be located south of Santa Monica Boulevard between Sepulveda Boulevard and Bentley Avenue.	Underground (within station)
3	TPSS 3 would be located at the southeast corner of UCLA Gateway Plaza.	Underground (within station)
4	TPSS 4 would be located south of Bellagio Road and west of Stone Canyon Road.	Underground (adjacent to tunnel)
5	TPSS 5 would be located west of Roscomare Road, between Donella Circle and Linda Flora Drive.	Underground (adjacent to tunnel)
6	TPSS 6 would be located east of Loom Place, between Longbow Drive and Vista Haven Road.	Underground (adjacent to tunnel)
7	TPSS 7 would be located west of Sepulveda Boulevard, between the I-405 Northbound On-Ramp and Dickens Street.	At-grade (within station)
8	TPSS 8 would be located west of Sepulveda Boulevard, between the Metro G Line Busway and Oxnard Street.	At-grade (within station)
9	TPSS 9 would be located at the southwest corner of Sepulveda Boulevard and Sherman Way.	At-grade (within station)
10	TPSS 10 would be located south of the LOSSAN rail corridor and north of Raymer Street and Kester Avenue.	At-grade
11	TPSS 11 would be located south of the LOSSAN rail corridor and east of the Van Nuys Metrolink Station.	At-grade (within MSF)
12	TPSS 12 would be located south of the LOSSAN rail corridor and east of Hazeltine Avenue.	At-grade (within MSF)

Source: STCP, 2024; HTA, 2024

Figure 8-6. Alternative 4: Traction Power Substation Locations

Source: STCP, 2024; HTA, 2024

8.1.1.9 Roadway Configuration Changes

Table 8-3 lists the roadway changes necessary to accommodate the guideway of Alternative 4. Figure 8-7 shows the location of roadway changes in the Sepulveda Transit Corridor Project (Project) Study Area, and Figure 8-8 shows details of the street vacation at Del Gado Drive.

In addition to the changes made to accommodate the guideway, as listed in Table 8-3, roadways and sidewalks near stations would be reconstructed, resulting in modifications to curb ramps and driveways.

Table 8-3. Alternative 4: Roadway Changes

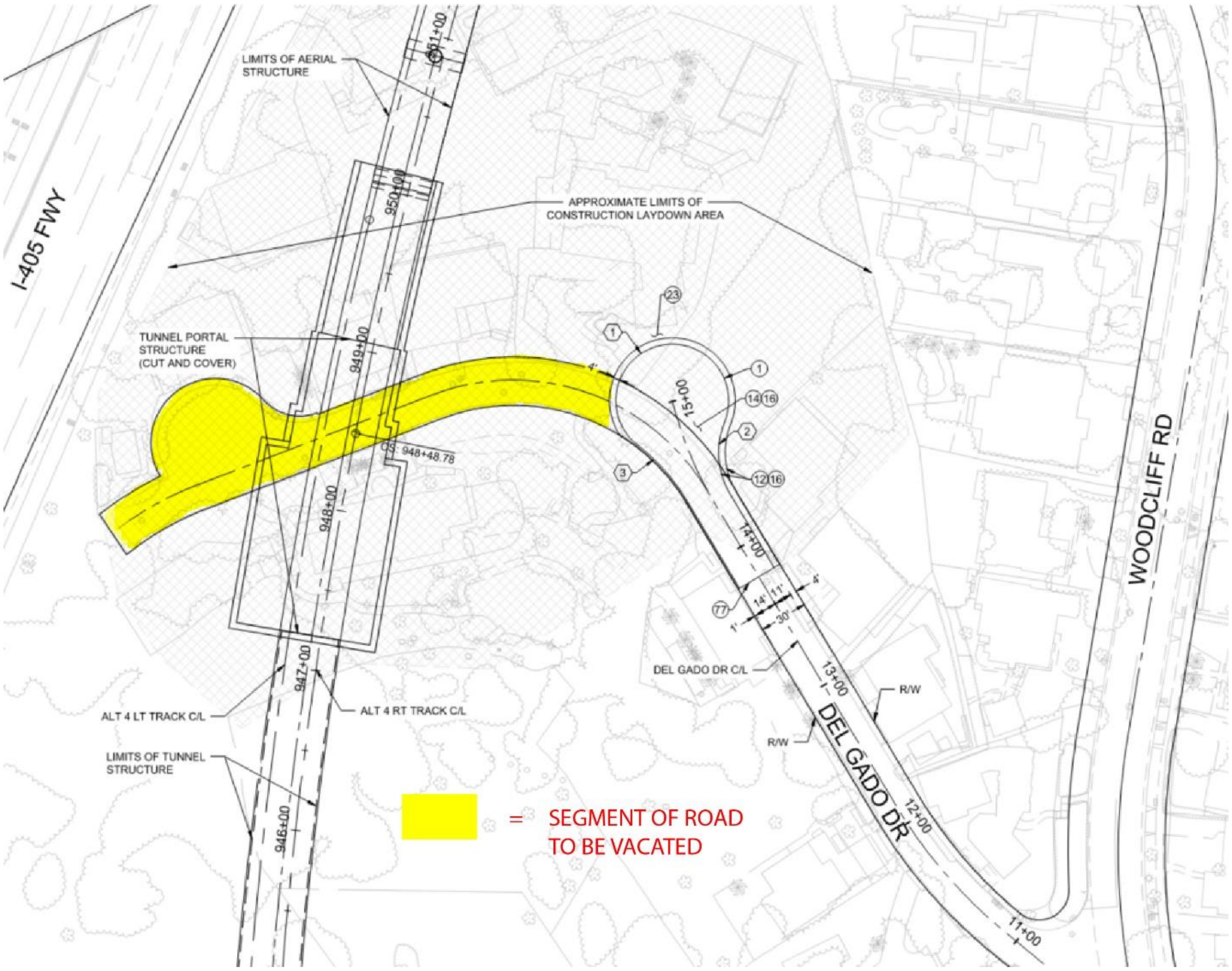
Location	From	To	Description of Change
Del Gado Drive	Woodcliff Road	Not Applicable	Vacation of approximately 325 feet of Del Gado Drive, east of I-405, to accommodate tunnel portal
Sepulveda Boulevard	Ventura Boulevard	Raymer Street	Construction of raised median and removal of all on-street parking on the southbound side of the street and some on-street parking on the northbound side of the street to accommodate aerial guideway columns
Sepulveda Boulevard	La Maida Street	Not Applicable	Prohibition of left turns to accommodate aerial guideway columns
Sepulveda Boulevard	Valleyheart Drive South, Hesby Street, Hartsook Street, Archwood Street, Hart Street, Leadwell Street, Covello Street	Not Applicable	Prohibition of left turns to accommodate aerial guideway columns
Raymer Street	Kester Avenue	Keswick Street	Reconstruction resulting in narrowing of width and removal of parking on the westbound side of the street to accommodate aerial guideway columns

Source: STCP, 2024; HTA, 2024

Figure 8-7. Alternative 4: Roadway Changes

Source: STCP, 2024; HTA, 2024

Figure 8-8. Alternative 4: Street Vacation at Del Gado Drive



Source: STCP, 2024; HTA, 2024

8.1.1.10 Ventilation Facilities

For ventilation of the alignment's underground portion, a plenum within the crown of the tunnel would provide a separate compartment for air circulation and allow multiple trains to operate between stations. Each underground station would include a fan room with additional ventilation facilities. Alternative 4 would also include a stand-alone ventilation facility at the tunnel portal on the northern end of the tunnel segment, located east of I-405 and south of Del Gado Drive. Within this facility, ventilation fan rooms would provide both emergency ventilation, in case of a tunnel fire, and regular ventilation, during non-revenue hours. The facility would also house sump pump rooms to collect water from various sources, including storm water; wash water (from tunnel cleaning); and water from a fire-fighting incident, system testing, or pipe leaks.

8.1.1.11 Fire/Life Safety – Emergency Egress

Within the tunnel segment, emergency walkways would be provided between the center dividing wall and each track. Sliding doors would be located in the central dividing wall at required intervals to connect the two sides of the railway with a continuous walkway to allow for safe egress to a point of safety (typically at a station) during an emergency. Similarly, the aerial guideway would include two emergency walkways with safety railing located on the outer side of the tracks. Access to tunnel segments for first responders would be through stations and the portal.

8.1.2 Construction Activities

Temporary construction activities for Alternative 4 would occur within project work zones at permanent facility locations, construction staging and laydown areas, and construction office areas. Construction of the transit facilities through substantial completion is expected to have a duration of 8 ¼ years. Early works, such as site preparation, demolition, and utility relocation, could start in advance of construction of the transit facilities.

For the guideway, Alternative 4 would consist of a single-bore tunnel through the Westside and Santa Monica Mountains. The tunnel would be comprised of two separate segments, one running north from the southern terminus to the UCLA Gateway Plaza Station (Westside segment), and the other running south from the portal in the San Fernando Valley to the UCLA Gateway Plaza Station (Santa Monica Mountains segment). Two tunnel boring machines (TBM) with approximately 45-foot-diameter cutting faces would be used to construct the two tunnel segments underground. For the Westside segment, the TBM would be launched from Staging Area No. 1 in Table 8-4 at Sepulveda Boulevard and National Boulevard. For the Santa Monica Mountains segment, the TBM would be launched from Staging Area No. 4 in the San Fernando Valley. Both TBMs would be extracted from the UCLA Gateway Plaza Station Staging Area No. 3 in Table 8-4. Figure 8-9 shows the location of construction staging locations along the Alternative 4 alignment.

Table 8-4. Alternative 4: On-Site Construction Staging Locations

No.	Location Description
1	Commercial properties on southeast corner of Sepulveda Boulevard and National Boulevard
2	North side of Wilshire Boulevard, between Veteran Avenue and Gayley Avenue
3	UCLA Gateway Plaza
4	Residential properties on both sides of Del Gado Drive and south side of Sepulveda Boulevard, adjacent to I-405
5	West of Sepulveda Boulevard, between Valley Vista Boulevard and Sutton Street
6	West of Sepulveda Boulevard, between US-101 and Sherman Oaks Castle Park
7	Lot behind Los Angeles Fire Department Station 88
8	Commercial property on southeast corner of Sepulveda Boulevard and Raymer Street
9	South of the LOSSAN rail corridor, east of Van Nuys Metrolink Station, west of Woodman Avenue

Source: STCP, 2024; HTA, 2024

Figure 8-9. Alternative 4: On-Site Construction Staging Locations

Source: STCP, 2024; HTA, 2024

The distance from the surface to the top of the tunnel for the Westside tunnel segment would vary from approximately 40 feet to 90 feet depending on the depth needed to construct the underground stations. The depth of the Santa Monica Mountains tunnel segment would vary from approximately 470 feet as it passes under the Santa Monica Mountains to 50 feet near UCLA. The tunnel segment through the Westside would be excavated in soft ground, while the tunnel through the Santa Monica Mountains would be excavated primarily in hard ground or rock as geotechnical conditions transition from soft to hard ground near the UCLA Gateway Plaza Station.

The aerial guideway viaduct would be primarily situated in the center of Sepulveda Boulevard in the San Fernando Valley, with guideway columns located in both the center and outside of the right-of-way of Sepulveda Boulevard. This would result in a linear work zone spanning the full width of Sepulveda Boulevard along the length of the aerial guideway. Three to five main phases would be required to construct the aerial guideway. A phased approach would allow travel lanes along Sepulveda Boulevard to remain open as construction individually occupies either the center, left, or right side of the roadway via the use of lateral lane shifts. Additional lane closures on side streets may be required along with appropriate detour routing.

The aerial guideway would comprise a mix of simple spans and longer balanced cantilever spans ranging from 80 to 250 feet in length. The repetitive simple spans would be utilized when guideway bent is located within the center median of Sepulveda Boulevard and would be constructed using Accelerated Bridge Construction (ABC) segmental span-by-span technology. Longer balanced cantilever spans would be provided at locations such as freeways, arterials, or street crossings, and would be constructed using ABC segmental balance cantilever technology. Foundations would consist of cast-in-drilled-hole (CIDH) shafts with both precast and cast-in-place structural elements. During construction of the aerial guideway, multiple crews would work on components of the guideway simultaneously.

Construction work zones would also be co-located with future MSF and station locations. All work zones would comprise the permanent facility footprint with additional temporary construction easements from adjoining properties.

The Metro E Line, Santa Monica Boulevard, Wilshire Boulevard/Metro D Line, and UCLA Gateway Plaza Stations would be constructed using a “cut-and-cover” method whereby the station structure would be constructed within a trench excavated from the surface with a portion or all being covered by a temporary deck and backfilled during the later stages of station construction. Traffic and pedestrian detours would be necessary during underground station excavation until decking is in place and the appropriate safety measures are taken to resume cross traffic. Constructing the Ventura Boulevard/Sepulveda Boulevard, Metro G Line Sepulveda, Sherman Way, and Van Nuys Metrolink Stations would include construction of CIDH elevated viaduct with two parallel side platforms supported by outrigger bents.

In addition to work zones, Alternative 4 would require construction staging and laydown areas at multiple locations along the alignment as well as off-site staging areas. Construction staging areas would provide the necessary space for the following activities:

- Contractors’ equipment
- Receiving deliveries
- Testing of soils for minerals or hazards
- Storing materials
- Site offices
- Work zone for excavation
- Other construction activities (including parking and change facilities for workers, location of construction office trailers, storage, staging and delivery of construction materials and permanent plant equipment, and maintenance of construction equipment)

A larger, off-site staging area would be used for temporary storage of excavated material from both tunneling and station cut-and-cover excavation activities. Table 8-4 and Figure 8-9 present potential construction staging areas along the alignment for Alternative 4. Table 8-5 and Figure 8-10 present candidate sites for off-site staging and laydown areas.

Table 8-5. Alternative 4: Potential Off-Site Construction Staging Locations

No.	Location Description
S1	East of Santa Monica Airport Runway
S2	Ralph's Parking Lot in Westwood Village
N1	West of Sepulveda Basin Sports Complex, south of the Los Angeles River
N2	West of Sepulveda Basin Sports Complex, north of the Los Angeles River
N3	Metro G Line Sepulveda Station Park & Ride Lot
N4	North of Roscoe Boulevard and Hayvenhurst Avenue
N5	LADWP property south of the LOSSAN rail corridor, east of Van Nuys Metrolink Station

Source: STCP, 2024; HTA, 2024

Figure 8-10. Alternative 4: Potential Off-Site Construction Staging Locations

Source: STCP, 2024; HTA, 2024

Construction of the HRT guideway between the Van Nuys Metrolink Station and the MSF would require reconfiguration of an existing rail spur serving LADWP property. The new location of the rail spur would require modification to the existing pedestrian undercrossing at the Van Nuys Metrolink Station.

Alternative 4 would require construction of a concrete casting facility for tunnel lining segments because no existing commercial fabricator capable of producing tunnel lining segments for a large-diameter tunnel exists within a practical distance of the Project Study Area. The site of the MSF would initially be used for this casting facility. The casting facility would include casting beds and associated casting equipment, storage areas for cement and aggregate, and a field quality control facility, which would need to be constructed on-site. When a more detailed design of the facility is completed, the contractor would obtain all permits and approvals necessary from the City of Los Angeles, the South Coast Air Quality Management District, and other regulatory entities.

As areas of the MSF site begin to become available following completion of pre-casting operations, construction of permanent facilities for the MSF would begin, including construction of surface buildings such as maintenance shops, administrative offices, train control, traction power and systems facilities. Some of the yard storage track would also be constructed at this time to allow delivery and inspection of passenger vehicles that would be fabricated elsewhere. Additional activities occurring at the MSF during the final phase of construction would include staging of trackwork and welding of guideway rail.

8.2 Existing Conditions

8.2.1 Regional Geology

Alternative 4 would pass through the northwestern portion of the Los Angeles Basin, through the Santa Monica Mountains, and then continue into the south and central portions of the San Fernando Valley. The Los Angeles Basin is a southwest-trending alluvial plain with gentle sloping. The Santa Monica Mountains trend east–west, where long southward-draining canyons are located on the south flank and shorter northward-draining canyons are located on the north flank. The San Fernando Valley basin trends east–west with alluvial fan deposits and channelized wash deposits (Metro, 2023b). Alternative 4 would be within two geologic provinces (City of Los Angeles, 2018):

- The northern portion of Alternative 4 would be located within the Transverse Ranges geomorphic province.
- The southern portion of Alternative 4 would be located within the Los Angeles Basin, which is the northern-most basin of the Peninsular Ranges geomorphic province.

8.2.1.1 Transverse Ranges Geomorphic Province

The Transverse Ranges geomorphic province is composed of several mountain ranges oriented in an east–west direction and extends over 320 miles from the Mojave and Colorado Desert Provinces to Point Arguello at the Pacific Ocean. Included within the Transverse Ranges are portions of Riverside, San Bernardino, Los Angeles, and Ventura Counties. Acting as a northern boundary, the Transverse Ranges truncate the northwest-trending structural grain of the Peninsular Ranges geomorphic province. Most active faults in the Transverse Ranges are east–west-trending faults. Rock types in this province include gneiss, granitic rocks, and sedimentary rocks. Volcanic rocks are found in the Santa Monica Mountains. Alluvial sediments are typically in canyon bottoms and valleys, with broad alluvial fans at the mouths of steep canyons (City of Los Angeles, 2018).

8.2.1.2 Peninsular Ranges Geomorphic Province

The Peninsular Ranges geomorphic province, composed of multiple mountain ranges and valleys, extends southward 775 miles past the United States-Mexico border. The Peninsular Ranges geomorphic province extends southward from the southern edge of the Transverse Ranges geomorphic province to the tip of Baja California in Mexico. The Peninsular Ranges are characterized by northwest–southeast-trending hills and valleys that are separated by similarly trending faults. Most active faults in the

Peninsular Ranges province are northwest trending. Rock types in this province in the Los Angeles region generally include schist and sedimentary rocks. Surface materials in canyon bottoms and basins generally consist of alluvium (City of Los Angeles, 2018).

8.2.1.3 San Fernando Valley

The San Fernando Valley is a triangular east–west-trending structural depression located within the Transverse Ranges geomorphic province. The Transverse Ranges province trends east–west from the offshore Channel Islands (Santa Rosa, Santa Cruz, Anacapa, etc.) to the eastern Mojave Desert. The province is characterized by east–west trending mountain ranges (such as the Santa Monica Mountains, San Gabriel Mountains, and San Bernardino Mountains) separated by similar trending intermontane valleys. The San Fernando Valley is bordered on the east by the Verdugo Mountains, on the north by the San Gabriel and Santa Susana Mountains, on the west by the Simi Hills, and on the south by the Santa Monica Mountains. The mountains that bound the San Fernando Valley are actively deforming anticlinal ranges bounded by thrust faults. Because the ranges have risen and deformed, the valley has subsided and accumulated sediment to create the elongated basin (City of Los Angeles, 2018).

8.2.1.4 Santa Monica Mountains

The Santa Monica Mountains are an east–west-trending linear mountain range within the western Transverse Ranges geomorphic province. Major east-trending folds, reverse faults, and left-lateral, strike-slip faults reflect regional north–south compression and are characteristic of the Transverse Ranges. The Santa Monica Mountains are being actively uplifted along a series of segmented frontal reverse faults (Malibu Coast fault, Santa Monica fault, and Raymond fault) on the south side of the range that extend from Arroyo Sequit in the west to Glendale in the east. This fault system is aligned with the Santa Cruz Island fault. The Los Angeles Basin on the southern side of the range is one of a series of basins forming a transition zone between the Transverse Ranges and the northwest–southeast-trending Peninsular Ranges geomorphic province to the south (Metro, 2023b).

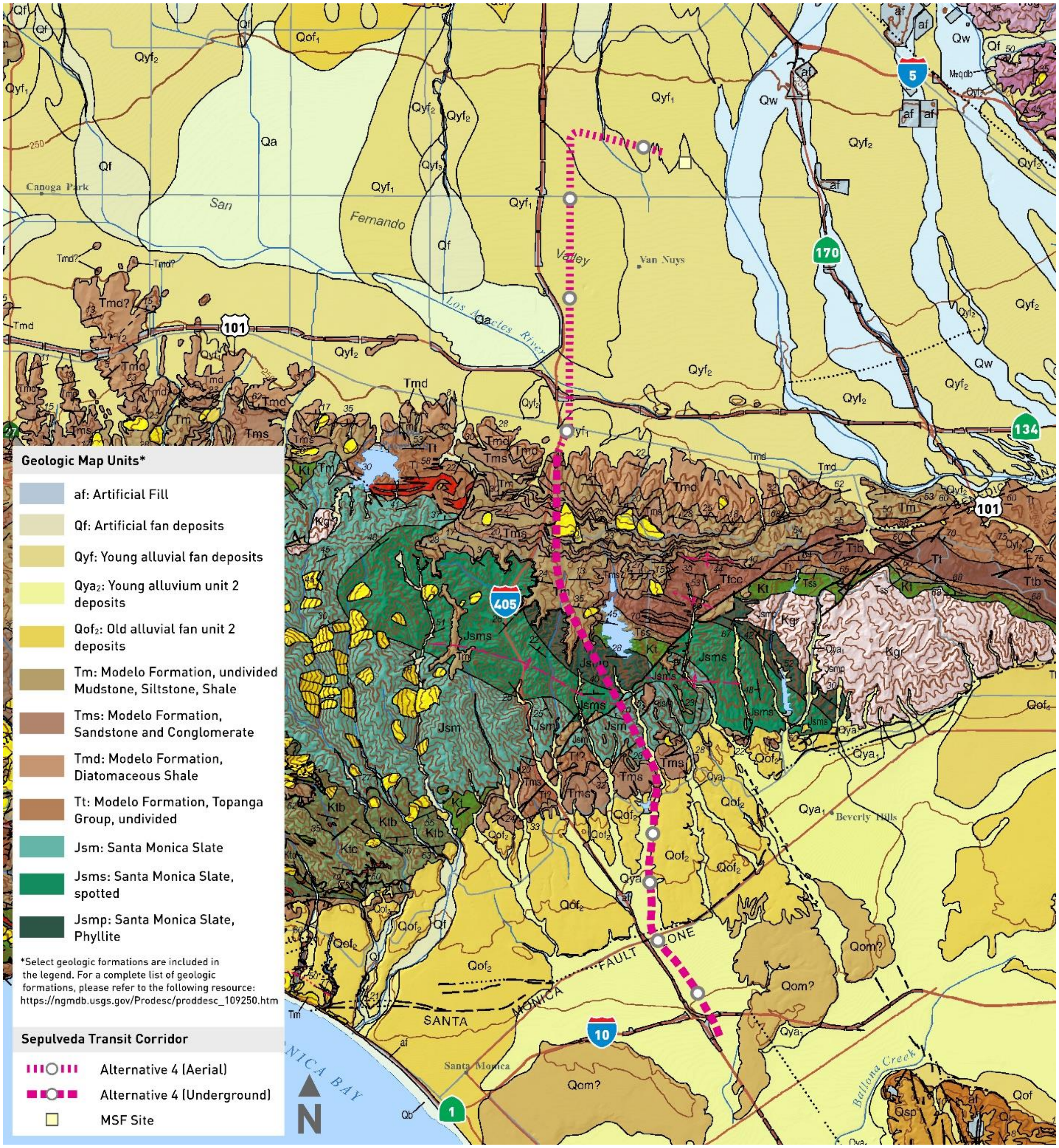
8.2.1.5 Los Angeles Basin

The Los Angeles Basin is a large low-lying coastal plain bordered by the Santa Monica Mountains on the north, the Repetto and Puente Hills on the northeast, the Santa Ana Mountains on the east, and the San Joaquin Hills on the south. The western margin of the basin is open to the Pacific Ocean except for one prominent hill: the Palos Verdes Peninsula. The floor of the Los Angeles Basin is a relatively flat surface that rises gently from sea level along the coastline to an apron of uplifted terrain along the base of the surrounding mountains, which rise abruptly to a few thousand feet above the plain. The flat basin floor is interrupted in a few localities by small hills, the most prominent of which are a northwest–southeast-trending alignment of hills and mesas that extend from the Newport Beach area on the south to the Beverly Hills area on the north (Metro, 2023b).

8.2.2 Project Site Soil Types and Characteristics

Figure 8-11 shows the geologic features of Alternative 4. The San Fernando Valley is an east–west-trending basin with alluvial fan deposits and channelized wash deposits. Within the Sherman Oaks area (southern portion of the San Fernando Valley) for Alternative 4, the Holocene alluvial fans derive from the canyons adjacent to the northern side of the Santa Monica Mountains. The alluvial fans predominantly comprise silt, clay, and sand. Along Alternative 4 in the Van Nuys area, the valley alluvium includes Holocene and Pleistocene sand, silt, and gravel (Metro, 2023a).

Figure 8-11. Alternative 4: Geologic Units



Source: USGS, 2016; HTA, 2024

The Santa Monica Mountains are an east–west-trending range with long southward-draining canyons on the southern flank and relatively shorter northward-draining canyons on the northern flank. Elongated ridge spurs generally trend subparallel to the mountain canyons. Along Alternative 4 in the Santa Monica Mountains, the Jurassic-age Santa Monica Slate forms an anticline (i.e., a broad “A”-shaped geologic structure), with the anticlinal axis trending roughly west-northwest/east-southeast. This formation includes slate, phyllite, and schist, depending on the local degree of metamorphism. The Santa Monica Slate is overlain on the mountain flanks by marine sedimentary rock that primarily consists of sandstone, shale, and diatomaceous shale of the Miocene-age Modelo Formation, and sandstone and mudstone of the Pliocene-age Fernando Formation (Metro, 2023b).

Older (late to middle Pleistocene) alluvial fan deposits, which form the Santa Monica Plain, are mapped along the southern edge of the Santa Monica Mountains. They continue in the subsurface in the Los Angeles Basin. These sediments were deposited by stream channels that had flowed southward from the Santa Monica Mountains during the late Pleistocene age. They consist of a thick series of alluvial fans that spread out southward from the mountain front toward the ocean. These deposits are described as moderately consolidated, silt, sand, and gravel deposits on alluvial fans (Metro, 2023b).

8.2.2.1 Artificial Fill

Artificial fill (af) is comprised of silty sand, a mixture of moist, brown and gray, silty sand of fine-grained to coarse-grained composure. Some clay or gray pockets may be observed. The most commonly observed lithology for the Project Study Area along the alignment is typically at the ground surface. (Metro, 2023b).

8.2.2.2 Modelo Formation

The Modelo Formation (Tm, Tms, Tmd) is a late Miocene-age sedimentary bedrock that generally consists of gray to brown, thinly bedded mudstone, and shale and siltstone, with interbeds of very fine-grained to coarse-grained sandstone. The most commonly observed lithology for Alternative 4 is near I-405, with thinly bedded shale to shaley siltstone with interbeds of fine sandstone. Additionally, localized diatomaceous shale and siltstone with interbeds of bentonite and fine sandstone are within the formation (Metro, 2023b).

8.2.2.3 Old Alluvial Fan Deposits

Older (Late to middle Pleistocene) alluvial fan deposits (Qof), which form the Santa Monica Plain, are mapped along the southern edge of the Santa Monica Mountains. They continue in the subsurface in the Los Angeles Basin. These sediments were deposited by stream channels that had flowed southward from the Santa Monica Mountains during the late Pleistocene. They consist of a thick series of alluvial fans that spread out southward from the mountain front toward the ocean. These deposits are described by Campbell et al. (2016) as moderately consolidated, silt, sand, and gravel deposits on alluvial fans (Metro, 2023b).

8.2.2.4 Santa Susana Formation

The Paleocene Santa Susana Formation (Tss), which underlies the Topanga Formation, is exposed in the slopes bordering the west side of the Stone Canyon Reservoir (SCR). Campbell et al. (2016) described the formation as consisting predominantly of fine- to medium-grained sandstone with some interbeds of gray clay shale, mudstone and siltstone, and some lenses of pebble-cobble conglomerate. Shale beds commonly contain indurated limestone concretions.

8.2.2.5 Santa Monica Slate

The Santa Monica Slate (Jsm, Jsms, Jsmp) is a Jurassic-age metamorphic rock that generally consists of black slate and, to a lesser degree, meta-siltstone and fine-grained meta-graywacke. The rock is generally sheared and intensely jointed due to the localized folding and faulting within the Santa Monica Mountains. The Santa Monica Slate is exposed throughout the southern side of the Santa Monica Mountains, with exposures generally highly fractured with small surficial slides within the fractured rock (Metro, 2023b).

8.2.2.6 Topanga Formation

In the Project Study Area, the middle Miocene Topanga Formation (Tt and Tb) unconformably underlies the Modelo Formation. The Topanga Formation is exposed in slopes that are adjacent to the east side of SCR and Upper Stone Canyon Reservoir (USCR). Campbell et al. (2016) described the Topanga Formation as a heterogenous sequence of sedimentary and volcanic rocks containing marine facies. Campbell et al. (2016) subdivided the Topanga Formation into undifferentiated sedimentary rocks or volcanic rocks. Sedimentary rock lithologies include interbedded gray, micaceous claystone, clay shale, and siltstone; semi-friable to well cemented arkosic sandstone; and locally includes gravely sandstone and lenses of pebble to cobble conglomerate. In general, the lower portion of the Topanga Formation (toward the south) commonly contains the coarser-grained lithologies (sandstones and conglomerates), and the upper portion contains fine-grained sandstone, siltstone, and shales. Volcanic rocks within the Topanga Formation (Tb) include extrusive flows, intrusive sills, tuffs, and volcanic breccias.

8.2.2.7 Tuna Canyon Formation

The Cretaceous Tuna Canyon Formation (Kt), which underlies the Santa Susana Formation, is exposed in the slopes bordering SCR. Campbell et al. (2014) described the formation as consisting of marine sandstone, siltstone, and conglomerate. The sandstones range from thinly to very thickly bedded and locally contain abundant fragments of black slate. LADWP (1998) reported that the formation, as exposed in roadcuts along the west side of SCR, includes very thick to massive conglomerate beds that contain weak to extremely strong cobble to boulder-sized granitic, metavolcanic, and quarzitic clasts up to 18-inches in diameter.

8.2.2.8 Younger Alluvial Fan Deposits

The younger alluvial units (QyF and Qya) along both the northern and southern sides of the Santa Monica Mountains consist of sand, silt, silty clay, silty sand, and clayey sand with some interbedded units of gravel to cobble-size clasts. The gravel units are composed of slate and are scattered through the alluvium along the southern side of the mountains; while along the northern side, the gravel transitions to sandstone and is less frequent and abundant. The younger alluvium generally varies in thickness from a few feet to over 50 feet or more in some areas along Alternative 4 (Metro, 2023b).

8.2.3 Seismicity

The entire Southern California region is seismically active. A network of major regional faults and minor local faults crisscrosses the region. The faulting and seismicity are dominated by the San Andreas fault system, which separates two of the major tectonic plates that comprise the earth’s crust. The Pacific Plate lies west of the San Andreas fault system. This plate is moving in a northwesterly direction relative to the North American Plate, which lies east of the San Andreas fault system. This relative movement between the two plates is the driving force of fault ruptures in western California. The San Andreas fault generally trends northwest–southeast; however, north of the Transverse Ranges province, the fault trends more in an east–west direction, causing a north–south compression between the two plates. North–south compression in Southern California has been estimated from 5 millimeters per year (mm/year) to 20 mm/year. This compression has produced rapid uplift of many of the mountain ranges in Southern California (Metro, 2023a).

In addition to the San Andreas fault, numerous faults in Southern California are categorized as active, potentially active, and inactive. A fault is classified as active if it has either moved during the Holocene epoch (from about 11,700 years to the present) or is included in an Alquist-Priolo Earthquake Fault Zone (as established by California Geological Survey [CGS]). A fault is classified as potentially active if it has experienced movement within the Quaternary period (geologic time starting 1.6 million years ago and continuing to the present day). Faults that have not moved in the last 1.8 million years generally are considered inactive. Surface displacement can be recognized by the existence of cliffs in alluvium, terraces, offset stream courses, fault troughs and saddles, the alignment of depressions, sag ponds, and the existence of steep mountain fronts.

Generally defined, an earthquake is an abrupt release of accumulated energy in the form of seismic waves that are created when movement occurs along a fault plane. The severity of an earthquake is generally expressed in two ways: magnitude and intensity. The energy released, measured on the Moment Magnitude (Mw) scale, represents the “size” of an earthquake. The Richter Magnitude (M) scale has been replaced in most modern building codes by the MW scale because the MW scale provides more useful information to design engineers. The Alternative 4 site is subject to earthquakes of MW 6.0 to MW 8.0 by the surrounding faults (CGS, 2023; USGS, 2017a, 2017b, 2017c, 2017d, 2023; SCEDC, 2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2023g, 2023h, 2023i, 2023j, 2023k, 2023l, 2023m, 2023n, 2023o, 2023p, 2023q, 2023r; and Shaw et al. 2022).

The intensity of an earthquake is measured by the Modified Mercalli Intensity (MMI) scale, which emphasizes the current seismic environment at a particular site and measures ground shaking severity according to damage done to structures, changes in the earth surface, and personal accounts. Table 8-6 identifies the level of intensity according to the MMI scale and describes that intensity with respect to how it would be received or sensed by its receptors.

Table 8-6. Alternative 4: Modified Mercalli Intensity Scale

Intensity	Shaking	Description/Damage
I	Not Felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration is similar to the passing of a truck. Duration is estimated.
IV	Light	Felt indoors by many and outdoors by few during the day. At night, some are awakened. Dishes, windows, doors are disturbed; walls make cracking sound. Sensation is like a heavy truck striking a building. Standing motor cars are rocked noticeably.
V	Moderate	Felt by nearly everyone; many are awakened. Some dishes and windows are broken. Unstable objects are overturned. Pendulum clocks may stop.
VI	Strong	Felt by all; many are frightened. Some heavy furniture is moved; there are a few instances of fallen plaster. Damage is slight.
VII	Very Strong	Damage is negligible in buildings of good design and construction, slight to moderate in well-built ordinary structures, and considerable in poorly built structures; some chimneys are broken.

Intensity	Shaking	Description/Damage
VIII	Severe	Damage is slight in specially designed structures, considerable in ordinary substantial buildings with partial collapse, and great in poorly built structures. Chimneys, factory stacks, columns, monuments, and walls fall. Heavy furniture is overturned.
IX	Violent	Damage is considerable in specially designed structures; well-designed frame structures are thrown out of plum. Damage is great in substantial buildings, with partial collapse. Buildings are shifted off foundations.
X	Extreme	Some well-built wooden structures are destroyed; most masonry and frame structures are destroyed with foundations. Rails are bent.

Source: USGS, 2022

Over the past 54 years, Southern California has experienced three significant earthquakes: the 1971 San Fernando earthquake (also known as the Sylmar earthquake, on the Sierra Madre Fault), which registered as MW 6.6; the 1987 Whittier Narrows earthquake, which registered as MW 5.9; and the Northridge earthquake, which occurred in January 1994 and registered as MW 6.7.

8.2.4 Regional and Local Faults

Major regional and local faults are identified in Table 8-7 and are shown on **Error! Reference source not found.**Figure 8-12 and Figure 8-13.

Table 8-7. Alternative 4: Major Regional and Local Faults

Fault Name	Approximate Closest Distance from Alternative 4 to the Fault (miles)	Compass Direction	Alquist-Priolo Earthquake Fault Zone	Maximum Moment Magnitude (Mw)
Santa Monica Fault	Crosses Alternative 4 corridor southeast of South Bentley Avenue and Massachusetts Avenue	Southeast	Yes	7.0
Overland Avenue Fault	0.7	East	No	6.6
Northridge Hills Fault	1.5	North	No	—
Hollywood Fault	1.7	East	Yes	6.5
Newport-Inglewood-Rose Canyon Fault	1.8	East	Yes	7.2
Charnock Fault	2.6	Southeast	No	6.5
Mission Hills Fault	4.4	North	No	—
Sierra Madre Fault	4.8	Northeast	Yes	7.0
Verdugo Fault	6.4	East	No	6.8
Puente Hills Blind Thrust System	6.8	Southeast	No	—
Chatsworth Fault	7.7	Northwest	No	6.8
Northridge Blind Thrust Fault	8.4	North	No	7.5
Simi-Santa Rosa Fault	9.0	Northwest	Yes	6.9
San Gabriel Fault	10.4	Northeast	Yes	6.7
Malibu Coast Fault	12.0	West	Yes	7.0
Raymond Fault	12.5	Northeast	Yes	6.7
Eagle Rock Fault	12.9	Southeast	No	7.0
Hosler Fault	14.4	Northwest	No	—
Palos Verdes Fault	14.7	South	No	6.5
Del Valle Fault	17.5	Northwest	No	7.1

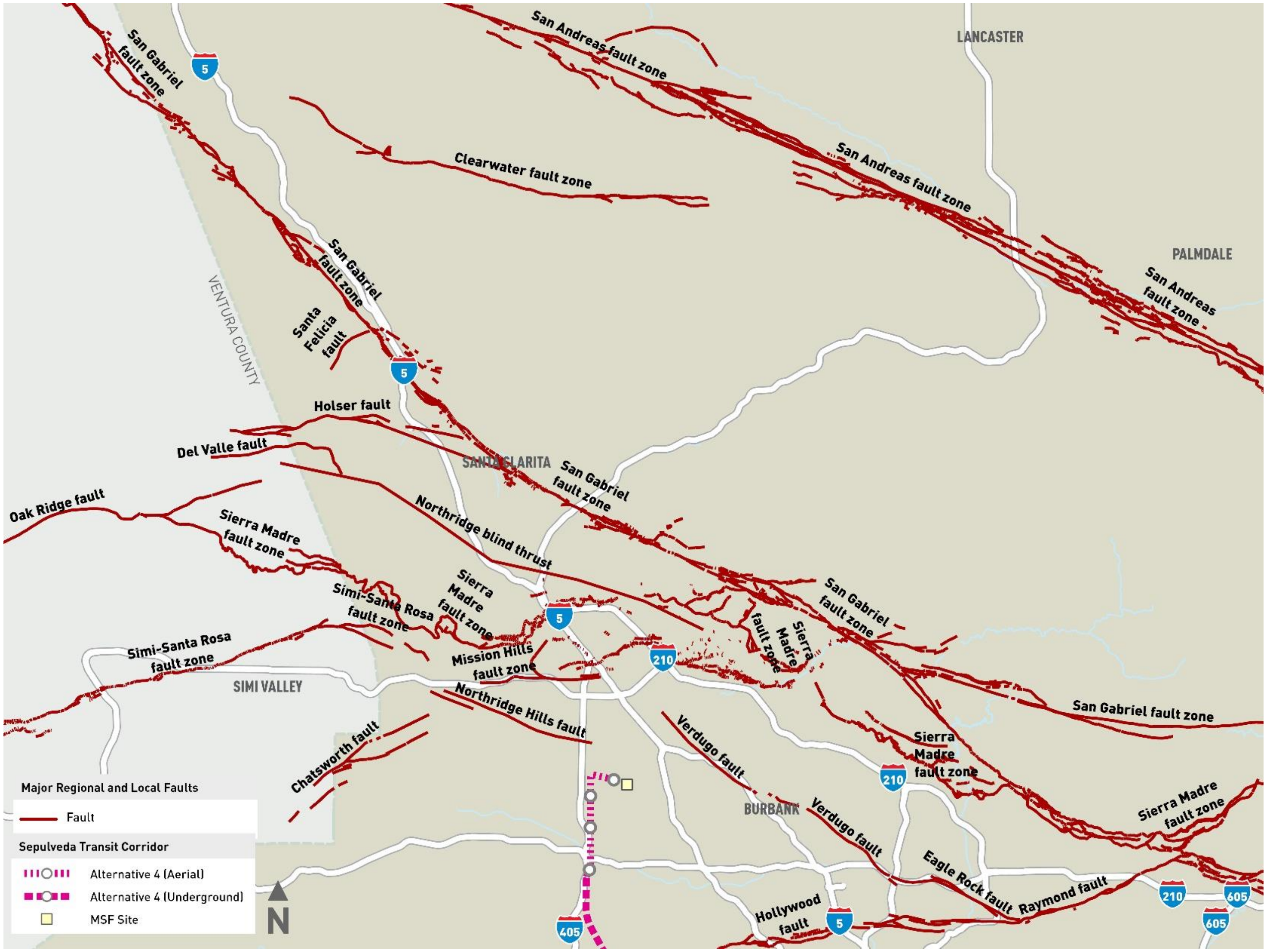
Fault Name	Approximate Closest Distance from Alternative 4 to the Fault (miles)	Compass Direction	Alquist-Priolo Earthquake Fault Zone	Maximum Moment Magnitude (Mw)
Oak Ridge Fault	19.9	Northwest	No	7.5
Santa Felicia Fault	21.9	Northwest	No	—
Clearwater Fault	26.2	North	No	—
San Andreas Fault	29.5	Northeast	Yes	8.0

Source: CGS, 2023; USGS, 2017a, 2017b, 2017c, 2017d, 2023; SCEDC, 2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2023g, 2023h, 2023i, 2023j, 2023k, 2023l, 2023m, 2023n, 2023o, 2023p, 2023q, 2023r; and Shaw et al., 2022

Figure 8-12. Alternative 4: Major Regional and Local Faults – South

Source: CGS, 2023; HTA, 2024

Figure 8-13. Alternative 4: Major Regional and Local Faults – North



Source: CGS, 2023; HTA, 2024

8.2.4.1 Charnock Fault

The Charlock fault is located approximately 2.6 miles southeast from the southern portion of Alternative 4. Charnock fault extends southeast from near Venice Boulevard to the City of Gardena and runs parallel to the axis of the Gardena syncline for most of its length. The northeastern side of the fault is downthrown relative to the southwestern side (CDWRSD, 1961). Faulted rocks of late Quaternary age (between present day and 700,000 years ago) is present along this fault (USGS, 1981). The Charnock fault runs underneath the Los Angeles International Airport (LAX) runway.

8.2.4.2 Chatsworth Fault

The Chatsworth fault is located approximately 7.7 miles northwest from the northern portion of Alternative 4. The Chatsworth fault is 12.4 miles long and is classified as a late Quaternary (between present day and 700,000 years ago). The Chatsworth fault has a probable magnitude of M_w 6.0 to M_w 6.8. The Chatsworth fault is a reverse fault, where the displacement is predominantly vertical. This fault is north-dipping, and the slip rate is currently unknown (SCEDC, 2023a).

8.2.4.3 Clearwater Fault Zone

The Clearwater fault is located approximately 26.2 miles north from the northern portion of Alternative 4. The Clearwater fault is 19.9 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Clearwater fault varies from north-dipping to vertical (SCEDC, 2023b).

8.2.4.4 Del Valle Fault

The Del Valle fault is located approximately 17.5 miles northwest from the northern portion of Alternative 4. The Del Valle fault is classified as late Quaternary (between present day and 700,000 years ago). The Del Valle fault is a south-dipping reverse fault, and it contains the prominent tectonic geomorphic features (Yeats et al., 1985).

8.2.4.5 Eagle Rock Fault

The Eagle Rock fault is located approximately 12.9 miles southeast from the mid-section of Alternative 4. The Eagle Rock fault is 6.8 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Eagle Rock fault is a thrust fault, which is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much, if not all, of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an obvious sign of compressional tectonics (SCEDC, 2023c, 2023s). The slip rate for Eagle Rock fault is probably less than 0.1 mm/year. The possibility of simultaneous rupture with the Verdugo fault is uncertain. The Eagle Rock fault dips to the northeast (SCEDC, 2023c).

8.2.4.6 Hollywood Fault

The Hollywood fault is located approximately 1.7 miles east from the mid-section of Alternative 4. The Hollywood fault is 9.3 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023d, 2023s). The Hollywood fault is left-reverse fault and has a probable magnitude between M_w 5.8 and M_w 6.5. There is a potential for the probable magnitude to be larger if rupture is simultaneous with an adjacent fault. The slip rate for the Hollywood fault is between 0.33 and 0.75 mm/year. The Hollywood fault could be considered a westward extension of the Raymond fault and is roughly parallel to the Santa Monica fault (SCEDC, 2023d). The Hollywood fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act.

8.2.4.7 Holser Fault

The Holser fault is located approximately 14.4 miles northwest from the northern portion of Alternative 4. The Holser fault is 12.4 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Holser fault is a reverse fault with a slip rate between 0.4 mm/year; the displacement is predominantly vertical, and the dip is to the south (SCEDC, 2023e).

8.2.4.8 Malibu Coast Fault

The Malibu Coast fault is located approximately 12 miles west from the mid-section of Alternative 4. The Malibu Coast fault is 21.1 miles long with several parallel strands. The Malibu Coast fault is classified as Holocene (from about 10,000 years ago to the present) in part; otherwise, the fault is classified as late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023f, 2023s). The Malibu Coast fault is a reverse fault with a slip rate of 0.3 mm/year. The Malibu Coast fault is a north-dipping fault. The slip rate may be higher at its eastern end, where it meets the Santa Monica fault and develops left-reverse motion (SCEDC, 2023f). The Malibu Coast fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

8.2.4.9 Mission Hills Fault

The Mission Hills fault is located approximately 4.4 miles north from the northern portion of Alternative 4. The Mission Hills fault is 6.2 miles long. The Mission Hills fault is classified as late Quaternary (between present day and 700,000 years ago) and possibly Holocene (from about 10,000 years ago to the present) (SCEDC, 2023g, 2023s). The Mission Hills fault is a reverse fault, where the displacement is predominantly vertical. The Mission Hills fault has a slip rate of 0.5 mm/year (SCEDC, 2023g).

8.2.4.10 Newport-Inglewood-Rose Canyon Fault

The Newport-Inglewood-Rose Canyon fault is located approximately 1.8 miles east from the southern portion of Alternative 4. The Newport-Inglewood-Rose Canyon fault is 55.9 miles long. The Newport-Inglewood-Rose Canyon fault is mostly classified as Quaternary (1.6 million years ago and continuing to the present day) and in part classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023h, 2023s). The Newport-Inglewood-Rose Canyon fault is a right-lateral fault, which is a fault that slips in such a way that the two sides move with a predominantly lateral motion (with respect to each other). The Newport-Inglewood-Rose Canyon fault has a probable magnitude between M_w 6.0 and M_w 7.2 and a slip rate between 0.8 and 2.1 mm/year (SCEDC, 2023h). The Newport-Inglewood-Rose Canyon fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

8.2.4.11 Northridge Blind Thrust Fault

The Northridge Blind Thrust fault is located approximately 8.4 miles north from the northern portion of Alternative 4. The Northridge Blind Thrust fault is part of the Oak Ridge fault system (SCEDC, 2023j). At its eastern end, the Oak Ridge Thrust is progressively more difficult to trace and is buried, or also known as *blind*. The Northridge Blind Thrust fault has a probable magnitude of M_w 6.5 to M_w 7.5. The slip rate for the Northridge Blind Thrust fault is between 3.5 to 6 mm/year (SCEDC, 2023j). The Northridge Blind Thrust fault, as part of the Oak Ridge fault system, is classified mostly as late Quaternary (between present day and 700,000 years ago) and in part as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023j, 2023s). The Northridge Blind Thrust fault is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much if not all of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an obvious sign of compressional tectonics (SCEDC, 2023j, 2023s). This blind thrust fault is assumed to be part of the fault system responsible for the 1994 Northridge earthquake.

8.2.4.12 Northridge Hills Fault

The Northridge Hills fault is located approximately 1.5 miles north from the northern portion of Alternative 4. The Northridge Hills fault is not the fault on which the 1994 Northridge earthquake occurred. The Northridge Hills fault is classified as late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023i, 2023s), The Northridge Hills fault is 15.5 miles long, and is a reverse fault, where the displacement is predominantly vertical. The dip for the Mission Hills fault is probably to the north (SCEDC, 2023i).

8.2.4.13 Overland Avenue Fault

The Overland Avenue fault is located approximately 0.7 miles east from the southern portion of Alternative 4. The Overland Avenue fault trends northwest and extends from Santa Monica Boulevard to the northwestern flank of the Baldwin Hills. Displacement of the fault is believed to be vertical, with a magnitude of approximately 30 feet. Faulted rocks of late Quaternary age (between present day and 700,000 years ago) is present along this fault (USGS, 1981). The northeastern side of the fault is raised relative to the southwestern side (CDWRSD, 1961).

8.2.4.14 Oak Ridge Fault

The Oak Ridge fault is located approximately 19.9 miles northwest from the northern portion of Alternative 4. The Oak Ridge fault system is connected to the 1994 Northridge earthquake. The Oak Ridge fault is approximately 55.9 miles in length (SCEDC, 2023j). The Oak Ridge fault has a probable magnitude of M_w 6.5 to M_w 7.5. The slip rate for Oak Ridge fault is between 3.5 and 6 mm/year (SCEDC, 2023j). The Oak Ridge fault system is classified mostly as late Quaternary (between present day and 700,000 years ago) and in part as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023j, 2023s). The Oak Ridge fault is a thrust fault, which is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much, if not all, of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an obvious sign of compressional tectonics (SCEDC, 2023j, 2023s). This fault dips to the south at a fairly shallow (less than 45 degrees) angle. Thus, epicenters of earthquakes on this (and any other thrust) fault may appear far removed from the surface trace. The surface trace of the Oak Ridge fault forms a ridge (hence its name) to the south of its trace; at its eastern end, the Oak Ridge fault becomes progressively more difficult to trace (SCEDC, 2023j). The Oak Ridge fault appears to be overthrust by the *Santa Susana* fault becoming a *blind thrust fault,* including the Northridge Blind Thrust fault.

8.2.4.15 Palos Verdes Fault

The Palos Verdes fault is located approximately 14.7 miles south from the southern portion of Alternative 4. The Palos Verdes fault is 49.7 miles long and is classified as Holocene (from about 10,000 years ago to the present) offshore and late Quaternary (between present day and 700,000 years ago) onshore (SCEDC, 2023k, 2023s). The Palos Verdes fault is a right-reverse fault and has a probable magnitude between M_w 6.0 and M_w 7.0. The slip rate is between 0.1 and 3.0 mm/year (SCEDC, 2023k).

8.2.4.16 Puente Hills Blind Thrust Fault

The Puente Hills Blind Thrust fault is located approximately 6.8 miles southeast from the southern portion of Alternative 4. The Puente Hills Blind Thrust fault is 24.9 miles long. In 1987, the Puente Hills Blind Thrust fault produced an M_w 5.9 earthquake in Whittier. In March 2014, the Puente Hills Blind

Thrust fault produced an M_w 5.1 earthquake with over 100 aftershocks (KCAL News, 2014). The Puente Hills Blind Thrust fault has a probable magnitude between M_w 6.5 and M_w 6.6 for frequency of a single segment and a probable magnitude of M_w 7.1 for multi-segment rupture scenarios. The slip rates on the ramp segments range from 0.44 to 1.7 mm/year, with preferred rates between 0.62 and 1.28 mm/year (Shaw et al., 2022).

8.2.4.17 Raymond Fault

The Raymond fault is located approximately 12.5 miles northeast from the mid-section of Alternative 4. The Raymond fault is 16.2 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023l, 2023s). The Raymond fault is a left-reverse fault and has a probable magnitude between M_w 6.0 and M_w 7.0. The slip rate is between 0.10 and 0.22 mm/year (SCEDC, 2023l). The Raymond fault dips at about 75 degrees to the north. There is evidence that at least eight surface-rupturing events have occurred along this fault in the last 36,000 years. The exact nature of the slip along the Raymond fault has been a subject of debate for quite some time. In late 1988, the *Pasadena earthquake* occurred on the Raymond fault, and the motion of this earthquake was predominantly left-lateral, with a reverse component of only about 1/15 the size of the lateral component. If the Raymond fault is indeed primarily a left-lateral fault, it could be responsible for transferring slip southward from the *Sierra Madre* Fault Zone to other fault systems (SCEDC, 2023l). The Raymond fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

8.2.4.18 San Andreas Fault

The San Andreas fault is located approximately 29.5 miles northeast from the northern portion of Alternative 4. The San Andreas fault is 745.6 miles long. The San Andreas fault has a probable magnitude between M_w 6.8 and M_w 8.0. The interval between major ruptures averages about 140 years on the Mojave segment, and the recurrence interval varies greatly from under 20 years (at Parkfield only) to over 300 years. The slip rate is between 20 and 35 mm/year (SCEDC, 2023m). The last major rupture of the San Andreas fault occurred on January 9, 1857 at the Mojave segment and on April 18, 1906 at the northern segment. The San Andreas fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

8.2.4.19 San Gabriel Fault

The San Gabriel fault is located approximately 10.4 miles northeast from the northern portion of Alternative 4. The San Gabriel fault is 87 miles long. The San Gabriel fault is primarily a right-lateral strike slip, which is a fault where the slip motion is parallel to the direction, or trend, of the line marking the intersection of a fault plane (or another planar geologic feature) with the horizontal. The San Gabriel fault is classified as late Quaternary (between present day and 700,000 years ago) west of the intersection with the Sierra Madre Fault Zone, Quaternary (1.6 million years ago and continuing to the present) east of that intersection, and Holocene (from about 10,000 years ago to the present) between Saugus and Castaic. The slip rate is between 1 and 5 mm/year (SCEDC, 2023n). The slip rate and reoccurrence interval vary significantly along the length of the San Gabriel fault. The western half is more active than the eastern half, and the dip is generally steep and to the north. The San Gabriel fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

8.2.4.20 Santa Felicia Fault

The Santa Felicia fault is located approximately 21.9 miles northwest from the northern portion of Alternative 4. The Santa Felicia fault is a fault that is less well understood. The Santa Felicia fault is classified as late Quaternary (between present day and 700,000 years ago). The Santa Felicia fault apparently overrides the youngest strand of the San Gabriel fault. The Santa Felicia fault is a south-dipping reverse fault. The Santa Felicia fault has no recognized tectonic geomorphic features, although it follows the Santa Felicia Canyon for part of its length (Yeats et al., 1985).

8.2.4.21 Santa Monica Fault

The Santa Monica fault would cross Alternative 4 approximately southeast of South Bentley Avenue and Massachusetts Avenue. The Santa Monica fault is 14.9 miles long. The Santa Monica fault has a probable magnitude between M_w 6.0 and M_w 7.0. The Santa Monica fault is classified as late Quaternary (between present day and 700,000 years ago) and is a left-reverse fault. The Santa Monica fault is a north-dipping fault, and the slip rate may be greatest at its western end. The slip rate is between 0.27 and 0.39 mm/year (SCEDC, 2023o). In 2015, the Santa Monica Fault Zone was evaluated for the Alquist-Priolo Earthquake Fault Zoning program (Olson, 2015). Currently, the Santa Monica Fault Zone is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023). The guideway for Alternative 4 would fall within the Alquist-Priolo Earthquake Fault Zone. No habitable structures including stations are located within the Alquist-Priolo Earthquake Fault Zone for Alternative 4.

8.2.4.22 Sierra Madre Fault

The Sierra Madre fault is located approximately 4.8 miles northeast from the northern portion of Alternative 4. The Sierra Madre fault is 46.6 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023p, 2023s). The Sierra Madre fault is a reverse fault, where the displacement is predominantly vertical. The Sierra Madre fault has a probable magnitude between M_w 6.0 and M_w 7.0. The slip rate is between 0.36 and 4.0 mm/year (SCEDC, 2023k). The Sierra Madre fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

8.2.4.23 Simi-Santa Rosa Fault

The Simi-Santa Rosa fault is located approximately 9 miles northwest from the northern portion of Alternative 4. The Simi-Santa Rosa fault is 24.9 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023q, 2023s). The Simi-Santa Rosa fault is a reverse fault, where the displacement is predominantly vertical. This fault dips to the north. The Simi-Santa Rosa fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

8.2.4.24 Verdugo Fault

The Verdugo fault is located approximately 6.4 miles east from the mid-section of Alternative 4. The Verdugo fault is 13 miles long and is classified as Holocene (from about 10,000 years ago to the present) and late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023r, 2023s). The Verdugo fault is a reverse fault and has a probable magnitude between M_w 6.0 and M_w 6.8. The slip rate is roughly 0.5 mm/year (SCEDC, 2023r). The Verdugo fault dips to the northeast.

8.2.5 Geological Hazards

8.2.5.1 Fault Rupture

Faults are geologic zones of weakness. Surface rupture occurs when movement on a fault deep in the earth breaks through to the ground surface. Surface ruptures associated with the 1994 Northridge earthquake began as a rupture at a depth of about 10.9 miles beneath the San Fernando Valley. For 8 seconds following the initial break, the rupture propagated upward and northwestward along the fault plan at a rate of about 1.9 miles per second. The size of the rupture covered an area of approximately 9.3 by 12.4 miles (USGS, 2013). Not all earthquakes result in surface rupture; however, due to the proximity of known active faults, fault ruptures and the subsequent hazard posed by seismic activity are potentially high. An earthquake could cause major damage, and not have the fault trace break at the ground surface. Fault rupture almost always follows preexisting faults, which are zones of weakness. Rupture may occur suddenly during an earthquake or slowly in the form of fault creep. Sudden displacements are more damaging to structures because they are accompanied by shaking.

8.2.5.2 Ground Shaking

A major cause of structural damage that results from earthquakes is ground shaking. The amount of motion can vary from "zero to forceful," depending upon the distance to the fault, the magnitude of the earthquake, and the local geology. Greater movement can be expected at sites located on poorly consolidated material such as alluvium located near the source of the earthquake epicenter or in response to an earthquake of great magnitude. Strong ground shaking can damage large freeway overpasses and unreinforced masonry buildings. It can also trigger a variety of secondary hazards such as liquefaction, landslides, fire, and dam failure.

The amount of damage to a building does not depend solely on how hard it is shaken. In general, smaller buildings such as houses are damaged more by stronger earthquakes, and houses must be relatively close to the epicenter to be severely damaged. Larger structures such as high-rise buildings are damaged more by weaker earthquakes and will be more noticeably affected by the largest earthquakes, even at considerable distances.

Damages as a result of ground shaking is not limited to aboveground structures. Seismic waves generated by the earthquake cause the ground to move, leading to dynamic forces on underground structures. This shaking can induce ground deformation and displacements, and can potentially damage the structural integrity of tunnels, basements, and other underground facilities.

The intensity of ground motion expected at a particular site depends upon the magnitude of the earthquake, the distance to the epicenter, and the geology of the area between the epicenter and the property. Another factor affecting structural damage due to ground shaking is the quality and condition of the existing structure, which is influenced by whether it adheres to current or past building codes. Greater movement can be expected at sites on poorly consolidated material, such as loose alluvium, in proximity to the causative fault, or in response to an event of great magnitude. The general area is susceptible to earthquakes of M_w 6.0 to M_w 8.0. Due to the proximity of known active faults, the hazard posed by seismic shaking is potentially high.

8.2.5.3 Difficult Ground Conditions for Excavating, Drilling, or Tunneling

Alternative 4's alignment through the Santa Monica Mountains (primarily in single-bore rock tunnel) will encounter potentially challenging bedrock conditions – under potentially high hydrostatic groundwater pressures (Metro, 2023b). The bedrock materials tend to be heavily folded, faulted, and intruded sedimentary rock – especially in shale, slate, phyllite, schist, and sandstone. Drilling in this area is anticipated to be slow; casing (if used) installation into these materials would also be difficult. Hard drilling should be anticipated.

8.2.6 Dry Sand Settlement

Settlement is defined as areas that are prone to rates of ground-surface collapse and densification (soil particle compaction) that are greater than those of the surrounding area. Such areas are often underlain by sediments that differ laterally in composition or degree of existing compaction. Differential settlement refers to areas that have more than one rate of settlement. Settlement can damage structures, pipelines, and other subsurface entities.

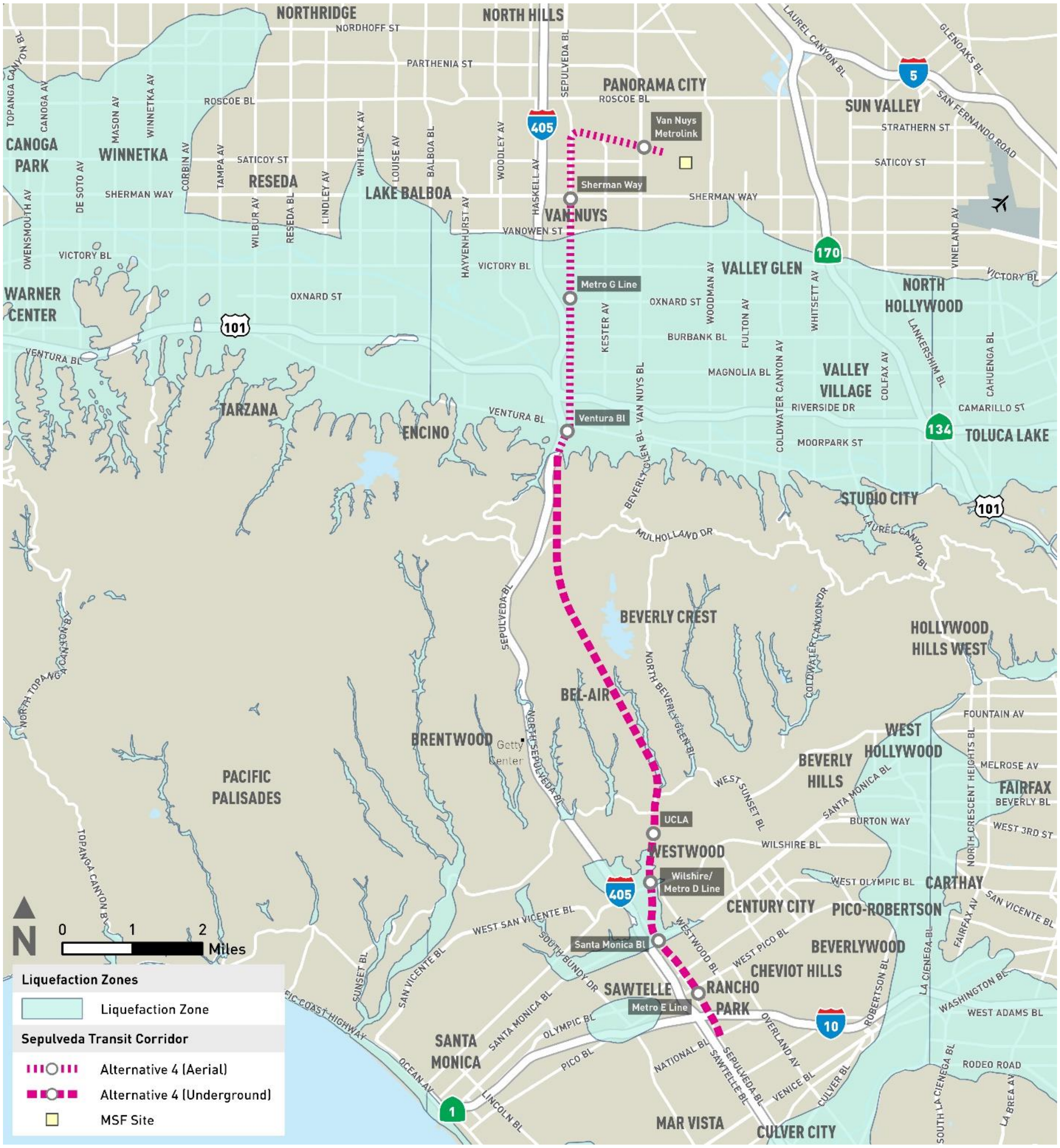
Strong ground shaking can cause soil settlement by vibrating sediment particles into more tightly compacted configurations, thereby reducing pore space. Unconsolidated, loosely packed alluvial deposits and sand (unsaturated or saturated) are especially susceptible to this phenomenon. Poorly compacted artificial fills may experience seismically induced settlement. Due to the presence of alluvial deposits in the Project Study Area, the hazard posed by seismically induced settlement is potentially high.

8.2.7 Liquefaction

Liquefaction involves a sudden loss in strength of a saturated, cohesionless, uniformly particle-sized soil, that is typically caused by ground-shaking activities, which causes temporary transformation of the soil to a fluid mass. In rare instances, ground-borne vibrations can cause liquefaction from activities such as pile driving or tunnel boring. If the liquefying layer is near the ground surface, the effects may resemble those of quicksand. If the layer is deep below the ground surface, it may provide a sliding surface for the material above it and/or cause differential settlement of the ground surface, which may damage building foundations by altering weight-bearing characteristics.

During a liquefaction event, soils behave similarly to liquids, losing bearing strength. Structures built on these soils may tilt or settle when the soils liquefy. Liquefaction occurs more often in earthquake-prone areas underlain by young sandy alluvium where the groundwater table is less than 50 feet below ground surface (Metro, 2023b). Per the County of Los Angeles, liquefaction zones identify where the stability of foundation soils must be investigated, and countermeasures undertaken in the design and construction of buildings for human occupancy (LA County Planning, 2022a). As shown on Figure 8-14, the alignment of Alternative 4 would traverse a Liquefaction Zone, and the potential for a liquefaction event is relatively high for the mapped areas shown (California Department of Conservation, 1998). Site-specific liquefaction potential would be evaluated in more detail based on future site-specific subsurface investigation data.

Figure 8-14. Alternative 4: Liquefaction Zones



Source: County of Los Angeles, Enterprise GIS (eGIS) 2022; HTA, 2024

8.2.8 Subsidence

Subsidence involves a sudden sinking or gradual settling and compaction of soil and other surface material with little or no horizontal motion. This is typically caused by the removal of groundwater, oil, or natural gas, or by natural processes like the compaction of soil. This can lead to structural damage to buildings and infrastructure. The Los Angeles Basin is vulnerable to subsidence, particularly due to

groundwater and oil extraction. Over-extraction of groundwater can be concerning because as the groundwater table drops, the soil compacts, leading to subsidence that can damage infrastructure, buildings, and roads. Information relating to groundwater conditions can be found in the *Sepulveda Transit Corridor Project Water Resources Technical Report* (Metro, 2025).

Subsidence typically impacts surface level soils. Although half of the alignment is in a relatively deep subsurface tunnel, stations have surface level elements. Moreover, alluvial deposits are susceptible to subsidence, especially when they consist of loose, unconsolidated sediments. As shown on Figure 8-11, alluvial deposits are present at all of Alternative 4's stations and as such, the hazard posed by subsidence is potentially high at those locations.

8.2.9 Expansive Soils

Expansive soils have a significant amount of clay particles that can give up water (shrink) or take on water (swell). The change in volume exerts stress on buildings and other loads placed on these soils. The occurrence of these soils is often associated with geologic units having marginal stability. Expansive soils can be dispersed widely and can be found in hillside areas as well as low-lying areas in alluvial basins. Municipal grading and building codes require routine soils testing to identify expansive characteristics and appropriate remediation measures. Specific treatments to eliminate expansion of soils at building sites include, but are not limited to, grouting (cementing the soil particles together), re-compaction (watering and compressing the soils), and replacement with non-expansive material (excavation of unsuitable soil followed by filling with suitable material), all of which are common practice in California. Expansive soils typically impact surface level soils. Although half of the alignment is in a relatively deep subsurface tunnel, stations have surface level elements. As shown on Figure 8-11, alluvial deposits are present at all of Alternative 4's stations and, as such, the hazard posed by expansive soils is potentially high at those locations.

8.2.10 Collapsible Soils

Collapsible soils undergo a rearrangement of their grains and a loss of cementation, resulting in substantial and rapid settlement under relatively low loads. Collapsible soils occur predominantly at the base of mountain ranges where Holocene-age alluvial fan and wash sediments have been deposited during rapid runoff events. Soils prone to collapse are commonly associated with human-made fill, wind-laid sands and silts, and alluvial fan and mudflow sediments deposited during flash floods. Additionally, desert soils are commonly associated with hydro-compression and collapse associated with wetting. Examples of common problems associated with collapsible soils include tilting floors, cracking or separation in structures, sagging floors, and nonfunctional windows and doors. Collapsible soils typically impact earth at surface levels. Although half of the alignment is in a relatively deep subsurface tunnel, all stations have surface level elements. As shown on Figure 8-11, alluvial deposits are present at all of Alternative 4's stations and, as such, the hazard posed by collapsible soils is potentially high at those locations.

8.2.11 Lateral Spreading

Lateral spread is the finite, lateral displacement of sloping ground (0.1 to < 6 percent) as a result of pore pressure buildup or liquefaction in a shallow, underlying soil deposit during an earthquake. Lateral spreading, as a result of liquefaction, occurs when a soil mass slides laterally on a liquefied layer, and gravitational and inertial forces cause the layer and the overlying non-liquefied material to move in a downslope direction. Due to the presence of mountainside areas in the Project Study Area, the hazard posed by lateral spreading is potentially high at those locations.

8.2.12 Slope Stability

Slope failures include many phenomena that involve the downslope displacement of material, which is triggered by static (i.e., gravity) or dynamic (i.e., earthquake) forces such as landslides, rock-falls, debris slides, and soil creeps. Slope stability can depend on complex variables, including the geology, structure, and amount of groundwater present, as well as external processes such as climate, topography, slope geometry, and human activity. Landslides and other slope failures may occur on slopes of 15 percent or less; however, the probability is greater on steeper slopes that exhibit old landslide features such as scarps, slanted vegetation, and offset surfaces. Due to the presence of slopes (of 15 percent greater) in the Project Study Area, particularly in the hilly Santa Monica Mountain communities of Bel-Air, Beverly Crest, and Brentwood, the hazard posed by slope failures is potentially high at those locations.

8.2.13 Landslides

Landslides are the downhill movement of a mass of earth and rock. Landslides are a geological phenomenon that includes a wide range of ground movements, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary cause of a landslide, the following other factors contribute:

- Erosion by rivers, glaciers, or ocean waves
- Rock and soil slopes that are weakened through saturation by snowmelt or heavy rains
- Earthquakes that create stresses such that weak slopes fail
- Volcanic eruptions that produce loose ash deposits, heavy rain, and/or debris flows
- Vibrations from machinery, traffic, blasting, and even thunder
- Excess weight from accumulation of rain or snow, stockpiling of rock or ore from waste piles, or from human-made structures.

As shown on Figure 8-15, the potential landslide hazard for Alternative 4 is located within the Santa Monica Mountains.

Figure 8-15. Alternative 4: Landslide Hazard Zones

Source: County of Los Angeles, eGIS, 2022; HTA, 2024

8.2.14 Soil Erosion

Soil erosion is the process by which soil particles are removed from a land surface by wind, water, or gravity. Most natural erosion occurs at slow rates; however, the rate of erosion increases when land is cleared of vegetation or structures, or otherwise altered and left in a disturbed condition. Erosion can occur as a result of, and can be accelerated by, site preparation activities associated with development.

Vegetation removal in pervious landscaped areas could reduce soil cohesion, as well as the buffer provided by vegetation from wind, water, and surface disturbance, which could render the exposed soils more susceptible to erosive forces.

Excavation or grading may result in erosion during construction activities, irrespective of whether hardscape previously existed at the construction site, because bare soils would be exposed and could be eroded by wind or water. The effects of erosion are intensified with an increase in slope (as water moves faster, it gains momentum to carry more debris) and the narrowing of runoff channels (which increases the velocity of water). Surface structures, such as paved roads and buildings, decrease the potential for erosion. Once covered, such as with a paved road, soil is no longer exposed to the elements, and erosion generally does not occur.

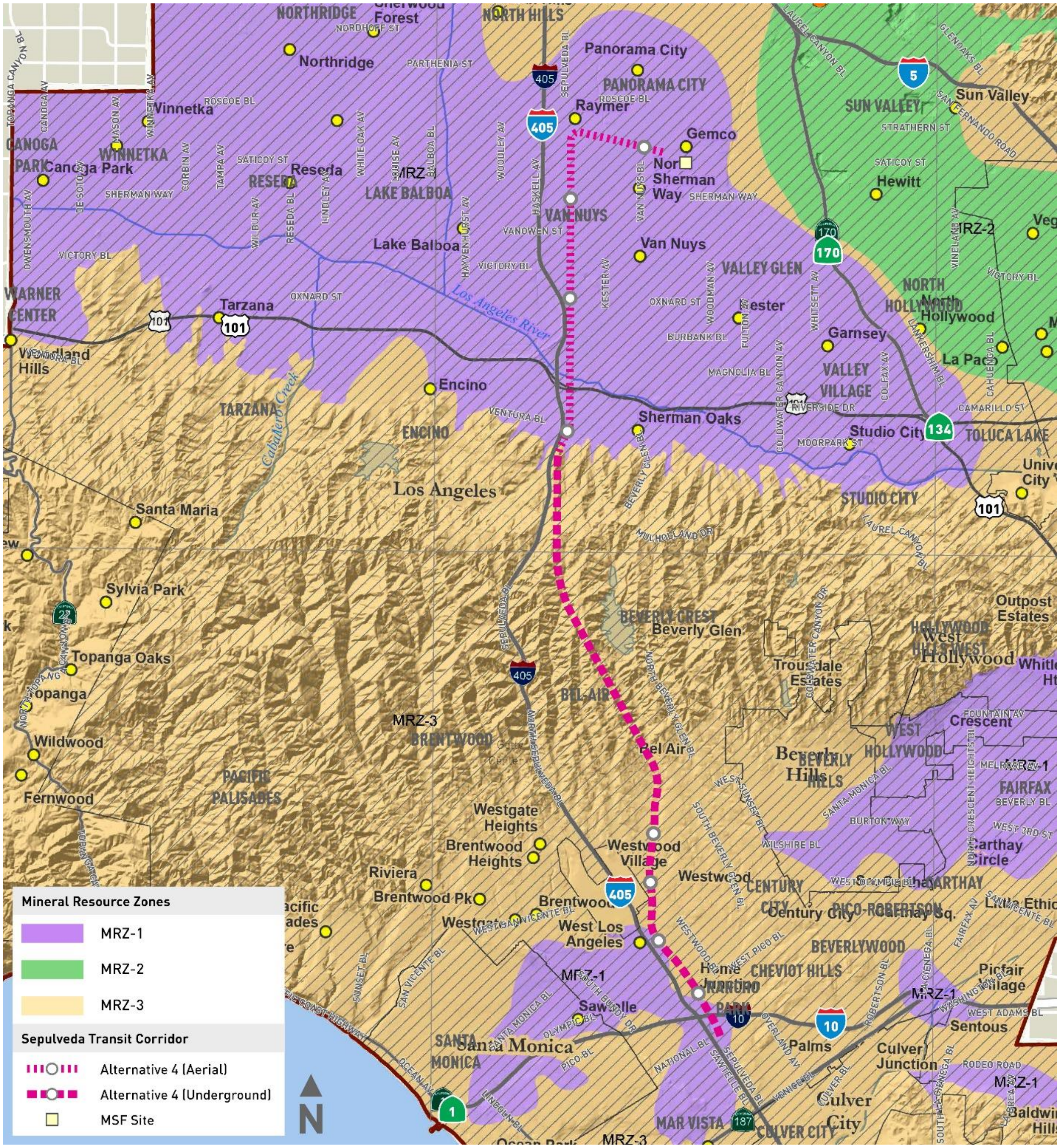
8.3 Mineral Resources

Mineral resource areas are identified according to the Surface Mining and Reclamation Act of 1975 and the following criteria for Mineral Resource Zones (MRZ), Scientific Resource Zones (SZ), and Identified Resource Areas. The MRZ and SZ categories used by the State Geologist in classifying the state’s lands, the geologic and economic data, and the substantiation of which each unit MRZ or SZ assignment is based on land classification information provided by the State Geologist to the Board of Supervisors for the following areas:

- **MRZ-1:** Adequate information indicates that no significant mineral deposits are present or little likelihood exists for their presence. This zone shall be applied where well-developed lines of reasoning, based on economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is nil or slight.
- **MRZ-2:** Adequate information indicates that significant mineral deposits are present or a high likelihood for their presence exists. This zone shall be applied to known mineral deposits or where well-developed lines of reasoning, based on economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is high.
- **MRZ-3:** Areas containing deposits whose significance cannot be evaluated from available data.
- **MRZ-4:** Available information is inadequate for assignment to any other MRZ zone.
- **SZ Areas:** Areas containing unique or rare occurrences of rocks, minerals, or fossils that are of outstanding scientific significance shall be classified in this zone.

Alternative 4 would contain areas designated as MRZ-1 and MRZ-3 (Figure 8-16). The California Department of Conservation, Division of Mines and Geology has classified areas of regional significance as MRZ-2 (CGS, 2021). Alternative 4 would not be located within an area designated as MRZ-2. Alternative 4 would be largely located within areas designated as MRZ-3, which contains deposits whose significance cannot be evaluated from available data. Alternative 4 would be located within areas designated as MRZ-1 in the northern portion of Alternative 4 in the San Fernando Valley as well as the southern portion of the Alternative 4 near West Los Angeles. MRZ-1-designated areas indicate that no significant mineral deposits are present or little likelihood exists for their presence.

Figure 8-16. Alternative 4: Mineral Resources



Source: CGS, 2021; HTA, 2024

8.4 Paleontological Resources

A paleontological records search from the Natural History Museum of Los Angeles County (NHMLAC) revealed no fossil locality located directly within the Resource Study Area (RSA). However, the paleontological records search from NHMLAC has revealed that 15 fossil localities are located within 5 miles of the RSA that produced fossil vertebrates and invertebrates in similar geologic units found within the project footprint. These results indicate a high paleontological sensitivity in the area. Underground components of Alternative 4 have increased impacts to paleontological resources. Deeper portions of any paleontologically sensitive unit have potential to produce rare or scientifically important taxa. Paleontological sensitivity refers to the paleontological potential for a geologic unit to contain fossil remains, traces, and fossil collecting localities. The following sensitivity ratings indicate the potential for containing significant paleontological resources.

- High paleontological sensitivity indicates that geologic units have a history of or are considered to have a high potential for paleontological resources (i.e., fossil remains).
- Moderate paleontological sensitivity indicates that fossil remains or traces have been found but are in poor condition, are a common paleontological resource, or do not have scientific significance.
- Low paleontological sensitivity indicates a low potential for containing fossil paleontological resources.
- No paleontological sensitivity indicates areas that are not conducive to significant paleontological resources due to environmental conditions.

For Alternative 4, it is difficult to quantify the number of sensitive formations and their sensitivity level with precision due to a blanket of soil that covers the entire RSA underground and current construction in the area. Appendix A to this technical report, the stand-alone Paleontological Technical Memorandum, contains a detailed analysis of paleontological resources.

8.5 Impacts Evaluation

8.5.1 Impact GEO-1: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map, issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.

8.5.1.1 Operational Impacts

As listed in Table 8-7 and shown on Figure 8-12, Alternative 4 crosses the Santa Monica Fault, designated as an Alquist-Priolo Earthquake Fault Zone, in an underground alignment. The Santa Monica Fault Zone is located approximately 1,000 feet north of the proposed Santa Monica Boulevard Station. The next nearest Alquist-Priolo Earthquake Fault Zones to Alternative 4 are the Hollywood Fault, located approximately 1.7 miles east from its mid-section, and the Newport-Inglewood-Rose Canyon Fault, located approximately 1.8 miles east of the southern portion of Alternative 4.

The Alquist-Priolo Earthquake Fault Zoning Act prohibits the construction of structures for human occupancy (i.e., houses, apartments, offices, stations, etc.) on the surface trace of active faults. However, the Alquist-Priolo Earthquake Fault Zoning Act does not prohibit the construction of non-habitable structures (i.e., not suitable to be lived in such as carport, roads, train tracks, bridges, etc.). Alternative 4 is a heavy rail transit (HRT) system with a hybrid underground and aerial guideway track configuration that would include four underground stations, four aerial stations, and TPSS sites. Alternative 4’s alignment would include a fixed guideway within the Alquist-Priolo Earthquake Fault Zone.

More specifically, Alternative 4 is a heavy rail transit (HRT) system with a hybrid underground and aerial guideway track configuration. Aerial operations of Alternative 4 would not directly or indirectly cause the rupture of a fault because the HRT trains would travel along an aerial guideway at least 15 feet above ground level. Moreover, underground operations of Alternative 4 involves traveling along a guideway ranging between 40 to 470 feet below surface level which would not cause fault rupture. Both the aerial and subterranean components would be constructed in compliance with applicable seismic and geotechnical regulatory requirements, as described and Section 2 Regulatory and Policy Framework, and using established engineering practices to minimize ground disturbance and ensure structural stability in areas near active faults. Therefore, operational impacts associated with substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault would be less than significant.

8.5.1.2 Construction Impacts

Construction of Alternative 4 would occur within the Santa Monica Fault zone, north of Santa Monica Boulevard and along I-405. Aerial guideway and station construction would involve installing CIDH piles (shafts with both precast and CIP structural elements), simple spans, and longer balanced cantilever spans within the I-405 ROW, arterials, and street crossings. A TBM would be used to construct the underground segment of the guideway. Tunneling depth would range between 40 feet to 470 feet. Underground stations would use a “cut-and-cover” construction method whereby the station structure would be constructed within a trench excavated from the surface that is covered by a temporary deck and backfilled during the later stages of station construction.

These components would be constructed in compliance with applicable seismic and geotechnical regulatory requirements, as described and Section 2 Regulatory and Policy Framework, and using established engineering practices to minimize ground disturbance and ensure structural stability in areas near active faults. Construction of Alternative 4 would not directly or indirectly exacerbate rupture of a known earthquake fault causing substantial adverse effects, including the risk of loss, injury, or death because these elements, including the CIDH piles, TBM-excavated tunnels, and cut-and-cover stations, do not reach a depth or be of an intensity that would affect geological processes such as faults. Therefore, construction impacts related to the rupture of a fault are less than significant.

8.5.1.3 Maintenance and Storage Facility

The proposed MSF would be located west of Woodman Avenue and south of the LOSSAN rail corridor ROW. The proposed MSF would not be within an Alquist-Priolo Earthquake Fault Zone. The closest Alquist-Priolo Earthquake Fault Zone is the Hollywood fault located approximately 8.3 miles southeast from the proposed MSF. Therefore, there are no impacts related to loss, injury, or death involving the rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map during operations or construction.

8.5.2 Impact GEO-2: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking and/or seismic-related ground failure, including liquefaction?

8.5.2.1 Operational Impacts

Seismic-related ground failures include liquefaction, post-liquefaction settlements, and landslides. Hazards related to landslides is discussed in Section 8.5.3. Alternative 4 during operation activities would experience earthquake-induced ground shaking activity because of its proximity to known active faults as listed in Table 8-7. Alternative 4 would be located in a seismically active region and would be subject to the seismic ground shaking that could result in damage to structures or human injury or death. For Alternative 4, this could include damage to aerial structures and underground tunnels, stations, and TPSS sites. Seismic ground shaking could also injure humans using or working on the system from falls to the ground or structural collapse and being trapped in the underground tunnel or stations. Therefore, Alternative 4 would experience moderate to high ground shaking from these fault zones, as well as some background shaking from other seismically active areas of the Southern California region.

Earthquakes are prevalent within Southern California, and the potential to experience substantial seismic ground shaking is a common hazard for every project within the region. Alternative 4 would be designed and constructed in conformance with the equivalent design criteria such as the MRDC. Additionally, measures to minimize the risk of loss, injury, and death from the effects of earthquakes and seismic ground shaking for project elements would be designed and constructed in conformance with applicable portions of building and seismic code requirements, including the most recent edition of the CBC, with specific provisions for seismic design, Metro's standard design specifications, and industry standards.

Consistent with equivalent design criteria such as the MRDC requirements, project structures and tunnels would be designed to perform in accordance with the two-level seismic evaluation approach based on the maximum design earthquake (MDE) and operating design earthquake (ODE). Aerial structures and underground tunnels would be designed and constructed in accordance with federal, state, and local thresholds for seismicity. Additionally, consistency with equivalent design criteria such as MRDC Section 5, Structural, dictates that during final design, a geotechnical investigation must be conducted, including a detailed and site-specific evaluation of geotechnical hazards. The resulting final geotechnical engineering recommendations and any additional recommendations that come out of the review process would be incorporated into the final design plans, consistent with equivalent design criteria such as the MRDC and standard practice to address any unstable geologic and related conditions present along the alignment. Therefore, compliance with the latest earthquake-resistant building design standards and other seismic safety parameters would substantially reduce potential structural damage and the risk to public safety from seismic events by ensuring that strong seismic ground shaking would not cause potential substantial effects, including the risk of loss, injury, or death.

As shown on Figure 8-14, the alignment of Alternative 4 would traverse a Liquefaction Zone in portions where the alignment exits or enters the underground portion just south of the Ventura Boulevard Station. Alternative 4 also includes surface station (Santa Monica Boulevard Station and the Wilshire/Metro D Line Station) as well as aerial stations with surface elements (Ventura Boulevard Station and the Metro G Line Station), and there is a potential for liquefaction in these areas. As mentioned in
Section 8.2.7, liquefaction is considered most likely to occur within the first 50 feet below ground surface. The underground portions of the alignment would be significantly deeper than 50 feet below ground surface; therefore, the potential liquefaction impacts on the tunnel are low. During severe ground shaking, loose granular soils below the groundwater table may liquefy. Seismic-related ground failure and liquefaction could result in damage to structures and human injuries where the soil undergoes a temporary loss of strength. Ground instability could affect structural stability, which in turn could damage structures or injure humans occupying structures on unstable ground. The proposed alignment and stations would be predominately in the younger alluvium, where the potential for adverse impact due to liquefaction is considered moderate to high. However, the aerial portion of the proposed alignment and stations would be supported on a deep foundation system to minimize risk of

liquefaction (Metro, 2025). Alternative 4 would be designed in accordance with design standards specific to ground stability. A geotechnical investigation would be performed during final design consistent with the equivalent design criteria such as the MRDC; the required design-level geotechnical investigation would provide information pertaining to the depths and areal extents of potential liquefaction and seismically induced settlement.

During the design process, if it is determined that these hazards could result in an unacceptable soil or structural response, ground improvements such as dynamic compaction, stone columns, jet grouting, and cement deep soil mixing and compaction grouting or deep foundation support to account for liquefaction or seismically induced settlement potential would be implemented and would be consistent with the recommendations contained in the geotechnical investigation and design standards. Therefore, adherence to the provisions listed in the CBC and equivalent design criteria such as the MRDC would substantially reduce potential structural damage and the risk to public safety from seismic events by ensuring that seismic-related ground failure and liquefaction would not cause potential substantial effects, including the risk of loss, injury, or death. As such, the potential impacts related to seismic-related ground failure and liquefaction would be less than significant during operations.

8.5.2.2 Construction Impacts

Alternative 4 would be located in a seismically active area. Active and potentially active faults in Southern California are capable of producing seismic ground shaking, and the Alternative 4 RSA would be anticipated to experience ground acceleration caused by these earthquakes. As stated previously, Alternative 4 would be surrounded by faults capable of generating a characteristic earthquake between M_W 6.0 and M_W 8.0. To reduce the risks associated with seismically induced ground shaking, which could include the risk of loss, injury, or death, the design of foundations and structures must consider the location and type of subsurface materials underlying Alternative 4. Because Alternative 4 would be located within the CBC, structures would be required to be designed in accordance with applicable parameters of the current CBC.

As shown on Figure 8-14, Alternative 4 traverses several Liquefaction Zones both within the San Fernando Valley and the Los Angeles Basin. Construction of Alternative 4 would occur within liquefaction zones, both within the San Fernando Valley and the Los Angeles Basin. Aerial guideway and station construction would involve installing CIDH piles (shafts with both precast and CIP structural elements), simple spans, and longer balanced cantilever spans within the I-405 ROW, arterials, and street crossings. A TBM would be used to construct the underground segment of the guideway. Tunneling depth would range between 40 feet to 470 feet. Underground stations would use a "cut-and-cover" construction method whereby the station structure would be constructed within a trench excavated from the surface that is covered by a temporary deck and backfilled during the later stages of station construction.

While construction activities for the underground alignment would involve subsurface work at depths where liquefaction could potentially occur, these activities would not directly or indirectly cause seismic ground shaking or induce liquefaction because the construction processes would not be of sufficient intensity to cause geological processes such as faults or liquefaction. Moreover, as described in Section 2 Regulatory and Policy Framework, the construction of Alternative 4 would adhere to seismic and geotechnical regulations, which would require appropriate engineering measures to ensure that liquefaction risks do not exceed unacceptable levels. Adherence to existing regulations (i.e., the CBC, equivalent design criteria such as the MRDC, County of Los Angeles Building Code, and City of Los Angeles Building Code) would ensure that Alternative 4 remains with a less than significant impact associated with exposing people or structures to seismic ground shaking, including effects related to seismic-related ground and liquefaction failure during construction activities.

8.5.2.3 Maintenance and Storage Facility

The proposed MSF would be located east of the Van Nuys Metrolink Station and would encompass approximately 46 acres. The HRT MSF would be designed to accommodate 184 rail cars and would be bounded by single-family residences to the south, the LOSSAN rail corridor to the north, Woodman Avenue on the east, and Hazeltine Avenue and industrial manufacturing enterprises to the west. Trains would access the site from the fixed guideway’s tail tracks at the northwest corner of the site. Trains would then travel southeast to maintenance facilities and storage tracks. The site would include the following facilities:

- Two entrance gates with guard shacks
- Main shop building
- MOW building
- Storage tracks
- Carwash building
- Cleaning and inspections platforms
- Material storage building
- Hazmat storage locker
- TPSS located on the west end of the MSF to serve the mainline
- TPSS located on the east end of the MSF to serve the yard and shops
- Parking area for employees
- Grade-separated access roadway (over the HRT tracks at the east end of the facility, and necessary drainage)

Operation and construction of the proposed HRT MSF do not involve extensive excavation and do not reach a depth or be of an intensity that would affect geological processes such as faults. As such, impacts related to seismic ground shaking including liquefaction would be less than significant during operations and construction.

8.5.3 Impact GEO-3: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides?

8.5.3.1 Operational Impacts

As shown on Figure 8-15, the underground segment of Alternative 4 would traverse the Santa Monica Mountains, which are within a designated LHZ and contain surface areas prone to landslides. Alternative 4 would operate a public transportation line with a fixed guideway.

According to the Caltrans Geotechnical Manual, the most adverse slope behavior is greatly influenced by water (Caltrans, 2020). Concentrated storm runoff can result in severe slope erosion leading to a loss of structural support and catastrophic failure. Perched groundwater and infiltration from irrigation, rainfall, or snowmelt frequently cause landslides. However, impacts related to topsoil erosion and water infiltration are managed separately and would not directly influence the operational impacts related to landslides.

Earthquake-induced landslides are slope failures/movements that occur from shaking during an earthquake event. Operational activities of Alternative 4 involve operating a public transportation line with a fixed guideway. Operational activities associated with Alternative 4would not directly or indirectly cause strong seismic ground shaking including landslides as these activities would not involve interaction with geological processes such as faults or the alteration of natural slopes.

According to the USGS, certain human activities can cause landslides. They are commonly a result of building roads and structures without adequate grading of slopes, poorly planned alteration of drainage patterns, and disturbing old landslides (USGS, 2024). However, operational activities for Alternative 4 would not involve grading of slopes, modification of drainage systems, or disturbance of existing landslides. Additionally, the design of Alternative 4 would minimize interaction with natural slopes by employing an elevated guideway positioned above steep terrain and avoiding direct contact with unstable areas. The design would also incorporate drainage and erosion control measures to prevent water-related slope instability and comply with applicable geotechnical and engineering standards described in Section 2 Regulatory and Policy Framework. Therefore, Alternative 4 would have a less than significant impact related to landslides during operations.

8.5.3.2 Construction Impacts

As shown on Figure 8-15, the tunnel portal for Alternative 4 traverses through the Santa Monica Mountains which are within a designated LHZ making construction near surface-level soils vulnerable to inducing a landslide. As such, the impacts associated with a landslide hazard within the Santa Monica Mountains are potentially significant.

However, the portions of Alternative 4 that cross the LHZ would be situated deep underground in this location and the risk of landslides would be low. According to the *Sepulveda Transit Corridor Project, Final Draft Geotechnical Design Memorandum* (Metro, 2023b), the north tunnel portal in Sherman Oaks would be the most impacted section of the Alternative 4 alignment in terms of landslide risk. The Modelo Formation, which consists of diatomaceous shale, is exposed in a slope in this area. The layers of this shale are angled toward the north, which is not ideal for the proposed portal excavation. To improve long-term slope stability in this area, Alternative 4 may install an anchored retaining wall or use ground anchors (Metro, 2023b).

Consistent with local requirements, further investigations into the slope along I-405 would be conducted during the design phase when site-specific data and final geometry of improvements are available. The foundation types would be determined as part of the required site-specific geotechnical investigation conducted during the final design phase and would ensure that the potential for landslides would not cause potential for substantial adverse effects, including the risk of loss, injury, or death.

Construction activities for Alternative 4 would also include the installation of the portal in the Sherman Oaks community. Temporary engineering would be erected to support the retaining wall during cut-and-cover excavation. These activities would be located within a designated LHZ, and potential landslides during construction could cause injury or death to construction workers.

Construction of Alternative 4 would adhere to existing regulations and the provisions listed in the CBC and equivalent design criteria as the MRDC that require site-specific geotechnical evaluation during the final design phase that would include specific structural engineering recommendations. Grading and construction activities would be carried out in compliance with the regulatory requirements defined in Section 2 Regulatory and Policy Framework, including state regulations and the equivalent design criteria such as the MRDC, to account for the portion of Alternative 4 that would be within an LHZ.

The final design of the tunnel portal’s retaining walls, and its temporary engineering would abide with structural engineering standards set forth in the provisions listed in the CBC. The CBC provisions that relate to the construction and design of the retaining walls include the requirements for foundation and soil investigations, excavation, grading, and fill-allowable, load-bearing values of soils. The CBC provision also relates to design of footings, foundations, and slope clearances, retaining walls, and pier, pile, driven, and CIP foundation support systems (Section 1810). Chapter 33 includes requirements for safeguards at work sites to ensure stable excavations and cut or fill slopes). Appendix J includes grading requirements for the design of excavations and fills (Sections J106 and J107) and for erosion control (Section J110). Construction activities are subject to occupational safety standards for excavation, shoring, and trenching as specified in Cal/OSHA regulations (CCR Title 8).

Alternative 4 would require a site-specific slope-stability design to ensure adherence to the standards contained in the CBC and any County of Los Angeles and City of Los Angeles guidelines, as well as by Cal/OSHA requirements for stabilization. Alternative 4 would include manufactured slopes (using grading techniques) in the retention basins, which would mostly occur on the perimeter of the construction sites where they would also serve as a buffer to protect the tunnel and surrounding infrastructure from landslide-related hazards. Retention basins would be designed with due consideration for slope stability.

The combination of site-specific slope-stability design, compliance with applicable regulatory requirements, and the use of manufactured slopes and retention basins is anticipated to effectively manage constructed-slope instability such that impacts associated with constructed-slope instability, including landslides, are reduced, but may still be potentially significant.

This is particularly true for temporary slopes, as excavation activities for Alternative 4 within Landslide Zones could encounter unstable soils. Temporary slopes generally pose a higher risk of slope failure due to their steeper gradients compared to permanent, manufactured slopes. Similar to permanent slope construction, temporary slopes would be required to comply with Cal/OSHA requirements for shoring and stabilization.

To address these significant impacts, MM GEO-2 would be implemented so that any excavations for the construction of the underground segment of Alternative 4 would shore excavation walls or flatten or “lay back” the excavation walls to a shallower gradient as required by applicable local, state, or federal laws or regulations to ensure stability of temporary slopes.

With the implementation of MM GEO-2, the impacts associated with landslides and/or slope instability during construction activities would be reduced to less than significant.

8.5.3.3 Maintenance and Storage Facilities

The proposed MSF would be located west of Woodman Avenue and south of the LOSSAN rail corridor. The proposed MSF would not be located on land designated as an LHZ, which are areas prone to landslides (Figure 8-15); the closest LHZ is located approximately 4.10 miles south from the proposed MSF. Therefore, the proposed MSF would not directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides, and no impact would occur.

8.5.4 Impact GEO-4: Would the project result in substantial soil erosion or the loss of topsoil?

8.5.4.1 Operational Impacts

Implementation of Alternative 4 would not result in substantial soil erosion or the loss of topsoil during operations. Topsoil is the uppermost layer of soil — usually the top 6 to 8 inches —which has the highest concentration of organic matter and micro-organisms and is where most biological soil activity occurs. Plants generally concentrate their roots in, and obtain most of their nutrients from, this layer. Topsoil erosion is of concern when the topsoil layer is blown or washed away, which makes plant life or agricultural production impossible. In addition, significant erosion typically occurs on steep slopes where stormwater and high winds can carry topsoil down hillsides.

Some areas of pervious surfaces are associated with the open space areas within the adjacent Santa Monica Mountains region and a minimal extent of setbacks and residential yards along the Alternative 4 alignment. Alternative 4 would traverse the Santa Monica Mountains deep in an underground tunnel. North of the Santa Monica Mountain, Alternative 4 would operate at an aerial alignment along the Sepulveda Corridor. The aerial guideway viaduct would be primarily situated in the center of Sepulveda Boulevard in the San Fernando Valley, a highly urbanized and developed area, with guideway columns located in both the center and outside of the ROW of Sepulveda Boulevard. The depth of cover at which the tunnel segments would operate vary along the alignment but would vary between 40 feet to 470 feet, much deeper than what is considered topsoil (6 to 8 inches of the uppermost layer of soil). As such, operation of Alternative 4 would not result in substantial ground disturbance or an increase in the amount of exposed soil as compared to existing conditions. Moreover, operational activities would not change the amount of erosion and spreading grounds within the Santa Monica Mountains and residential yards along the Alternative 4 RSA compared to existing conditions.

As described in the *Sepulveda Transit Corridor Project Water Resources Technical Report* (Metro, 2025), Alternative 4 would result in a net loss of impervious surface area. Alternative 4 not result in a significant increase in impervious surfaces because approximately half of the proposed stations (four stations) are underground and the majority of the land surfaces associated with the proposed aerial stations and other ancillary facilities in the Project Study Area are developed and covered by existing impervious surfaces. Components of Alternative 4 that would increase existing impervious areas include: UCLA Gateway Plaza Station, Metro G Line Station, and the Van Nuys Metrolink Station. Components that would decrease the existing impervious surface area include the Metro E Line Station, Santa Monica Boulevard Station, Wilshire Boulevard/Metro D Line Station, Ventura Boulevard Station, Sherman Way Station, and proposed MSFs adjacent to the Van Nuys Metrolink/Amtrak Station at the northern end of Alternative 4. The actual footprint of the aerial stations at the ground level would be covered only by column footings and vertical circulation elements. Total net impervious surface area created by Alternative 4 elements would total -13,497 square feet. Further details on new impervious surfaces and its impact on erosion resulting from Alternative 4 can be found in the *Sepulveda Transit Corridor Project Water Resources Technical Report* (Metro, 2025).

Alternative 4 would be designed to incorporate several sustainability features, such as native landscaping, rainwater cisterns for capture and reuse, permeable surfaces, soil improvements, increased vegetation, and on-site retention, in compliance with the *Low Impact Development Standards Manual* (LACDPW, 2014), which would serve to reduce impervious area and limit runoff that may cause erosion.

Alternative 4 would comply with post-construction measures in applicable National Pollutant Discharge Elimination System (NPDES) permits and Low Impact Development (LID) standards required by Los Angeles County and other local jurisdictions, which aim to minimize erosion impacts from development projects. With adherence to existing regulations, Alternative 4 would result in a less than significant impact related to substantial soil erosion or the loss of topsoil during operations.

8.5.4.2 Construction Impacts

Ground-disturbing activities occurring during construction would temporarily expose surficial soils to wind and water erosion and have the potential to temporarily increase erosion and loss of topsoil. Construction work that would involve ground-disturbing activities would include installation of CIDH piles for the HRT aerial guideway, installation of temporary engineering for the portal, installation of

TPSS sites, utility relocations, mass excavation of the underground stations, and grading relating to these activities. Retaining-wall installation at the portal would involve considerable earth-moving activities. However, construction activities would be required to comply with existing regulatory requirements, including implementation of best management practices (BMPs) and other erosion and sedimentation control measures that would ensure that grading, excavation, and other earth-moving activities would avoid a significant impact.

Metro would be required to prepare a *Stormwater Pollution Prevention Plan*, and a site-specific *Standard Urban Storm Water Mitigation Plan* (SUSMP), which is part of the NPDES Municipal General Permit. Preparation of the site-specific SUSMP would describe the minimum required BMPs to be incorporated into the Alternative 4 design and on-going operation of the facilities. Prior to the initiation of grading activities associated with implementation of Alternative 4, Metro would submit a site-specific SUSMP to reduce the discharge of pollutants to the maximum extent practical using BMPs, control techniques and systems, design and engineering methods, and other provisions that are appropriate during construction activities. All development activities associated with Alternative 4 would comply with the site-specific SUSMP.

Preparation of a site-specific SUSMP and adherence to existing regulations would ensure the maximum practicable protection available for soils excavated during the construction of buildings and associated infrastructure. Compliance with existing regulations would minimize effects from erosion through repair and rehabilitation of topsoil post-construction and ensure consistency with the *Regional Water Quality Control Board Water Quality Control Plan*. In view of these requirements, Alternative 4 would have a less than significant impact associated with soil erosion or loss of topsoil during construction activities.

8.5.4.3 Maintenance and Storage Facilities

Operation of the proposed MSF would include the maintenance, cleaning, and storage of HRT vehicles. The proposed MSF site would be located within an urbanized area that is primarily impervious with no exposed soil. Operation of the proposed MSF would not result in ground disturbance or a change in the amount of exposed soil as compared to existing conditions and would adhere to existing regulations. The proposed MSF would comply with post-construction measures in applicable NPDES permits and LID standards required by Los Angeles County and the City of Los Angeles that aim to minimize erosion impacts from development projects. Therefore, the proposed MSF would result in a less than significant impact related to substantial soil erosion or the loss of topsoil during operations and construction.

8.5.5 Impact GEO-5: Would the project be located on a geographic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?

8.5.5.1 Operational Impacts

Section 8.5.2 addresses impacts related to liquefaction and Section 8.5.3 addresses impacts related to landslides. The analysis in this section addresses impacts related to unstable soils as a result of subsidence, differential settlement, lateral spreading, or collapse.

The underground and aerial segments of Alternative 4 would not be located on a geographic unit or soil that is unstable, or that would become unstable, potentially resulting in lateral spreading, subsidence, liquefaction, or collapse. Based on the flat topography at station/facility sites and limited locations having open free-face conditions (and given that a significant portion of the Alternative 4 alignment would be in a tunnel), the overall potential for earthquake-induced lateral spreading is considered low as identified in the *Sepulveda Transit Corridor Project, Final Draft Geotechnical Design Memorandum* (Metro, 2023b). Additionally, ground shaking leading to liquefaction of saturated soil could result in lateral spreading where the soil undergoes a temporary loss of strength, and if the liquefied soil is not contained laterally, it may result in deformation of the slope.

As mentioned in Section 8.2.7, liquefaction is considered most likely to occur within the first 50 feet below ground surface. The underground portions of the alignment would be significantly deeper than 50 feet below ground surface; therefore, the potential liquefaction impacts on the tunnel are low.

Using unsuitable materials for fill and/or foundation support would have the potential to create future heaving, subsidence, spreading, or collapse problems, which would lead to building settlement and/or utility line and pavement disruption. Structural engineering standards to address geological conditions are part of standard construction requirements and standard construction practices. Alternative 4 would be designed in accordance with equivalent design criteria such as MRDC Section 5, Structural; Metro's Supplemental Seismic Design Criteria (2017); and the California Seismic Hazards Mapping Act. Furthermore, Alternative 4 would be designed in accordance with recommendations developed in a detailed geotechnical report prepared during final design, which would provide site-specific information pertaining to the depths and areal extents of lateral spreading, subsidence, or collapse.

During the design process, if it is determined that these conditions identified in the geotechnical report could result in an unacceptable soil or structural response (to be defined during final design and dependent on the type of structure), the resulting final geotechnical engineering would include recommendations that would be incorporated into the final design plans consistent with standard practice to address any unstable geologic and related conditions present along the alignment. Recommendations may include deep foundations and/or ground improvements such as dynamic compaction, stone columns, jet grouting, and cement deep soil mixing and compaction grouting.

Given compliance with these regulatory and design requirements, Alternative 4 would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils as a result of subsidence, differential settlement, lateral spreading, or collapse during operations.

8.5.5.2 Construction Impacts

Section 8.5.2 addresses impacts related to liquefaction, and Section 8.5.3 addresses impacts related to landslides. The analysis in this section addresses impacts related to unstable soils as a result of subsidence, differential settlement, lateral spreading, or collapse.

Construction activities for Alternative 4 would involve foundation support installation and earthwork at the tunnel portal at the Sherman Oaks Community. Certain construction activities, such as CIDH drilling for the aerial guideway and excavation and erection of the temporary engineering of the tunnel portal, could affect soil stability leading to ground movements (both lateral movements and settlements) or subsidence. Additionally, the use of unsuitable materials for fill and/or foundation support would have the potential to create future heaving, subsidence, spreading, or collapse problems, leading to foundation and roadway settlement. Excavation for construction of underground structures — such as station boxes, cut-and-cover tunnels, and tunnel portals — would be reinforced by shoring systems to protect abutting buildings, utilities, and other infrastructure. Tunneling using a TBM would result in ground volume loss and potential ground movements. Dewatering, when performed to create a dry work condition for construction of the underground structures, if allowed to draw down the groundwater table beyond the limits of excavation, could result in compaction or consolidation of the subsurface soils and thus potentially result in surface settlements.

However, Alternative 4 would be in compliance with the regulatory requirements as defined in PM GEO-2 as described in Section 8.6. Under PM GEO-2, a site-specific evaluation of soil conditions that shall contain recommendations for ground preparation, earthwork, and compaction specification based on the geological conditions specific to the site.

As described in Section 8.6, MM GEO-1 through MM GEO-5 would be implemented as part of Alternative 4. MM GEO-3 ensures compliance with the recommendations of the final soils and geotechnical report, which would provide site-specific information pertaining to the depths and areal extents of lateral spreading, subsidence, or collapse. MM GEO-5 specifies that Alternative 4 shall prepare a *Construction Management Plan* (CMP) prior to construction detailing how to address geologic constraints and minimize or avoid impacts to geologic hazards during construction.

Adherence to existing regulations and policies and implementation of MM GEO-1 through MM GEO-5 would ensure the maximum practicable protection available for users of buildings and infrastructure and associated trenches, slopes, and foundations. Therefore, with the implementation of mitigation measures, Alternative 4 would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils.

8.5.5.3 Maintenance and Storage Facilities

As addressed in Section 8.5.2 and Section 8.5.3, the proposed MSF would be located on stable soils where no liquefaction or landslide zones are present. Construction and operations would not occur on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed MSF, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse. The proposed MSF would be designed in compliance with applicable local, state, or federal laws or regulations, including recommendations on engineering and design considerations, as described in Section 8.5.5.2 and identified in MM GEO-1 through MM GEO-5. Thus, operations and construction of the proposed MSF would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

8.5.6 Impact GEO-6: Would the project be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property?

8.5.6.1 Operational Impacts

The majority of fine-grained soil and rock encountered in the Project Study Area exhibited low plasticity, with very low to medium expansion potential (Metro, 2023a). However, expansive soils can be found almost anywhere, particularly in coastal plains and low-lying valleys such as the Los Angeles Basin and San Fernando Valley. Expansive clays can be found in weathered bedrock along the Santa Monica Mountains. Much of the northern section of the Santa Monica Mountains is in Modelo Formation. Clay-rich soils may exist locally within alluvial soils present along Alternative 4 that could swell and shrink with wetting and drying. The change in soil volume is capable of exerting enough force on structures to damage foundations, structures, and underground utilities. Damage can also occur as these soils dry out and contract. As part of PM GEO-2 during construction, a California-registered geologist and geotechnical engineer would submit to and conduct a site-specific evaluation of unstable soil conditions to confirm the existence of expansive soils.

While expansive soils could have an impact on project elements, operational activities of Alternative 4 do not directly or indirectly cause risks of life or property as operations would not involve wetting or drying of expansive soils. Therefore, impacts related to expansive soils are less than significant during operations.

8.5.6.2 Construction Impacts

Construction activities for Alternative 4 involve building both aerial and underground sections, as well as its aerial and underground stations. The underground guideway will be constructed using a TBM whereas the aerial guideway would consist of simple spans and longer balanced cantilever spans. Foundations require CIDH shafts with both precast and CIP structural elements. Underground stations would be constructed using a "cut-and-cover" method whereby the station structure would be constructed within a trench excavated from the surface with a portion or all being covered by a temporary deck and backfilled during the later stages of station construction. Aerial stations would include construction of CIDH elevated viaduct with two parallel side platforms supported by outrigger bents.

Expansive soils can be found almost anywhere, including the Los Angeles Basin, Santa Monica Mountains, and San Fernando Valley. Expansive soils could have an impact on project elements, including the proposed stations, guideway, and TPSS sites. Construction of Alternative 4 includes excavation and surface ground disturbances, if expansive soils do exist, construction activities have the potential to create substantial direct or indirect risks to life or property. As such, impacts related to construction activities could be potentially significant.

To reduce these risks, Alternative 4 would be designed in accordance with the equivalent seismic design criteria such as the MRDC, Los Angeles County and other applicable local building codes, and the CBC. This includes compliance with equivalent MRDC Section 5 (or equivalent seismic design criteria), which requires preparation of a geotechnical investigation during final design (refer to Section 2 Regulatory and Policy Framework for additional information). This design-level geotechnical investigation must include a detailed evaluation of geologic hazards, including the depths and areal extents of liquefaction, soil expansiveness, lateral spread, and seismically induced settlement. This investigation would include collecting soil samples and performing tests to assess the potential for corrosion, consolidation, expansion, and collapse. Based on the investigation and test results, specific design recommendations, including potential remediation of expansive soils, would be developed to address any identified issues. Expansive soil remediation could include soil removal and replacement, chemical treatment, or structural enhancements.

Alternative 4 would be in compliance with the regulatory requirements as defined in PM GEO-2 which calls for a California-registered geologist and geotechnical engineer to submit to and conduct a site-specific evaluation of unstable soil conditions to confirm the existence of expansive soils. The evaluation would also provide recommendations for ground preparation and earthwork activities specific to the site and take into consideration both aerial and underground construction.

Moreover, Alternative 4 would be required to comply with applicable provisions of the CBC and MRDC regarding soil hazard-related design, as described by PM GEO-3. The MRDC equivalent and the County of Los Angeles and City of Los Angeles building codes require site-specific investigations and reports for each construction site. The reports must identify any unsuitable soil conditions and provide recommendations for foundation type and design criteria, consistent with the analysis and building code standards. Regulations exist to address weak soil issues, including expansion. PM GEO-3, as described in

Section 8.6.2, would be implemented and as such, Alternative 4 would comply with applicable local, state, or federal laws or regulations to address any potential weak soil issues during construction.

Finally, prior to construction, the Project shall implement MM GEO-5, which requires preparation of a CMP which addresses geologic hazards such as soils with shrink-swell potential (expansive soils) and outlines strategies to minimize or avoid impacts.

With compliance with the regulatory requirements as defined in PM GEO 2, PM GEO-3, and implementation of MM GEO-5, Alternative 4 would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils during construction.

8.5.6.3 Maintenance and Storage Facilities

Operations related to the proposed MSF do not involve grading, excavation, or other ground disturbances. Therefore, impacts related to operational activities are less than significant.

Construction of the proposed MSF may involve grading, excavation, or other ground disturbances. If expansive soils exist at these sites, construction activities have the potential to create substantial direct or indirect risks to life or property. As such, impacts related to construction activities could be potentially significant.

The proposed MSF would be in compliance with the regulatory requirements as defined in PM GEO-2 which calls for a California-registered geologist and geotechnical engineer to submit to and conduct a site-specific evaluation of unstable soil conditions to confirm the existence of expansive soils. The evaluation would also provide recommendations for ground preparation and earthwork activities specific to the site. Moreover, the proposed MSF would be required to comply with applicable provisions of the CBC and an MRDC equivalent with regard to soil hazard-related design, as described by PM GEO-3. Finally, prior to construction, the proposed MSF shall implement MM GEO-5, which requires the preparation of a CMP which addresses geologic hazards such as soils with shrink-swell potential (expansive soils) and outlines strategies to minimize or avoid impacts.

With compliance with the regulatory requirements as defined in PM GEO-2, PM GEO-3, and implementation of MM GEO-5, the proposed MSF would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils during construction.

8.5.7 Impact GEO-7: Would the project have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?

8.5.7.1 Operational Impacts

No septic systems or alternative wastewater disposal systems are proposed for Alternative 4. Alternative 4 would have no impacts associated with soils incapable of adequately supporting such systems during operations.

8.5.7.2 Construction Impacts

No septic systems or alternative wastewater disposal systems are proposed for Alternative 4. Alternative 4 would have no impacts associated with soils incapable of adequately supporting such systems during construction activities.

8.5.7.3 Maintenance and Storage Facilities

No septic systems or alternative wastewater disposal systems are proposed for the proposed MSF. Therefore, the proposed MSF would have no impacts associated with soils incapable of adequately supporting such systems during operations.

8.5.8 Impact GEO-8: Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

8.5.8.1 Operational Impacts

Operations of Alternative 4 would not include activities that involve ground disturbance. Therefore, there would be no operational impacts related to paleontological resources.

8.5.8.2 Construction Impacts

Alternative 4 would have more than half of the rail it proposes to be located under the ground surface. The proposed tunnel would be nearly 9 miles long and would begin in a tunnel that would be just east of Sepulveda Boulevard and south of National Boulevard. The proposed tunnel would have four underground stations and would transition from a tunnel to an elevated guideway that would go from Sepulveda Boulevard until Raymer Street where it would turn southeast and run along the south side of the Amtrak/Metrolink corridor to Van Nuys Boulevard. The surface sediments that the elevated guideway would overlie are mapped as alluvium (Qa), young alluvium fan deposits, unit 1 (Qyf1), and young alluvium fan deposits, unit 2 (Qyf2). However, these units listed are not representative of what can be encountered below the surface level (Campbell et al., 2016). Qa, Qyf1, and Qyf2 vary in thickness from 20 feet to several hundred feet below the surface.

It is difficult to specify for certain which units lie beneath these surface sediments. The areas where the heavy rail would transition to a tunnel would have a depth that would vary from 80 to 100 feet below the ground surface. The sediments mapped at the surface of where the tunnel system would go for Alternative 4 are mapped as young alluvium, unit 2 (Qya2), Modelo Formation undivided (Tm), Modelo Formation sandstone (Tms), Modelo Formation diatomaceous shale (Tmd), Santa Monica Slate spotted slate (Jsms), Santa Monica Slate undivided (Jsm), and Santa Monica Slate phyllite (Jsmp). As previously stated, knowing what is at depth is difficult to discern using only surface data. Geologic units such as the Santa Monica Slate (Jsm, Jsms, and Jsmp) do not have any paleontological sensitivity to preserve fossil material. Santa Monica Slate is a geologic unit that comprises metamorphic rock, which undergoes intense pressure and temperature and limits fossil preservation potential. This metamorphic process usually destroys and deforms any fossil material that could have been located within, but due to the relatively low grade of metamorphism, enough relevant features of the fossils were preserved (Imlay, 1963). Additionally, the Quaternary young alluvium (Qya2) has a low sensitivity due to a limited potential for preserving fossil material because this unit is too young to have preserved any significant fossil material. The Modelo Formation labelled Tm, Tmss, and Tmd all have a high sensitivity for preserving fossil material due to their age and the fossil localities found within the same map units nearby (SVP, 1995; Bell, 2023).

Possible construction impacts involved with Alternative 4 would all be a result of access, staging, and lay down areas that would be required for placing the heavy rail track and excavating the tunnel. The CIDH method would be used during the construction of the foundations for the columns. This method does not allow for careful monitoring as it grinds the soil. Consequently, this method would cause potentially significant and unavoidable impacts to paleontological resources when utilized in paleontologically sensitive geologic formations (*Paleontological Technical Memorandum*, Attachment 1, Figure 5 of this report). Additionally, there will also be significant impacts to surrounding sediments for staging areas and access pathways for all 4 of the underground stations that are planned for this alternative (Metro E Line/Sepulveda, Santa Monica Boulevard, Wilshire Boulevard/Metro D Line, UCLA Gateway Plaza).

An automated TBM will be excavating the tunnels for the underground portion of Alternative 4. The TBM will excavate sediments to the dimensions of the finished tunnel, remove the sediments from the forward portion of the TBM via an internal conveyer belt, and erect the segmental, precast concrete tunnel liner. Therefore, the impact to paleontological resources in the tunnels would be significant and unavoidable. The operation of the TBM does not allow the monitor to view the sediments as they are being excavated, or the walls of the tunnel following removal of excess sediments and prior to the installation of the tunnel's concrete liner. For these reasons, monitoring paleontological resources adjacent to the TBM is not possible. Thus, in consideration of the California Environmental Quality Act (CEQA), excavations for tunnel construction would result in significant and unavoidable impacts to paleontological resources in paleontologically sensitive geologic units (*Paleontological Technical Memorandum*, Attachment 1, Figure 5 of this report) (SVP, 2010; Scott and Springer, 2003).

When considering Quaternary aged deposits, deeper (i.e., older) portions of paleontologically sensitive geologic units are generally more sensitive from a scientific point of view. Thus, a mapped geologic unit considered to have low paleontological sensitivity at the surface has the potential to become more sensitive paleontologically at depth. Therefore, the impact to paleontological resources at TBM launching and extracting sites would be significant (*Paleontological Technical Memorandum*, Attachment 1, Figure 5 of this report). However, when excavations take place to launch and extract the TBM in paleontologically sensitive units, MM GEO-6 through MM GEO-9 shall be implemented to reduce the impact to paleontological resources to less than significant (SVP, 2010; Scott and Springer, 2003).

8.5.8.3 Maintenance and Storage Facilities

The impacts involved with the MSF would include all administrative buildings, maintenance buildings, wash facilities, drive aisles, and storage tracks. The surface sediments in the underground portions of the proposed MSF are mapped as Qya2 but may be more paleontologically sensitive (older) than indicated at depth. There should be a qualified paleontologist to monitor ground disturbance when this unit is encountered (SVP, 1995; Bell, 2023). With implementation of MM GEO-6 through MM GEO-9, impacts associated with the MSF would be less than significant.

8.5.9 Impact GEO-9: Would the project result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state or result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?

8.5.9.1 Operational Impacts

Operation of Alternative 4 would not require excavation that may affect mineral resources. No mining operations are present within the Alternative 4 RSA, so operation of Alternative 4 would not disrupt mining operations. Therefore, Alternative 4 would have no impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

8.5.9.2 Construction Impacts

Construction of Alternative 4 would require excavation (cut and cover) for underground stations and column foundations and would use a TBM for tunnel construction. However, Alternative 4 would not be located in an area with known mineral deposits. As mentioned in Section 8.3, Alternative 4 is located in areas designated as MRZ-1 and MRZ-3. The California Department of Conservation, Division of Mines and Geology has classified areas of regional significance as MRZ-2 (CGS, 2021). Alternative 4 would not be located within an area designated as MRZ-2. Alternative 4 would be located within areas designated as MRZ-1 in the northern portion of Alternative 4 in the San Fernando Valley as well as the southern portion of Alternative 4 near West Los Angeles. MRZ-1-designated areas indicate that no significant mineral deposits are present or little likelihood exists for their presence.

No mining operations are present within the Alternative 4 RSA, so construction of Alternative 4 would not disrupt mining operations. Therefore, Alternative 4 would have no construction impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

8.5.9.3 Maintenance and Storage Facilities

Operation and construction of the MSF would not require excavation that may affect mineral resources. No mining operations are present within or in the vicinity of the MSF. Therefore, the MSF would have no operational or construction impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

8.6 Project and Mitigation Measures

8.6.1 Operational Impacts

No mitigation measures are required.

8.6.2 Construction Impacts

Alternative 4 would implement the following project and mitigation measures to ensure that impacts to the geology, soils, and seismicity remain less than significant during construction activities:

PM GEO-1: *The Project shall demonstrate to the County of Los Angeles and the City of Los Angeles that the design of the Project complies with all applicable provisions of the California Building Code with respect to seismic design. Compliance shall include the following:*

- *California Building Code Seismic Zone 4 Standards as the minimum seismic-resistant design for all proposed facilities*
- *Seismic-resistant earthwork and construction design criteria (i.e., for the construction of the tunnel below ground surface, liquefaction, landslide, etc.), based on the site-specific recommendations of a California Registered Geologist in cooperation with the Project Engineers.*
- *An engineering analysis to characterize site specific performance of alluvium or fill where either forms part or all of the support.*

PM GEO-2: *A California-registered geologist and geotechnical engineer shall submit to and have approval by the Project a site specific evaluation of unstable soil conditions, including recommendations for ground preparation and earthwork activities specific to the site and in conformance with City of Los Angeles Building Code, County of Los Angeles Building Code, the California Building Code, Metro Rail Design Criteria (as applicable), and Caltrans Structure Seismic Design Criteria.*

PM GEO-3: *The Project shall demonstrate that the design of the Project complies with all applicable provisions of the County of Los Angeles Building Code and City of Los Angeles Building Code.*

MM GEO-1: *The Project's design shall include integration and installation of early warning system to detect and respond to strong ground motion associated with ground rupture. Known active fault(s) (i.e., Santa Monica Fault) shall be monitored. Linear monitoring systems such as time domain reflectometers or equivalent or more effective technology shall be installed along fixed guideway in the zone of potential ground rupture.*

MM GEO-2: *Where excavations are made for the construction of the below surface tunnel, the Project shall either shore excavation walls with shoring designed to withstand additional loads or reduce the slope of the excavation walls to a shallower gradient. Excavation spoils shall not be placed immediately adjacent to excavation walls unless the excavation wall is shored to support the added load. Spoils should be stored at a safe distance from the excavation site to prevent undue pressure on the walls.*

MM GEO-3: *The Project shall comply with the recommendations of the final soils and geotechnical report. These recommendations shall be implemented in the design of the Project, including but not limited to measures associated with site preparation, fill placement, temporary shoring and permanent dewatering, groundwater seismic design features, excavation stability, foundations, soil stabilization, establishment of deep foundations, concrete slabs and pavements, surface drainage, cement type and corrosion measures, erosion control, shoring and internal bracing, and plan review.*

MM GEO-4: *In locations where soils have a potential to be corrosive to steel and concrete, the soils shall be removed, and buried structures shall be designed for corrosive conditions, and corrosion-protected materials shall be used in infrastructure.*

MM GEO-5: *Prior to construction, the Project shall prepare a Construction Management Plan (CMP) that addresses geologic constraints and outlines strategies to minimize or avoid impacts to geologic hazards during construction. The plan shall address the following geological and geotechnical constraints/resources and incorporate standard mitigation measures (shown in parentheses):*

- *Groundwater withdrawal (using dewatering pumps and proper disposal of contaminated groundwater according to legal requirements)*
- *Risk of ground failure from unstable soils (retaining walls and inserting soil stabilizers)*
- *Subsidence (retaining walls and shoring)*
- *Erosion control methods (netting on slopes, bioswales, sediment basins, re-vegetation)*
- *Soils with shrink-swell potential (inserting soil stabilizers)*
- *Soils with corrosive potential (protective coatings and protection for metal, steel or concrete structures, soil treatment, removal of corrosive soils and proper disposal of any corrosive soils)*

- *Impact to topsoils (netting, and dust control)*
- *The recommendations of the CMP would be incorporated into the project plans and specifications.*

MM GEO-6: *The potential to avoid impacts to previously unrecorded paleontological resources shall be avoided by having a qualified Paleontologist or Archaeologist cross-trained in paleontology, meeting the Society of Vertebrate Paleontology Standards retained as the project paleontologist, with a minimum of a bachelor's degree (B.S./B.A.) in geology, or related discipline with an emphasis in paleontology and demonstrated experience and competence in paleontological research, fieldwork, reporting, and curation. A paleontological monitor, under the guidance of the project paleontologist, shall be present as required by the type of earth-moving activities in the Project, specifically in areas south of Ventura Boulevard that have been deemed areas of high sensitivity for paleontological resources. The monitor shall be a trained paleontological monitor with experience and knowledge of sediments, geologic formations, and the identification and treatment of fossil resources.*

MM GEO-7: *A Paleontological Resources Impact Mitigation Program (PRIMP) shall be prepared by a qualified paleontologist. The PRIMP shall include guidelines for developing and implementing mitigation efforts, including minimum requirements, general fieldwork, and laboratory methods, threshold for assessing paleontological resources, threshold for excavation and documentation of significant or unique paleontological resources, reporting requirements, considerations for the curation of recovered paleontological resources into a relevant institution, and process of documents to Metro and peer review entities.*

MM GEO-8: *The project paleontologist or paleontological monitor shall perform a Workers Environmental Awareness Program training session for each worker on the project site to familiarize the worker with the procedures in the event a paleontological resource is discovered. Workers hired after the initial Workers Environmental Awareness Program training conducted at the pre-grade meeting shall be required to take additional Workers Environmental Awareness Program training as part of their site orientation.*

MM GEO-9: *To prevent damage to unanticipated paleontological resources, a paleontological monitor shall observe ground-disturbing activities including but not limited to grading, trenching, drilling, etc. Paleontological monitoring shall start at full time for geological units deemed to have "High" paleontological sensitivity. Geological units deemed to have "Low" paleontological sensitivity shall be monitored by spot checks. No monitoring is required for geologic units identified as having "No" paleontological sensitivity. "Unknown" paleontological sensitivity is assigned to the less metamorphosed portions of the Santa Monica Slate, as detailed below.*

- *The monitor shall be empowered to temporarily halt or redirect construction efforts if paleontological resources are discovered. The paleontological monitor shall flag an area 50 feet around the discovery and notify the construction crew immediately. No further disturbance in the flagged area shall occur until the qualified paleontologist has cleared the area. In consultation with the qualified paleontologist, the monitor shall quickly assess the nature and significance of the find. If the specimen is not significant, it shall be quickly removed, and the area cleared. In the event paleontological resources are discovered and deemed by the project paleontologist to be scientifically important, the paleontological resources shall be recovered by excavation (i.e., salvage and bulk sediment sample) or immediate removal if the resource is small enough and can be removed safely in this fashion without damage to the paleontological resource. If the discovery is significant, the qualified paleontologist shall notify Metro immediately. In consultation with Metro, the qualified paleontologist shall develop a plan of mitigation, which will likely include salvage excavation and removal of the find, removal of sediment from around the specimen (in the laboratory), research to identify and categorize the find, curation of the find in a local qualified repository, and preparation of a report summarizing the find.*
- *Generally, geologic units that have endured metamorphic processes (i.e., extreme heat and pressure over long periods of time) do not contain paleontological resources. The Santa Monica Slate, originally a fossiliferous shale, has been subjected to various levels of metamorphism and thus, in areas of "low-grade metamorphism," paleontological resources may be discovered. Due to the rarity of paleontological resources dating to the Mesozoic (between approximately 65.5 to 252 million years ago) of Southern California, any such materials have high importance to the paleontology of the region. When encountered, the project paleontologist shall assess the levels of metamorphism that portion of the Santa Monica Slate has experienced. The Santa Monica Slate shall be monitored part time where the project paleontologist has determined lower levels of metamorphism have taken place and the preservation of paleontological resources is possible. If exposures of the Santa Monica Slate have been subjected to high levels of metamorphism (i.e., phyllite components of Jsmp), paleontological monitoring in that portion of the formation is not necessary.*
- *Recovered paleontological resources shall be prepared, identified to the lowest taxonomic level possible, and curated into a recognized repository (i.e., Natural History Museum of Los Angeles County). Bulk sediment samples, if collected, shall be "screen-washed" to recover the contained paleontological resources, which will then be identified to the lowest taxonomic level possible, and curated (as above). The report and all relevant field notes shall be accessioned along with the paleontological resources.*

8.6.3 Impacts After Mitigation

Adherence to existing regulations and implementation of PM GEO-1 and MM GEO-1 would ensure that Alternative 4 remains with less than significant impacts associated with exposing people or structures to seismic ground shaking, including effects related to seismic-related ground failure during construction activities.

Adherence to existing regulations and implementation of PM GEO-1 would ensure that Alternative 4 remains with a less than significant impact associated with the exposure of people or structures to liquefaction during construction activities.

With implementation of PM GEO-1 and adherence to existing regulations, Alternative 4 would have a less than significant impact associated with landslides and/or slope instability during construction activities.

Adherence to existing regulations and policies, and implementation of PM GEO-2 and MM GEO-3 through MM GEO-5, would ensure the maximum practicable protection available for users of buildings and infrastructure and associated trenches, slopes, and foundations. Therefore, Alternative 4 would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils.

With implementation of PM GEO-3 and adherence to existing regulations, Alternative 4 would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils.

Possible construction impacts involved with paleontological resources would all be a result of access, staging and lay down areas that would be required for placing the heavy rail track and excavating the tunnel. With implementation of MM GEO-6 through MM GEO-9, impacts to surrounding sediments for staging areas and access pathways for all four of the underground stations that are planned for Alternative 4 (Metro E Line Expo/Sepulveda Station, Santa Monica Boulevard Station, Wilshire Boulevard/Metro D Line Station, UCLA Gateway Plaza Station) would be reduced to less than significant.

9 ALTERNATIVE 5

9.1 Alternative Description

Alternative 5 consists of a heavy rail transit (HRT) system with a primarily underground guideway track configuration, including seven underground stations and one aerial station. This alternative would include five transfers to high-frequency fixed guideway transit and commuter rail lines, including the Los Angeles County Metropolitan Transportation Authority's (Metro) E, Metro D, and Metro G Lines, East San Fernando Valley Light Rail Transit Line, and the Metrolink Ventura County Line. The length of the alignment between the terminus stations would be approximately 13.8 miles, with 0.7 miles of aerial guideway and 13.1 miles of underground configuration.

The seven underground and one aerial HRT stations would be as follows:

1. Metro E Line Expo/Sepulveda Station (underground)
2. Santa Monica Boulevard Station (underground)
3. Wilshire Boulevard/Metro D Line Station (underground)
4. UCLA Gateway Plaza Station (underground)
5. Ventura Boulevard/Sepulveda Boulevard Station (underground)
6. Metro G Line Sepulveda Station (underground)
7. Sherman Way Station (underground)
8. Van Nuys Metrolink Station (aerial)

9.1.1 Operating Characteristics

9.1.1.1 Alignment

As shown on Figure 9-1, from its southern terminus station at the Metro E Line Expo/Sepulveda Station, the alignment of Alternative 5 would run underground north through the Westside of Los Angeles (Westside), the Santa Monica Mountains, and the San Fernando Valley (Valley) to a tunnel portal east of Sepulveda Boulevard and south of Raymer Street. As it approaches the tunnel portal, the alignment would curve eastward and begin to transition to an aerial guideway along the south side of the Los Angeles-San Diego-San Luis Obispo (LOSSAN) rail corridor that would continue to the northern terminus station adjacent to the Van Nuys Metrolink/Amtrak Station.

The proposed southern terminus station would be located underground east of Sepulveda Boulevard, between the existing elevated Metro E Line tracks and Pico Boulevard. Tail tracks for vehicle storage would extend underground south of National Boulevard, east of Sepulveda Boulevard. The alignment would continue north beneath Bentley Avenue before curving northwest to an underground station at the southeast corner of Santa Monica Boulevard and Sepulveda Boulevard. From the Santa Monica Boulevard Station, the alignment would continue and curve eastward to the Wilshire Boulevard/Metro D Line Station beneath the Metro D Line Westwood/UCLA Station, which is currently under construction as part of the Metro D Line Extension Project. From there, the underground alignment would curve slightly to the northeast and continue beneath Westwood Boulevard before reaching the UCLA Gateway Plaza Station.

Figure 9-1. Alternative 5: Alignment

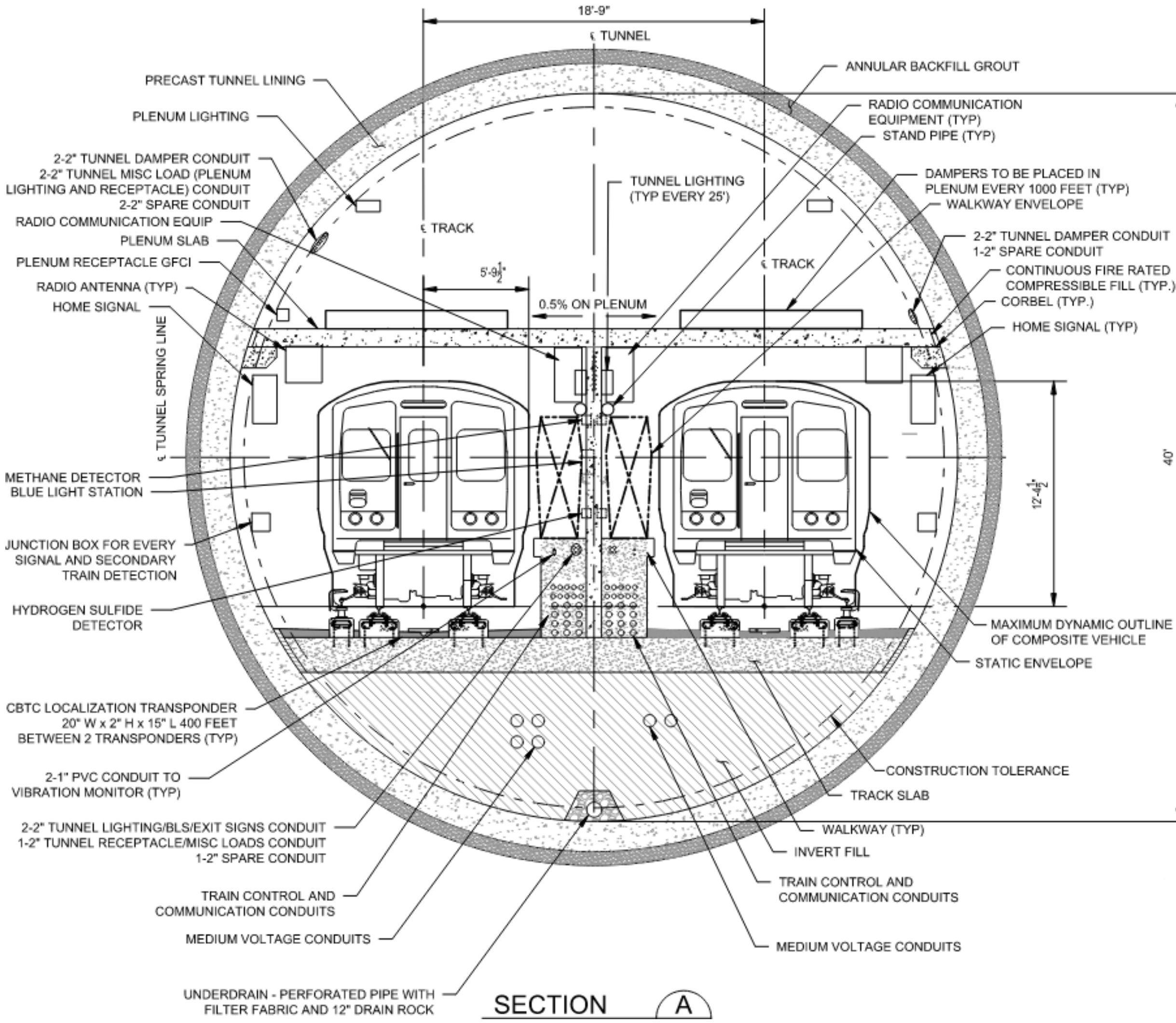
Source: STCP, 2024; HTA, 2024

From the UCLA Gateway Plaza Station, the alignment would turn to the northwest beneath the Santa Monica Mountains to the east of Interstate 405 (I-405). South of Mulholland Drive, the alignment would curve to the north, aligning with Saugus Avenue south of Valley Vista Boulevard. The Ventura Boulevard Station would be located under Saugus Avenue between Greenleaf Street and Dickens Street. The alignment would then continue north beneath Sepulveda Boulevard to the Metro G Line Sepulveda Station immediately south of the Metro G Line Busway. After leaving the Metro G Line Sepulveda Station, the alignment would continue beneath Sepulveda Boulevard to reach the Sherman Way Station, the final underground station along the alignment, immediately south of Sherman Way. From the Sherman Way Station, the alignment would continue north before curving slightly to the northeast to the tunnel portal south of Raymer Street. The alignment would then transition from an underground configuration to an aerial guideway structure after exiting the tunnel portal. East of the tunnel portal, the alignment would transition to a cut-and-cover U-structure segment followed by a trench segment before transitioning to an aerial guideway that would run east along the south side of the LOSSAN rail corridor. Parallel to the LOSSAN rail corridor, the guideway would conflict with the existing Willis Avenue Pedestrian Bridge which would be demolished. The alignment would follow the LOSSAN rail corridor before reaching the proposed northern terminus Van Nuys Metrolink Station, located adjacent to the existing Metrolink/Amtrak Station. The tail tracks and yard lead tracks would descend to the proposed at-grade maintenance and storage facility (MSF) east of the proposed northern terminus station. Modifications to the existing pedestrian underpass to the Metrolink platforms to accommodate these tracks would result in reconfiguration of an existing rail spur serving City of Los Angeles Department of Water and Power (LADWP) property.

9.1.1.2 Guideway Characteristics

For underground sections, Alternative 5 would utilize a single-bore tunnel configuration with an outside diameter of approximately 43.5 feet. The tunnel would include two parallel tracks at 18.75-foot spacing in tangent sections separated by a continuous central dividing wall throughout the tunnel. Inner walkways would be constructed adjacent to the two tracks. Inner and outer walkways would be constructed within tunnel sections near the track crossovers. At the crown of tunnel, a dedicated air plenum would be provided by constructing a concrete slab above the railway corridor. The air plenum would allow for ventilation throughout the underground portion of the alignment. Figure 9-2 illustrates these components at a typical cross-section of the underground guideway.

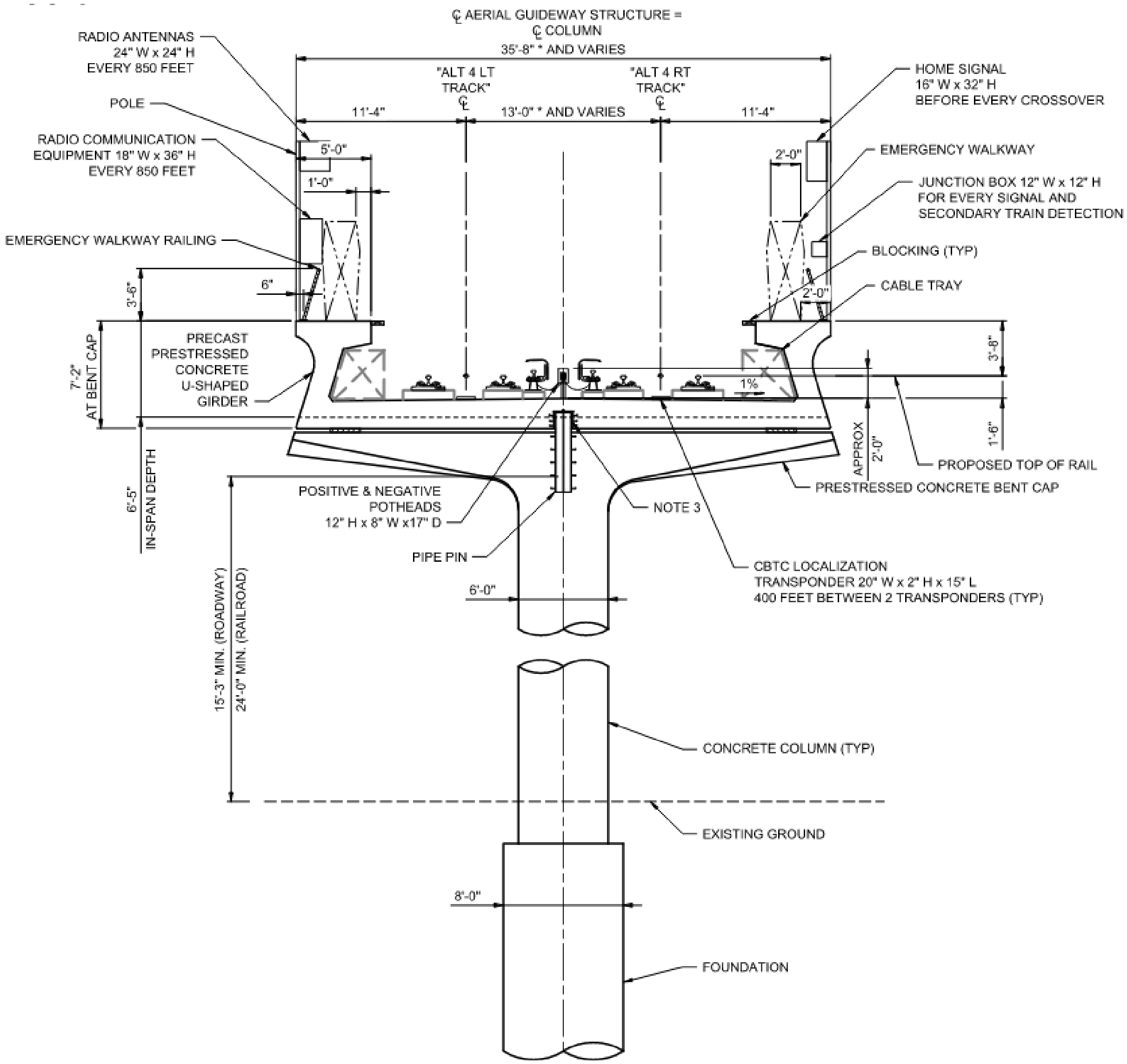
Figure 9-2. Typical Underground Guideway Cross-Section



Source: STCP, 2024

In aerial sections adjacent to Raymer Street and the LOSSAN rail corridor, the guideway would consist of single-column spans. The single-column spans would include a U-shaped concrete girder structure that supports the railway track atop a series of individual columns. The single-column aerial guideway would be approximately 36 feet wide. The track would be constructed on the concrete girders with direct fixation and would maintain a minimum of 13 feet between the two-track centerlines. On the outer side of the tracks, emergency walkways would be constructed with a minimum width of 2 feet. The single-column aerial guideway would be the primary aerial structure throughout the aerial portion of the alignment. Figure 9-3 shows a typical cross-section of the single-column aerial guideway.

Figure 9-3. Typical Aerial Guideway Cross-Section



Source: STCP, 2024

9.1.1.3 Vehicle Technology

Alternative 5 would utilize steel-wheel HRT trains, with automated train operations and planned peak-period headways of 2.5 minutes and off-peak-period headways ranging from 4 to 6 minutes. Each train could consist of three or four cars with open gangways between cars. The HRT vehicle would have a maximum operating speed of 70 miles per hour; actual operating speeds would depend on the design of the guideway and distance between stations. Train cars would be approximately 10 feet wide with three double doors on each side. Each car would be approximately 72 feet long with capacity for 170 passengers. Trains would be powered by a third rail.

9.1.1.4 Stations

Alternative 5 would include seven underground stations and one aerial station with station platforms measuring 280 feet long for both station configurations. The aerial station would be constructed a minimum of 15.25 feet above ground level, supported by rows of dual columns with 8-foot diameters. The southern terminus station would be adjacent to the Metro E Line Expo/Sepulveda Station, and the northern terminus station would be adjacent to the Van Nuys Metrolink/Amtrak Station.

All stations would be side-platform stations where passengers would select and travel up to station platforms depending on their direction of travel. All stations would include 20-foot-wide side platforms separated by 30 feet for side-by-side trains. Each underground station would include an upper and lower concourse level prior to reaching the train platforms. The Van Nuys Metrolink Station would include a mezzanine level prior to reaching the station platforms. Each station would have a minimum of two elevators, two escalators, and one stairway from ground level to the concourse or mezzanine.

Stations would include automatic, bi-parting fixed doors along the edges of station platforms. These platform screen doors would be integrated into the automatic train control system and would not open unless a train is stopped at the platform.

The following information describes each station, with relevant entrance, walkway, and transfer information. Bicycle parking would be provided at each station.

Metro E Line Expo/Sepulveda Station

- This underground station would be located just north of the existing Metro E Line Expo/Sepulveda Station, on the east side of Sepulveda Boulevard.
- A station entrance would be located on the east side of Sepulveda Boulevard north of the Metro E Line.
- A direct internal transfer to the Metro E Line would be provided at street level within the fare paid zone.
- A 126-space parking lot would be located immediately north of the station entrance, east of Sepulveda Boulevard. Passengers would also be able to park at the existing Metro E Line Expo/Sepulveda Station parking facility, which provides 260 parking spaces.

Santa Monica Boulevard Station

- This underground station would be located under the southeast corner of Santa Monica Boulevard and Sepulveda Boulevard.
- The station entrance would be located on the south side of Santa Monica Boulevard, between Sepulveda Boulevard and Bentley Avenue.
- No dedicated station parking would be provided at this station.

Wilshire Boulevard/Metro D Line Station

- This underground station would be located beneath the Metro D Line tracks and platform under Gayley Avenue, between Wilshire Boulevard and Lindbrook Drive.
- Station entrances would be provided on the northeast corner of Wilshire Boulevard and Gayley Avenue and on the northeast corner of Lindbrook Drive and Gayley Avenue. Passengers would also be able to use the Metro D Line Westwood/UCLA Station entrances to access the station platform.

- A direct internal station transfer to the Metro D Line would be provided at the south end of the station.
- No dedicated station parking would be provided at this station.

UCLA Gateway Plaza Station

- This underground station would be located underneath Gateway Plaza on the University of California, Los Angeles (UCLA) campus.
- Station entrances would be provided on the north side of Gateway Plaza and on the east side of Westwood Boulevard across from Strathmore Place.
- No dedicated station parking would be provided at this station.

Ventura Boulevard/Sepulveda Boulevard Station

- This underground station would be located under Saugus Avenue, between Greenleaf Street and Dickens Street.
- A station entrance would be located on the southeast corner of Saugus Avenue and Dickens Street.
- Approximately 92 parking spaces would be supplied at this station west of Sepulveda Boulevard, between Dickens Street and the U.S. Highway 101 (US-101) on-ramp.

Metro G Line Sepulveda Station

- This underground station would be located under Sepulveda Boulevard immediately south of the Metro G Line Busway.
- A station entrance would be provided on the west side of Sepulveda Boulevard south of the Metro G Line Busway.
- Passengers would be able to park at the existing Metro G Line Sepulveda Station parking facility, which has a capacity of 1,205 parking spaces. Currently, only 260 parking spaces are currently used for transit parking. No new parking would be constructed.

Sherman Way Station

- This underground station would be located below Sepulveda Boulevard, between Sherman Way and Gault Street.
- The station entrance would be located near the southwest corner of Sepulveda Boulevard and Sherman Way.
- Approximately 122 parking spaces would be supplied at this station on the west side of Sepulveda Boulevard with vehicle access from Sherman Way.

Van Nuys Metrolink Station

- This aerial station would span Van Nuys Boulevard, just south of the LOSSAN rail corridor.
- The primary station entrance would be located on the east side of Van Nuys Boulevard just south of the LOSSAN rail corridor. A secondary station entrance would be located between Raymer Street and Van Nuys Boulevard.
- An underground pedestrian walkway would connect the station plaza to the existing pedestrian underpass to the Metrolink/Amtrak platform outside the fare paid zone.

- Existing Metrolink Station parking would be reconfigured, maintaining approximately the same number of spaces, but 66 parking spaces would be relocated west of Van Nuys Boulevard. Metrolink parking would not be available to Metro transit riders.

9.1.1.5 Station-to-Station Travel Times

Table 9-1 presents the station-to-station distance and travel times at peak period for Alternative 5. The travel times include both run time and dwell time. Dwell time is 30 seconds for transfer stations and 20 seconds for other stations. Northbound and southbound travel times vary slightly because of grade differentials and operational considerations at end-of-line stations.

Table 9-1. Alternative 5: Station-to-Station Travel Times and Station Dwell Times

From Station	To Station	Distance (miles)	Northbound Station-to-Station Travel Time (seconds)	Southbound Station-to-Station Travel Time (seconds)	Dwell Time (seconds)
Metro E Line Station					*30*
Metro E Line	Santa Monica Boulevard	0.9	89	86	—
Santa Monica Boulevard Station					*20*
Santa Monica Boulevard	Wilshire/Metro D Line	0.9	91	92	—
Wilshire/Metro D Line Station					*30*
Wilshire/Metro D Line	UCLA Gateway Plaza	0.7	75	69	—
UCLA Gateway Plaza Station					*20*
UCLA Gateway Plaza	Ventura Boulevard	6.0	368	359	—
Ventura Boulevard Station					*20*
Ventura Boulevard	Metro G Line	2.0	137	138	—
Metro G Line Station					*30*
Metro G Line	Sherman Way	1.4	113	109	—
Sherman Way Station					*20*
Sherman Way	Van Nuys Metrolink	1.9	166	162	—
Van Nuys Metrolink Station					*30*

Source: STCP, 2024

— = no data

9.1.1.6 Special Trackwork

Alternative 5 would include 10 double crossovers throughout the alignment enabling trains to cross over to the parallel track. Each terminus station would include a double crossover immediately north and south of the station. Except for the Santa Monica Boulevard Station, each station would have a double crossover immediately south of the station. The remaining crossover would be located along the alignment midway between the UCLA Gateway Plaza Station and the Ventura Boulevard Station.

9.1.1.7 Maintenance and Storage Facility

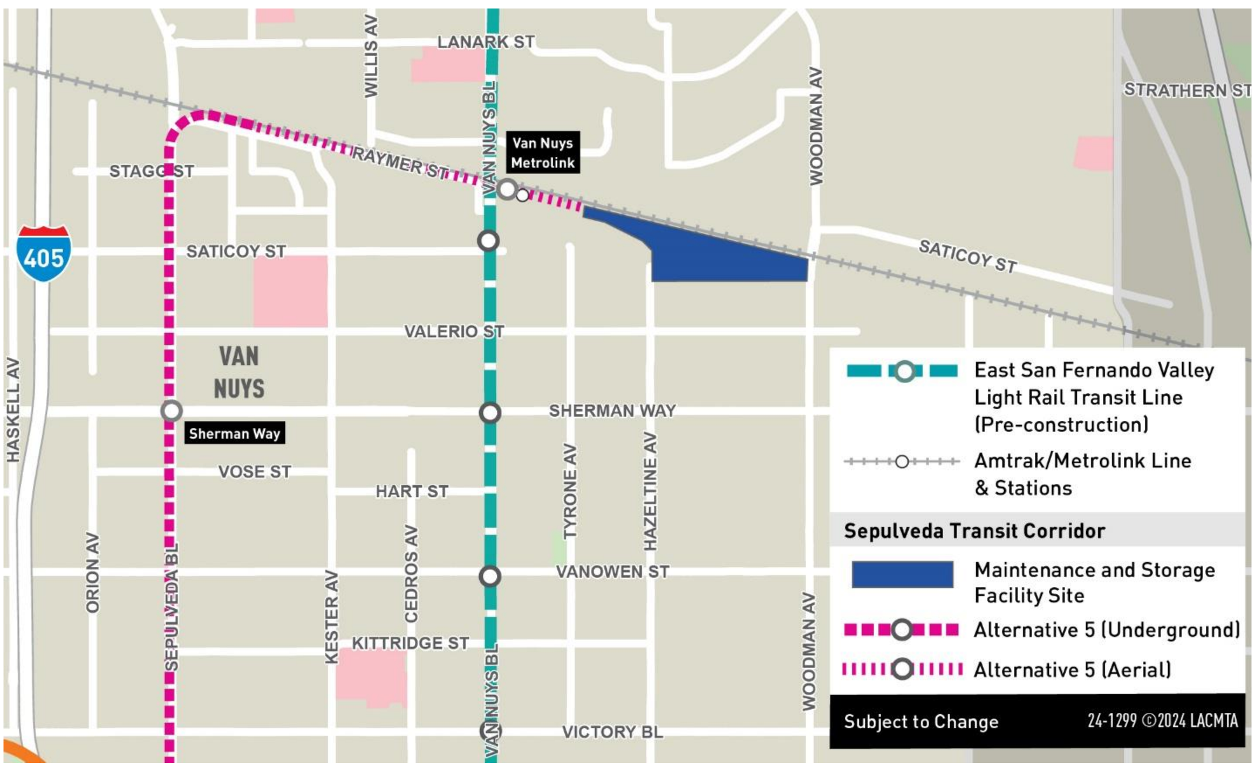
The MSF for Alternative 5 would be located east of the Van Nuys Metrolink Station and would encompass approximately 46 acres. The MSF would be designed to accommodate 184 rail cars and would be bounded by single-family residences to the south, the LOSSAN rail corridor to the north, Woodman Avenue on the east, and Hazeltine Avenue and industrial manufacturing enterprises to the west. Trains would access the site from the fixed guideway's tail tracks at the northwest corner of the site. Trains would then travel southeast to maintenance facilities and storage tracks.

The site would include the following facilities:

- Two entrance gates with guard shacks
- Main shop building
- Maintenance-of-way building
- Storage tracks
- Carwash building
- Cleaning and inspections platforms
- Material storage building
- Hazmat storage locker
- Traction power substation (TPSS) located on the west end of the MSF to serve the mainline
- TPSS located on the east end of the MSF to serve the yard and shops
- Parking area for employees
- Grade separated access roadway (over the HRT tracks at the east end of the facility) and necessary drainage

Figure 9-4 shows the location of the MSF site for Alternative 5.

Figure 9-4. Alternative 5: Maintenance and Storage Facility Site



Source: STCP, 2024; HTA, 2024

9.1.1.8 Traction Power Substations

TPSSs transform and convert high voltage alternating current supplied from power utility feeders into direct current suitable for transit operation. Twelve TPSS facilities would be located along the alignment and would be spaced approximately 0.5 to 2.5 miles apart. All TPSS facilities would generally be located within the stations, adjacent to the tunnel through the Santa Monica Mountains, or within the MSF. Table 9-2 lists the TPSS locations for Alternative 5.

Figure 9-5 shows the TPSS locations along the Alternative 5 alignment.

Table 9-2. Alternative 5: Traction Power Substation Locations

TPSS No.	TPSS Location Description	Configuration
1	TPSS 1 would be located east of Sepulveda Boulevard and north of the Metro E Line.	Underground (within station)
2	TPSS 2 would be located south of Santa Monica Boulevard, between Sepulveda Boulevard and Bentley Avenue.	Underground (within station)
3	TPSS 3 would be located at the southeast corner of UCLA Gateway Plaza.	Underground (within station)
4	TPSS 4 would be located south of Bellagio Road and west of Stone Canyon Road.	Underground (adjacent to tunnel)
5	TPSS 5 would be located west of Roscomare Road, between Donella Circle and Linda Flora Drive.	Underground (adjacent to tunnel)
6	TPSS 6 would be located east of Loom Place, between Longbow Drive and Vista Haven Road.	Underground (adjacent to tunnel)
7	TPSS 7 would be located west of Sepulveda Boulevard, between the I-405 Northbound On-Ramp and Dickens Street.	Underground (within station)
8	TPSS 8 would be located west of Sepulveda Boulevard, between the Metro G Line Busway and Oxnard Street.	Underground (within station)
9	TPSS 9 would be located at the southwest corner of Sepulveda Boulevard and Sherman Way.	Underground (within station)
10	TPSS 10 would be located south of the LOSSAN rail corridor and north of Raymer Street and Kester Avenue.	At-grade
11	TPSS 11 would be located south of the LOSSAN rail corridor and east of the Van Nuys Metrolink Station.	At-grade (within MSF)
12	TPSS 12 would be located south of the LOSSAN rail corridor and east of Hazeltine Avenue.	At-grade (within MSF)

Source: STCP, 2024; HTA, 2024

Note: Sepulveda Transit Corridor Partners (STCP) has stated that Alternative 5 TPSS locations are derived from and assumed to be similar to the Alternative 4 TPSS locations.

Figure 9-5. Alternative 5: Traction Power Substation Locations

Source: STCP, 2024; HTA, 2024

9.1.1.9 Roadway Configuration Changes

Table 9-3 lists the roadway changes necessary to accommodate the guideway of Alternative 5. Figure 9-6 shows the location of the roadway changes within the Sepulveda Transit Corridor Project (Project) Study Area. In addition to the changes made to accommodate the guideway, as listed in Table 9-3, roadways and sidewalks near stations would be reconstructed, resulting in modifications to curb ramps and driveways.

Table 9-3. Alternative 5: Roadway Changes

Location	From	To	Description of Change
Raymer Street	Kester Avenue	Keswick Street	Reconstruction resulting in narrowing of width and removal of parking on the westbound side of the street to accommodate aerial guideway columns.
Cabrito Road	Raymer Street	Marson Street	Closure of Cabrito Road at the LOSSAN rail corridor at-grade crossing. A new segment of Cabrito Road would be constructed from Noble Avenue and Marson Street to provide access to extra space storage from the north.

Source: STCP, 2024; HTA, 2024

Figure 9-6. Alternative 5: Roadway Changes

Source: STCP, 2024; HTA, 2024

9.1.1.10 Ventilation Facilities

For ventilation, a plenum within the crown of the tunnel would provide a separate compartment for air circulation and allow multiple trains to operate between stations. Each underground station would include a fan room with additional ventilation facilities. Alternative 5 would also include a stand-alone ventilation facility at the tunnel portal on the northern end of the tunnel segment, located east of Sepulveda Boulevard and south of Raymer Street. Within this facility, ventilation fan rooms would provide both emergency ventilation, in case of a tunnel fire, and regular ventilation, during non-revenue hours. The facility would also house sump pump rooms to collect water from various sources, including storm water; wash-water (from tunnel cleaning); and water from a fire-fighting incident, system testing, or pipe leaks.

9.1.1.11 Fire/Life Safety – Emergency Egress

Within the tunnel segment, emergency walkways would be provided between the center dividing wall and each track. Sliding doors would be located in the central dividing wall at required intervals to connect the two sides of the railway with a continuous walkway to allow for safe egress to a point of safety (typically at a station) during an emergency. Similarly, the aerial guideway near the LOSSAN rail corridor would include two emergency walkways with safety railing located on the outer side of the tracks. Access to tunnel segments for first responders would be through stations and the portal.

9.1.2 Construction Activities

Temporary construction activities for Alternative 5 would include project work zones at permanent facility locations, construction staging and laydown areas, and construction office areas. Construction of the transit facilities through substantial completion is expected to have a duration of 8 ¼ years. Early works, such as site preparation, demolition, and utility relocation, could start in advance of construction of the transit facilities.

For the guideway, Alternative 5 would consist of a single-bore tunnel through the Westside, Valley, and Santa Monica Mountains. The tunnel would comprise three separate segments, one running north from the southern terminus to the UCLA Gateway Plaza Station (Westside segment), one running south from the Ventura Boulevard Station to the UCLA Gateway Plaza Station (Santa Monica Mountains segment), and one running north from the Ventura Boulevard Station to the portal near Raymer Street (Valley segment). Tunnel boring machines (TBM) with approximately 45-foot-diameter cutting faces would be used to construct the tunnel segments underground. For the Westside segment, the TBM would be launched from Staging Area No. 1 in Table 9-4 at Sepulveda Boulevard and National Boulevard. For the Santa Monica Mountains segment, the TBMs would be launched from the Ventura Boulevard Station. Both TBMs would be extracted from the UCLA Gateway Plaza Station Staging Area No. 3 in Table 9-4. For the Valley segment, the TBM would be launched from Staging Area No. 8, as shown in Table 9-4, and extracted from the Ventura Boulevard Station. Figure 9-7 shows the location of construction staging locations along the Alternative 5 alignment.

Table 9-4. Alternative 5: On-Site Construction Staging Locations

No.	Location Description
1	Commercial properties on southeast corner of Sepulveda Boulevard and National Boulevard
2	North side of Wilshire Boulevard, between Veteran Avenue and Gayley Avenue
3	UCLA Gateway Plaza
4	Commercial property on southwest corner of Sepulveda Boulevard and Dickens Street
5	West of Sepulveda Boulevard, between US-101 and Sherman Oaks Castle Park
6	Lot behind Los Angeles Fire Department Station 88
7	Property on the west side of Sepulveda Boulevard, between Sherman Way and Gault Street
8	Industrial property on both sides of Raymer Street, west of Burnet Avenue
9	South of the LOSSAN rail corridor, east of Van Nuys Metrolink Station, west of Woodman Avenue

Source: STCP, 2024; HTA, 2024

Figure 9-7. Alternative 5: On-Site Construction Staging Locations

Source: STCP, 2024; HTA, 2024

The distance from the surface to the top of the tunnel for the Westside tunnel would vary from approximately 40 feet to 90 feet depending on the depth needed to construct the underground stations. The depth of the Santa Monica Mountains tunnel segment varies greatly from approximately 470 feet as it passes under the Santa Monica Mountains to 50 feet near UCLA. The depth of the Valley segment would vary from approximately 40 feet near the Ventura Boulevard/Sepulveda Station and north of the Metro G Line Sepulveda Station to 150 feet near Weddington Street. The tunnel segments through the Westside and Valley would be excavated in soft ground while the tunnel through the Santa Monica Mountains would be excavated primarily in hard ground or rock as geotechnical conditions transition from soft to hard ground near the UCLA Gateway Plaza Station.

Construction work zones would also be co-located with future MSF and station locations. All work zones would comprise of the permanent facility footprint with additional temporary construction easements from adjoining properties.

All underground stations would be constructed using a “cut-and-cover” method whereby the underground station structure would be constructed within a trench excavated from the surface with a portion or all being covered by a temporary deck and backfilled during the later stages of station construction. Traffic and pedestrian detours would be necessary during underground station excavation until decking is in place and the appropriate safety measures are taken to resume cross traffic.

In addition to work zones, Alternative 5 would include construction staging and laydown areas at multiple locations along the alignment as well as off-site staging areas. Construction staging areas would provide the necessary space for the following activities:

- Contractors’ equipment
- Receiving deliveries
- Testing of soils for minerals or hazards
- Storing materials
- Site offices
- Work zone for excavation
- Other construction activities (including parking and change facilities for workers, location of construction office trailers, storage, staging and delivery of construction materials and permanent plant equipment, and maintenance of construction equipment).

A larger, off-site staging area would be used for temporary storage of excavated material from both tunneling and station cut-and-cover excavation activities. Table 9-4 and Figure 9-7 present the potential construction staging areas along the alignment for Alternative 5. Table 9-5 and Figure 9-8 present candidate sites for off-site staging and laydown areas.

Table 9-5. Alternative 5: Potential Off-Site Construction Staging Locations

No.	Location Description
S1	East of Santa Monica Airport Runway
S2	Ralph’s Parking Lot in Westwood Village
N1	West of Sepulveda Basin Sports Complex, south of the Los Angeles River
N2	West of Sepulveda Basin Sports Complex, north of the Los Angeles River
N3	Metro G Line Sepulveda Station Park & Ride Lot
N4	North of Roscoe Boulevard and Hayvenhurst Avenue
N5	LADWP property south of the LOSSAN rail corridor, east of Van Nuys Metrolink Station

Source: STCP, 2024; HTA, 2024

Figure 9-8. Alternative 5: Potential Off-Site Construction Staging Locations

Source: STCP, 2024; HTA, 2024

Construction of the HRT guideway between the Van Nuys Metrolink Station and the MSF would require reconfiguration of an existing rail spur serving LADWP property. The new location of the rail spur would require modification to the existing pedestrian undercrossing at the Van Nuys Metrolink Station.

Alternative 5 would require construction of a concrete casting facility for tunnel lining segments because no existing commercial fabricator capable of producing tunnel lining segments for a large-diameter tunnel exists within a practical distance of the Project Study Area. The site of the MSF would initially be used for this casting facility. The casting facility would include casting beds and associated casting equipment, storage areas for cement and aggregate, and a field quality control facility, which would need to be constructed on-site. When a more detailed design of the facility is completed, the contractor would obtain all permits and approvals necessary from the City of Los Angeles, the South Coast Air Quality Management District, and other regulatory entities.

As areas of the MSF site begin to become available following completion of pre-casting operations, construction of permanent facilities for the MSF would begin, including construction of surface buildings such as maintenance shops, administrative offices, train control, traction power, and systems facilities. Some of the yard storage track would also be constructed at this time to allow delivery and inspection of passenger vehicles that would be fabricated elsewhere. Additional activities occurring at the MSF during the final phase of construction would include staging of trackwork and welding of guideway rail.

9.2 Existing Conditions

9.2.1 Regional Geology

Alternative 5 would pass through the northwestern portion of the Los Angeles Basin, through the Santa Monica Mountains, and then continue into the south and central portions of the San Fernando Valley. The Los Angeles Basin is a southwest-trending alluvial plain with gentle sloping. The Santa Monica Mountains trend east–west, where long southward-draining canyons are located on the south flank and shorter northward-draining canyons are located on the north flank. The San Fernando Valley basin trends east–west with alluvial fan deposits and channelized wash deposits (Metro, 2023b). Alternative 5 would be within two geologic provinces (City of Los Angeles, 2018):

- The northern portion of Alternative 5 would be located within the Transverse Ranges geomorphic province.
- The southern portion of Alternative 5 would be located within the Los Angeles Basin, which is the northern-most basin of the Peninsular Ranges geomorphic province.

9.2.1.1 Transverse Ranges Geomorphic Province

The Transverse Ranges geomorphic province is composed of several mountain ranges oriented in an east–west direction and extends over 320 miles from the Mojave and Colorado Desert Provinces to Point Arguello at the Pacific Ocean. Included within the Transverse Ranges are portions of Riverside, San Bernardino, Los Angeles, and Ventura Counties. Acting as a northern boundary, the Transverse Ranges truncate the northwest-trending structural grain of the Peninsular Ranges geomorphic province. Most active faults in the Transverse Ranges are east–west-trending faults. Rock types in this province include gneiss, granitic rocks, and sedimentary rocks. Volcanic rocks are found in the Santa Monica Mountains. Alluvial sediments are typically in canyon bottoms and valleys, with broad alluvial fans at the mouths of steep canyons (City of Los Angeles, 2018).

9.2.1.2 Peninsular Ranges Geomorphic Province

The Peninsular Ranges geomorphic province, composed of multiple mountain ranges and valleys, extends southward 775 miles past the United States-Mexico border. The Peninsular Ranges geomorphic province extends southward from the southern edge of the Transverse Ranges geomorphic province to the tip of Baja California in Mexico. The Peninsular Ranges are characterized by northwest–southeast-trending hills and valleys that are separated by similarly trending faults. Most active faults in the Peninsular Ranges province are northwest trending. Rock types in this province in the Los Angeles region generally include schist and sedimentary rocks. Surface materials in canyon bottoms and basins generally consist of alluvium (City of Los Angeles, 2018).

9.2.1.3 San Fernando Valley

The San Fernando Valley is a triangular east–west-trending structural depression located within the Transverse Ranges geomorphic province. The Transverse Ranges province trends east–west from the offshore Channel Islands (Santa Rosa, Santa Cruz, Anacapa, etc.) to the eastern Mojave Desert. The province is characterized by east–west trending mountain ranges (such as the Santa Monica Mountains, San Gabriel Mountains, and San Bernardino Mountains) separated by similar trending intermontane valleys. The San Fernando Valley is bordered on the east by the Verdugo Mountains, on the north by the San Gabriel and Santa Susana Mountains, on the west by the Simi Hills, and on the south by the Santa Monica Mountains. The mountains that bound the San Fernando Valley are actively deforming anticlinal ranges bounded by thrust faults. Because the ranges have risen and deformed, the valley has subsided and accumulated sediment to create the elongated basin (Metro, 2023b).

9.2.1.4 Santa Monica Mountains

The Santa Monica Mountains are an east–west-trending linear mountain range within the western Transverse Ranges geomorphic province. Major east-trending folds, reverse faults, and left-lateral, strike-slip faults reflect regional north–south compression and are characteristic of the Transverse Ranges. The Santa Monica Mountains are being actively uplifted along a series of segmented frontal reverse faults (Malibu Coast fault, Santa Monica fault, and Raymond fault) on the south side of the range that extend from Arroyo Sequit in the west to Glendale in the east. This fault system is aligned with the Santa Cruz Island fault. The Los Angeles Basin on the southern side of the range is one of a series of basins forming a transition zone between the Transverse Ranges and the northwest–southeast-trending Peninsular Ranges geomorphic province to the south (Metro, 2023b).

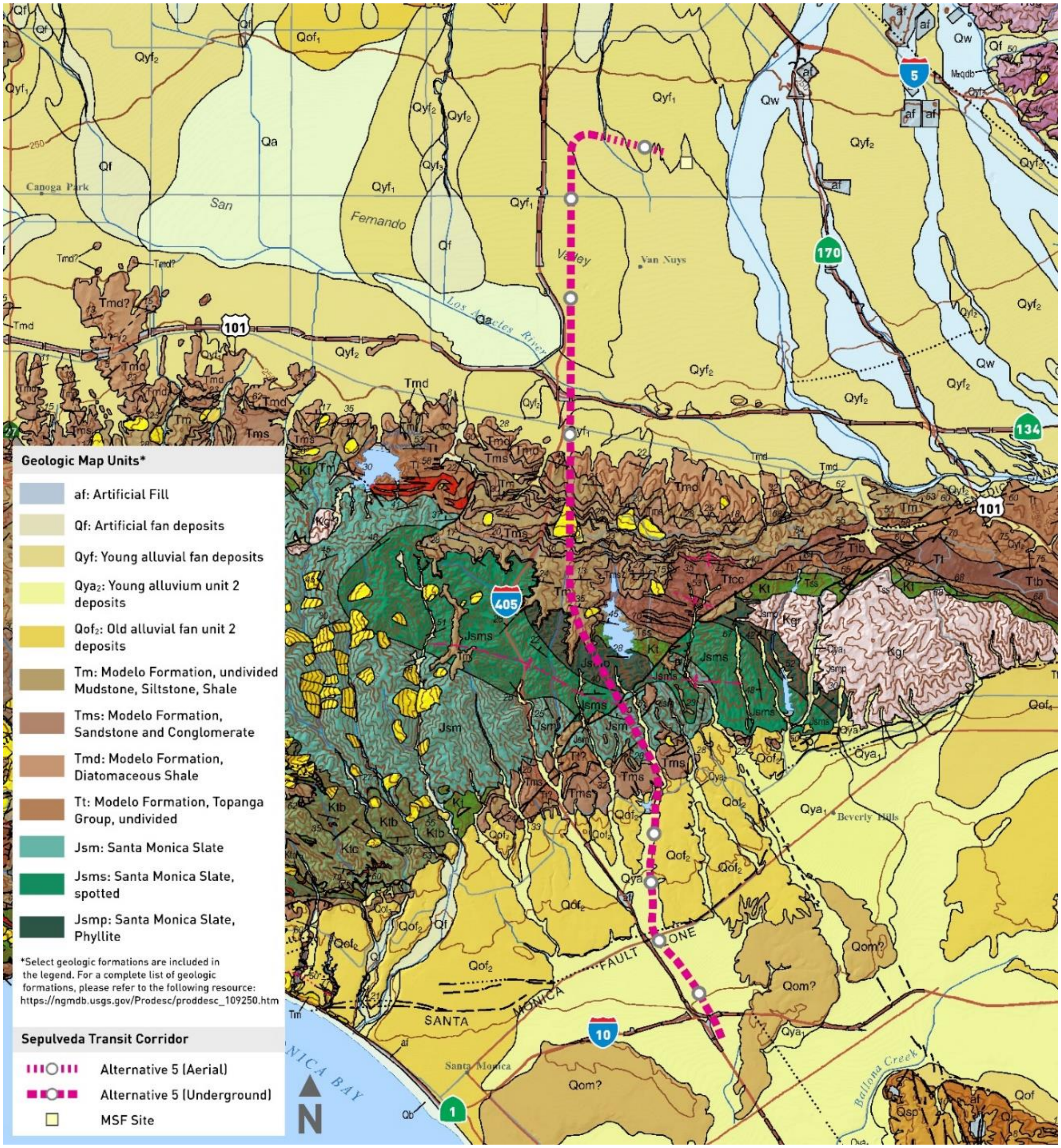
9.2.1.5 Los Angeles Basin

The Los Angeles Basin is a large low-lying coastal plain bordered by the Santa Monica Mountains on the north, the Repetto and Puente Hills on the northeast, the Santa Ana Mountains on the east, and the San Joaquin Hills on the south. The western margin of the basin is open to the Pacific Ocean except for one prominent hill: the Palos Verdes Peninsula. The floor of the Los Angeles Basin is a relatively flat surface that rises gently from sea level along the coastline to an apron of uplifted terrain along the base of the surrounding mountains, which rise abruptly to a few thousand feet above the plain. The flat basin floor is interrupted in a few localities by small hills, the most prominent of which are a northwest–southeast-trending alignment of hills and mesas that extend from the Newport Beach area on the south to the Beverly Hills area on the north (Metro, 2023b).

9.2.2 Project Site Soil Types and Characteristics

Figure 9-9 shows the geologic features of Alternative 5. The San Fernando Valley is an east–west-trending basin with alluvial fan deposits and channelized wash deposits. Within the Sherman Oaks area (southern portion of the San Fernando Valley) for Alternative 5, the Holocene alluvial fans derive from the canyons adjacent to the northern side of the Santa Monica Mountains. The alluvial fans predominantly comprise silt, clay, and sand. Along Alternative 5 in the Van Nuys area, the valley alluvium includes Holocene and Pleistocene sand, silt, and gravel (Metro, 2023b).

Figure 9-9. Alternative 5: Geologic Units



Source: USGS, 2016; HTA, 2024

The Santa Monica Mountains are an east–west-trending range with long southward-draining canyons on the southern flank and relatively shorter northward-draining canyons on the northern flank. Elongated ridge spurs generally trend subparallel to the mountain canyons. Along Alternative 5 in the Santa Monica Mountains, the Jurassic-age Santa Monica Slate forms an anticline (i.e., a broad “A”-shaped geologic structure), with anticlinal axis trending roughly west-northwest/east-southeast. This formation includes slate, phyllite, and schist, depending on the local degree of metamorphism. The Santa Monica

Slate is overlain on the mountain flanks by marine sedimentary rock that primarily consists of sandstone, shale, and diatomaceous shale of the Miocene-age Modelo Formation, and sandstone and mudstone of the Pliocene-age Fernando Formation (Metro, 2023b).

9.2.2.1 Artificial Fill

Artificial fill (af) is comprised of silty sand, a mixture of moist, brown and gray, silty sand of fine-grained to coarse-grained composure. Some clay or gray pockets may be observed. The most commonly observed lithology for the Project Study Area along the alignment is typically at the ground surface (Metro, 2023b).

9.2.2.2 Modelo Formation

The Modelo Formation (Tm, Tms, Tmd) is a late Miocene-age sedimentary bedrock that generally consists of gray to brown, thinly bedded mudstone, and shale and siltstone, with interbeds of very fine-grained to coarse-grained sandstone. The most commonly observed lithology for Alternative 5 is near I-405, with thinly bedded shale to shaley siltstone with interbeds of fine sandstone. Additionally, localized diatomaceous shale and siltstone with interbeds of bentonite and fine sandstone are within the formation (Metro, 2023b).

9.2.2.3 Old Alluvial Fan Deposits

Older (late to middle Pleistocene) alluvial fan deposits (Qof), which form the Santa Monica Plain, are mapped along the southern edge of the Santa Monica Mountains. They continue in the subsurface in the Los Angeles Basin. These sediments were deposited by stream channels that had flowed southward from the Santa Monica Mountains during the late Pleistocene. They consist of a thick series of alluvial fans that spread out southward from the mountain front toward the ocean. These deposits are described by Campbell et al. (2016) as moderately consolidated, silt, sand, and gravel deposits on alluvial fans (Metro, 2023b).

9.2.2.4 Santa Susana Formation

The Paleocene Santa Susana Formation (Tss), which underlies the Topanga Formation, is exposed in the slopes bordering the west side of the Stone Canyon Reservoir (SCR). Campbell et al. (2016) described the formation as consisting predominantly of fine- to medium-grained sandstone with some interbeds of gray clay shale, mudstone and siltstone, and some lenses of pebble-cobble conglomerate. Shale beds commonly contain indurated limestone concretions.

9.2.2.5 Santa Monica Slate

The Santa Monica Slate (Jsm, Jsms, Jsmp) is a Jurassic-age metamorphic rock that generally consists of black slate and, to a lesser degree, meta-siltstone and fine-grained meta-graywacke. The rock is generally sheared and intensely jointed due to the localized folding and faulting within the Santa Monica Mountains. The Santa Monica Slate is exposed throughout the southern side of the Santa Monica Mountains, with exposures generally highly fractured with small surficial slides within the fractured rock (Metro, 2023b).

9.2.2.6 Topanga Formation

In the Project Study Area, the middle Miocene Topanga Formation (Tt and Tb) unconformably underlies the Modelo Formation. The Topanga Formation is exposed in slopes that are adjacent to the east side of SCR and Upper Stone Canyon Reservoir (USCR). Campbell et al. (2016) described the Topanga Formation as a heterogenous sequence of sedimentary and volcanic rocks containing marine facies. Campbell et al.

(2016) subdivided the Topanga Formation into undifferentiated sedimentary rocks or volcanic rocks. Sedimentary rock lithologies include interbedded gray, micaceous claystone, clay shale, and siltstone; semi-friable to well cemented arkosic sandstone; and locally includes gravely sandstone and lenses of pebble to cobble conglomerate. In general, the lower portion of the Topanga Formation (toward the south) commonly contains the coarser-grained lithologies (sandstones and conglomerates), and the upper portion contains fine-grained sandstone, siltstone, and shales. Volcanic rocks within the Topanga Formation (Tb) include extrusive flows, intrusive sills, tuffs, and volcanic breccias.

9.2.2.7 Tuna Canyon Formation

The Cretaceous Tuna Canyon Formation (Kt), which underlies the Santa Susana Formation, is exposed in the slopes bordering SCR. Campbell et al (2014) described the formation as consisting of marine sandstone, siltstone, and conglomerate. The sandstones range from thinly to very thickly bedded and locally contain abundant fragments of black slate. LADWP (1998) reported that the formation, as exposed in roadcuts along the west side of SCR, includes very thick to massive conglomerate beds that contain weak to extremely strong cobble to boulder-sized granitic, metavolcanic, and quarzitic clasts up to 18 inches in diameter.

9.2.2.8 Younger Alluvial Fan Deposits

The younger alluvial units (QyF and Qya) along both the northern and southern sides of the Santa Monica Mountains consist of sand, silt, silty clay, silty sand, and clayey sand with some interbedded units of gravel to cobble-size clasts. The gravel units are composed of slate and are scattered through the alluvium along the southern side of the mountains; while along the northern side, the gravel transitions to sandstone and is less frequent and abundant. The younger alluvium generally varies in thickness from a few feet to over 50 feet or more in some areas along Alternative 5 (Metro, 2023b).

9.2.3 Seismicity

The entire Southern California region is seismically active. A network of major regional faults and minor local faults crisscrosses the region. The faulting and seismicity are dominated by the San Andreas fault system, which separates two of the major tectonic plates that comprise the earth’s crust. The Pacific Plate lies west of the San Andreas fault system. This plate is moving in a northwesterly direction relative to the North American Plate, which lies east of the San Andreas fault system. This relative movement between the two plates is the driving force of fault ruptures in western California. The San Andreas fault generally trends northwest/southeast; however, north of the Transverse Ranges province, the fault trends more in an east–west direction, causing a north–south compression between the two plates. North–south compression in Southern California has been estimated from 5 millimeters per year (mm/year) to 20 mm/year. This compression has produced rapid uplift of many of the mountain ranges in Southern California (Metro, 2023a).

In addition to the San Andreas fault, numerous faults in Southern California are categorized as active, potentially active, and inactive. A fault is classified as active if it has either moved during the Holocene epoch (from about 11,700 years to the present) or is included in an Alquist-Priolo Earthquake Fault Zone (as established by California Geological Survey [CGS]). A fault is classified as potentially active if it has experienced movement within the Quaternary period (geologic time starting 1.6 million years ago and continuing to the present day). Faults that have not moved in the last 1.8 million years generally are considered inactive. Surface displacement can be recognized by the existence of cliffs in alluvium, terraces, offset stream courses, fault troughs and saddles, the alignment of depressions, sag ponds, and the existence of steep mountain fronts.

Generally defined, an earthquake is an abrupt release of accumulated energy in the form of seismic waves that are created when movement occurs along a fault plane. The severity of an earthquake is generally expressed in two ways: magnitude and intensity. The energy released, measured on the Moment Magnitude (M_w) scale, represents the “size” of an earthquake. The Richter Magnitude (M) scale has been replaced in most modern building codes by the M_W scale because the M_W scale provides more useful information to design engineers. The Alternative 5 site is subject to earthquakes of M_W 6.0 to M_W 8.0 by the surrounding faults (CGS, 2023; USGS, 2017a, 2017b, 2017c, 2017d, 2023; SCEDC, 2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2023g, 2023h, 2023i, 2023j, 2023k, 2023l, 2023m, 2023n, 2023o, 2023p, 2023q, 2023r; and Shaw et al., 2022).

The intensity of an earthquake is measured by the Modified Mercalli Intensity (MMI) scale, which emphasizes the current seismic environment at a particular site and measures ground shaking severity according to damage done to structures, changes in the earth surface, and personal accounts. Table 9-6 identifies the level of intensity according to the MMI scale and describes that intensity with respect to how it would be received or sensed by its receptors.

Table 9-6. Alternative 5: Modified Mercalli Intensity Scale

Intensity	Shaking	Description/Damage
I	Not Felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration is similar to the passing of a truck. Duration is estimated.
IV	Light	Felt indoors by many and outdoors by few during the day. At night, some are awakened. Dishes, windows, doors are disturbed; walls make cracking sound. Sensation is like a heavy truck striking a building. Standing motor cars are rocked noticeably.
V	Moderate	Felt by nearly everyone; many are awakened. Some dishes and windows are broken. Unstable objects are overturned. Pendulum clocks may stop.
VI	Strong	Felt by all; many are frightened. Some heavy furniture is moved; there are a few instances of fallen plaster. Damage is slight.
VII	Very Strong	Damage is negligible in buildings of good design and construction, slight to moderate in well-built ordinary structures, and considerable in poorly built structures; some chimneys are broken.
VIII	Severe	Damage is slight in specially designed structures, considerable in ordinary substantial buildings with partial collapse, and great in poorly built structures. Chimneys, factory stacks, columns, monuments, and walls fall. Heavy furniture is overturned.
IX	Violent	Damage is considerable in specially designed structures; well-designed frame structures are thrown out of plum. Damage is great in substantial buildings, with partial collapse. Buildings are shifted off foundations.
X	Extreme	Some well-built wooden structures are destroyed; most masonry and frame structures are destroyed with foundations. Rails are bent.

Source: USGS, 2022

Over the past 54 years, Southern California has experienced three significant earthquakes: the 1971 San Fernando earthquake (also known as the Sylmar earthquake, on the Sierra Madre Fault), which registered as M_W 6.6; the 1987 Whittier Narrows earthquake, which registered as M_W 5.9; and the Northridge earthquake, which occurred in January 1994 and registered as M_W 6.7.

9.2.4 Regional and Local Faults

Major regional and local faults are identified in Table 9-7 and are shown on **Error! Reference source not found.**Figure 9-10 and Figure 9-11.

Table 9-7. Alternative 5: Summary of Major Regional and Local Faults

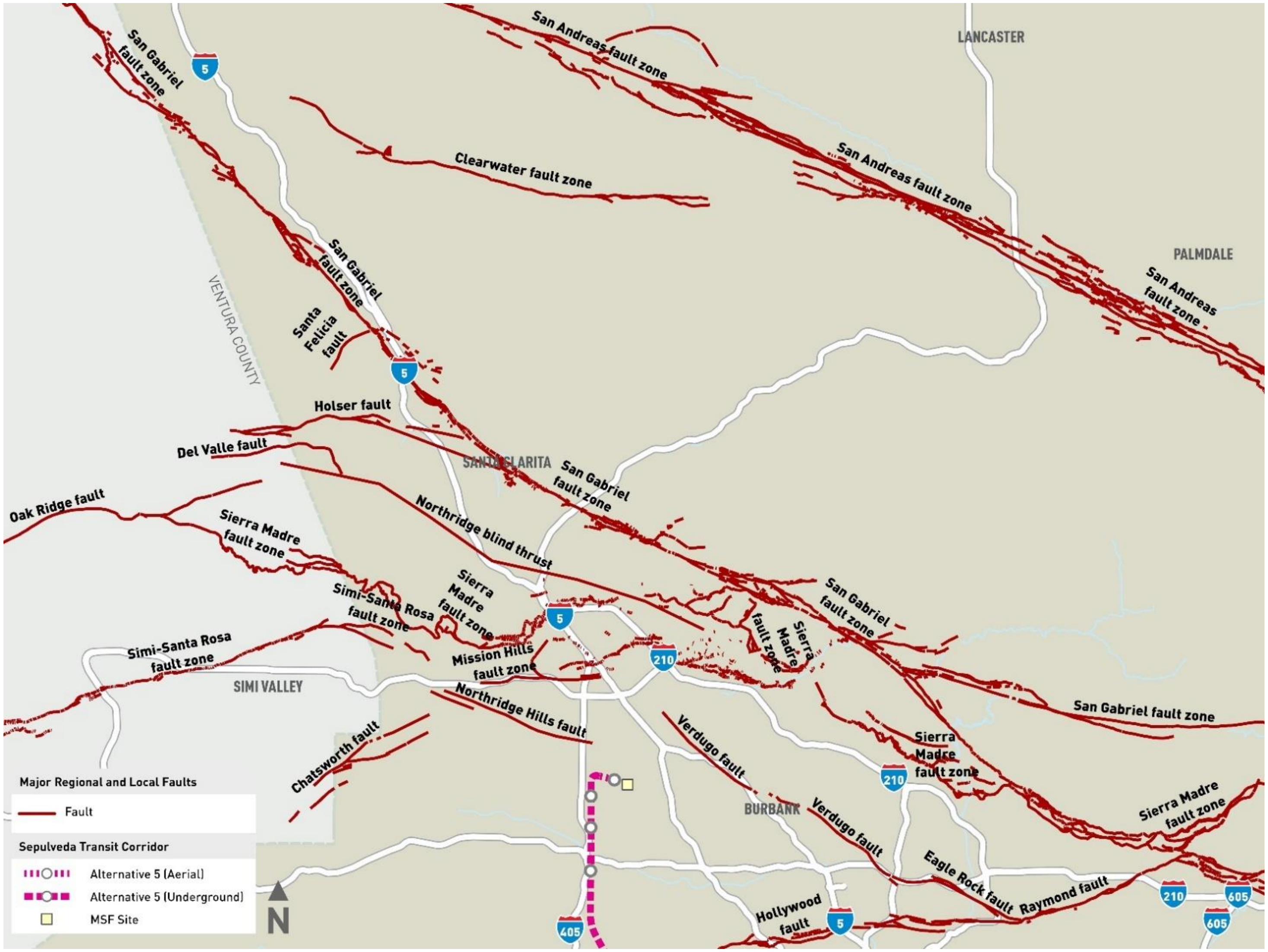
Fault Name	Approximate Closest Distance from Alternative 5 to the Fault (miles)	Compass Direction	Alquist-Priolo Earthquake Fault Zone	Maximum Moment Magnitude (Mw)
Santa Monica Fault	Crosses Alternative 5 corridor southeast of South Bentley Avenue and Massachusetts Avenue	North	Yes	7.0
Overland Avenue Fault	0.7	East	No	6.6
Northridge Hills Fault	1.5	North	No	—
Hollywood Fault	1.7	East	Yes	6.5
Newport-Inglewood-Rose Canyon Fault	1.8	East	Yes	7.2
Charnock Fault	2.6	Southeast	No	6.5
Mission Hills Fault	4.4	North	No	—
Sierra Madre Fault	4.8	Northeast	Yes	7.0
Verdugo Fault	6.4	East	No	6.8
Puente Hills Blind Thrust System	6.8	Southeast	No	—
Chatsworth Fault	7.7	Northwest	No	6.8
Northridge Blind Thrust Fault	8.4	North	No	7.5
Simi-Santa Rosa Fault	9.0	Northwest	Yes	6.9
San Gabriel Fault	10.4	Northeast	Yes	6.7
Malibu Coast Fault	12.0	West	Yes	7.0
Raymond Fault	12.5	Northeast	Yes	6.7
Eagle Rock Fault	12.9	Southeast	No	7.0
Hosler Fault	14.4	Northwest	No	—
Palos Verdes Fault	14.7	South	No	6.5
Del Valle Fault	17.5	Northwest	No	7.1
Oak Ridge Fault	19.9	Northwest	No	7.5
Santa Felicia Fault	21.9	Northwest	No	—
Clearwater Fault	26.2	North	No	—
San Andreas Fault	29.5	Northeast	Yes	8.0

Source: CGS, 2023; USGS, 2017a, 2017b, 2017c, 2017d, 2023; SCEDC, 2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2023g, 2023h, 2023i, 2023j, 2023k, 2023l, 2023m, 2023n, 2023o, 2023p, 2023q, 2023r; and Shaw et al., 2022

Figure 9-10. Alternative 5: Major Regional and Local Faults – South

Source: CGS, 2023; HTA, 2024

Figure 9-11. Alternative 5: Major Regional and Local Faults – North



Source: CGS, 2023; HTA, 2024

9.2.4.1 Charnock Fault

The Charlock fault is located approximately 2.6 miles southeast from the southern portion of Alternative 5. Charnock fault extends southeast from near Venice Boulevard to the City of Gardena and runs parallel to the axis of the Gardena syncline for most of its length. The northeastern side of the fault is downthrown relative to the southwestern side (CDWRSD, 1961). Faulted rocks of late Quaternary age (between present day and 700,000 years ago) are present along this fault (USGS, 1981). The Charnock fault runs underneath the Los Angeles International Airport (LAX) runway.

9.2.4.2 Chatsworth Fault

The Chatsworth fault is located approximately 7.7 miles northwest from the northern portion of Alternative 5. The Chatsworth fault is 12.4 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Chatsworth fault has a probable magnitude of M_w 6.0 and M_w 6.8. The Chatsworth fault is a reverse fault, where the displacement is predominantly vertical. This fault is north-dipping, and the slip rate is currently unknown (SCEDC, 2023a).

9.2.4.3 Clearwater Fault Zone

The Clearwater fault is located approximately 26.2 miles north from the northern portion of Alternative 5. The Clearwater fault is 19.9 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Clearwater fault varies from north-dipping to vertical (SCEDC, 2023b).

9.2.4.4 Del Valle Fault

The Del Valle fault is located approximately 17.5 miles northwest from the northern portion of Alternative 5. The Del Valle fault is classified as late Quaternary (between present day and 700,000 years ago). The Del Valle fault is a south-dipping reverse fault, and it contains the prominent tectonic geomorphic features (Yeats et al., 1985).

9.2.4.5 Eagle Rock Fault

The Eagle Rock fault is located approximately 12.9 miles southeast from the mid-section of Alternative 5. The Eagle Rock fault is 6.8 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Eagle Rock fault is a thrust fault, which is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much, if not all, of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an obvious sign of compressional tectonics (SCEDC, 2023c, 2023s). The slip rate for Eagle Rock fault is probably less than 0.1 mm/year. The possibility of simultaneous rupture with the Verdugo fault is uncertain. The Eagle Rock fault dips to the northeast (SCEDC, 2023c).

9.2.4.6 Hollywood Fault

The Hollywood fault is located approximately 1.7 miles east from the mid-section of Alternative 5. The Hollywood fault is 9.3 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023d, 2023s). The Hollywood fault is a left-reverse fault and has a probable magnitude between M_w 5.8 and M_w 6.5. There is a potential for the probable magnitude to be larger if rupture is simultaneous with an adjacent fault. The slip rate for the Hollywood fault is between 0.33 and 0.75 mm/year. The Hollywood fault could be considered a westward extension of the Raymond fault and is roughly parallel to the Santa Monica fault (SCEDC, 2023d). The Hollywood fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act.

9.2.4.7 Holser Fault

The Holser fault is located approximately 14.4 miles northwest from the northern portion of Alternative 5. The Holser fault is 12.4 miles long and is classified as a Late Quaternary (between present day and 700,000 years ago). The Holser fault is a reverse fault with a slip rate between 0.4 mm/year; the displacement is predominantly vertical, and the dip is to the south (SCEDC, 2023e).

9.2.4.8 Malibu Coast Fault

The Malibu Coast fault is located approximately 12 miles west from the mid-section of Alternative 5. The Malibu Coast fault is 21.1 miles long with several parallel strands. The Malibu Coast fault is classified as Holocene (from about 10,000 years ago to the present) in part; otherwise, the fault is classified as late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023f, 2023s). The Malibu Coast fault is a reverse fault with a slip rate of 0.3 mm/year. The Malibu Coast fault is a north-dipping fault. The slip rate may be higher at its eastern end, where it meets the Santa Monica fault and develops left-reverse motion (SCEDC, 2023f). The Malibu Coast fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

9.2.4.9 Mission Hills Fault

The Mission Hills fault is located approximately 4.4 miles north from the northern portion of Alternative 5. The Mission Hills fault is 6.2 miles long. The Mission Hills fault is classified as late Quaternary (between present day and 700,000 years ago) and possibly Holocene (from about 10,000 years ago to the present) (SCEDC, 2023g, 2023s). The Mission Hills fault is a reverse fault, where the displacement is predominantly vertical. The Mission Hills fault has a slip rate of 0.5 mm/year (SCEDC, 2023g).

9.2.4.10 Newport-Inglewood-Rose Canyon Fault

The Newport-Inglewood-Rose Canyon fault is located approximately 1.8 miles east from the southern portion of Alternative 5. The Newport-Inglewood-Rose Canyon fault is 55.9 miles long. The Newport-Inglewood-Rose Canyon fault is mostly classified as Quaternary (1.6 million years ago and continuing to the present day) and in part classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023h, 2023s). The Newport-Inglewood-Rose Canyon fault is a right-lateral fault, which is a fault that slips in such a way that the two sides move with a predominantly lateral motion (with respect to each other). The Newport-Inglewood-Rose Canyon fault has a probable magnitude between M_W 6.0 and M_W 7.2 and a slip rate between 0.8 mm/year and 2.1 mm/year (SCEDC, 2023h). The Newport-Inglewood-Rose Canyon fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

9.2.4.11 Northridge Blind Thrust Fault

The Northridge Blind Thrust fault is located approximately 8.4 miles north from the northern portion of Alternative 5. The Northridge Blind Thrust fault is part of the Oak Ridge fault system (SCEDC, 2023j). At its eastern end, the Oak Ridge Thrust fault is progressively more difficult to trace and is buried, or also known as *blind*. The Northridge Blind Thrust fault has a probable magnitude of M_W 6.5 to M_W 7.5. The slip rate for the Northridge Blind Thrust fault is between 3.5 and 6 mm/year (SCEDC, 2023j). The Northridge Blind Thrust fault, as part of the Oak Ridge fault system, is classified mostly as late Quaternary (between present day and 700,000 years ago) and in part as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023j, 2023s). The Northridge Blind Thrust fault is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much, if not all, of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an

obvious sign of compressional tectonics (SCEDC, 2023j, 2023s). This blind thrust fault is assumed to be part of the fault system responsible for the 1994 Northridge earthquake.

9.2.4.12 Northridge Hills Fault

The Northridge Hills fault is located approximately 1.5 miles north from the northern portion of Alternative 5. The Northridge Hills fault is not the fault on which the 1994 Northridge earthquake occurred. The Northridge Hills fault is classified as late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023i, 2023s). The Northridge Hills fault is 15.5 miles long, and is a reverse fault, where the displacement is predominantly vertical. The dip for the Mission Hills fault is probably to the north (SCEDC, 2023i).

9.2.4.13 Overland Avenue Fault

The Overland Avenue fault is located approximately 0.7 miles east from the southern portion of Alternative 5. The Overland Avenue fault trends northwest and extends from Santa Monica Boulevard to the northwestern flank of the Baldwin Hills. Displacement of the fault is believed to be vertical, with a magnitude of approximately 30 feet. The northeastern side of the fault is raised relative to the southwestern side (CDWRSD, 1961). Faulted rocks of late Quaternary age (between present day and 700,000 years ago) are present along this fault (USGS, 1981).

9.2.4.14 Oak Ridge Fault

The Oak Ridge fault is located approximately 19.9 miles northwest from the northern portion of Alternative 5. The Oak Ridge fault system is connected to the 1994 Northridge earthquake. The Oak Ridge fault is approximately 55.9 miles in length (SCEDC 2023j). The Oak Ridge fault has a probable magnitude of M_W 6.5 to M_W 7.5. The slip rate for the Oak Ridge fault is between 3.5 and 6 mm/year (SCEDC, 2023j). The Oak Ridge fault system is classified mostly as late Quaternary (between present day and 700,000 years ago) and in part as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023j, 2023s). The Oak Ridge fault is a thrust fault, which is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much, if not all, of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an obvious sign of compressional tectonics (SCEDC, 2023j, 2023s). This fault dips to the south at a fairly shallow (less than 45 degrees) angle. Thus, epicenters of earthquakes on this (and any other thrust) fault may appear far removed from the surface trace. The surface trace of the Oak Ridge fault forms a ridge (hence its name) to the south of its trace; at its eastern end, the Oak Ridge fault becomes progressively more difficult to trace (SCEDC, 2023j). The Oak Ridge fault appears to be overthrust by the *Santa Susana* fault becoming a *blind thrust fault,* including the Northridge Blind Thrust fault.

9.2.4.15 Palos Verdes Fault

The Palos Verdes fault is located approximately 14.7 miles south from the southern portion of Alternative 5. The Palos Verdes fault is 49.7 miles long and is classified as Holocene (from about 10,000 years ago to the present) offshore and as late Quaternary (between present day and 700,000 years ago) onshore (SCEDC, 2023k, 2023s). The Palos Verdes fault is a right-reverse fault and has a probable magnitude between M_W 6.0 and M_W7.0. The slip rate is between 0.1 and 3.0 mm/year (SCEDC, 2023k).

9.2.4.16 Puente Hills Blind Thrust Fault

The Puente Hills Blind Thrust fault is located approximately 6.8 miles southeast from the southern portion of Alternative 5. The Puente Hills Blind Thrust fault is 24.9 miles long. In 1987, the Puente Hills Blind Thrust fault produced an M_W 5.9 earthquake in Whittier. In March 2014, the Puente Hills Blind

Thrust fault produced an M_W 5.1 earthquake with over 100 aftershocks (KCAL News, 2014). The Puente Hills Blind Thrust fault has a probable magnitude between M_W 6.5 and M_W 6.6 for frequency of single segment and a probable magnitude of M_W 7.1 for multi-segment rupture scenarios. The slip rates on the ramp segments range from 0.44 to 1.7 mm/year, with preferred rates between 0.62 and 1.28 mm/year (Shaw et al., 2022).

9.2.4.17 Raymond Fault

The Raymond fault is located approximately 12.5 miles northeast from the mid-section of Alternative 5. The Raymond fault is 16.2 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023l, 2023s). The Raymond fault is a left-reverse fault and has a probable magnitude between M_W 6.0 and M_W 7.0, with a slip rate of between 0.10 and 0.22 mm/year (SCEDC, 2023l). The Raymond fault dips at about 75 degrees to the north. There is evidence that at least eight surface-rupturing events have occurred along this fault in the last 36,000 years. The exact nature of the slip along the Raymond fault has been a subject of debate for quite some time. In late 1988, the *Pasadena earthquake* occurred on the Raymond fault, and the motion of this earthquake was predominantly left-lateral, with a reverse component of only about 1/15 the size of the lateral component. If the Raymond fault is indeed primarily a left-lateral fault, it could be responsible for transferring slip southward from the *Sierra Madre* Fault Zone to other fault systems (SCEDC, 2023l). The Raymond fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

9.2.4.18 San Andreas Fault

The San Andreas fault is located approximately 29.5 miles northeast from the northern portion of Alternative 5. The San Andreas fault is 745.6 miles long. The San Andreas fault has a probable magnitude between M_W 6.8 to M_W 8.0. The interval between major ruptures averages about 140 years on the Mojave segment, and the recurrence interval varies greatly from under 20 years (at Parkfield only) to over 300 years. The slip rate is between 20 and 35 mm/year (SCEDC, 2023m). The last major rupture of the San Andreas fault occurred on January 9, 1857 at the Mojave segment and on April 18, 1906 at the northern segment. The San Andreas fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

9.2.4.19 San Gabriel Fault

The San Gabriel fault is located approximately 10.4 miles northeast from the northern portion of Alternative 5. The San Gabriel fault is 87 miles long. The San Gabriel fault is primarily a right-lateral strike slip, which is a fault where the slip motion is parallel to the direction, or trend, of the line marking the intersection of a fault plane (or another planar geologic feature) with the horizontal. The San Gabriel fault is classified as late Quaternary (between present day and 700,000 years ago) west of the intersection with the Sierra Madre Fault Zone, Quaternary (1.6 million years ago and continuing to the present) east of that intersection, and Holocene (from about 10,000 years ago to the present) between Saugus and Castaic. The slip rate is between 1 and 5 mm/year (SCEDC, 2023n). The slip rate and reoccurrence interval vary significantly along the length of the San Gabriel Fault. The western half is more active than the eastern half, and the dip is generally steep and to the north. The San Gabriel Fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the -Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

9.2.4.20 Santa Felicia Fault

The Santa Felicia fault is located approximately 21.9 miles northwest from the northern portion of Alternative 5. The Santa Felicia fault is a fault that is less well understood. The Santa Felicia fault is classified as late Quaternary (between present day and 700,000 years ago). The Santa Felicia fault apparently overrides the youngest strand of the San Gabriel Fault. The Santa Felicia fault is a south-dipping reverse fault. The Santa Felicia fault has no recognized tectonic geomorphic features, although it follows the Santa Felicia Canyon for part of its length (Yeats et al., 1985).

9.2.4.21 Santa Monica Fault

The Santa Monica fault would cross Alternative 5 approximately southeast of South Bentley Avenue and Massachusetts Avenue. The Santa Monica fault is 14.9 miles long. The Santa Monica fault has a probable magnitude between M_W 6.0 and M_W 7.0. The Santa Monica fault is classified as late Quaternary (between present day and 700,000 years ago) and is a left-reverse fault. The Santa Monica fault is a north-dipping fault, and the slip rate may be greatest at its western end. The slip rate is between 0.27 and 0.39 mm/year (SCEDC, 2023o). In 2015, the Santa Monica Fault Zone was evaluated for the Alquist-Priolo Earthquake Fault Zoning program (Olson, 2015). Currently, the Santa Monica Fault Zone is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023). The guideway for Alternative 5 would fall within the Alquist-Priolo Earthquake Fault Zone. No habitable structures and no stations are located within the Alquist-Priolo Earthquake Fault Zone for Alternative 5.

9.2.4.22 Sierra Madre Fault

The Sierra Madre fault is located approximately 4.8 miles northeast from the northern portion of Alternative 5. The Sierra Madre fault is 46.6 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023p, 2023s). The Sierra Madre fault is a reverse fault, where the displacement is predominantly vertical. The Sierra Madre fault has a probable magnitude between M_W 6.0 and M_W 7.0. The slip rate is between 0.36 and 4.0 mm/year (SCEDC, 2023k). The Sierra Madre fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

9.2.4.23 Simi-Santa Rosa Fault

The Simi-Santa Rosa fault is located approximately 9 miles northwest from the northern portion of Alternative 5. The Simi-Santa Rosa fault is 24.9 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023q, 2023s). The Simi-Santa Rosa fault is a reverse fault, where the displacement is predominantly vertical. This fault dips to the north. The Simi-Santa Rosa fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

9.2.4.24 Verdugo Fault

The Verdugo fault is located approximately 6.4 miles east from the mid-section of Alternative 5. The Verdugo fault is 13 miles long and is classified as Holocene (from about 10,000 years ago to the present) and late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023r, 2023s). The Verdugo fault is a reverse fault and has a probable magnitude between M_W 6.0 and M_W 6.8. The slip rate is roughly 0.5 mm/year (SCEDC, 2023r). The Verdugo fault dips to the northeast.

9.2.5 Geological Hazards

9.2.5.1 Fault Rupture

Faults are geologic zones of weakness. Surface rupture occurs when movement on a fault deep in the earth breaks through to the ground surface. Surface ruptures associated with the 1994 Northridge earthquake began as a rupture at a depth of about 10.9 miles beneath the San Fernando Valley. For 8 seconds following the initial break, the rupture propagated upward and northwestward along the fault plan at a rate of about 1.9 miles per second. The size of the rupture covered an area of approximately 9.3 by 12.4 miles (USGS, 2013). Not all earthquakes result in surface rupture; however, due to the proximity of known active faults, fault ruptures and the subsequent hazard posed by seismic activity are potentially high. An earthquake could cause major damage, and not have the fault trace break at the ground surface. Fault rupture almost always follows preexisting faults, which are zones of weakness. Rupture may occur suddenly during an earthquake or slowly in the form of fault creep. Sudden displacements are more damaging to structures because they are accompanied by shaking.

9.2.5.2 Ground Shaking

A major cause of structural damage that results from earthquakes is ground shaking. The amount of motion can vary from “zero to forceful” depending upon the distance to the fault, the magnitude of the earthquake, and the local geology. Greater movement can be expected at sites located on poorly consolidated material such as alluvium located near the source of the earthquake epicenter or in response to an earthquake of great magnitude. Strong ground shaking can damage large freeway overpasses and unreinforced masonry buildings. It can also trigger a variety of secondary hazards such as liquefaction, landslides, fire, and dam failure.

The amount of damage to a building does not depend solely on how hard it is shaken. In general, smaller buildings such as houses are damaged more by stronger earthquakes, and houses must be relatively close to the epicenter to be severely damaged. Larger structures such as high-rise buildings are damaged more by weaker earthquakes and will be more noticeably affected by the largest earthquakes, even at considerable distances.

Damages as a result of ground shaking are not limited to aboveground structures. Seismic waves generated by the earthquake cause the ground to move, leading to dynamic forces on underground structures. This shaking can induce ground deformation and displacements, and can potentially damage the structural integrity of tunnels, basements, and other underground facilities.

The intensity of ground motion expected at a particular site depends upon the magnitude of the earthquake, the distance to the epicenter, and the geology of the area between the epicenter and the property. Another factor affecting structural damage due to ground shaking is the quality and condition of the existing structure, which is influenced by whether it adheres to current or past building codes. Greater movement can be expected at sites on poorly consolidated material, such as loose alluvium, in proximity to the causative fault, or in response to an event of great magnitude. The general area is susceptible to earthquakes of M_W 6.0 to M_W 8.0. Due to the proximity of known active faults, the hazard posed by seismic shaking is potentially high.

9.2.5.3 Difficult Ground Conditions for Excavating, Drilling, or Tunneling

Alternative 5’s alignment through the Santa Monica Mountains (primarily in single-bore rock tunnel) would encounter potentially-challenging bedrock conditions – under potentially high hydrostatic groundwater pressures (Metro, 2023b). The bedrock materials tend to be heavily folded, faulted, and intruded sedimentary rock – especially in shale, slate, phyllite, schist, and sandstone. Drilling in this area is anticipated to be slow; casing (if used) installation into these materials will also be difficult. Hard drilling should be anticipated.

9.2.6 Dry Sand Settlement

Settlement is defined as areas that are prone to rates of ground-surface collapse and densification (soil particle compaction) that are greater than those of the surrounding area. Such areas are often underlain by sediments that differ laterally in composition or degree of existing compaction. Differential settlement refers to areas that have more than one rate of settlement. Settlement can damage structures, pipelines, and other subsurface entities.

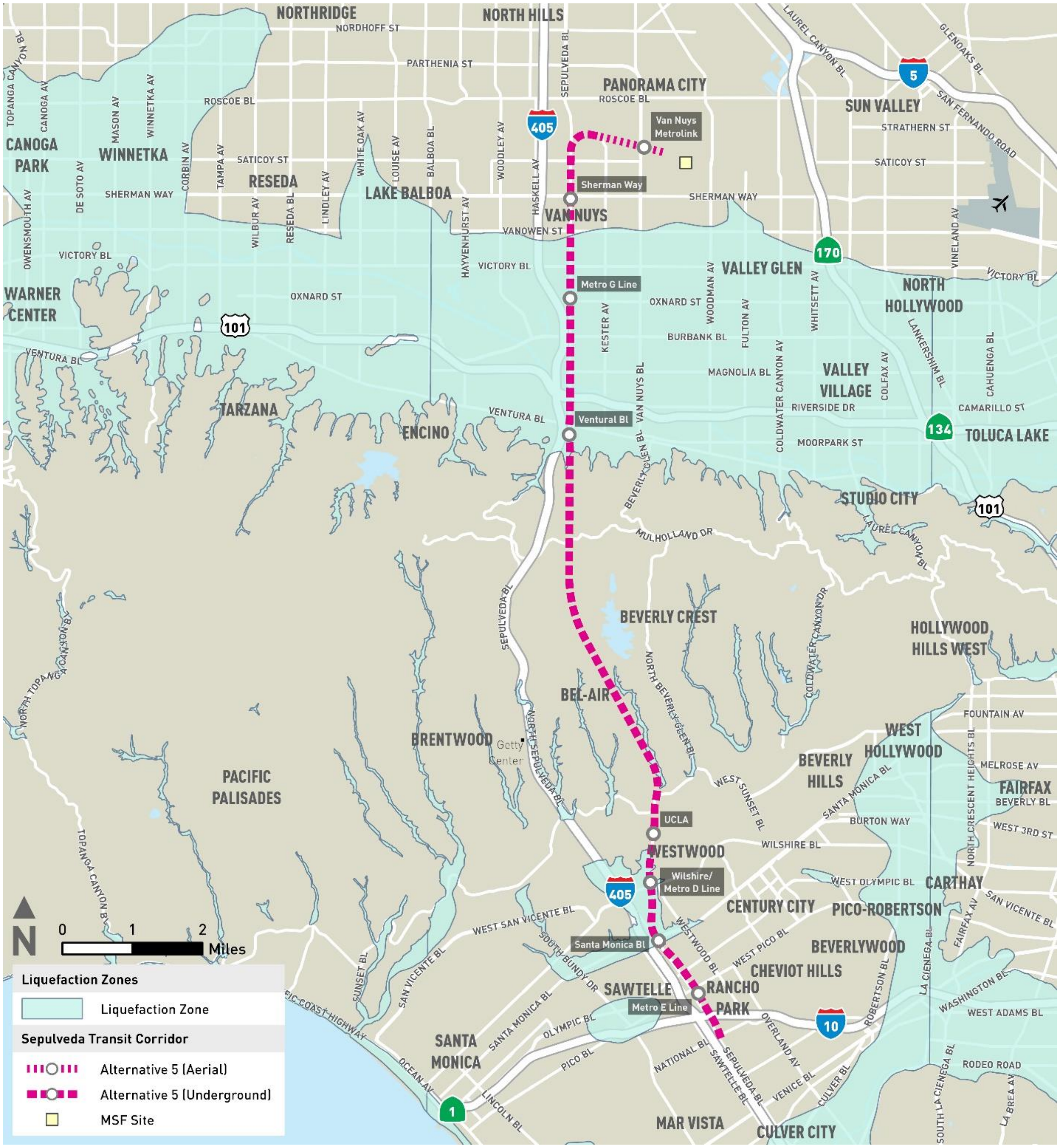
Strong ground shaking can cause soil settlement by vibrating sediment particles into more tightly compacted configurations, thereby reducing pore space. Unconsolidated, loosely packed alluvial deposits and sand (unsaturated or saturated) are especially susceptible to this phenomenon. Poorly compacted artificial fills may experience seismically induced settlement. Although much of the alignment is underground, stations have surface-level elements. As shown on Figure 9-9, alluvial deposits are present at all of Alternative 5’s stations and, as such, the hazard posed by seismically induced settlement is potentially high.

9.2.7 Liquefaction

Liquefaction involves a sudden loss in strength of a saturated, cohesionless, uniformly particle-sized soil, that is typically caused by ground-shaking activities, which causes temporary transformation of the soil to a fluid mass. In rare instances, ground-borne vibrations can cause liquefaction from activities such as pile driving or tunnel boring. If the liquefying layer is near the ground surface, the effects may resemble those of quicksand. If the layer is deep below the ground surface, it may provide a sliding surface for the material above it and/or cause differential settlement of the ground surface, which may damage building foundations by altering weight-bearing characteristics.

During a liquefaction event, soils behave similarly to liquids, losing bearing strength. Structures built on these soils may tilt or settle when the soils liquefy. Liquefaction occurs more often in earthquake-prone areas underlain by young sandy alluvium where the groundwater table is less than 50 feet below ground surface (Metro, 2023b). Per the County of Los Angeles, liquefaction zones identify where the stability of foundation soils must be investigated, and countermeasures undertaken in the design and construction of buildings for human occupancy (LA County Planning, 2022a). As shown on Figure 9-12, the alignment of Alternative 5 would traverse a Liquefaction Zone, and the potential for a liquefaction event is relatively high for the mapped areas shown (California Department of Conservation, 1998). Site-specific liquefaction potential would be evaluated in more detail based on future site-specific subsurface investigation data.

Figure 9-12. Alternative 5: Liquefaction Zones



Source: County of Los Angeles, Enterprise GIS (eGIS), 2022; HTA, 2024

9.2.8 Subsidence

Subsidence involves a sudden sinking or gradual settling and compaction of soil and other surface material with little or no horizontal motion. This is typically caused by the removal of groundwater, oil, or natural gas, or by natural processes like the compaction of soil. This can lead to structural damage to buildings and infrastructure. The Los Angeles Basin is vulnerable to subsidence, particular due to

groundwater and oil extraction. Over-extraction of groundwater can be concerning because as the groundwater table drops, the soil compacts, leading to subsidence that can damage infrastructure, buildings, and roads. Information relating to groundwater conditions can be found in the *Sepulveda Transit Corridor Project Water Resources Technical Report* (Metro, 2025).

Subsidence typically impacts surface-level soils. Although much of the alignment is in a relatively deep subsurface tunnel, all stations have surface-level elements. Moreover, alluvial deposits are susceptible to subsidence, especially when they consist of loose, unconsolidated sediments. As shown on Figure 9-9, alluvial deposits are present at all of Alternative 5’s stations and, as such, the hazard posed by subsidence is potentially high at those locations.

9.2.9 Expansive Soils

Expansive soils have a significant amount of clay particles that can give up water (shrink) or take on water (swell). The change in volume exerts stress on buildings and other loads placed on these soils. The occurrence of these soils is often associated with geologic units having marginal stability. Expansive soils can be dispersed widely and can be found in hillside areas as well as low-lying areas in alluvial basins. Municipal grading and building codes require routine soils testing to identify expansive characteristics and appropriate remediation measures. Specific treatments to eliminate expansion of soils at building sites include, but are not limited to, grouting (cementing the soil particles together), re-compaction (watering and compressing the soils), and replacement with non-expansive material (excavation of unsuitable soil followed by filling with suitable material), all of which are common practice in California. Expansive soils typically impact surface-level soils. Although much of the alignment is in a relatively deep subsurface tunnel, all stations have surface-level elements. As shown on Figure 9-9, alluvial deposits are present at all of Alternative 5’s stations and as such, the hazard posed by expansive soils is potentially high at those locations.

9.2.10 Collapsible Soil

Collapsible soils undergo a rearrangement of their grains and a loss of cementation, resulting in substantial and rapid settlement under relatively low loads. Collapsible soils occur predominantly at the base of mountain ranges where Holocene-age alluvial fan and wash sediments have been deposited during rapid runoff events. Soils prone to collapse are commonly associated with human-made fill, wind-laid sands and silts, and alluvial fan and mudflow sediments deposited during flash floods. Additionally, desert soils are commonly associated with hydro-compression and collapse associated with wetting. Examples of common problems associated with collapsible soils include tilting floors, cracking or separation in structures, sagging floors, and nonfunctional windows and doors. Collapsible soils typically impact earth at surface levels. Although much of the alignment is in a relatively deep subsurface tunnel, all stations have surface-level elements. As shown on Figure 9-9, alluvial deposits are present at all of Alternative 5’s stations and, as such, the hazard posed by collapsible soils is potentially high at those locations.

9.2.11 Lateral Spreading

Lateral spread is the finite, lateral displacement of sloping ground (0.1 to < 6 percent) as a result of pore pressure buildup or liquefaction in a shallow, underlying soil deposit during an earthquake. Lateral spreading, as a result of liquefaction, occurs when a soil mass slides laterally on a liquefied layer, and gravitational and inertial forces cause the layer and the overlying non-liquefied material to move in a downslope direction. Due to the presence of mountainside areas in the Project Study Area, the hazard posed by lateral spreading is potentially high at those locations.

9.2.12 Slope Stability

Slope failures include many phenomena that involve the downslope displacement of material, triggered by static (i.e., gravity) or dynamic (i.e., earthquake) forces, such as landslides, rock-falls, debris slides, and soil creeps. Slope stability can depend on complex variables, including the geology, structure, and amount of groundwater present, as well as external processes such as climate, topography, slope geometry, and human activity. Landslides and other slope failures may occur on slopes of 15 percent or less; however, the probability is greater on steeper slopes that exhibit old landslide features such as scarps, slanted vegetation, and offset surfaces. Due to the presence of slopes (of 15 percent greater) in the Project Study Area, particularly in the hilly Santa Monica Mountain communities of Bel-Air, Beverly Crest, and Brentwood, the hazard posed by slope failures is potentially high at those locations.

9.2.13 Landslides

Landslides are the downhill movement of a mass of earth and rock. Landslides are a geological phenomenon that includes a wide range of ground movements, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary cause of a landslide, the following other factors contribute:

- Erosion by rivers, glaciers, or ocean waves
- Rock and soil slopes that are weakened through saturation by snowmelt or heavy rains
- Earthquakes that create stresses such that weak slopes fail
- Volcanic eruptions that produce loose ash deposits, heavy rain, and/or debris flows
- Vibrations from machinery, traffic, blasting, and even thunder
- Excess weight from accumulation of rain or snow, stockpiling of rock or ore from waste piles, or from human-made structures

As shown on Figure 9-13, the potential landslide hazard for Alternative 5 is focused within the Santa Monica Mountains portion of the alternative.

Figure 9-13. Alternative 5: Landslide Hazard Zones

Source: County of Los Angeles, eGIS, 2022; HTA, 2024

9.2.14 Soil Erosion

Soil erosion is the process by which soil particles are removed from a land surface by wind, water, or gravity. Most natural erosion occurs at slow rates; however, the rate of erosion increases when land is cleared of vegetation or structures, or otherwise altered and left in a disturbed condition. Erosion can occur as a result of, and can be accelerated by, site preparation activities associated with development.

Vegetation removal in pervious landscaped areas could reduce soil cohesion, as well as the buffer provided by vegetation from wind, water, and surface disturbance, which could render the exposed soils more susceptible to erosive forces.

Excavation or grading may result in erosion during construction activities, irrespective of whether hardscape previously existed at the construction site, because bare soils would be exposed and could be eroded by wind or water. The effects of erosion are intensified with an increase in slope (as water moves faster, it gains momentum to carry more debris) and the narrowing of runoff channels (which increases the velocity of water). Surface structures, such as paved roads and buildings, decrease the potential for erosion. Once covered, such as with a paved road, soil is no longer exposed to the elements, and erosion generally does not occur.

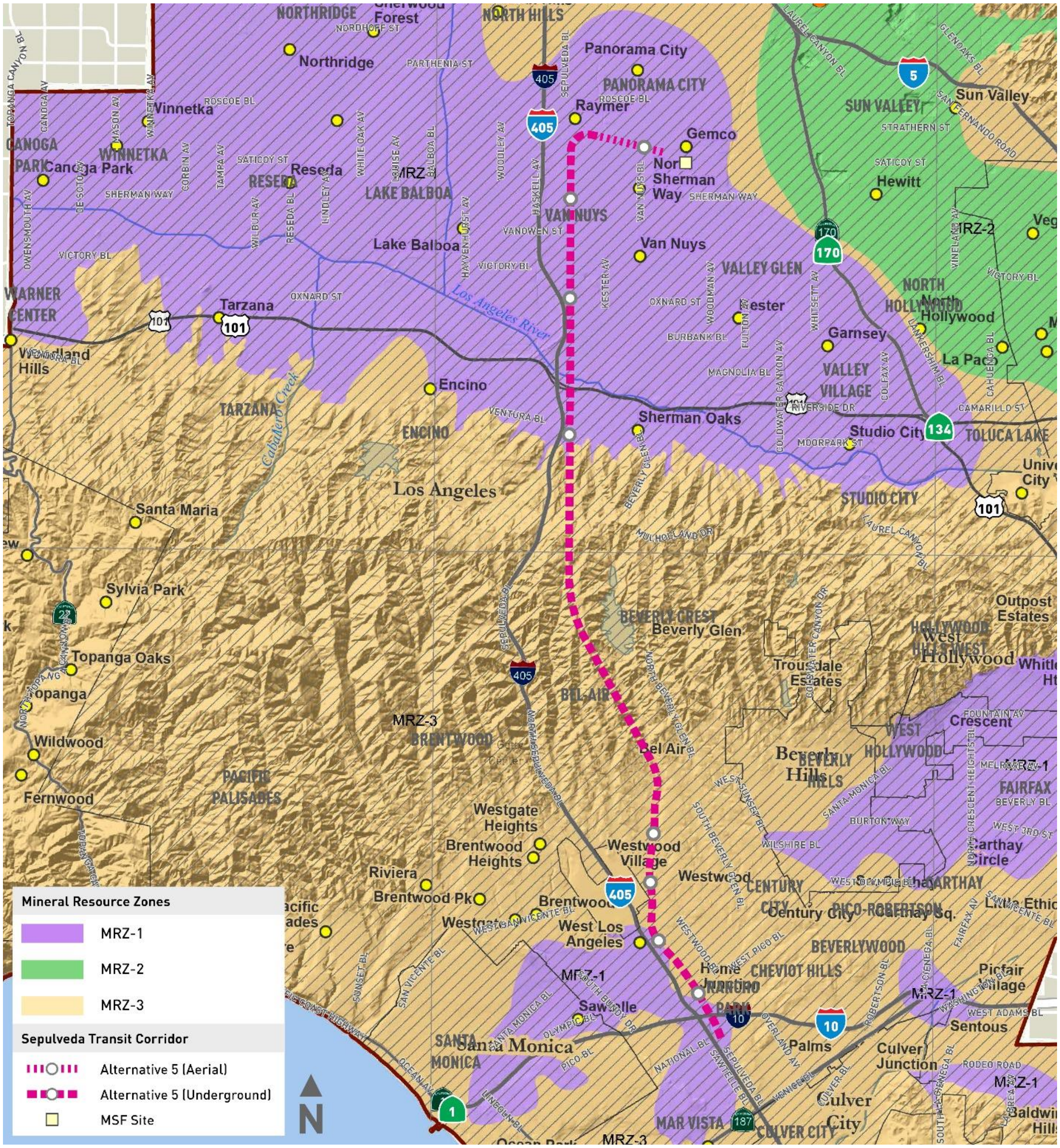
9.3 Mineral Resources

Mineral resource areas are identified according to the Surface Mining and Reclamation Act of 1975 and the following criteria for Mineral Resource Zones (MRZs), Scientific Resource Zones (SZs), and Identified Resource Areas. The MRZ and SZ categories used by the State Geologist in classifying the state's lands, the geologic and economic data, and the substantiation of which each unit MRZ or SZ assignment is based on land classification information provided by the State Geologist to the Board of Supervisors for the following areas:

- **MRZ-1:** Adequate information indicates that no significant mineral deposits are present or little likelihood exists for their presence. This zone shall be applied where well-developed lines of reasoning, based on economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is nil or slight.
- **MRZ-2:** Adequate information indicates that significant mineral deposits are present or a high likelihood for their presence exists. This zone shall be applied to known mineral deposits or where well-developed lines of reasoning, based on economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is high.
- **MRZ-3:** Areas containing deposits whose significance cannot be evaluated from available data.
- **MRZ-4:** Available information is inadequate for assignment to any other MRZ zone.
- **SZ Areas:** Areas containing unique or rare occurrences of rocks, minerals, or fossils that are of outstanding scientific significance shall be classified in this zone.

Alternative 5 would contain areas designated as MRZ-1 and MRZ-3 (Figure 9-14). The California Department of Conservation, Division of Mines and Geology has classified areas of regional significance as MRZ-2 (CGS, 2021). Alternative 5 would not be located within an area designated as MRZ-2. Alternative 5 would be largely located within areas designated as MRZ-3, which contains deposits whose significance cannot be evaluated from available data. A portion of Alternative 5 would be located within areas designated as MRZ-1 in the northern portion of Alternative 5 in the San Fernando Valley as well as the southern portion of Alternative 5 near West Los Angeles. MRZ-1-designated areas indicate that no significant mineral deposits are present or little likelihood exists for their presence.

Figure 9-14. Alternative 5: Mineral Resources



Source: CGS, 2021; HTA, 2024

9.4 Paleontological Resources

A paleontological records search from the Natural History Museum of Los Angeles County (NHMLAC) revealed that no fossil locality located directly within the Resource Study Area (RSA). However, the records search from NHMLAC has revealed that 15 fossil localities are located within 5 miles of the RSA that produced fossil vertebrates and invertebrates in similar geologic units found within the project footprint. Underground components of Alternative 5 have increased impacts to paleontological resources. Deeper portions of any paleontologically sensitive unit have the potential to produce rare or scientifically important taxa.

Paleontological sensitivity refers to the paleontological potential for a geologic unit to contain fossil remains, traces, and fossil collecting localities. The following sensitivity ratings indicate the potential for containing significant paleontological resources.

- High paleontological sensitivity indicates that geologic units have a history of or are considered to have a high potential for paleontological resources (i.e., fossil remains).
- Moderate paleontological sensitivity indicates that fossil remains or traces have been found but are in poor condition, are a common paleontological resource, or do not have scientific significance.
- Low paleontological sensitivity indicates a low potential for containing fossil paleontological resources.
- No paleontological sensitivity indicates areas that are not conducive to significant paleontological resources due to environmental conditions.

For Alternative 5, it is difficult to quantify the number of sensitive formations and their sensitivity level with precision due to a blanket of soil that covers the entire RSA underground and current construction in the area. Appendix A to this technical report, the stand-alone Paleontological Technical Memorandum, contains a detailed analysis of paleontological resources.

9.5 Impacts Evaluation

9.5.1 Impact GEO-1: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map, issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.

9.5.1.1 Operational Impacts

As listed in Table 9-7 and shown on Figure 9-10, Alternative 5 crosses the Santa Monica Fault, designated as an Alquist-Priolo Earthquake Fault Zone, in an underground alignment. The Santa Monica Fault Zone is located approximately 1,000 feet north of the proposed Santa Monica Boulevard Station. The next nearest Alquist-Priolo Earthquake Fault Zones to Alternative 5 are the Hollywood Fault, located approximately 1.7 miles east from its mid-section, and the Newport-Inglewood-Rose Canyon Fault, located approximately 1.8 miles east of the southern portion of Alternative 5.

The Alquist-Priolo Earthquake Fault Zoning Act prohibits the construction of structures for human occupancy (i.e., houses, apartments, offices, stations, etc.) on the surface trace of active faults. However, the Alquist-Priolo Earthquake Fault Zoning Act does not prohibit the construction of non-habitable structures (i.e., not suitable to be lived in such as carport, roads, train tracks, bridges, etc.). Alternative 5 consists of a heavy rail transit (HRT) system with a primarily underground guideway track configuration, including seven underground stations and one aerial station, and TPSS sites. Alternative 5's alignment would include a fixed guideway within the Alquist-Priolo Earthquake Fault Zone.

Alternative 5 is an HRT system with a hybrid underground and aerial guideway track configuration. Aerial operations of Alternative 5 would not directly or indirectly cause the rupture of a fault because HRT trains would travel along an aerial guideway at least 15 feet above ground level. Moreover, underground operations of Alternative 5 involve traveling along a guideway ranging between 40 to 470 feet below surface level which would not cause fault rupture. Both the aerial and subterranean components would be constructed in compliance with applicable seismic and geotechnical regulatory requirements, as described and Section 2 Regulatory and Policy Framework, and using established engineering practices to minimize ground disturbance and ensure structural stability in areas near active faults. Therefore, operational impacts associated with substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault would be less than significant.

9.5.1.2 Construction Impacts

Construction of Alternative 5 would occur within the Santa Monica Fault zone, north of Santa Monica Boulevard and along I-405. Aerial guideway and station construction would involve installing CIDH piles (shafts with both precast and CIP structural elements), simple spans, and longer balanced cantilever spans within the I-405 ROW, arterials, and street crossings. A TBM would be used to construct the underground segment of the guideway. Tunneling depth would range between 40 feet to 470 feet. Underground stations would use a “cut-and-cover” construction method whereby the station structure would be constructed within a trench excavated from the surface that is covered by a temporary deck and backfilled during the later stages of station construction. These components would be constructed in compliance with applicable seismic and geotechnical regulatory requirements, as described and Section 2 Regulatory and Policy Framework, and using established engineering practices to minimize ground disturbance and ensure structural stability in areas near active faults. Alternative 5 construction would not directly or indirectly exacerbate rupture of a known earthquake fault causing substantial adverse effects, including the risk of loss, injury, or death because these elements, including the CIDH piles, TBM-excavated tunnels, and cut-and-cover stations, do not reach a depth or be of an intensity that would affect geological processes such as faults. Therefore, construction impacts related to the rupture of a fault are less than significant.

9.5.1.3 Maintenance and Storage Facility

The proposed MSF would be located west of Woodman Avenue and south of the LOSSAN rail corridor ROW. The proposed MSF would not be within an Alquist-Priolo Earthquake Fault Zone. The closest Alquist-Priolo Earthquake Fault Zone is the Hollywood fault located approximately 8.3 miles southeast from the proposed MSF. Therefore, there are no impacts related to loss, injury, or death involving the rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map, during operations or construction.

9.5.2 Impact GEO-2: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking and/or seismic-related ground failure, including liquefaction?

9.5.2.1 Operational Impacts

Seismic-related ground failures include liquefaction, post-liquefaction settlements, and landslides. Hazards related to landslides is discussed in Section 9.5.3. Alternative 5, during operation activities, would experience earthquake-induced ground shaking activity because of its proximity to known active faults, as listed in Table 9-7. Alternative 5 would be located in a seismically active region and would be subject to seismic ground shaking that could result in damage to structures or human injury or death.

For Alternative 5, this could include damage to underground tunnels, stations, and TPSS sites. Seismic ground shaking could also injure humans using or working on the system from falls or being trapped within the underground tunnel alignment. Therefore, Alternative 5 would experience moderate to high ground shaking from these fault zones, as well as some background shaking from other seismically active areas of the Southern California region.

Earthquakes are prevalent within Southern California, and the potential to experience substantial seismic ground shaking is a common hazard for every project within the region. Alternative 5 would be designed and constructed in conformance with the equivalent design criteria such as the MRDC. Additionally, measures to minimize the risk of loss, injury, and death from the effects of earthquakes and seismic ground shaking for project elements would be designed and constructed in conformance with applicable portions of building and seismic code requirements, including the most recent edition of the CBC, with specific provisions for seismic design.

Consistent with equivalent design criteria such as the MRDC requirements, project structures and tunnels would be designed to perform in accordance with the two-level seismic evaluation approach based on the maximum design earthquake (MDE) and operating design earthquake (ODE). Underground tunnels would be designed and constructed in accordance with federal, state, and local thresholds for seismicity. Additionally, compliance would be required with equivalent design criteria such as MRDC Section 5, Structural, which dictates that during final design, a geotechnical investigation must be conducted, including a detailed and site-specific evaluation of geotechnical hazards. The resulting final geotechnical engineering recommendations and any additional recommendations that come out of the review process would be incorporated into the final design plans, consistent with equivalent design criteria such as the MRDC requirements and standard practice to address any unstable geologic and related conditions present along the alignment. Therefore, compliance with the latest earthquake-resistant building design standards and other seismic safety parameters would substantially reduce potential structural damage and the risk to public safety from seismic events by ensuring that strong seismic ground shaking would not cause potential substantial effects, including the risk of loss, injury, or death.

As mentioned in Section 9.2.7, liquefaction is considered most likely to occur within the first 50 feet below ground surface. The underground portions of the alignment would be significantly deeper than 50 feet below ground surface; therefore, the potential liquefaction impacts on the tunnel are low. As shown on Figure 9-12, Alternative 5 would have surface stations within a Liquefaction Zone at the Santa Monica Boulevard, Wilshire/Metro D Line, Ventura Boulevard and the Metro G Line stations, and there is a high potential for liquefaction in these areas. During severe ground shaking, loose granular soils below the groundwater table may liquefy. Seismic-related ground failure and liquefaction could result in damage to structures and human injuries where the soil undergoes a temporary loss of strength. Ground instability could affect structural stability, which in turn could damage structures or injure humans occupying structures on unstable ground. The proposed alignment and stations would be predominately in the younger alluvium where the potential for adverse impact due to liquefaction is considered moderate to high. However, the proposed alignment and stations would be supported on a deep foundation system to minimize risk of liquefaction (Metro, 2025).

Alternative 5 would be designed in accordance with design standards specific to ground stability. A geotechnical investigation would be performed during final design in consistent with the equivalent design criteria such as the MRDC; the required design-level geotechnical investigation would provide information pertaining to the depths and areal extents of potential liquefaction and seismically induced settlement. During the design process, if it is determined that these hazards could result in an unacceptable soil or structural response, ground improvements such as dynamic compaction, stone columns, jet grouting, and cement deep soil mixing and compaction grouting or deep foundation support to account for liquefaction or seismically induced settlement potential would be implemented and would be consistent with the recommendations contained in the geotechnical investigation and design standards. Therefore, adherence to the provisions listed in the CBC and equivalent design criteria such as the MRDC would substantially reduce potential structural damage and the risk to public safety from seismic events by ensuring that seismic-related ground failure and liquefaction would not cause potential substantial effects, including the risk of loss, injury, or death. As such, the potential impacts related to seismic-related ground failure liquefaction would be less than significant during operations.

9.5.2.2 Construction Impacts

Alternative 5 would be located in a seismically active area. Active and potentially active faults in Southern California are capable of producing seismic ground shaking, and the Alternative 5 RSA would be anticipated to experience ground acceleration caused by these earthquakes. As stated previously, Alternative 5 would be surrounded by faults capable of generating a characteristic earthquake between M_W 6.0 and M_W 8.0. To reduce the risks associated with seismically induced ground shaking, which could include the risk of loss, injury, or death, the design of foundations and structures must consider the location and type of subsurface materials underlying Alternative 5. Because Alternative 5 would be located within CBC, structures would be required to be designed in accordance with applicable parameters of the current CBC. According to the final geotechnical engineering recommendations, fault crossing may require a flexible tunnel lining (or perhaps a Sequential Excavation Method cavern, whereby the tunnel is dug out in small sections or bites using an excavator and cutting equipment) to accommodate future fault movement.

As shown on Figure 9-12, Alternative 5 traverses several Liquefaction Zones both within the San Fernando Valley and the Los Angeles Basin. Construction of Alternative 5 would occur within liquefaction zones, both within the San Fernando Valley and the Los Angeles Basin. Aerial guideway and station construction would involve installing CIDH piles (shafts with both precast and CIP structural elements), simple spans, and longer balanced cantilever spans within the I-405 ROW, arterials, and street crossings. A TBM would be used to construct the underground segment of the guideway. Tunneling depth would range between 40 feet to 470 feet. Underground stations would use a “cut-and-cover” construction method whereby the station structure would be constructed within a trench excavated from the surface that is covered by a temporary deck and backfilled during the later stages of station construction.

While construction activities for the underground alignment would involve subsurface work at depths where liquefaction could potentially occur, these activities would not directly or indirectly cause seismic ground shaking or induce liquefaction because the construction processes would not be of sufficient intensity to cause geological processes such as faults or liquefaction. Moreover, as described in Section 2 Regulatory and Policy Framework, the construction of Alternative 5 would adhere to seismic and geotechnical regulations, which would require appropriate engineering measures to ensure that liquefaction risks do not exceed unacceptable levels. Adherence to existing applicable regulations (i.e., the CBC, equivalent design criteria such as the MRDC, County of Los Angeles Building Code, and City of Los Angeles Building Code) would ensure that Alternative 5 remains with a less than significant impact associated with exposing people or structures to seismic ground shaking, including effects related to seismic-related ground failure and liquefaction during construction activities.

9.5.2.3 Maintenance and Storage Facility

The proposed MSF would be located east of the Van Nuys Metrolink Station and would encompass approximately 46 acres. The HRT MSF would be designed to accommodate 184 rail cars and would be bounded by single-family residences to the south, the LOSSAN rail corridor to the north, Woodman Avenue on the east, and Hazeltine Avenue and industrial manufacturing enterprises to the west. Trains would access the site from the fixed guideway's tail tracks at the northwest corner of the site. Trains would then travel southeast to maintenance facilities and storage tracks. The site would include the following facilities:

- Two entrance gates with guard shacks
- Main shop building
- MOW building
- Storage tracks
- Carwash building
- Cleaning and inspections platforms
- Material storage building
- Hazmat storage locker
- TPSS located on the west end of the MSF to serve the mainline
- TPSS located on the east end of the MSF to serve the yard and shops
- Parking area for employees
- Grade-separated access roadway (over the HRT tracks at the east end of the facility, and necessary drainage)

Operation and construction of the proposed HRT MSF do not involve extensive excavation and do not reach a depth or be of an intensity that would affect geological processes such as faults. As such, impacts related to seismic ground shaking including liquefaction would be less than significant during operations and construction.

9.5.3 Impact GEO-3: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides?

9.5.3.1 Operational Impacts

As shown on Figure 9-13, the underground segment of Alternative 5 would traverse the Santa Monica Mountains, which are within a designated LHZ and contain surface areas prone to landslides. Alternative 5 would operate a public transportation line with a fixed guideway.

According to the Caltrans Geotechnical Manual, the most adverse slope behavior is greatly influenced by water (Caltrans, 2020). Concentrated storm runoff can result in severe slope erosion leading to a loss of structural support and catastrophic failure. Perched groundwater and infiltration from irrigation, rainfall, or snowmelt frequently cause landslides. However, impacts related to topsoil erosion and water infiltration are managed separately and would not directly influence the operational impacts related to landslides.

Earthquake-induced landslides are slope failures/movements that occur from shaking during an earthquake event. Operational activities of Alternative 5 involve operating a public transportation line with a fixed guideway. Operational activities associated with Alternative 5 would not directly or indirectly cause strong seismic ground shaking including landslides as these activities would not involve interaction with geological processes such as faults or the alteration of natural slopes.

According to the USGS, certain human activities can cause landslides. They are commonly a result of building roads and structures without adequate grading of slopes, poorly planned alteration of drainage patterns, and disturbing old landslides (USGS, 2024). However, operational activities for Alternative 4, would not involve grading of slopes, modification of drainage systems, or disturbance of existing landslides. Additionally, the design of Alternative 4 would minimize interaction with natural slopes by employing an elevated guideway positioned above steep terrain and avoiding direct contact with unstable areas. The design would also incorporate drainage and erosion control measures to prevent water-related slope instability and comply with applicable geotechnical and engineering standards described in Section 2. Therefore, Alternative 4 would have a less than significant impact related to landslides during operations.

9.5.3.2 Construction Impacts

As shown on Figure 9-13, Alternative 5 traverses underground through the Santa Monica Mountains, a designated LHZ. This makes the landslide-related hazards during construction of the tunnel and surrounding infrastructure vulnerable and thus potentially significant.

However, Alternative 5 would be situated deep underground in this location and the risk of landslides would be low. Additionally, the portions of Alternative 5 that cross the LHZ would be situated deep underground in this location and the risk of landslides would be low. According to the *Sepulveda Transit Corridor Project, Final Draft Geotechnical Design Memorandum* (Metro, 2023b), the north tunnel portal in Sherman Oaks would be the most impacted section of the Alternative 5 alignment in terms of landslide risk. The Modelo Formation, which consists of diatomaceous shale, is exposed in a slope in this area. The layers of this shale are angled toward the north, which is not ideal for the proposed portal excavation. To improve long-term slope stability this area, Alternative 5 may install an anchored retaining wall or use ground anchors (Metro, 2023b).

Consistent with local requirements, further investigations into the slope along I-405 would be conducted during the design phase when site-specific data and final geometry of improvements are available. The foundation types would be determined as part of the required site-specific geotechnical investigation conducted during the final design phase and would ensure that the potential for landslides would not cause potential for substantial adverse effects, including the risk of loss, injury, or death.

Construction activities for Alternative 5 would include the installation of the portal in the Sherman Oaks community. Temporary engineering would be erected to support the retaining wall during cut-and-cover excavation. These activities would be located within a designated LHZ, and potential landslides during construction could cause injury or death to construction workers.

Construction of Alternative 5 would adhere to existing regulations and the provisions listed in the CBC and equivalent design criteria as the MRDC that require site-specific geotechnical evaluation during the final design phase that would include specific structural engineering recommendations. Grading and construction activities would be carried out in compliance with the regulatory requirements defined in Section 2 Regulatory and Policy Framework, including state regulations and the equivalent design criteria such as the MRDC, to account for the portion of Alternative 5 that would be within an LHZ.

The final design of the tunnel portal's retaining walls, and its temporary engineering would abide with structural engineering standards set forth in the provisions listed in the CBC. The CBC provisions that relate to the construction and design of the retaining walls include the requirements for foundation and soil investigations, excavation, grading, and fill-allowable, load-bearing values of soils. The CBC provision also relates to design of footings, foundations, and slope clearances, retaining walls, and pier, pile, driven, and CIP foundation support systems (Section 1810). Chapter 33 includes requirements for safeguards at work sites to ensure stable excavations and cut or fill slopes). Appendix J includes grading requirements for the design of excavations and fills (Sections J106 and J107) and for erosion control (Section J110). Construction activities are subject to occupational safety standards for excavation, shoring, and trenching as specified in Cal/OSHA regulations (CCR Title 8).

Alternative 5 would require a site-specific slope-stability design to ensure adherence to the standards contained in the CBC and County of Los Angeles and City of Los Angeles guidelines, as well as by Cal/OSHA requirements for stabilization. The proposed Alternative 5 would include manufactured slopes in the retention basins, which would mostly occur on the perimeter of the construction sites where they would also serve as a buffer to protect the tunnel and surrounding infrastructure from landslide-related hazards. Retention basins would be designed with due consideration for slope stability.

The combination of site-specific slope-stability design, compliance with applicable regulatory requirements, and the use of manufactured slopes and retention basins is anticipated to effectively manage constructed-slope instability such that impacts associated with constructed-slope instability, including landslides, are reduced, but may still be potentially significant.

This is particularly true for temporary slopes, as excavation activities for Alternative 5 within Landslide Zones could encounter unstable soils. Temporary slopes generally pose a higher risk of slope failure due to their steeper gradients compared to permanent, manufactured slopes. Similar to permanent slope construction, temporary slopes would be required to comply with Cal/OSHA requirements for shoring and stabilization.

To address these significant impacts MM GEO-2 would be implemented so that any excavations for the construction of the underground segment of Alternative 5 shall either shore excavation walls, as required by applicable local, state, or federal laws or regulations to ensure stability of temporary slopes. With the implementation of MM GEO-2, the impacts associated with landslides and/or slope instability during construction activities would be reduced to less than significant.

9.5.3.3 Maintenance and Storage Facilities

The proposed MSF would be located west of Woodman Avenue and south of the LOSSAN rail corridor ROW. The proposed MSF would not be located on land designated as an LHZ (Figure 9-13); the closest LHZ would be located approximately 4.10 miles south from the proposed MSF. Therefore, the proposed MSF would not directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides, and no impact would occur.

9.5.4 Impact GEO-4: Would the project result in substantial soil erosion or the loss of topsoil?

9.5.4.1 Operational Impacts

Implementation of Alternative 5 would not result in substantial soil erosion or the loss of topsoil during operations. Topsoil is the uppermost layer of soil — usually the top 6 to 8 inches —which has the highest concentration of organic matter and micro-organisms and is where most biological soil activity occurs. Plants generally concentrate their roots in, and obtain most of their nutrients from, this layer. Topsoil erosion is of concern when the topsoil layer is blown or washed away, which makes plant life or agricultural production impossible. In addition, significant erosion typically occurs on steep slopes where stormwater and high winds can carry topsoil down hillsides.

Some areas of pervious surfaces are associated with the open space areas within the adjacent Santa Monica Mountain region and a minimal extent of setbacks and residential yards along the Alternative 5

RSA. Since Alternative 5 would be entirely underground traversing the Santa Monica Mountains and would travel below the Sepulveda Corridor, operation of Alternative 5 would not result in substantial ground disturbance or an increase in the amount of exposed soil as compared to existing conditions and would not change the amount of erosion and spreading grounds within the Santa Monica Mountains and residential yards along the Alternative 5 RSA 5 compared to existing conditions.

As described in the *Sepulveda Transit Corridor Project Water Resources Technical Report* (Metro, 2025), Alternative 5 would result in a net loss of impervious surface area. During operations, Alternative 5 would not result in a significant increase in impervious surfaces because most of Alternative 5 is underground, and land surfaces with the proposed stations and other ancillary facilities in the Project Study Area are developed and covered by existing impervious surfaces. Components that may increase (based on initial estimates) the existing impervious surface area include the UCLA Gateway Plaza Station and the Van Nuys Metrolink Station. Components that would decrease the existing impervious surface area include the Metro E Line Station, Santa Monica Boulevard Station, Wilshire Boulevard/Metro D Line Station, Ventura Boulevard Station, Metro G Line Station, Sherman Way Station, and proposed MSFs adjacent to the Van Nuys Metrolink/Amtrak Station at the northern end of Alternative 5. The actual footprint of the aerial stations at the ground level would be covered only by column footings and vertical circulation elements. The footprints of proposed project components are nominal when compared to the area of the watershed or groundwater basin. Total net impervious surface area created by Alternative 5 elements would total -22,548 square feet.

Further details on new impervious surfaces and their impact on erosion resulting from Alternative 5 can be found in the *Sepulveda Transit Corridor Project Water Resources Technical Report* (Metro, 2025).

Alternative 5 would be designed to incorporate several sustainability features, such as native landscaping, rainwater cisterns for capture and reuse, permeable surfaces, soil improvements, increased vegetation, and on-site retention, in compliance with the *Low Impact Development Standards Manual* (LACDPW, 2014), which would serve to reduce impervious area and limit runoff which may cause erosion.

Alternative 5 would comply with post-construction measures in applicable National Pollutant Discharge Elimination System (NPDES) permits and Low Impact Development (LID) standards required by Los Angeles County and other local jurisdictions, which aim to minimize erosion impacts from development projects. With adherence to existing regulations, Alternative 5 would result in less than significant impact related to substantial soil erosion or the loss of topsoil during operations.

9.5.4.2 Construction Impacts

Ground-disturbing activities occurring during construction would temporarily expose surficial soils to wind and water erosion and have the potential to temporarily increase erosion and loss of topsoil. Construction work that would involve ground-disturbing activities would include installation of TPSS sites, utility relocations, mass excavation of the underground stations, and grading relating to these activities. However, construction activities would be required to comply with existing regulatory requirements, including implementation of best management practices and other erosion and sedimentation control measures that would ensure that grading, excavation, and other earth-moving activities would avoid a significant impact.

The developers of Alternative 5 would be required to prepare a *Stormwater Pollution Prevention Plan*, and a site-specific *Standard Urban Storm Water Mitigation Plan* (SUSMP), which is part of the NPDES Municipal General Permit. Preparation of the site-specific SUSMP would describe the minimum required best management practices to be incorporated into the Alternative 5 design and on-going operation of the facilities. Prior to the initiation of grading activities associated with implementation of Alternative 5, a site-specific SUSMP would be submitted to reduce the discharge of pollutants to the maximum extent practical using best management practices, control techniques and systems, design and engineering methods, and other provisions that are appropriate during construction activities. All development activities associated with Alternative 5 would comply with the site-specific SUSMP.

Preparation of a site-specific SUSMP and adherence to existing regulations would ensure the maximum practicable protection available for soils excavated and disposed during the construction of buildings and associated infrastructure. Compliance with existing regulations would minimize effects from erosion through repair and rehabilitation of topsoil post-construction and ensure consistency with the *Regional Water Quality Control Board Water Quality Control Plan*. In view of these requirements, Alternative 5 would have a less than significant impact associated with soil erosion or loss of topsoil during construction activities.

9.5.4.3 Maintenance and Storage Facilities

Operation of the proposed MSF would include the maintenance, cleaning, and storage of HRT vehicles. The proposed MSF site would be located within an urbanized area that is primarily impervious with no exposed soil. Operation of the proposed MSF would not result in ground disturbance or a change in the amount of exposed soil as compared to existing conditions and would adhere to existing regulations. The proposed MSF would comply with post-construction measures in applicable NPDES permits and LID standards required by Los Angeles County and the City of Los Angeles that aim to minimize erosion impacts from development projects. Therefore, the proposed MSF would result in a less than significant impact related to substantial soil erosion or the loss of topsoil during operations and construction.

9.5.5 Impact GEO-5: Would the project be located on a geographic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?

9.5.5.1 Operational Impacts

Section 9.5.2 addresses impacts related to liquefaction, and Section 9.5.3 addresses impacts related to landslides. The analysis in this section addresses impacts related to unstable soils as a result of subsidence, differential settlement, lateral spreading, or collapse.

The underground segments of Alternative 5 would not be located on a geographic unit or soil that is unstable, or that would become unstable, potentially resulting in lateral spreading, subsidence, liquefaction, or collapse. Based on the flat topography at station/facility sites and limited locations having open free-face conditions (and given that a significant portion of the Alternative 5 alignment would be in a tunnel), the overall potential for earthquake-induced lateral spreading is considered low as identified in the *Final Draft Geotechnical Design Memorandum* (Metro, 2023b). Additionally, ground shaking leading to liquefaction of saturated soil could result in lateral spreading where the soil undergoes a temporary loss of strength, and if the liquefied soil is not contained laterally, it may result in deformation of the slope.

As mentioned in Section 9.2.7, liquefaction is considered most likely to occur within the first 50 feet below ground surface. The underground portions of the alignment would be significantly deeper than 50 feet below ground surface; therefore, the potential liquefaction impacts on the tunnel are low.

Using unsuitable materials for fill and/or foundation support would have the potential to create future heaving, subsidence, spreading, or collapse problems, which would lead to building settlement and/or utility line and pavement disruption. Structural engineering standards to address geological conditions are part of standard construction requirements and standard construction practices. Alternative 5 would be designed consistent with equivalent design criteria such as MRDC Section 5, Structural; Metro's Supplemental Seismic Design Criteria (2017); and the California Seismic Hazards Mapping Act. Furthermore, Alternative 5 would be designed in accordance with recommendations developed in a detailed geotechnical report prepared during final design, which would provide site-specific information pertaining to the depths and areal extents of lateral spreading, subsidence, or collapse.

During the design process, if it is determined that these conditions identified in the geotechnical report could result in an unacceptable soil or structural response (to be defined during final design and dependent on the type of structure), the resulting final geotechnical engineering would include recommendations that would be incorporated into the final design plans consistent with standard practice to address any unstable geologic and related conditions present along the alignment. Recommendations may include deep foundations and/or ground improvements such as dynamic compaction, stone columns, jet grouting, and cement deep soil mixing and compaction grouting.

Given compliance with these regulatory and design requirements, Alternative 5 would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils as a result of subsidence, differential settlement, lateral spreading, or collapse during operations.

9.5.5.2 Construction Impacts

Section 9.5.2 addresses impacts related to liquefaction, and Section 9.5.3 addresses impacts related to landslides. The analysis in this section addresses impacts related to unstable soils as a result of subsidence, differential settlement, lateral spreading, or collapse.

Excavation for construction of underground structures — such as station boxes, cut-and-cover tunnels, and tunnel portals — would be reinforced by shoring systems to protect abutting buildings, utilities and other infrastructure. Tunneling using a TBM would result in ground volume loss and potential ground movements. Dewatering, when performed to create a dry work condition for construction of the underground structures, if allowed to draw down the groundwater table beyond the limits of excavation, could result in compaction or consolidation of the subsurface soils and thus result in surface settlements. Additionally, the use of unsuitable materials for fill and/or foundation support would have the potential to create future heaving, subsidence, spreading, or collapse problems leading to foundation and pavement settlement. Using such materials exclusively for landscaping would not cause these problems. An acceptable degree of soil stability can be achieved for expansive or compressible material by the incorporation of soil treatment programs (replacement, grouting, compaction, drainage control, etc.) in the excavation and construction plans that will be prepared to address site-specific soil conditions. A site-specific evaluation of soil conditions is required and must contain recommendations for ground preparation and earthwork specific to the site.

However, Alternative 5 would be in compliance with the regulatory requirements as defined in PM GEO-2 as defined in Section 9.6.2. Under PM GEO-2, a site-specific evaluation of soil conditions that shall contain recommendations for ground preparation, earthwork, and compaction specification based on the geological conditions specific to the site. In addition, Alternative 5 would implement MM GEO-1 through MM GEO-5 as described in Section 9.6.2, MM GEO-3 ensures compliance with the recommendations of the final soils and geotechnical report. Additionally, prior to construction, MM

GEO-5 specifies that Alternative 5 shall prepare a *Construction Management Plan* (CMP) detailing how to address geologic constraints and minimize or avoid impacts to geologic hazards during construction.

Adherence to existing regulations and policies, and implementation MM GEO-1 through MM GEO-5 would ensure the maximum practicable protection available for users of buildings and infrastructure and associated trenches, slopes, and foundations. Therefore, Alternative 5 would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils.

9.5.5.3 Maintenance and Storage Facilities

As addressed in Section 9.5.2.2 and Section 9.5.5.2, the proposed MSF would be located on stable soils where no liquefaction or landslide zones are present. Construction and operations would not occur on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed MSF, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse. The proposed MSF would be designed in compliance with applicable local, state, or federal laws or regulations, including recommendations on engineering and design considerations, as described in Section 9.5.5.2 and identified in MM GEO-1 through MM GEO-5. Thus, operations and construction of the proposed MSF would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

9.5.6 Impact GEO-6: Would the project be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property?

9.5.6.1 Operational Impacts

The majority of fine-grained soil and rock encountered in the Project Study Area exhibited low plasticity, with very low to medium expansion potential (Metro, 2023a). However, expansive soils can be found almost anywhere, particularly in coastal plains and low-lying valleys such as the Los Angeles Basin and San Fernando Valley. Expansive clays can be found in weathered bedrock along the Santa Monica Mountains. Much of the northern section of the Santa Monica Mountains is in Modelo Formation. Clay-rich soils may exist locally within alluvial soils present along Alternative 5 that could swell and shrink with wetting and drying. The change in soil volume is capable of exerting enough force on structures to damage foundations, structures, and underground utilities. Damage can also occur as these soils dry out and contract. As part of PM GEO-2 during construction, a California-registered geologist and geotechnical engineer would submit to and conduct a site-specific evaluation of unstable soil conditions to confirm the existence of expansive soils.

While expansive soils could have an impact on project elements, operational activities of Alternative 5 do not directly or indirectly cause risks of life or property as operations would not involve wetting or drying of expansive soils. Therefore, impacts related to expansive soils are less than significant during operations.

9.5.6.2 Construction Impacts

Expansive soils can be found almost anywhere, including the Los Angeles Basin, Santa Monica Mountains, and San Fernando Valley. Expansive soils could have an impact on project elements, including the proposed stations, guideway, and TPSS sites. Construction of Alternative 5 includes excavation and surface ground disturbances, if expansive soils do exist, construction activities have the potential to create substantial direct or indirect risks to life or property. As such, impacts related to construction activities could be potentially significant.

To reduce these risks, Alternative 5 would be designed in accordance with the equivalent seismic design criteria such as the MRDC, Los Angeles County and other applicable local building codes, and the CBC. This includes compliance with equivalent MRDC Section 5 (or equivalent seismic design criteria), which requires preparation of a geotechnical investigation during final design (refer to Section 2 Regulatory and Policy Framework for additional information). This design-level geotechnical investigation must include a detailed evaluation of geologic hazards, including the depths and areal extents of liquefaction, soil expansiveness, lateral spread, and seismically induced settlement. This investigation would include collecting soil samples and performing tests to assess the potential for corrosion, consolidation, expansion, and collapse. Based on the investigation and test results, specific design recommendations, including potential remediation of expansive soils, would be developed to address any identified issues. Expansive soil remediation could include soil removal and replacement, chemical treatment, or structural enhancements.

Alternative 5 would be in compliance with the regulatory requirements as defined in PM GEO-2 which calls for a California-registered geologist and geotechnical engineer to submit to and conduct a site-specific evaluation of unstable soil conditions to confirm the existence of expansive soils. The evaluation would also provide recommendations for ground preparation and earthwork activities specific to the site and take into consideration both aerial and underground construction.

Moreover, Alternative 5 would be required to comply with applicable provisions of the CBC and MRDC regarding to soil hazard-related design, as described by PM GEO-3. The MRDC equivalent and the County of Los Angeles and City of Los Angeles building codes require site-specific investigations and reports for each construction site. The reports must identify any unsuitable soil conditions and provide recommendations for foundation type and design criteria, consistent with the analysis and building code standards. Regulations exist to address weak soil issues, including expansion. PM GEO-3, as described in Section 9.6.2, would be implemented and as such, Alternative 5 would comply with applicable local, state, or federal laws or regulations to address any potential weak soil issues during construction.

Finally, prior to construction, the Project shall implement MM GEO-5, which requires preparation of a CMP which addresses geologic hazards such as soils with shrink-swell potential (expansive soils) and outlines strategies to minimize or avoid impacts.

With compliance with the regulatory requirements as defined in PM GEO 2, PM GEO-3, and implementation of MM GEO-5, Alternative 5 would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils during construction.

9.5.6.3 Maintenance and Storage Facilities

Operations related to the proposed MSF do not involve grading, excavation, or other ground disturbances. Therefore, impacts related to operational activities are less than significant.

Construction of the proposed MSF may involve grading, excavation, or other ground disturbances. If expansive soils exist at these sites, construction activities have the potential to create substantial direct or indirect risks to life or property. As such, impacts related to construction activities could be potentially significant.

The proposed MSF would be in compliance with the regulatory requirements as defined in PM GEO-2 which calls for a California-registered geologist and geotechnical engineer to submit to and conduct a site-specific evaluation of unstable soil conditions to confirm the existence of expansive soils. The evaluation would also provide recommendations for ground preparation and earthwork activities specific to the site. Moreover, the proposed MSF would be required to comply with applicable provisions of the CBC and an MRDC equivalent with regard to soil hazard-related design, as described by PM GEO-3. Finally, prior to construction, the proposed MSF shall implement MM GEO-5, which requires the preparation of a CMP which addresses geologic hazards such as soils with shrink-swell potential (expansive soils) and outlines strategies to minimize or avoid impacts.

With compliance with the regulatory requirements as defined in PM GEO-2, PM GEO-3, and implementation of MM GEO-5, the proposed MSF would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils during construction.

9.5.7 Impact GEO-7: Would the project have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?

9.5.7.1 Operational Impacts

No septic systems or alternative wastewater disposal systems are proposed for Alternative 5. Alternative 5 would have no impacts associated with soils incapable of adequately supporting such systems during operations.

9.5.7.2 Construction Impacts

No septic systems or alternative wastewater disposal systems are proposed for Alternative 5. Alternative 5 would have no impacts associated with soils incapable of adequately supporting such systems during construction activities.

9.5.7.3 Maintenance and Storage Facilities

No septic systems or alternative wastewater disposal systems are proposed for the proposed MSF. Therefore, the proposed MSF would have no impacts associated with soils incapable of adequately supporting such systems during operations.

9.5.8 Impact GEO-8: Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

9.5.8.1 Operational Impacts

Operations of Alternative 5 would not include activities that involve ground disturbance. Therefore, there would be no operational impacts related to paleontological resources.

9.5.8.2 Construction Impacts

Alternative 5 would involve a heavy rail system with majority of the proposed rail to be located under the ground surface. The proposed tunnel would extend the existing tunnel system from the Metro D Line north along Sepulveda Boulevard. Alternative 5 would have seven underground stations (Sherman Way, Metro G Line, Ventura Boulevard, UCLA Gateway Plaza, Wilshire/Metro D Line, Santa Monica Boulevard, Metro E Line) and one aerial station (Van Nuys Metrolink). Alternative 5 would mostly affect sediments that are located below the ground surface. As stated before, knowing for certain what geologic units will be affected at depth is difficult to say for certain without someone monitoring the sediments in any given working area. However, the sediments mapped at the surface of where the tunnel system would be emplaced for Alternative 5 are mapped as young alluvium, unit 2 (Qya2), young alluvium fan deposits, unit 1 (Qyf1), young alluvium fan deposits, unit 2 (Qyf2), Modelo Formation undivided I, Modelo Formation sandstone (Tms), Modelo Formation diatomaceous shale (Tmd), Santa Monica Slate spotted slate (Jsms), Santa Monica Slate undivided (Jsm), and Santa Monica Slate phyllite (Jsmp).

Generally, geologic units such as the Santa Monica Slate (Jsms, Jsmp) do not have any paleontological sensitivity to preserve fossil material. The Santa Monica Slate is a geologic unit that comprises metamorphic rock, which undergoes intense pressure and temperature. This metamorphic process usually destroys and deforms any fossil material that could have been located within the rock; however, because of the relatively low grade of metamorphism, enough relevant features of the fossils were preserved in portions of the Santa Monica Slate. When the Santa Monica Slate (Jsms, Jsmp) is encountered, the project paleontologist would determine whether low-grade metamorphic conditions are present. If that is the case, that portion of the unit (Jsms) may be considered “Low” paleontological sensitivity and monitored accordingly (Imlay, 1963). Additionally, the Qyf1, Qyf2, and Qya2 units have a “Low” sensitivity for preserving fossil material, because these units are too young to have preserved any significant fossil material. The geologic map unit labelled as Tm, Tms, and Tmd all have a high sensitivity for preserving fossil material due to their age, as well as the fossil localities found within the same map units nearby (SVP, 1995; Bell, 2023).

Possible construction impacts involved with Alternative 5 would all be a result of access, staging, and lay down areas that would be required for placing the heavy rail track and excavating the tunnel. Additionally, there would also be potentially significant impacts to surrounding sediments for staging areas and access pathways for all seven of the underground stations that are planned for Alternative 5 (Sherman Way, Metro G Line, Ventura Boulevard, UCLA Gateway Plaza, Wilshire/Metro D Line, Santa Monica Boulevard, Metro E Line).

An automated TBM would be excavating the tunnels for the underground portion of Alternative 5. The TBM would excavate sediments to the dimensions of the finished tunnel, remove the sediments from the forward portion of the TBM via an internal conveyer belt, and erect the segmental, precast concrete tunnel liner. The operation of the TBM does not allow the monitor to view the sediments as they are being excavated, or the walls of the tunnel following removal of excess sediments and prior to the installation of the tunnel’s concrete liner. For these reasons, monitoring paleontological resources adjacent to the TBM is not possible. Thus, in consideration of the California Environmental Quality Act (CEQA), excavations for tunnel construction would result in significant and unavoidable impacts to paleontological resources in paleontologically sensitive geologic units (*Paleontological Technical Memorandum*, Attachment 1, Figure 5 of this report) (SVP, 2010; Scott and Springer, 2003).

When considering Quaternary aged deposits, deeper (i.e., older) portions of paleontologically sensitive geologic units are generally more sensitive from a scientific point of view. Thus, a mapped geologic unit considered to have low paleontological sensitivity at the surface has the potential to become more sensitive paleontologically at depth. Excavations for launching or extracting the TBM would be made at points along the ROW. Therefore, the impact to paleontological resources at TBM launching and extracting sites would be significant (*Paleontological Technical Memorandum*, Attachment 1, Figure 5 of this report). However, when excavations take place to launch and extract the TBM in paleontologically sensitive units, MM GEO-6 through MM GEO-9 shall be implemented to reduce the impact to paleontological resources to less than significant (SVP, 2010; Scott and Springer, 2003).

9.5.8.3 Maintenance and Storage Facilities

The impacts involved with the MSF would include all administrative buildings, maintenance buildings, wash facilities, drive aisles, and storage tracks. The surface sediments in the underground portions of the proposed MSF are mapped as Qya2 but may be more paleontologically sensitive (older) than indicated at depth. There should be a qualified paleontologist to monitor ground disturbance when this unit is encountered (SVP, 1995; Bell, 2023). With implementation of MM GEO-6 through MM GEO-9, impacts associated with the MSF would be less than significant.

9.5.9 Impact GEO-9: Would the project result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state or result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?

9.5.9.1 Operational Impacts

Operation of Alternative 5 would not require excavation that may affect mineral resources. No mining operations are present within the Alternative 5 RSA, so operation of Alternative 5 would not disrupt mining operations. Therefore, Alternative 5 would have no impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

9.5.9.2 Construction Impacts

Construction of Alternative 5 would require excavation (cut and cover) for underground stations and column foundations and would use a TBM for tunnel construction. However, Alternative 5 would not be located in an area with known mineral deposits. As mentioned in Section 9.3, Alternative 5 is located in areas designated as MRZ-1 and MRZ-3. The California Department of Conservation, Division of Mines and Geology has classified areas of regional significance as MRZ-2 (CGS, 2021). Alternative 5 would not be located within an area designated as MRZ-2. Alternative 5 would be located within areas designated as MRZ-1 in the northern portion of Alternative 5 in the San Fernando Valley as well as the southern portion of Alternative 5 near West Los Angeles. MRZ-1-designated areas indicate that no significant mineral deposits are present or little likelihood exists for their presence. No mining operations are present within the Alternative 5 RSA, so construction of Alternative 5 would not disrupt mining operations. Therefore, Alternative 5 would have no construction impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

9.5.9.3 Maintenance and Storage Facilities

Operation and construction of the MSF would not require excavation that may affect mineral resources. No mining operations are present within or in the vicinity of the MSF. Therefore, the MSF would have no operational or construction impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

9.6 Project and Mitigation Measures

9.6.1 Operational Impacts

No mitigation measures are required.

9.6.2 Construction Impacts

Alternative 5 would implement the following project and mitigation measures to ensure that impacts to the geology, soils, and seismicity remain less than significant during construction activities.

PM GEO-1: *The Project shall demonstrate to the County of Los Angeles and the City of Los Angeles that the design of the Project complies with all applicable provisions of the California Building Code with respect to seismic design. Compliance shall include the following:*

- *California Building Code Seismic Zone 4 Standards as the minimum seismic-resistant design for all proposed facilities*
- *Seismic-resistant earthwork and construction design criteria (i.e., for the construction of the tunnel below ground surface, liquefaction, landslide, etc.), based on the site-specific recommendations of a California Registered Geologist in cooperation with the Project Engineers.*
- *An engineering analysis to characterize site specific performance of alluvium or fill where either forms part or all of the support.*

PM GEO-2: *A California-registered geologist and geotechnical engineer shall submit to and have approval by the Project a site specific evaluation of unstable soil conditions, including recommendations for ground preparation and earthwork activities specific to the site and in conformance with City of Los Angeles Building Code, County of Los Angeles Building Code, the California Building Code, Metro Rail Design Criteria (as applicable), and Caltrans Structure Seismic Design Criteria.*

PM GEO-3: *The Project shall demonstrate that the design of the Project complies with all applicable provisions of the County of Los Angeles Building Code and City of Los Angeles Building Code.*

MM GEO-1: *The Project's design shall include integration and installation of early warning system to detect and respond to strong ground motion associated with ground rupture. Known active fault(s) (i.e., Santa Monica Fault) shall be monitored. Linear monitoring systems such as time domain reflectometers or equivalent or more effective technology shall be installed along fixed guideway in the zone of potential ground rupture.*

MM GEO-2: *Where excavations are made for the construction of the below surface tunnel, the Project shall either shore excavation walls with shoring designed to withstand additional loads or reduce the slope of the excavation walls to a shallower gradient. Excavation spoils shall not be placed immediately adjacent to excavation walls unless the excavation wall is shored to support the added load. Spoils should be stored at a safe distance from the excavation site to prevent undue pressure on the walls.*

MM GEO-3: *The Project shall comply with the recommendations of the final soils and geotechnical report. These recommendations shall be implemented in the design of the Project, including but not limited to measures associated with site preparation, fill placement, temporary shoring and permanent dewatering, groundwater seismic design features, excavation stability, foundations, soil stabilization, establishment of deep foundations, concrete slabs and pavements, surface drainage, cement type and corrosion measures, erosion control, shoring and internal bracing, and plan review.*

MM GEO-4: *In locations where soils have a potential to be corrosive to steel and concrete, the soils shall be removed, and buried structures shall be designed for corrosive conditions, and corrosion-protected materials shall be used in infrastructure.*

MM GEO-5: *Prior to construction, the Project shall prepare a Construction Management Plan (CMP) that addresses geologic constraints and outlines strategies to minimize or avoid impacts to geologic hazards during construction. The plan shall address the following geological and geotechnical constraints/resources and incorporate standard mitigation measures (shown in parentheses):*

- *Groundwater withdrawal (using dewatering pumps and proper disposal of contaminated groundwater according to legal requirements)*
- *Risk of ground failure from unstable soils (retaining walls and inserting soil stabilizers)*
- *Subsidence (retaining walls and shoring)*
- *Erosion control methods (netting on slopes, bioswales, sediment basins, re-vegetation)*
- *Soils with shrink-swell potential (inserting soil stabilizers)*
- *Soils with corrosive potential (protective coatings and protection for metal, steel or concrete structures, soil treatment, removal of corrosive soils and proper disposal of any corrosive soils)*
- *Impact to topsoils (netting, and dust control)*
- *The recommendations of the CMP would be incorporated into the project plans and specifications.*

MM GEO-6: *The potential to avoid impacts to previously unrecorded paleontological resources shall be avoided by having a qualified Paleontologist or Archaeologist cross-trained in paleontology, meeting the Society of Vertebrate Paleontology Standards retained as the project paleontologist, with a minimum of a bachelor's degree (B.S./B.A.) in geology, or related discipline with an emphasis in paleontology and demonstrated experience and competence in paleontological research, fieldwork, reporting, and curation. A paleontological monitor, under the guidance of the project paleontologist, shall be present as required by the type of earth-moving activities in the Project, specifically in areas south of Ventura Boulevard that have been deemed areas of high sensitivity for paleontological resources. The monitor shall be a trained paleontological monitor with experience and knowledge of sediments, geologic formations, and the identification and treatment of fossil resources.*

MM GEO-7: *A Paleontological Resources Impact Mitigation Program (PRIMP) shall be prepared by a qualified paleontologist. The PRIMP shall include guidelines for developing and implementing mitigation efforts, including minimum requirements, general fieldwork, and laboratory methods, threshold for assessing paleontological resources, threshold for excavation and documentation of significant or unique paleontological resources, reporting requirements, considerations for the curation of recovered paleontological* *resources into a relevant institution, and process of documents to Metro and peer review entities.*

MM GEO-8: *The project paleontologist or paleontological monitor shall perform a Workers Environmental Awareness Program training session for each worker on the project site to familiarize the worker with the procedures in the event a paleontological resource is discovered. Workers hired after the initial Workers Environmental Awareness Program training conducted at the pre-grade meeting shall be required to take additional Workers Environmental Awareness Program training as part of their site orientation.*

MM GEO-9: *To prevent damage to unanticipated paleontological resources, a paleontological monitor shall observe ground-disturbing activities including but not limited to grading, trenching, drilling, etc. Paleontological monitoring shall start at full time for geological units deemed to have "High" paleontological sensitivity. Geological units deemed to have "Low" paleontological sensitivity shall be monitored by spot checks. No monitoring is required for geologic units identified as having "No" paleontological sensitivity. "Unknown" paleontological sensitivity is assigned to the less metamorphosed portions of the Santa Monica Slate, as detailed below.*

- *The monitor shall be empowered to temporarily halt or redirect construction efforts if paleontological resources are discovered. The paleontological monitor shall flag an area 50 feet around the discovery and notify the construction crew immediately. No further disturbance in the flagged area shall occur until the qualified paleontologist has cleared the area. In consultation with the qualified paleontologist, the monitor shall quickly assess the nature and significance of the find. If the specimen is not significant, it shall be quickly removed, and the area cleared. In the event paleontological resources are discovered and deemed by the project paleontologist to be scientifically important, the paleontological resources shall be recovered by excavation (i.e., salvage and bulk sediment sample) or immediate removal if the resource is small enough and can be removed safely in this fashion without damage to the paleontological resource. If the discovery is significant, the qualified paleontologist shall notify Metro immediately. In consultation with Metro, the qualified paleontologist shall develop a plan of mitigation, which will likely include salvage excavation and removal of the find, removal of sediment from around the specimen (in the laboratory), research to identify and categorize the find, curation of the find in a local qualified repository, and preparation of a report summarizing the find.*
- *Generally, geologic units that have endured metamorphic processes (i.e., extreme heat and pressure over long periods of time) do not contain paleontological resources. The Santa Monica Slate, originally a fossiliferous shale, has been subjected to various levels of metamorphism and thus, in areas of "low-grade metamorphism," paleontological resources may be discovered. Due to the rarity of paleontological resources dating to the Mesozoic (between approximately 65.5 to 252 million years ago) of Southern California, any such materials have high importance to the paleontology of the region. When encountered, the project paleontologist shall assess the levels of metamorphism that portion of the Santa Monica Slate has experienced. The Santa Monica Slate shall be monitored part*

time where the project paleontologist has determined lower levels of metamorphism have taken place and the preservation of paleontological resources is possible. If exposures of the Santa Monica Slate have been subjected to high levels of metamorphism (i.e., phyllite components of Jsmp), paleontological monitoring in that portion of the formation is not necessary.

- *Recovered paleontological resources shall be prepared, identified to the lowest taxonomic level possible, and curated into a recognized repository (i.e., Natural History Museum of Los Angeles County). Bulk sediment samples, if collected, shall be "screen-washed" to recover the contained paleontological resources, which will then be identified to the lowest taxonomic level possible, and curated (as above). The report and all relevant field notes shall be accessioned along with the paleontological resources.*

9.6.3 Impacts After Mitigation

Adherence to existing regulations and implementation of PM GEO-1 and MM GEO-1 would ensure that Alternative 5 remains with less than significant impacts associated with exposing people or structures to seismic ground shaking, including effects related to seismic-related ground failure during construction activities.

Adherence to existing regulations and implementation of PM GEO-1 would ensure that Alternative 5 remains with less than significant impact with the exposure of people or structures to liquefaction during construction activities.

With implementation of MM GEO-2 and adherence to existing regulations, Alternative 5 would have a less than significant impact associated with landslides and/or slope instability during construction activities.

Adherence to existing regulations and policies, and implementation of PM GEO-2 and MM GEO-3 through MM GEO-5, would ensure the maximum practicable protection available for users of buildings and infrastructure and associated trenches, slopes, and foundations. Therefore, Alternative 5 would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils.

With implementation of PM GEO-3 and adherence to existing regulations, Alternative 5 would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils.

Possible construction impacts involved with paleontological resources would all be a result of access, staging and lay down areas that would be required for placing the heavy rail track and excavating the tunnel. With implementation of MM GEO-6 through MM GEO-9, impacts to surrounding sediments for staging areas and access pathways for all seven of the underground stations that are planned for Alternative 5 (Metro E Line Expo/Sepulveda Station, Santa Monica Boulevard Station, Wilshire Boulevard/Metro D Line Station, UCLA Gateway Plaza Station, Ventura Boulevard/Sepulveda Boulevard Station, Metro G Line Sepulveda Station, and Sherman Way Station) would be reduced to less than significant.

10 ALTERNATIVE 6

10.1 Alternative Description

Alternative 6 is a heavy rail transit (HRT) system with an underground track configuration. This alternative would provide transfers to five high-frequency fixed guideway transit and commuter rail lines, including the Los Angeles County Metropolitan Transportation Authority's (Metro) E, Metro D, and Metro G Lines, East San Fernando Valley Light Rail Transit Line, and the Metrolink Ventura County Line. The length of the alignment between the terminus stations would be approximately 12.9 miles.

The seven underground HRT stations would be as follows:

1. Metro E Line Expo/Bundy Station (underground)
2. Santa Monica Boulevard Station (underground)
3. Wilshire Boulevard/Metro D Line Station (underground)
4. UCLA Gateway Plaza Station (underground)
5. Ventura Boulevard/Van Nuys Boulevard Station (underground)
6. Metro G Line Van Nuys Station (underground)
7. Van Nuys Metrolink Station (underground)

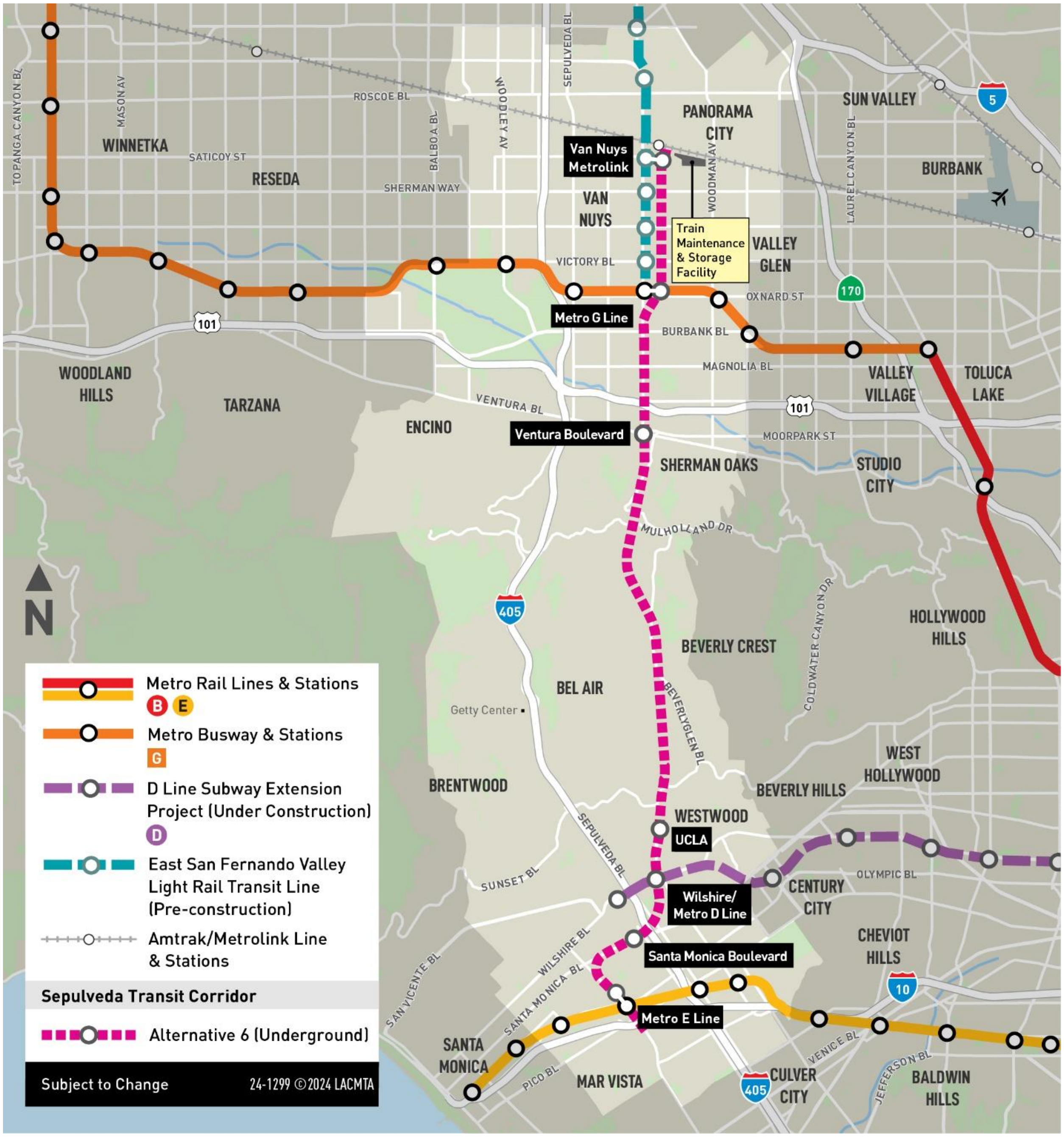
10.1.1 Operating Characteristics

10.1.1.1 Alignment

As shown on Figure 10-1, from its southern terminus station at the Metro E Line Expo/Bundy Station, the alignment of Alternative 6 would run underground through the Westside of Los Angeles (Westside), the Santa Monica Mountains, and the San Fernando Valley (Valley) to the alignment's northern terminus adjacent to the Van Nuys Metrolink/Amtrak Station.

The proposed southern terminus station would be located beneath the Bundy Drive and Olympic Boulevard intersection. Tail tracks for vehicle storage would extend underground south of the station along Bundy Drive for approximately 1,500 feet, terminating just north of Pearl Street. The alignment would continue north beneath Bundy Drive before turning to the east near Iowa Avenue to run beneath Santa Monica Boulevard. The Santa Monica Boulevard Station would be located between Barrington Avenue and Federal Avenue. After leaving the Santa Monica Boulevard Station, the alignment would turn to the northeast and pass under Interstate 405 (I-405) before reaching the Wilshire Boulevard/Metro D Line Station beneath the Metro D Line Westwood/UCLA Station, which is currently under construction as part of the Metro D Line Extension Project. From there, the underground alignment would curve slightly to the northeast and continue beneath Westwood Boulevard before reaching the UCLA Gateway Plaza Station.

Figure 10-1. Alternative 6: Alignment



Source: HTA, 2024

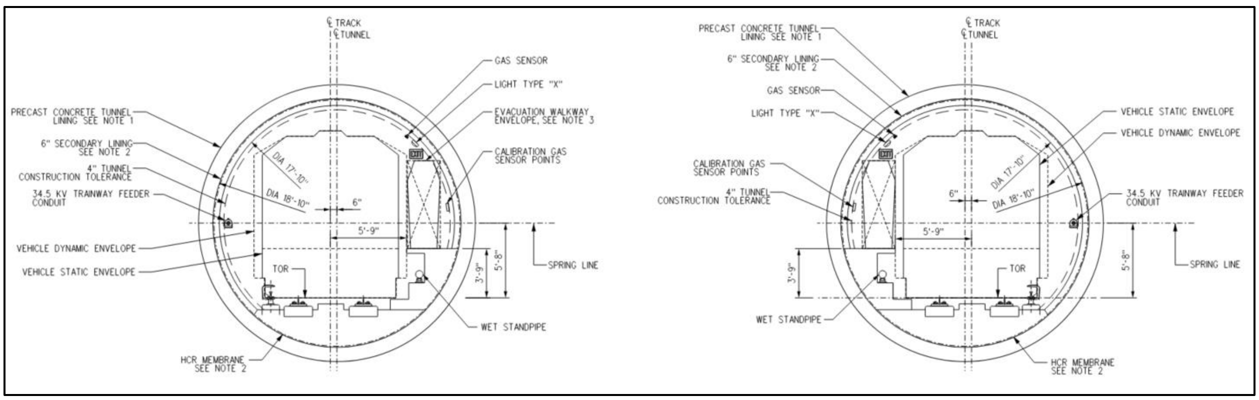
After leaving the UCLA Gateway Plaza Station, the alignment would continue to the north and travel under the Santa Monica Mountains. While still under the mountains, the alignment would shift slightly to the west to travel under the City of Los Angeles Department of Water and Power (LADWP) Stone Canyon Reservoir property to facilitate placement of a ventilation shaft on that property east of the reservoir. The alignment would then continue to the northeast to align with Van Nuys Boulevard at Ventura Boulevard as it enters the San Fernando Valley. The Ventura Boulevard Station would be beneath Van Nuys Boulevard at Moorpark Street. The alignment would then continue under Van Nuys

Boulevard before reaching the Metro G Line Van Nuys Station just south of Oxnard Street. North of the Metro G Line Van Nuys Station, the alignment would continue under Van Nuys Boulevard until reaching Sherman Way, where it would shift slightly to the east and run parallel to Van Nuys Boulevard before entering the Van Nuys Metrolink Station. The Van Nuys Metrolink Station would serve as the northern terminus station and would be located between Saticoy Street and Keswick Street. North of the station, a yard lead would turn sharply to the southeast and transition to an at-grade configuration and continue to the proposed maintenance and storage facility (MSF) east of the Van Nuys Metrolink Station.

10.1.1.2 Guideway Characteristics

The alignment of Alternative 6 would be underground using Metro's standard twin-bore tunnel design. Figure 10-2 shows a typical cross-section of the underground guideway. Cross-passages would be constructed at regular intervals in accordance with Metro Rail Design Criteria (MRDC). Each of the tunnels would have a diameter of 19 feet (not including the thickness of wall). Each tunnel would include an emergency walkway that measures a minimum of 2.5 feet wide for evacuation.

Figure 10-2. Typical Underground Guideway Cross-Section



Source: HTA, 2024

10.1.1.3 Vehicle Technology

Alternative 6 would utilize driver-operated steel-wheel HRT trains, as used on the Metro B and D Lines, with planned peak headways of 4 minutes and off-peak-period headways ranging from 8 to 20 minutes. Trains would consist of four or six cars and are expected to consist of six cars during the peak period. The HRT vehicle would have a maximum operating speed of 67 miles per hour; actual operating speeds would depend on the design of the guideway and distance between stations. Train cars would be 10.3 feet wide with three double doors on each side. Each car would be approximately 75 feet long with capacity for 133 passengers. Trains would be powered by a third rail.

10.1.1.4 Stations

Alternative 6 would include seven underground stations with station platforms measuring 450 feet long. The southern terminus underground station would be adjacent to the existing Metro E Line Expo/Bundy Station, and the northern terminus underground station would be located south of the existing Van Nuys Metrolink/Amtrak Station. Except for the Wilshire Boulevard/Metro D Line, UCLA Gateway Plaza, and Metro G Line Van Nuys Stations, all stations would have a 30-foot-wide center platform. The Wilshire/Metro D Line Station would have a 32-foot-wide platform to accommodate the anticipated passenger transfer volumes, and the UCLA Gateway Plaza Station would have a 28-foot-wide platform because of the width constraint between the existing buildings. At the Metro G Line Van Nuys Station, the track separation would increase significantly in order to straddle the future East San Fernando Valley Light Rail Transit Line Station piles. The platform width at this station would increase to 58 feet.

The following information describes each station, with relevant entrance, walkway, and transfer information. Bicycle parking would be provided at each station.

Metro E Line Expo/Bundy Station

- This underground station would be located under Bundy Drive at Olympic Boulevard.
- Station entrances would be located on either side of Bundy Drive, between the Metro E Line and Olympic Boulevard, as well as on the northeast corner of Bundy Drive and Mississippi Avenue.
- At the existing Metro E Line Expo/Bundy Station, escalators from the plaza to the platform level would be added to improve inter-station transfers.
- An 80-space parking lot would be constructed east of Bundy Drive and north of Mississippi Avenue. Passengers would also be able to park at the existing Metro E Line Expo/Bundy Station parking facility, which provides 217 parking spaces.

Santa Monica Boulevard Station

- This underground station would be located under Santa Monica Boulevard between Barrington Avenue and Federal Avenue.
- Station entrances would be located on the southwest corner of Santa Monica Boulevard and Barrington Avenue and on the southeast corner of Santa Monica Boulevard and Federal Avenue.
- No dedicated station parking would be provided at this station.

Wilshire Boulevard/Metro D Line Station

- This underground station would be located under Gayley Avenue, between Wilshire Boulevard and Lindbrook Drive.
- A station entrance would be provided on the northwest corner of Midvale Avenue and Ashton Avenue. Passengers would also be able to use the Metro D Line Westwood/UCLA Station entrances to access the station platform.
- Direct internal station transfers to the Metro D Line would be provided at the south end of the station.
- No dedicated station parking would be provided at this station.

UCLA Gateway Plaza Station

- This underground station would be located underneath Gateway Plaza on the University of California, Los Angeles (UCLA) campus.
- Station entrances would be provided on the north side of Gateway Plaza, north of the Luskin Conference Center, and on the east side of Westwood Boulevard across from Strathmore Place.
- No dedicated station parking would be provided at this station.

Ventura Boulevard/Van Nuys Boulevard Station

- This underground station would be located under Van Nuys Boulevard at Moorpark Street.
- The station entrance would be located on the northwest corner of Van Nuys Boulevard and Ventura Boulevard.
- Two parking lots with a total of 185 parking spaces would be provided on the west side of Van Nuys Boulevard, between Ventura Boulevard and Moorpark Street.

Metro G Line Van Nuys Station

- This underground station would be located under Van Nuys Boulevard south of Oxnard Street.
- The station entrance would be located on the southeast corner of Van Nuys Boulevard and Oxnard Street.
- Passengers would be able to park at the existing Metro G Line Van Nuys Station parking facility, which provides 307 parking spaces. No additional automobile parking would be provided at the proposed station.

Van Nuys Metrolink Station

- This underground station would be located immediately east of Van Nuys Boulevard, between Saticoy Street and Keswick Street.
- Station entrances would be located on the northeast corner of Van Nuys Boulevard and Saticoy Street and on the east side of Van Nuys Boulevard, just south of the Los Angeles-San Diego-San Luis Obispo (LOSSAN) rail corridor.
- Existing Metrolink Station parking would be reconfigured, maintaining approximately the same number of spaces. Metrolink parking would not be available to Metro transit riders.

10.1.1.5 Station-to-Station Travel Times

Table 10-1 presents the station-to-station distance and travel times for Alternative 6. The travel times include both run time and dwell time. Dwell time is 30 seconds for stations anticipated to have higher passenger volumes and 20 seconds for other stations. Northbound and southbound travel times vary slightly because of grade differentials and operational considerations at end-of-line stations.

Table 10-1. Alternative 6: Station-to-Station Travel Times and Station Dwell Times

From Station	To Station	Distance (miles)	Northbound Station-to-Station Travel Time (seconds)	Southbound Station-to-Station Travel Time (seconds)	Dwell Time (seconds)
Metro E Line Station					*20*
Metro E Line	Santa Monica Boulevard	1.1	111	121	—
Santa Monica Boulevard Station					*20*
Santa Monica Boulevard	Wilshire/Metro D Line	1.3	103	108	—
Wilshire/Metro D Line Station					*30*
Wilshire/Metro D Line	UCLA Gateway Plaza	0.7	69	71	—
UCLA Gateway Plaza Station					*30*
UCLA Gateway Plaza	Ventura Boulevard	5.9	358	358	—
Ventura Boulevard Station					*20*
Ventura Boulevard	Metro G Line	1.8	135	131	—
Metro G Line Station					*30*
Metro G Line	Van Nuys Metrolink	2.1	211	164	—
Van Nuys Metrolink Station					*30*

Source: HTA, 2024

— = no data

10.1.1.6 Special Trackwork

Alternative 6 would include seven double crossovers within the revenue service alignment, enabling trains to cross over to the parallel track with terminal stations having an additional double crossover beyond the end of the platform.

10.1.1.7 Maintenance and Storage Facility

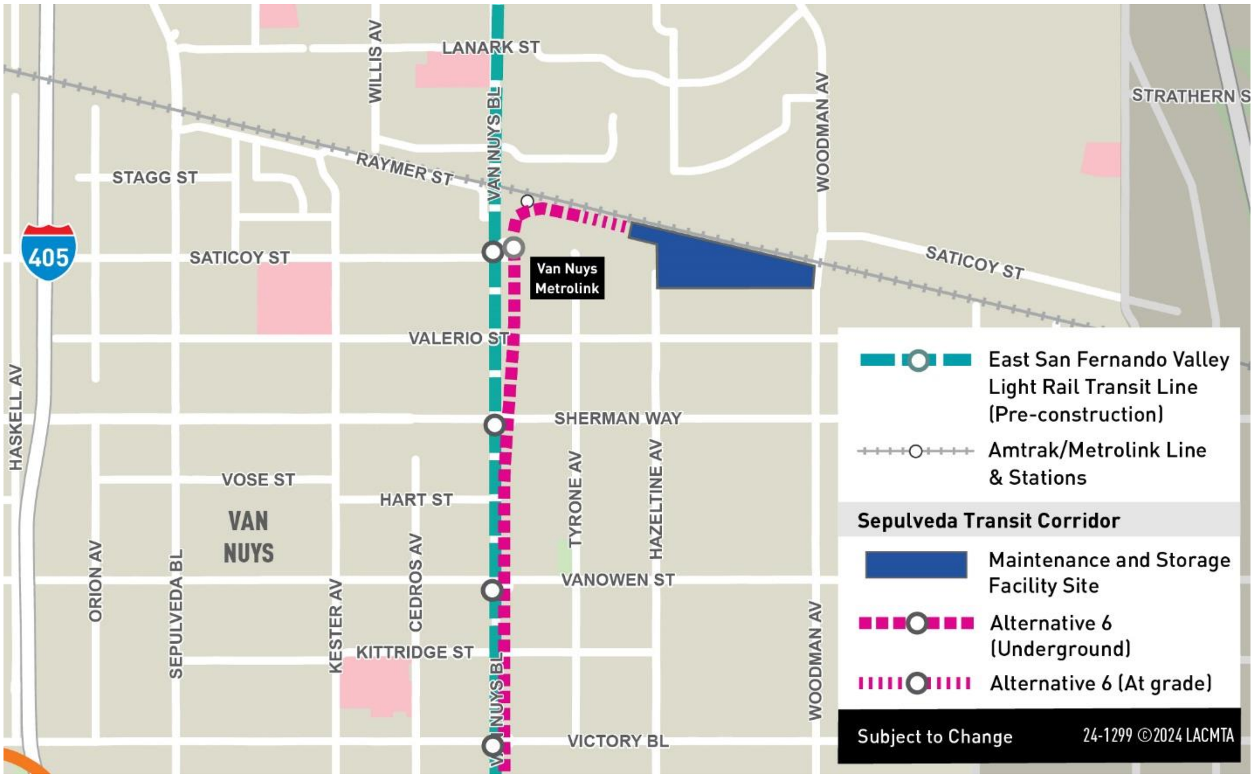
The MSF for Alternative 6 would be located east of the Van Nuys Metrolink Station and would encompass approximately 41 acres. The MSF would be designed to accommodate 94 vehicles and would be bounded by single-family residences to the south, the LOSSAN rail corridor to the north, Woodman Avenue to the east, and Hazeltine Avenue and industrial manufacturing enterprises to the west. Heavy rail trains would transition from underground to an at-grade configuration near the MSF, the northwest corner of the site. Trains would then travel southeast to maintenance facilities and storage tracks.

The site would include the following facilities:

- Two entrance gates with guard shacks
- Maintenance facility building
- Maintenance-of-way facility
- Storage tracks
- Carwash
- Cleaning platform
- Administrative offices
- Pedestrian bridge connecting the administrative offices to employee parking
- Two traction power substations (TPSS)

Figure 10-3 shows the location of the MSF for Alternative 6.

Figure 10-3. Alternative 6: Maintenance and Storage Facility Site



Source: HTA, 2024

10.1.1.8 Traction Power Substations

TPSSs transform and convert high voltage alternating current supplied from power utility feeders into direct current suitable for transit operation. Twenty-two TPSS facilities would be located along the alignment and would be spaced approximately 1 mile apart except within the Santa Monica Mountains. Each at-grade TPSS along the alignment would be approximately 5,000 square feet. Table 10-2 lists the TPSS locations for Alternative 6.

Figure 10-4 shows the TPSS locations along the Alternative 6 alignment.

Table 10-2. Alternative 6: Traction Power Substation Locations

TPSS No.	TPSS Location Description	Configuration
1 and 2	TPSSs 1 and 2 would be located immediately north of the Bundy Drive and Mississippi Avenue intersection.	Underground (within station)
3 and 4	TPSSs 3 and 4 would be located east of the Santa Monica Boulevard and Stoner Avenue intersection.	Underground (within station)
5 and 6	TPSSs 5 and 6 would be located southeast of the Kinross Avenue and Gayley Avenue intersection.	Underground (within station)
7 and 8	TPSSs 7 and 8 would be located at the north end of the UCLA Gateway Plaza Station.	Underground (within station)
9 and 10	TPSSs 9 and 10 would be located east of Stone Canyon Reservoir on LADWP property.	At-grade
11 and 12	TPSSs 11 and 12 would be located at the Van Nuys Boulevard and Ventura Boulevard intersection.	Underground (within station)
13 and 14	TPSSs 13 and 14 would be located immediately south of Magnolia Boulevard and west of Van Nuys Boulevard.	At-grade
15 and 16	TPSSs 15 and 16 would be located along Van Nuys Boulevard between Emelita Street and Califa Street.	Underground (within station)
17 and 18	TPSSs 17 and 18 would be located east of Van Nuys Boulevard and immediately north of Vanowen Street.	At-grade
19 and 20	TPSSs 19 and 20 would be located east of Van Nuys Boulevard between Saticoy Street and Keswick Street.	Underground (within station)
21 and 22	TPSSs 21 and 22 would be located south of the Metrolink tracks and east of Hazeltine Avenue.	At-grade (within MSF)

Source: HTA, 2024

Figure 10-4. Alternative 6: Traction Power Substation Locations

Source: HTA, 2024

10.1.1.9 Roadway Configuration Changes

In addition to the access road described in the following section, Alternative 6 would require reconstruction of roadways and sidewalks near stations.

10.1.1.10 Ventilation Facilities

Tunnel ventilation for Alternative 6 would be similar to existing Metro ventilation systems for light and heavy rail underground subways. In case of emergency, smoke would be directed away from trains and extracted through the use of emergency ventilation fans installed at underground stations and crossover locations adjacent to the stations. In addition, a mid-mountain facility located on LADWP property east of Stone Canyon Reservoir in the Santa Monica Mountains would include a ventilation shaft for the extraction of air, along with two TPSSs. An access road from the Stone Canyon Reservoir access road would be constructed to the location of the shaft, requiring grading of the hillside along its route.

10.1.1.11 Fire/Life Safety – Emergency Egress

Each tunnel would include an emergency walkway that measures a minimum of 2.5 feet wide for evacuation. Cross-passages would be provided at regular intervals to connect the two tunnels to allow for safe egress to a point of safety (typically at a station) during an emergency. Access to tunnel segments for first responders would be through stations.

10.1.2 Construction Activities

Temporary construction activities for Alternative 6 would include construction of ancillary facilities, as well as guideway and station construction and construction staging and laydown areas, which would be co-located with future MSF and station locations. Construction of the transit facilities through substantial completion is expected to have a duration of 7½ years. Early works, such as site preparation, demolition, and utility relocation, could start in advance of construction of the transit facilities.

For the guideway, twin-bore tunnels would be constructed using two tunnel boring machines (TBM). The tunnel alignment would be constructed over three segments—including the Westside, Santa Monica Mountains, and Valley—using a different pair of TBMs for each segment. For the Westside segment, the TBMs would be launched from the Metro E Line Station and retrieved at the UCLA Gateway Plaza Station. For the Santa Monica Mountains segment, the TBMs would operate from the Ventura Boulevard Station in a southerly direction for retrieval from UCLA Gateway Plaza Station. In the Valley, TBMs would be launched from the Van Nuys Metrolink Station and retrieved at the Ventura Boulevard Station.

The distance from the surface to the top of the tunnels would vary from approximately 50 feet to 130 feet in the Westside, between 120 feet and 730 feet in the Santa Monica Mountains, and between 40 feet and 75 feet in the Valley.

Construction work zones would also be co-located with future MSF and station locations. All work zones would comprise the permanent facility footprint with additional temporary construction easements from adjoining properties. In addition to permanent facility locations, TBM launch at the Metro E Line Station would require the closure of I-10 westbound off-ramps at Bundy Drive for the duration of the Sepulveda Transit Corridor Project (Project) construction.

Alternative 6 would include seven underground stations. All stations would be constructed using a “cut-and-cover” method, whereby the station structure would be constructed within a trench excavated from the surface that is covered by a temporary deck and backfilled during the later stages of station construction. Traffic and pedestrian detours would be necessary during underground station excavation until decking is in place and the appropriate safety measures have been taken to resume cross traffic. In addition, portions of the Wilshire Boulevard/Metro D Line Station crossing underneath the Metro D Line Westwood/UCLA Station and underneath a mixed-use building at the north end of the station would be constructed using the sequential excavation method, as it would not be possible to excavate the station from the surface.

Construction of the MSF site would begin with demolition of existing structures, followed by earthwork and grading. Building foundations and structures would be constructed, followed by yard improvements and trackwork, including paving, parking lots, walkways, fencing, landscaping, lighting, and security systems. Finally, building mechanical, electrical, and plumbing systems, finishes, and equipment would be installed. The MSF site would also be used as a staging site.

Station and MSF sites would be used for construction staging areas. A construction staging area, shown on Figure 10-5, would also be located off Stone Canyon Road northeast of the Upper Stone Canyon Reservoir. In addition, temporary construction easements outside of the station and MSF footprints would be required along Bundy Drive, Santa Monica Boulevard, Wilshire Boulevard, and Van Nuys Boulevard. The westbound to southbound loop off-ramp of the I-10 interchange at Bundy Drive would also be used as a staging area and would require extended ramp closure. Construction staging areas would provide the necessary space for the following activities:

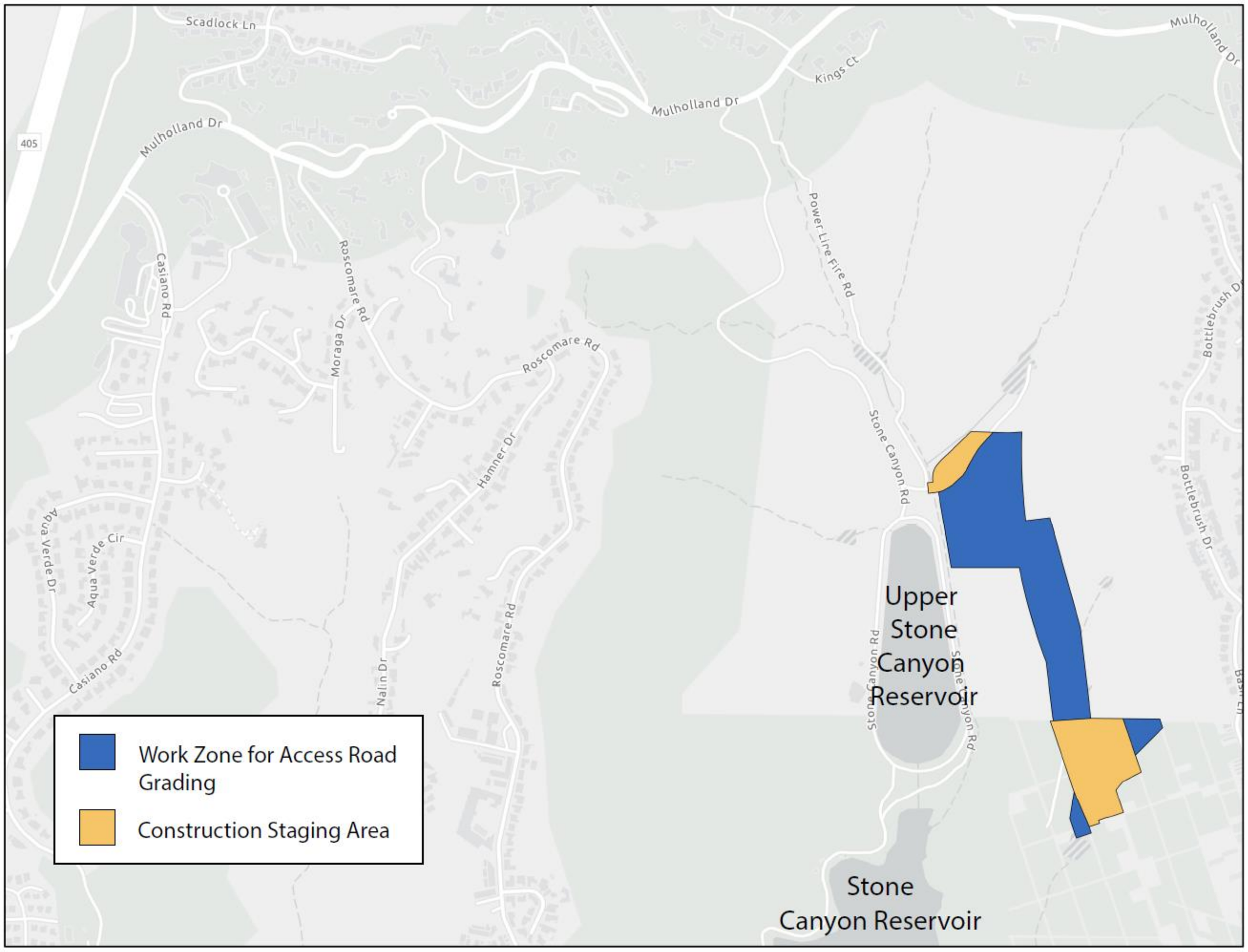
- Contractors’ equipment
- Receiving deliveries
- Testing of soils for minerals or hazards
- Storing materials
- Site offices
- Work zone for excavation
- Other construction activities (including parking and change facilities for workers, location of construction office trailers, storage, staging and delivery of construction materials and permanent plant equipment, and maintenance of construction equipment)

The size of proposed construction staging areas for each station would depend on the level of work to be performed for a specific station and considerations for tunneling, such as TBM launch or extraction. Staging areas required for TBM launching would include areas for launch and access shafts, cranes, material and equipment, precast concrete segmental liner storage, truck wash areas, mechanical and electrical shops, temporary services, temporary power, ventilation, cooling tower, plants, temporary construction driveways, storage for spoils, and space for field offices.

Alternative 6 would also include several ancillary facilities and structures, including TPSS structures, a deep vent shaft structure at Stone Canyon Reservoir, as well as additional vent shafts at stations and crossovers. TPSSs would be co-located with MSF and station locations, except for two TPSSs at the Stone Canyon Reservoir vent shaft and four along Van Nuys Boulevard in the Valley. The Stone Canyon Reservoir vent shaft would be constructed using a vertical shaft sinking machine that uses mechanized shaft sinking equipment to bore a vertical hole down into the ground. Operation of the machine would be controlled and monitored from the surface. The ventilation shaft and two TPSSs in the Santa Monica Mountains would require an access road within the LADWP property at Stone Canyon Reservoir. Construction of the access road would require grading east of the reservoir. Construction of all mid-mountain facilities would take place within the footprint shown on Figure 10-5.

Additional vent shafts would be located at each station with one potential intermediate vent shaft where stations are spaced apart. These vent shafts would be constructed using the typical cut-and-cover method, with lateral bracing as the excavation proceeds. During station construction, the shafts would likely be used for construction crew, material, and equipment access.

Figure 10-5. Alternative 6: Mid-Mountain Construction Staging Site



Source: HTA, 2024

Alternative 6 would utilize precast tunnel lining segments in the construction of the transit tunnels. These tunnel lining segments would be similar to those used in recent Metro underground transit projects. Therefore, it is expected that the tunnel lining segments would be obtained from an existing casting facility in Los Angeles County and no additional permits or approvals would be necessary specific to the facility.

10.2 Existing Conditions

10.2.1 Regional Geology

Alternative 6, from north to south, would cross the south-central portion of the San Fernando Valley, the Santa Monica Mountains, and the Coastal Plain of the Los Angeles Basin. The Los Angeles Basin is a southwest-trending alluvial plain with gentle sloping. The Santa Monica Mountains trend east–west, where long southward-draining canyons are located on the south flank and shorter northward-draining canyons are located on the north flank. The San Fernando Valley basin trends east–west with alluvial fan deposits and channelized wash deposits (Metro, 2024c). Alternative 6 would cross the boundary between two California geomorphic provinces: the Transverse Ranges and the Peninsular Ranges (Metro, 2024c).

10.2.1.1 Transverse Ranges Geomorphic Province

The Transverse Ranges geomorphic province is composed of several mountain ranges oriented in an east–west direction and extends over 320 miles from the Mojave and Colorado Desert Provinces to Point Arguello at the Pacific Ocean. Included within the Transverse Ranges are portions of Riverside, San Bernardino, Los Angeles, and Ventura Counties. Acting as a northern boundary, the Transverse Ranges truncate the northwest-trending structural grain of the Peninsular Ranges geomorphic province. Most active faults in the Transverse Ranges are east–west-trending faults. Rock types in this province include gneiss, granitic rocks, and sedimentary rocks, Volcanic rocks are found in the Santa Monica Mountains. Alluvial sediments are typically in canyon bottoms and valleys, with broad alluvial fans at the mouths of steep canyons (City of Los Angeles, 2018). The northern portion of Alternative 6 would be located within the Transverse Ranges.

10.2.1.2 Peninsular Ranges Geomorphic Province

The Peninsular Ranges geomorphic province, composed of multiple mountain ranges and valleys extends southward 775 miles past the United States-Mexico border. The Peninsular Ranges geomorphic province extends southward from the south edge of the Transverse Ranges geomorphic province to the tip of Baja California in Mexico. The Peninsular Ranges are characterized by northwest–southeast-trending hills and valleys that are separated by similarly trending faults. Most active faults in the Peninsular Ranges province are northwest trending. Rock types in this province in the Los Angeles region generally include schist and sedimentary rocks. Surface materials in canyon bottoms and basins generally consist of alluvium (City of Los Angeles, 2018). The southern portion of Alternative 6 would be located within the Los Angeles Basin, which is the northernmost basin of the Peninsular Ranges.

10.2.1.3 San Fernando Valley

The San Fernando Valley is an east–west-trending, alluvial-filled basin, which is bounded by the uplifted, Santa Susana and San Gabriel Mountain Ranges to the north, the Simi Hills to the west, the Verdugo Mountains to the east, and the Santa Monica Mountains to the south. The San Fernando Valley is an almost fully enclosed basin that drains via the Los Angeles River and its tributaries, through a narrow gap at its southeastern corner. Tectonic uplift of the surrounding mountains has caused sediments to erode and become deposited in the basin, primarily as alluvial fan deposits. These deposits consist primarily of sand, silt, and gravel of Holocene and older Pleistocene age (Metro, 2024c). Major sources of alluvial deposits in the northern and eastern parts of the San Fernando Valley are the Tujunga and Pacoima washes. Deposits from these washes are composed primarily of sand and gravel, reflecting the crystalline rock of the San Gabriel Mountains source area. Along the southern edge of the San Fernando Valley, in the Sherman Oaks area, the alluvial fan deposits are derived from drainages emanating from the northern flank of the Santa Monica Mountains. These drainages dissect the primarily fine-grained, sedimentary rocks of the Santa Monica Mountains; thus, the deposits are finer grained, predominantly composed of silts and clays with minor sands (Metro, 2024c).

10.2.1.4 Santa Monica Mountains

The Santa Monica Mountains, which form the southern margin of the San Fernando Valley, are an east–west-trending coastal range that is about 45 miles long and about 8 to 15 miles wide. The mountains rise about 1,000 to 3,000 feet above mean sea level. Tectonic uplift of the range began in the latest Miocene (Metro, 2024c). Basement rocks consisting of Jurassic-age metamorphic rock (slate), locally intruded by late Cretaceous granitic rock, form the core of the range. These basement rocks are unconformably overlain by a moderately to steeply dipping sequence of uppermost Cretaceous and lower Tertiary marine sedimentary and volcanic rocks that are unconformably overlain by a shallow dipping late

Miocene sequence of marine clastic rocks. The Santa Monica Mountains were squeezed up and thrust southward on the northward dipping Santa Monica fault system along its southern border (Metro, 2024c). Structurally the eastern part of the Santa Monica Mountains is a broad anticline for which its axis lies in the central area of the Jurassic slate (Metro, 2024c). Erosion of the mountains has resulted in deeply incised canyons and alluvial fans that project from these canyons out onto the adjacent basin floors of the San Fernando Valley and the Los Angeles Basin.

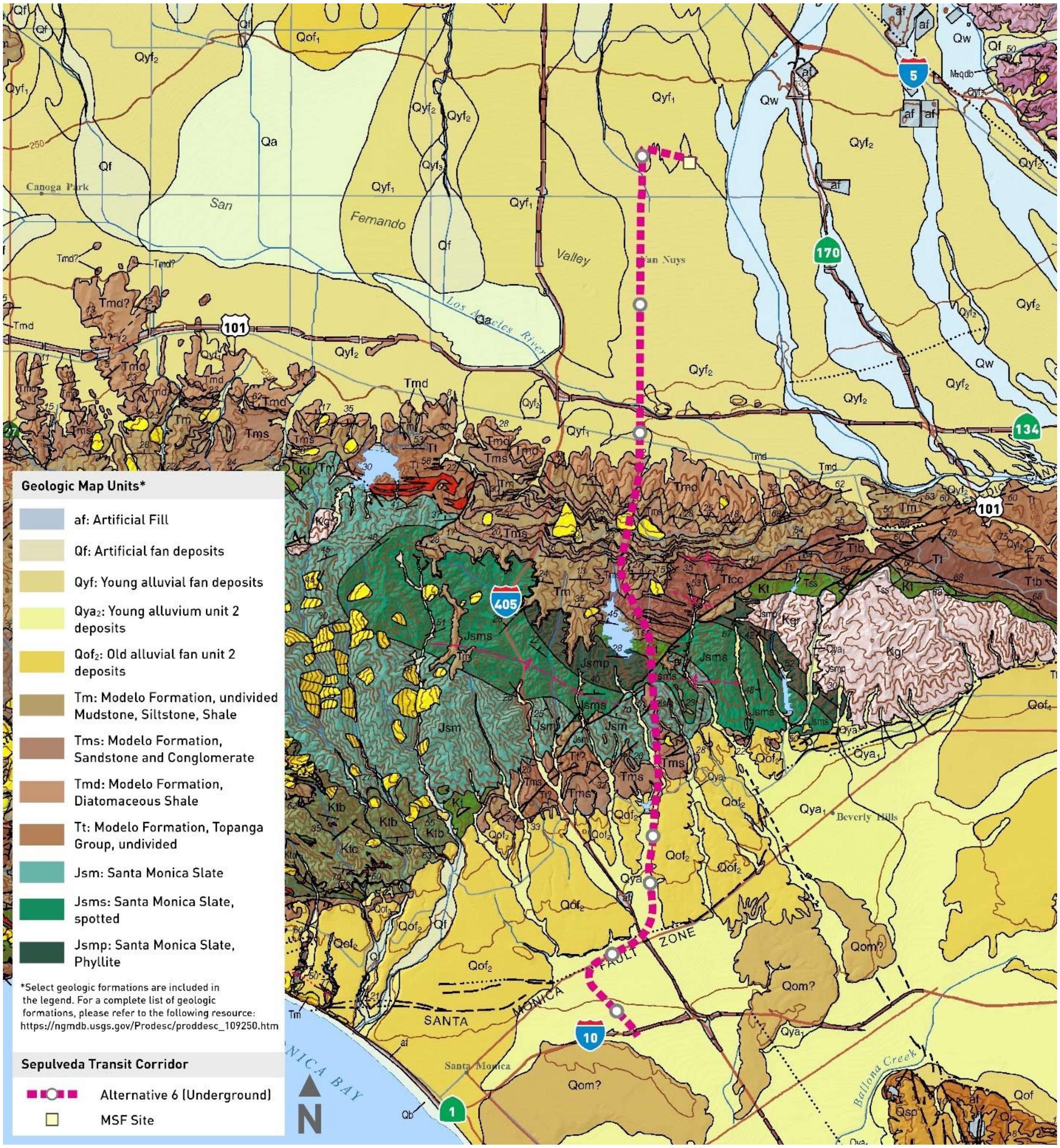
10.2.1.5 Los Angeles Basin

South of the Santa Monica Mountains is a broad sediment-filled trough referred to as the “Los Angeles Basin.” The Los Angeles Basin is underlain by over 1,000 feet of sediments, which have been deposited within this down-warped basin since Pliocene time (Metro, 2024c). Within the Los Angeles Basin, thick accumulations of Quaternary-age, non-marine to shallow marine deposits overlie deep marine Pliocene-age, weakly lithified sedimentary formations. The area of the Los Angeles Basin adjacent to the coastline is referred to as the Coastal Plain. The Coastal Plain of the Los Angeles Basin is a gently southwest-sloping, alluvial plain of low topographic relief. In the vicinity of Alternative 6, erosion of the Santa Monica Mountains has produced large alluvial fans that have projected out onto the Coastal Plain. Older (Pleistocene age) alluvial fans form an elevated alluvial surface known as the “Santa Monica Plain.” The surface of the Santa Monica Plain ranges from 600 to 175 feet above mean sea level. The Santa Monica Plain has been dissected by active streams (Sepulveda, Dry, Stone, and Brown canyons) that have left a lower southwest sloping surface that ranges from about 400 to 140 feet above mean sea level at the southern end of Alternative 6 (Metro, 2024c).

10.2.2 Project Site Soil Types and Characteristics

Figure 10-6 shows the geologic features for Alterative 6. Alternative 6 is mostly composed of alluvial fans (9.8 percent) and hillslopes (9.6 percent) that consist of Quaternary debris generated from erosion of the Santa Monica Mountains (Metro, 2024c). The transitional area between the mountains and the Coastal Plain consists of alluvial fans that have developed from erosion of the Santa Monica Mountains. Soil types vary across, including clay, sandy clay loam, and fine sandy clay (Metro, 2024c).

Figure 10-6. Alternative 6: Geologic Units



Source: USGS, 2016; HTA, 2024

10.2.2.1 Artificial Fill

Artificial fill (af) is comprised of silty sand, a mixture of moist, brown and gray, silty sand of fine-grained to coarse-grained composure. Some clay or gray pockets may be observed. The most commonly observed lithology for the Project Study Area along the alignment is typically at the ground surface. (Metro, 2024c).

10.2.2.2 Modelo Formation

The Modelo Formation (Tm, Tms, Tmd) is a late Miocene-age sedimentary bedrock that generally consists of gray to brown, thinly bedded mudstone, and shale and siltstone, with interbeds of very fine-grained to coarse-grained sandstone. The most commonly observed lithology is near I-405, with thinly bedded shale to shaley siltstone with interbeds of fine sandstone. Additionally, localized diatomaceous shale and siltstone with interbeds of bentonite and fine sandstone are within the formation (Metro, 2024c).

10.2.2.3 Old Alluvial Fan Deposits

Older (Late to middle Pleistocene) alluvial fan deposits (Qof), which form the Santa Monica Plain, are mapped along the southern edge of the Santa Monica Mountains. They continue in the subsurface in the Los Angeles Basin. These sediments were deposited by stream channels that had flowed southward from the Santa Monica Mountains during the late Pleistocene. They consist of a thick series of alluvial fans that spread out southward from the mountain front toward the ocean. These deposits are described by Campbell et al. (2016) as moderately consolidated, silt, sand, and gravel deposits on alluvial fans (Metro, 2024c).

10.2.2.4 Santa Susana Formation

The Paleocene Santa Susana Formation (Tss), which underlies the Topanga Formation, is exposed in the slopes bordering the west side of the SCR. Campbell et al. (2016) described the formation as consisting predominantly of fine- to medium-grained sandstone with some interbeds of gray clay shale, mudstone and siltstone, and some lenses of pebble-cobble conglomerate. Shale beds commonly contain indurated limestone concretions.

10.2.2.5 Santa Monica Slate

The Santa Monica Slate (Jsm, Jsms, Jsmp) is a Jurassic-age metamorphic rock that generally consists of black slate and, to a lesser degree, meta-siltstone and fine-grained meta-graywacke. The rock is generally sheared and intensely jointed due to the localized folding and faulting within the Santa Monica Mountains. The Santa Monica Slate is exposed throughout the southern side of the Santa Monica Mountains, with exposures generally highly fractured with small surficial slides within the fractured rock (Metro, 2024c).

10.2.2.6 Topanga Formation

In the Project Study Area, the middle Miocene Topanga Formation (Tt and Tb) unconformably underlies the Modelo Formation. The Topanga Formation is exposed in slopes that are adjacent to the east side of SCR and Upper Stone Canyon Reservoir (USCR). Campbell et al. (2016) described the Topanga Formation as a heterogenous sequence of sedimentary and volcanic rocks containing marine facies. Campbell et al. (2016) subdivided the Topanga Formation into undifferentiated sedimentary rocks or volcanic rocks. Sedimentary rock lithologies include interbedded gray, micaceous claystone, clay shale, and siltstone; semi-friable to well cemented arkosic sandstone; and locally includes gravely sandstone and lenses of pebble to cobble conglomerate. In general, the lower portion of the Topanga Formation (toward the south) commonly contains the coarser-grained lithologies (sandstones and conglomerates), and the upper portion contains fine-grained sandstone, siltstone, and shales. Volcanic rocks within the Topanga Formation (Tb) include extrusive flows, intrusive sills, tuffs, and volcanic breccias.

10.2.2.7 Tuna Canyon Formation

The Cretaceous Tuna Canyon Formation (Kt), which underlies the Santa Susana Formation, is exposed in the slopes bordering SCR. Campbell et al. (2014) described the formation as consisting of marine sandstone, siltstone, and conglomerate. The sandstones range from thinly to very thickly bedded and locally contain abundant fragments of black slate. LADWP (1998) reported that the formation, as exposed in roadcuts along the west side of SCR, includes very thick to massive conglomerate beds that contain weak to extremely strong cobble to boulder-sized granitic, metavolcanic, and quarzitic clasts up to 18 inches in diameter.

10.2.2.8 Younger Alluvial Fan Deposits

The younger alluvial units (QyF and Qya) along both the northern and southern sides of the Santa Monica Mountains consist of sand, silt, silty clay, silty sand, and clayey sand with some interbedded units of gravel to cobble-size clasts. The gravel units are composed of slate and are scattered through the alluvium along the southern side of the mountains; while along the northern side, the gravel transitions to sandstone and is less frequent and abundant. The younger alluvium generally varies in thickness from a few feet to over 50 feet or more in some areas along Alternative 6 (Metro, 2024c).

10.2.3 Seismicity

The entire Southern California region is seismically active. A network of major regional faults and minor local faults crisscrosses the region. The faulting and seismicity are dominated by the San Andreas fault system, which separates two of the major tectonic plates that comprise the earth’s crust. The Pacific Plate lies west of the San Andreas fault system. This plate is moving in a northwesterly direction relative to the North American Plate, which lies east of the San Andreas fault system. This relative movement between the two plates is the driving force of fault ruptures in western California. The San Andreas fault generally trends northwest/southeast; however, north of the Transverse Ranges Province, the fault trends more in an east/west direction, causing a north/south compression between the two plates. North/south compression in Southern California has been estimated from 5 to 20 millimeters per year (mm/year). This compression has produced rapid uplift of many of the mountain ranges in Southern California.

In addition to the San Andreas Fault, numerous faults in Southern California are categorized as active, potentially active, and inactive. A fault is classified as active if it has either moved during the Holocene epoch (from about 11,700 years to the present) or is included in an Alquist-Priolo Earthquake Fault Zone (as established by California Geological Survey [CGS]). A fault is classified as potentially active if it has experienced movement within the Quaternary period (geologic time starting 1.6 million years ago and continuing to the present day. Faults that have not moved in the last 1.8 million years generally are considered inactive. Surface displacement can be recognized by the existence of cliffs in alluvium, terraces, offset stream courses, fault troughs and saddles, the alignment of depressions, sag ponds, and the existence of steep mountain fronts.

Generally defined, an earthquake is an abrupt release of accumulated energy in the form of seismic waves created when movement occurs along a fault plane. The severity of an earthquake is generally expressed in two ways: magnitude and intensity. The energy released, measured on the Moment Magnitude (M_w) scale, represents the “size” of an earthquake. The Richter Magnitude (M) scale has been replaced in most modern building codes by the M_W scale because the M_W scale provides more useful information to design engineers. Alternative 6 is subject to earthquakes of M_W 6.0 to M_W 8.0 by the surrounding faults (CGS, 2023; USGS, 2017a, 2017b, 2017c, 2017d, 2023; SCEDC, 2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2023g, 2023h, 2023i, 2023j, 2023k, 2023l, 2023m, 2023n, 2023o, 2023p, 2023q, 2023r; and Shaw et al., 2022).

The intensity of an earthquake is measured by the Modified Mercalli Intensity (MMI) scale, which emphasizes the current seismic environment at a particular site and measures ground-shaking severity according to damage done to structures, changes in the earth surface, and personal accounts. Table 10-3 identifies the level of intensity according to the MMI scale and describes that intensity with respect to how it would be received or sensed by its receptors.

Table 10-3. Alternative 6: Modified Mercalli Intensity Scale

Intensity	Shaking	Description/Damage
I	Not Felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration is similar to the passing of a truck. Duration is estimated.
IV	Light	Felt indoors by many and outdoors by few during the day. At night, some are awakened. Dishes, windows, doors are disturbed; walls make cracking sound. Sensation is like a heavy truck striking a building. Standing motor cars are rocked noticeably.
V	Moderate	Felt by nearly everyone; many are awakened. Some dishes and windows are broken. Unstable objects are overturned. Pendulum clocks may stop.
VI	Strong	Felt by all; many are frightened. Some heavy furniture is moved; there are a few instances of fallen plaster. Damage is slight.
VII	Very Strong	Damage is negligible in buildings of good design and construction, slight to moderate in well-built ordinary structures, and considerable in poorly built structures; some chimneys are broken.
VIII	Severe	Damage is slight in specially designed structures, considerable in ordinary substantial buildings with partial collapse, and great in poorly built structures. Chimneys, factory stacks, columns, monuments, and walls fall. Heavy furniture is overturned.
IX	Violent	Damage is considerable in specially designed structures; well-designed frame structures are thrown out of plum. Damage is great in substantial buildings, with partial collapse. Buildings are shifted off foundations.
X	Extreme	Some well-built wooden structures are destroyed; most masonry and frame structures are destroyed with foundations. Rails are bent.

Source: USGS, 2022

Ground motions also are reported in terms of a percentage of the acceleration of gravity (percent g, where g equals 32 feet per second). One hundred percent of gravity (1 g) is the acceleration a skydiver would experience during free-fall. An acceleration of 0.4 g is equivalent to accelerating from 0 to 60 miles per hour in about 7 seconds.

Over the past 54 years, Southern California has experienced three significant earthquakes: the 1971 San Fernando earthquake (also known as the Sylmar earthquake, on the Sierra Madre Fault), which registered as M_W 6.6; the 1987 Whittier Narrows earthquake, which registered as M_W 5.9; and the Northridge earthquake, which occurred in January 1994 and registered as M_W 6.7.

10.2.4 Regional and Local Faults

Major regional and local faults are identified in Table 10-4 and are shown on **Error! Reference source not found.**Figure 10-7 and
Figure 10-8.

Table 10-4. Alternative 6: Summary of Major Regional and Local Faults

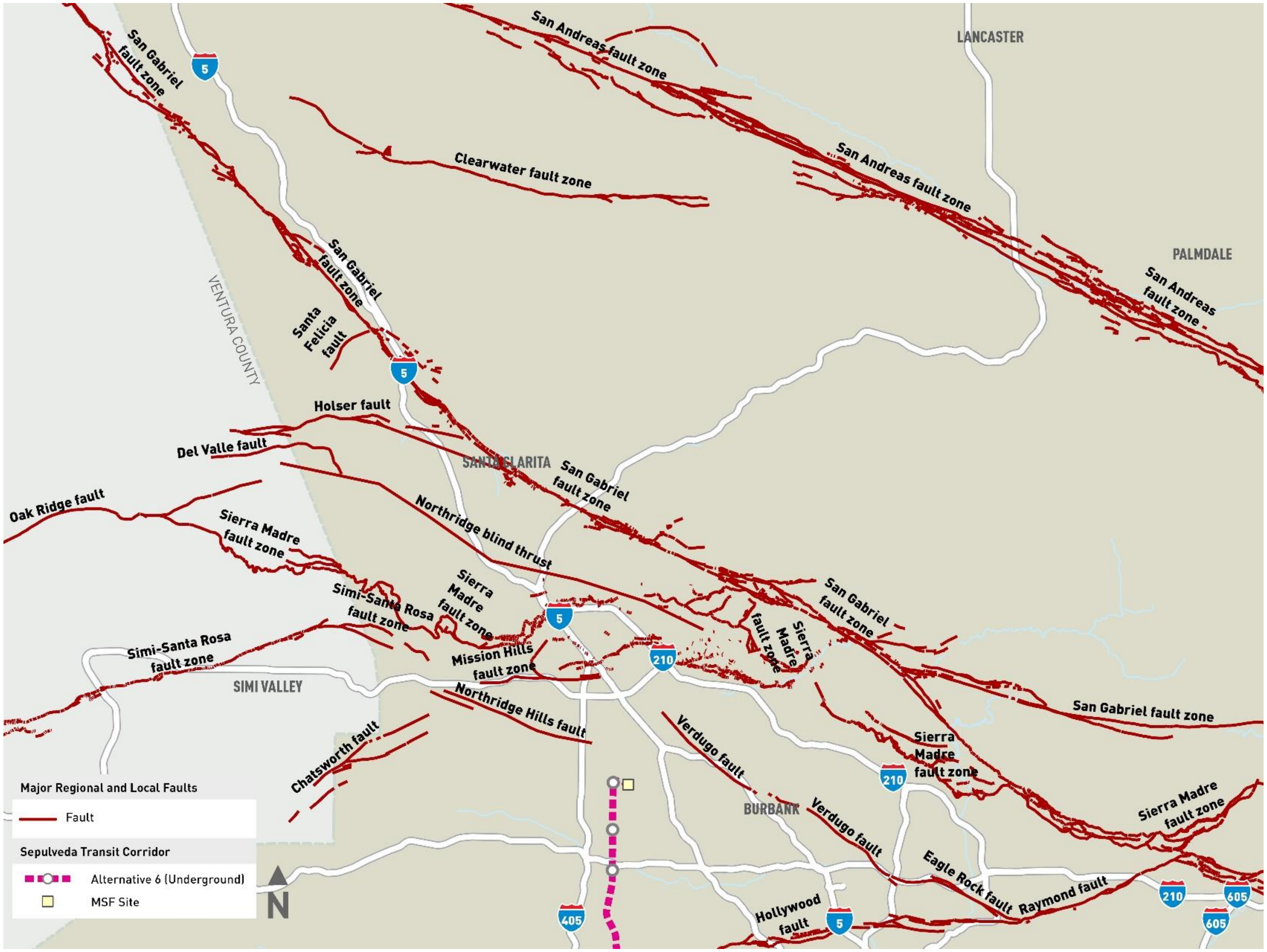
Fault Name	Approximate Closest Distance from Alternative 6 to the Fault (miles)	Compass Direction	Alquist-Priolo Earthquake Fault Zone	Maximum Moment Magnitude (M_w)
Santa Monica Fault	Crosses Alternative 6 north of Massachusetts Avenue and I-405	North	Yes	7.0
Overland Avenue Fault	1.8	West	No	6.6
Northridge Hills Fault	1.9	Northeast	No	—
Hollywood Fault	2.0	Northeast	Yes	6.5
Newport-Inglewood-Rose Canyon Fault	3.1	Northeast	Yes	7.2
Charnock Fault	3.4	Southeast	No	6.5
Verdugo Fault	3.4	Northeast	No	—
Mission Hills Fault	4.5	Northwest	No	7.0
Sierra Madre Fault	5.3	North	Yes	6.8
Puente Hills Blind Thrust System	8.0	Southeast	No	6.8
Northridge Blind Thrust Fault	8.5	North	No	7.5
Chatsworth Fault	8.6	Northwest	No	6.9
Simi-Santa Rosa Fault	9.8	Northwest	Yes	6.7
San Gabriel Fault	10.4	Northeast	Yes	7.0
Malibu Coast Fault	12.6	Northwest	Yes	6.7
Raymond Fault	12.7	West	Yes	7.0
Eagle Rock Fault	13.1	East	No	—
Hosler Fault	14.9	Northwest	No	6.5
Palos Verdes Fault	15.0	South	No	7.1
Del Valle Fault	18.5	Northwest	No	—
Oak Ridge Fault	20.8	Northwest	No	7.5
Santa Felicia Fault	22.7	Northwest	No	—
Clearwater Fault	26.5	North	No	—
San Andreas Fault	29.5	Northeast	Yes	8.0

Source: CGS, 2023; USGS, 2017a, 2017b, 2017c, 2017d, 2023; SCEDC, 2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2023g, 2023h, 2023i, 2023j, 2023k, 2023l, 2023m, 2023n, 2023o, 2023p, 2023q, 2023r; and Shaw et al. 2022.

Figure 10-7. Alternative 6: Major Regional and Local Faults – South

Source: CGS, 2023; HTA, 2024

Figure 10-8. Alternative 6: Major Regional and Local Faults – North



Source: CGS, 2023; HTA, 2024

10.2.4.1 Charnock Fault

The Charlock fault is located approximately 3.4 miles southeast from the southern portion of Alternative 6. Charnock fault extends southeast from near Venice Boulevard to the City of Gardena and runs parallel to the axis of the Gardena syncline for most of its length. The northeastern side of the fault is downthrown relative to the southwestern side (California Department of Water Resources, Southern District [CDWRSD], 1961). Faulted rocks of late Quaternary age (between present day and 700,000 years ago) is present along this fault (USGS, 1981). The Charnock fault runs underneath the Los Angeles International Airport (LAX) runway.

10.2.4.2 Chatsworth Fault

The Chatsworth fault is located approximately 8.6 miles northwest from the northern portion of Alternative 6. The Chatsworth fault is 12.4 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Chatsworth fault has probable magnitude between M_W 6.0 to M_W 6.8. The Chatsworth fault is a reverse fault, where the displacement is predominantly vertical. This fault is north dipping, and the slip rate is currently unknown (SCEDC, 2023a).

10.2.4.3 Clearwater Fault Zone

The Clearwater fault is located approximately 26.5 miles north from the northern portion of Alternative 6. The Clearwater fault is 19.9 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Clearwater fault varies from north dipping to vertical (SCEDC, 2023b).

10.2.4.4 Del Valle Fault

The Del Valle fault is located approximately 18.5 miles northwest from the northern portion of Alternative 6. The Del Valle fault is classified as late Quaternary (between present day and 700,000 years ago). The Del Valle fault is a south-dipping reverse fault, and it contains the prominent tectonic geomorphic features (Yeats et al., 1985).

10.2.4.5 Eagle Rock Fault

The Eagle Rock fault is located approximately 13.1 miles east from the mid-section of Alternative 6. The Eagle Rock fault is 6.8 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Eagle Rock fault is a thrust fault, which is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much, if not all, of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an obvious sign of compressional tectonics (SCEDC, 2023c, 2023s). The slip rate for Eagle Rock fault is probably less than 0.1 mm/year. The possibility of simultaneous rupture with the Verdugo fault is uncertain. The Eagle Rock fault dips to the northeast (SCEDC, 2023c).

10.2.4.6 Hollywood Fault

The Hollywood fault is located approximately 2 miles northeast from the mid-section of Alternative 6. The Hollywood fault is 9.3 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023d, 2023s). The Hollywood fault is a left-reverse fault and has a probable magnitude between M_W 5.8 and M_W 6.5. There is a potential for the probable magnitude to be larger if rupture is simultaneous with an adjacent fault. The slip rate for the Hollywood fault is between 0.33 mm/year and 0.75 mm/year. The Hollywood fault could be considered a westward extension of the Raymond fault and is roughly parallel to the Santa Monica fault (SCEDC, 2023d). The Hollywood fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

10.2.4.7 Holser Fault

The Holser fault is located approximately 14.9 miles northwest from the northern portion of Alternative 6. The Holser fault is 12.4 miles long and is classified as late Quaternary (between present day and 700,000 years ago). The Holser fault is a reverse fault with a slip rate between 0.4 mm/year; the displacement is predominantly vertical, and the dip is to the south (SCEDC, 2023e).

10.2.4.8 Malibu Coast Fault

The Malibu Coast fault is located approximately 12.6 miles northwest from the mid-section of Alternative 6. The Malibu Coast fault is 21.1 miles long with several parallel strands. The Malibu Coast fault is classified as Holocene (from about 10,000 years ago to the present) in part; otherwise, the fault is classified as late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023f, 2023s). The Malibu Coast fault is a reverse fault with a slip rate of 0.3 mm/year. The Malibu Coast fault is a north-dipping fault. The slip rate may be higher at its eastern end, where it meets the Santa Monica fault and develops left-reverse motion (SCEDC, 2023f). The Malibu Coast fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

10.2.4.9 Mission Hills Fault

The Mission Hills fault is located approximately 4.5 miles northwest from the northern portion of Alternative 6. The Mission Hills fault is 6.2 miles long. The Mission Hills fault is classified as late Quaternary (between present day and 700,000 years ago) and possibly Holocene (from about 10,000 years ago to the present) (SCEDC, 2023g, 2023s). The Mission Hills fault is a reverse fault, where the displacement is predominantly vertical. The Mission Hills fault has a slip rate of 0.5 mm/year (SCEDC, 2023g).

10.2.4.10 Newport-Inglewood-Rose Canyon Fault

The Newport-Inglewood-Rose Canyon fault is located approximately 3.1 miles northeast from the southern portion of Alternative 6. The Newport-Inglewood-Rose Canyon fault is 55.9 miles long. The Newport-Inglewood-Rose Canyon fault is mostly classified as Quaternary (1.6 million years ago and continuing to the present day) and in part classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023h, 2023s). The Newport-Inglewood-Rose Canyon fault is a right-lateral fault, which is a fault that slips in such a way that the two sides move with a predominantly lateral motion (with respect to each other). The Newport-Inglewood-Rose Canyon fault has a probable magnitude between M_W 6.0 and M_W 7.2 and a slip rate between 0.8 mm/year and 2.1 mm/year (SCEDC, 2023h). The Newport-Inglewood-Rose Canyon fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

10.2.4.11 Northridge Blind Thrust Fault

The Northridge Blind Thrust fault is located approximately 8.5 miles north from the northern portion of Alternative 6. The Northridge Blind Thrust fault is part of the Oak Ridge fault system (SCEDC, 2023j). At its eastern end, the Oak Ridge Thrust fault is progressively more difficult to trace and is buried or also known as *blind*. The Northridge Blind Thrust fault has a probable magnitude of M_W 6.5 to M_W 7.5. The slip rate for the Northridge Blind Thrust fault is between 3.5 mm/year and 6 mm/year (SCEDC, 2023j). The Northridge Blind Thrust Fault, as part of the Oak Ridge fault system, is classified mostly as a late Quaternary (between present day and 700,000 years ago) and in part as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023j, 2023s). The Northridge Blind Thrust fault is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much if not all of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an obvious sign of compressional tectonics (SCEDC, 2023j, 2023s). This blind thrust fault is assumed to be part of the fault system responsible for the 1994 Northridge earthquake.

10.2.4.12 Northridge Hills Fault

The Northridge Hills fault is located approximately 1.9 miles northeast from the northern portion of Alternative 6. The Northridge Hills fault is not the fault on which the 1994 Northridge earthquake occurred. The Northridge Hills fault is classified as late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023i, 2023s). The Northridge Hills fault is 15.5 miles long and is a reverse fault, where the displacement is predominantly vertical. The dip for the Mission Hills fault is probably to the north (SCEDC, 2023i).

10.2.4.13 Overland Avenue Fault

The Overland Avenue fault is located approximately 1.8 miles west from the southern portion of Alternative 6. The Overland Avenue fault trends northwest and extends from Santa Monica Boulevard to the northwestern flank of the Baldwin Hills. Displacement of the fault is believed to be vertical, with a magnitude of approximately 30 feet. The northeastern side of the fault is raised relative to the southwestern side (CDWRSD, 1961). Faulted rocks of late Quaternary age (between present day and 700,000 years ago) is present along this fault (USGS, 1981).

10.2.4.14 Oak Ridge Fault

The Oak Ridge fault is located approximately 20.8 miles northwest from the northern portion of Alternative 6. The Oak Ridge fault system is connected to the 1994 Northridge earthquake. The Oak Ridge fault is approximately 55.9 miles in length (SCEDC, 2023j). The Oak Ridge fault has a probable magnitude of M_W 6.5 to M_W 7.5. The slip rate for Oak Ridge fault is between 3.5 mm/year and 6 mm/year (SCEDC, 2023j). The Oak Ridge fault system is classified mostly as late Quaternary (between present day and 700,000 years ago) and in part as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023j, 2023s). The Oak Ridge fault is thrust fault, which is a special kind of reverse fault in which the dip of the fault is less than 45 degrees over much if not all of its length. It is characterized not so much by vertical displacement, but by horizontal compression. Thrust faults are an obvious sign of compressional tectonics (SCEDC, 2023j, 2023s). This fault dips to the south, at a fairly shallow (less than 45 degrees) angle. Thus, epicenters of earthquakes on this (and any other thrust) fault may appear far removed from the surface trace. The surface trace of the Oak Ridge fault forms a ridge (hence its name) to the south of its trace; at its eastern end, the Oak Ridge fault becomes progressively more difficult to trace (SCEDC, 2023j). The Oak Ridge fault appears to be overthrust by the *Santa Susana* fault becoming a *blind thrust fault,* including the Northridge Blind Thrust fault.

10.2.4.15 Palos Verdes Fault

The Palos Verdes fault is located approximately 15.0 miles south from the southern portion of Alternative 6. The Palos Verdes fault is 49.7 miles long and is classified as Holocene (from about 10,000 years ago to the present) offshore and late Quaternary (between present day and 700,000 years ago) onshore (SCEDC, 2023k, 2023s). The Palos Verdes fault is a right-reverse fault and has a probable magnitude between M_W 6.0 and M_W 7.0. The slip rate is between 0.1 mm/year and 3.0 mm/year (SCEDC, 2023k).

10.2.4.16 Puente Hills Blind Thrust Fault

The Puente Hills Blind Thrust fault is located approximately 8.0 miles southeast from the southern portion of Alternative 6. The Puente Hills Blind Thrust fault is 24.9 miles long. In 1987, the Puente Hills Blind Thrust fault produced an M_W 5.9 earthquake in Whittier. In March 2014, the Puente Hills Blind Thrust fault produced an M_W 5.1 earthquake with over 100 aftershocks (KCAL News, 2014). The Puente Hills Blind Thrust fault has a probable magnitude between M_W 6.5 and M_W 6.6 for frequency of single a segment and a probable magnitude of M_W 7.1 for multi-segment rupture scenarios. The slip rates on the ramp segments range from 0.44 mm/year to 1.7 mm/year, with preferred rates between 0.62 mm/year and 1.28 mm/year (Shaw et al., 2022).

10.2.4.17 Raymond Fault

The Raymond fault is located approximately 12.7 miles west from the mid-section of Alternative 6. The Raymond fault is 16.2 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023l, 2023s). The Raymond fault is a left-reverse fault and has a probable magnitude between M_W 6.0 and M_W 7.0. The slip rate is between 0.10 mm/year and 0.22 mm/year (SCEDC, 2023l). The Raymond fault dips at about 75 degrees to the north. There is evidence that at least eight surface-rupturing events have occurred along this fault in the last 36,000 years. The exact nature of the slip along the Raymond fault has been a subject of debate for quite some time. In late 1988, the *Pasadena earthquake* occurred on the Raymond Fault, and the motion of this earthquake was predominantly left-lateral, with a reverse component of only about 1/15 the size of the lateral component. If the Raymond fault is indeed primarily a left-lateral fault, it could be responsible for transferring slip southward from the *Sierra Madre* Fault Zone to other fault systems (SCEDC, 2023l). The Raymond fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

10.2.4.18 San Andreas Fault

The San Andreas fault is located approximately 29.5 miles northeast from the northern portion of Alternative 6. The San Andreas fault is 745.6 miles long. The San Andreas fault has a probable magnitude between M_W 6.8 and M_W 8.0. The interval between major ruptures averages about 140 years on the Mojave segment, and the recurrence interval varies greatly from under 20 years (at Parkfield only) to over 300 years. The slip rate is between 20 mm/year and 35 mm/year (SCEDC, 2023m). The last major rupture of the San Andreas fault occurred on January 9, 1857, at the Mojave segment and on April 18, 1906, at the northern segment. The San Andreas fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

10.2.4.19 San Gabriel Fault

The San Gabriel fault is located approximately 10.4 miles northeast from the northern portion of Alternative 6. The San Gabriel fault is 87 miles long. The San Gabriel fault is a primarily right-lateral strike slip, which is a fault where the slip motion is parallel to the direction, or trend, of the line marking the intersection of a fault plane (or another planar geologic feature) with the horizontal. The San Gabriel fault is classified as late Quaternary (between present day and 700,000 years ago) west of the intersection with the Sierra Madre Fault Zone, Quaternary (geologic time starting 1.6 million years ago and continuing to the present day) east of that intersection and Holocene (from about 10,000 years ago to the present) between Saugus and Castaic. The slip rate is between 1 mm/year and 5 mm/year (SCEDC, 2023n). The slip rate and reoccurrence interval vary significantly along the length of the San Gabriel Fault. The western half is more active than the eastern half and the dip is generally steep and to the north. The San Gabriel fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

10.2.4.20 Santa Felicia Fault

The Santa Felicia fault is located approximately 22.7 miles northwest from the northern portion of Alternative 6. The Santa Felicia fault is a fault that is less well understood. The Santa Felicia fault is classified as late Quaternary (between present day and 700,000 years ago). The Santa Felicia fault apparently overrides the youngest strand of the San Gabriel Fault. The Santa Felicia fault is a south-dipping reverse fault. The Santa Felicia fault has no recognized tectonic geomorphic features, although it follows the Santa Felicia Canyon for part of its length (Yeats et al., 1985).

10.2.4.21 Santa Monica Fault

The Santa Monica fault would cross Alternative 6 approximately north of Massachusetts Avenue and I-405. The Santa Monica fault is 14.9 miles long. The Santa Monica fault has a probable magnitude between M_W 6.0 and M_W 7.0. The Santa Monica fault is classified as late Quaternary (between present day and 700,000 years ago) and is a left-reverse fault. The Santa Monica fault is a north-dipping fault, and the slip rate may be greatest at its western end. The slip rate is between 0.27 mm/year and 0.39 mm/year (SCEDC, 2023o). In 2015, the Santa Monica Fault Zone was evaluated for the Alquist-Priolo Earthquake Fault Zoning program (Olson, 2015). Currently, the Santa Monica Fault Zone is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023). The guideway for Alternative 6 would fall within the Alquist-Priolo Earthquake Fault Zone. No habitable structures including stations are located within the Alquist-Priolo Earthquake Fault Zone for Alternative 6.

10.2.4.22 Sierra Madre Fault

The Sierra Madre fault is located approximately 5.3 miles north from the northern portion of Alternative 6. The Sierra Madre fault is 46.6 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023p, 2023s). The Sierra Madre fault is reverse fault, where the displacement is predominantly vertical. The Sierra Madre fault has a probable magnitude between M_W 6.0 and M_W 7.0. The slip rate is between 0.36 mm/year and 4.0 mm/year (SCEDC, 2023k). The Sierra Madre fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

10.2.4.23 Simi-Santa Rosa Fault

The Simi-Santa Rosa fault is located approximately 9.8 miles northwest from the northern portion of Alternative 6. The Simi-Santa Rosa fault is 24.9 miles long and is classified as Holocene (from about 10,000 years ago to the present) (SCEDC, 2023q, 2023s). The Simi-Santa Rosa fault is a reverse fault, where the displacement is predominantly vertical. This fault dips to the north. The Simi-Santa Rosa fault is a designated Alquist-Priolo Earthquake Fault Zone that is subject to the Alquist-Priolo Earthquake Fault Zoning Act (California Department of Conservation, 2023).

10.2.4.24 Verdugo Fault

The Verdugo fault is located approximately 3.4 miles northeast from the mid-section of Alternative 6. The Verdugo fault is 13 miles long and is classified as Holocene (from about 10,000 years ago to the present) and late Quaternary (between present day and 700,000 years ago) (SCEDC, 2023r, 2023s). The Verdugo fault is a reverse fault and has a probable magnitude between M_W 6.0 and M_W 6.8. The slip rate is roughly 0.5 mm/year (SCEDC, 2023r). The Verdugo fault dips to the northeast.

10.2.5 Geological Hazards

10.2.5.1 Fault Rupture

Faults are geologic zones of weakness. Surface rupture occurs when movement on a fault deep in the earth breaks through to the ground surface. Surface ruptures associated with the 1994 Northridge earthquake began as a rupture at a depth of about 10.9 miles beneath the San Fernando Valley. For 8 seconds following the initial break, the rupture propagated upward and northwestward along the fault plan at a rate of about 1.9 miles per second. The size of the rupture covered an area of approximately 9.3 by 12.4 miles (USGS, 2013). Not all earthquakes result in surface rupture; however, due to the proximity of known active faults, fault ruptures and the subsequent hazard posed by seismic activity are potentially high. An earthquake could cause major damage, and not have the fault trace break at the ground surface. Fault rupture almost always follows preexisting faults, which are zones of weakness. Rupture may occur suddenly during an earthquake or slowly in the form of fault creep. Sudden displacements are more damaging to structures because they are accompanied by shaking.

10.2.5.2 Ground Shaking

A major cause of structural damage that results from earthquakes is ground shaking. The amount of motion can vary from “zero to forceful” depending upon the distance to the fault, the magnitude of the earthquake, and the local geology. Greater movement can be expected at sites located on poorly consolidated material such as alluvium located near the source of the earthquake epicenter or in response to an earthquake of great magnitude. Strong ground shaking can damage large freeway overpasses and unreinforced masonry buildings. It can also trigger a variety of secondary hazards such as liquefaction, landslides, fire, and dam failure.

The amount of damage to a building does not depend solely on how hard it is shaken. In general, smaller buildings such as houses are damaged more by stronger earthquakes, and houses must be relatively close to the epicenter to be severely damaged. Larger structures such as high-rise buildings are damaged more by weaker earthquakes and will be more noticeably affected by the largest earthquakes, even at considerable distances.

Damages as a result of ground shaking are not limited to aboveground structures. Seismic waves generated by the earthquake cause the ground to move, leading to dynamic forces on underground structures. This shaking can induce ground deformation and displacements, and can potentially damage the structural integrity of tunnels, basements, and other underground facilities.

The intensity of ground motion expected at a particular site depends upon the magnitude of the earthquake, the distance to the epicenter, and the geology of the area between the epicenter and the property. Another factor affecting structural damage due to ground shaking is the quality and condition of the existing structure, which is influenced by whether it adheres to current or past building codes. Greater movement can be expected at sites on poorly consolidated material, such as loose alluvium, in proximity to the causative fault, or in response to an event of great magnitude. The general area is susceptible to earthquakes of M_W 6.0 to M_W 8.0. Due to the proximity of known active faults, the hazard posed by seismic shaking is potentially high.

10.2.5.3 Difficult Ground Conditions for Excavating, Drilling, or Tunneling

Difficult excavating, drilling, and tunneling conditions may be encountered due to the presence of the Santa Monica Slate with hard zones (compressive strength of up to 27,000 pounds per square inch) in the Santa Monica Mountain areas (Metro, 2024c). Drilling in this area is anticipated to be slow, casing (if used) installation into these materials will also be difficult. Hard drilling should be anticipated.

Difficulties can arise when tunneling through either active or inactive fault zones. Fault zones typically have highly heterogeneous strength properties, including a fractured to brecciated rock mass and fine-grained fault gouge, often with adjacent altered and weakened rock. Tunneling through fault zones can thus be similar to mixed-face tunneling. Ground conditions within a fault zone depend on the depth below the ground surface, the faulted material, the strength of the fault gouge, and the groundwater conditions. Fault zones can act as either fast-flow paths or as barriers for groundwater flow, but high groundwater flows are often characteristic. The heterogeneity of a fault zone and the potential for high groundwater flows often results in difficult tunneling conditions.

For conceptual design purposes, it should be assumed that the Benedict Canyon fault zone in the Santa Monica Mountains will exhibit relatively poor rock mass characteristics. The width of the fault zone and the severity of the anticipated poor-quality rock at the tunnel crossing is not known. In addition, if the tunnel crossing is below the groundwater level, increased groundwater inflows might be expected in the fault zone. Variability in rock mass permeability can change rapidly over the width of a fault zone. In low permeability zones (e.g., clay gouge zones), groundwater can become trapped and then rapidly released by the tunnel excavation penetrating from the low permeability zone into a higher permeability zone. Highly fractured and brecciated rock with higher permeability might also result in increased groundwater inflows (Metro, 2024c).

10.2.6 Dry Sand Settlement

Settlement is defined as areas that are prone to rates of ground-surface collapse and densification (soil particle compaction) that are greater than those of the surrounding area. Such areas are often underlain by sediments that differ laterally in composition or degree of existing compaction. Differential settlement refers to areas that have more than one rate of settlement. Settlement can damage structures, pipelines, and other subsurface entities.

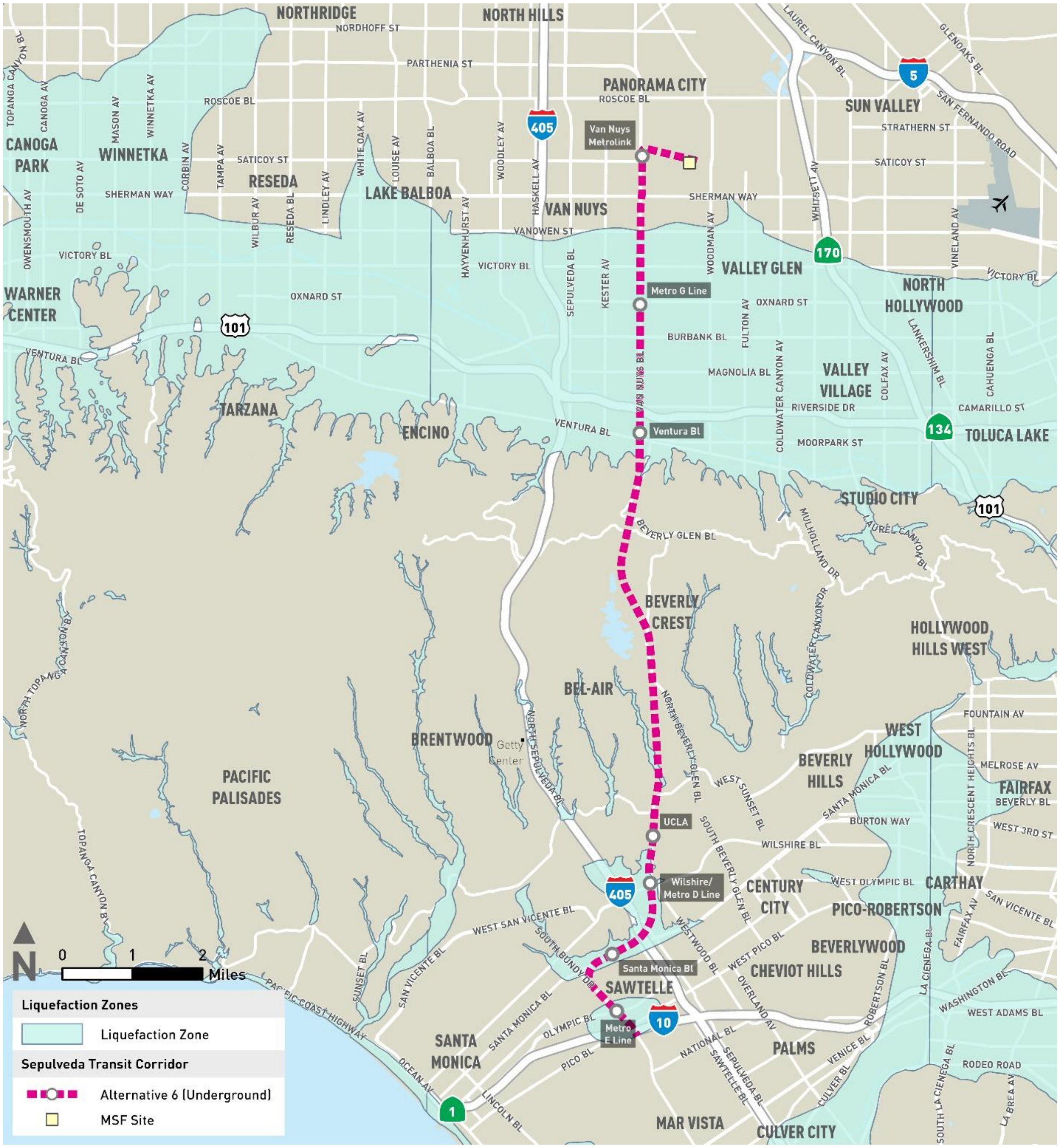
Strong ground shaking can cause soil settlement by vibrating sediment particles into more tightly compacted configurations, thereby reducing pore space. Unconsolidated, loosely packed alluvial deposits and sand (unsaturated or saturated) are especially susceptible to this phenomenon. Poorly compacted artificial fills may experience seismically induced settlement.

10.2.7 Liquefaction

Liquefaction involves a sudden loss in strength of a saturated, cohesionless, uniformly particle-sized soil, that is typically caused by ground-shaking activities, which causes temporary transformation of the soil to a fluid mass. In rare instances, ground-borne vibrations can cause liquefaction from activities such as pile driving or tunnel boring. If the liquefying layer is near the ground surface, the effects may resemble those of quicksand. If the layer is deep below the ground surface, it may provide a sliding surface for the material above it and/or cause differential settlement of the ground surface, which may damage building foundations by altering weight-bearing characteristics.

During a liquefaction event, soils behave similarly to liquids, losing bearing strength. Structures built on these soils may tilt or settle when the soils liquefy. Liquefaction occurs more often in earthquake-prone areas underlain by young sandy alluvium where the groundwater table is less than 50 feet below ground surface (Metro 2023c). Per the County of Los Angeles, liquefaction zones identify where the stability of foundation soils must be investigated, and countermeasures undertaken in the design and construction of buildings for human occupancy (LA County Planning, 2022a). As shown on Figure 10-9, Alternative 6 would traverse multiple liquefaction zones, and the potential for a liquefaction event is relatively high for the mapped areas shown (California Department of Conservation, 1998). Site-specific liquefaction potential would be evaluated in more detail based on future site-specific subsurface investigation data.

Figure 10-9. Alternative 6: Liquefaction Zones



Source: County of Los Angeles, Enterprise GIS (eGIS), 2022; HTA, 2024

10.2.8 Subsidence

Subsidence involves a sudden sinking or gradual settling and compaction of soil and other surface material with little or no horizontal motion. This is typically caused by the removal of groundwater, oil, or natural gas, or by natural processes like the compaction of soil. This can lead to structural damage to buildings and infrastructure. The Los Angeles Basin is vulnerable to subsidence, particular due to groundwater and oil extraction. Over-extraction of groundwater can be concerning because as the groundwater table drops, the soil compacts, leading to subsidence that can damage infrastructure, buildings, and roads. Information relating to groundwater conditions can be found in the *Sepulveda Transit Corridor Project Water Resources Technical Report* (Metro, 2025).

Subsidence typically impact surface level soils. Although the entire alignment is in a relatively deep subsurface tunnel, stations have surface level elements. Moreover, alluvial deposits are susceptible to subsidence, especially when they consist of loose, unconsolidated sediments. As shown on Figure 10-6, alluvial deposits are present at all of Alternative 6’s stations and, as such, the hazard posed by subsidence is potentially high at those locations.

10.2.9 Expansive Soils

Expansive soils have a significant amount of clay particles that can give up water (shrink) or take on water (swell). The change in volume exerts stress on buildings and other loads placed on these soils. The occurrence of these soils is often associated with geologic units having marginal stability. Expansive soils can be dispersed widely and can be found in hillside areas as well as low-lying areas in alluvial basins. Municipal grading and building codes require routine soils testing to identify expansive characteristics and appropriate remediation measures. Specific treatments to eliminate expansion of soils at building sites include, but are not limited to, grouting (cementing the soil particles together), re-compaction (watering and compressing the soils), and replacement with non-expansive material (excavation of unsuitable soil followed by filling with suitable material), all of which are common practice in California. Expansive soils typically impact surface level soils. Although the entire alignment is in a relatively deep subsurface tunnel, stations have surface-level elements. As shown on Figure 10-6, alluvial deposits are present at all of Alternative 6’s stations and, as such, the hazard posed by expansive soils is potentially high at those locations.

10.2.10 Collapsible Soils

Collapsible soils undergo a rearrangement of their grains and a loss of cementation, resulting in substantial and rapid settlement under relatively low loads. Collapsible soils occur predominantly at the base of mountain ranges where Holocene-age alluvial fan and wash sediments have been deposited during rapid runoff events. Soils prone to collapse are commonly associated with human-made fill, wind-laid sands and silts, and alluvial fan and mudflow sediments deposited during flash floods. Additionally, desert soils are commonly associated with hydro-compression and collapse associated with wetting. Examples of common problems associated with collapsible soils include tilting floors, cracking or separation in structures, sagging floors, and nonfunctional windows and doors. Collapsible soils typically impact earth at surface levels. Although the entire alignment is underground, stations have surface-level elements. As shown on Figure 10-6, alluvial deposits are present at all of Alternative 6’s stations and, as such, the hazard posed by collapsible soils is potentially high at those locations.

10.2.11 Lateral Spreading

Lateral spread is the finite, lateral displacement of sloping ground (0.1 to < 6 percent) as a result of pore pressure buildup or liquefaction in a shallow, underlying soil deposit during an earthquake. Lateral spreading, as a result of liquefaction, occurs when a soil mass slides laterally on a liquefied layer, and gravitational and inertial forces cause the layer, and the overlying non-liquefied material to move in a downslope direction. Due to the presence of mountainside areas in the Project Study Area, the hazard posed by lateral spreading is potentially high at those locations.

10.2.12 Slope Stability

Slope failures include many phenomena that involve the downslope displacement of material, triggered by static (i.e., gravity) or dynamic (i.e., earthquake) forces, such as landslides, rock-falls, debris slides, and soil creeps. Slope stability can depend on complex variables, including the geology, structure, and amount of groundwater present, as well as external processes such as climate, topography, slope geometry, and human activity. Landslides and other slope failures may occur on slopes of 15 percent or less; however, the probability is greater on steeper slopes that exhibit old landslide features such as scarps, slanted vegetation, and offset surfaces. Due to the presence of slopes (of 15 percent or greater) in the Project Study Area, the hazard posed by slope failures is potentially high near the mid-mountain shaft area.

10.2.13 Landslides

Landslides are the downhill movement of a mass of earth and rock. Landslides are a geological phenomenon that includes a wide range of ground movements, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary cause of a landslide, the following other factors contribute:

- Erosion by rivers, glaciers, or ocean waves
- Rock and soil slopes that are weakened through saturation by snowmelt or heavy rains
- Earthquakes that create stresses such that weak slopes fail
- Volcanic eruptions that produce loose ash deposits, heavy rain, and/or debris flows
- Vibrations from machinery, traffic, blasting, and even thunder
- Excess weight from accumulation of rain or snow, stockpiling of rock or ore from waste piles, or from human-made structures

As shown on Figure 10-10, the potential landslide hazard for Alternative 6 is focused within the Santa Monica Mountains portion of the alternative.

Figure 10-10. Alternative 6: Landslide Hazard Zones

Source: County of Los Angeles, eGIS, 2022; HTA, 2024

10.2.14 Soil Erosion

Soil erosion is the process by which soil particles are removed from a land surface by wind, water, or gravity. Most natural erosion occurs at slow rates; however, the rate of erosion increases when land is cleared of vegetation or structures, or otherwise altered and left in a disturbed condition. Erosion can occur as a result of, and can be accelerated by, site preparation activities associated with development.

Vegetation removal in pervious landscaped areas could reduce soil cohesion, as well as the buffer provided by vegetation from wind, water, and surface disturbance, which could render the exposed soils more susceptible to erosive forces.

Excavation or grading may result in erosion during construction activities, irrespective of whether hardscape previously existed at the construction site, because bare soils would be exposed and could be eroded by wind or water. The effects of erosion are intensified with an increase in slope (as water moves faster, it gains momentum to carry more debris), and the narrowing of runoff channels (which increases the velocity of water). Surface structures, such as paved roads and buildings, decrease the potential for erosion. Once covered, such as with a paved road, soil is no longer exposed to the elements, and erosion generally does not occur.

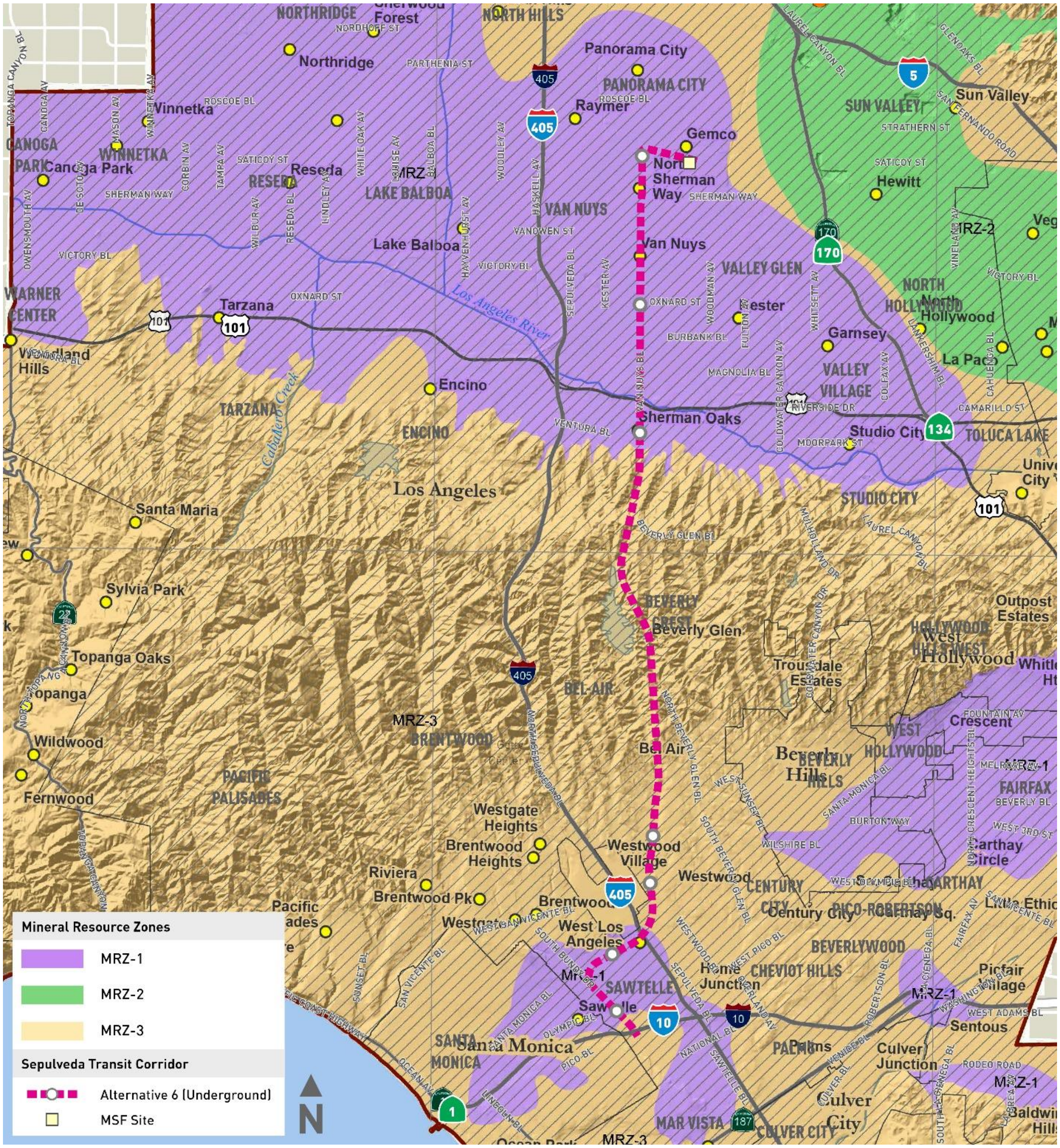
10.3 Mineral Resources

Mineral resource areas are identified according to the Surface Mining and Reclamation Act of 1975 and the following criteria for Mineral Resource Zones (MRZs), Scientific Resource Zones (SZs), and Identified Resource Areas. The MRZ and SZ categories used by the State Geologist in classifying the state's lands, the geologic and economic data, and the substantiation of which each unit MRZ or SZ assignment is based on land classification information provided by the State Geologist to the Board of Supervisors for the following areas:

- **MRZ-1:** Adequate information indicates that no significant mineral deposits are present or little likelihood exists for their presence. This zone shall be applied where well-developed lines of reasoning, based on economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is nil or slight.
- **MRZ-2:** Adequate information indicates that significant mineral deposits are present or a high likelihood for their presence exists. This zone shall be applied to known mineral deposits or where well-developed lines of reasoning, based on economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is high.
- **MRZ-3:** Areas containing deposits whose significance cannot be evaluated from available data.
- **MRZ-4:** Available information is inadequate for assignment to any other MRZ zone.
- **SZ Areas:** Areas containing unique or rare occurrences of rocks, minerals, or fossils that are of outstanding scientific significance shall be classified in this zone.

Alternative 6 would contain areas designated as MRZ-1 and MRZ-3 (Figure 10-11). The California Department of Conservation, Division of Mines and Geology has classified areas of regional significance as MRZ-2 (CGS, 2021). Alternative 6 would not be located within an area designated as MRZ-2. Alternative 6 would be largely located within areas designated as MRZ-3, which contains deposits whose significance cannot be evaluated from available data. Alternative 6 would be located within areas designated as MRZ-1 in the northern portion of Alternative 6 in the San Fernando Valley as well as the southern portion of Alternative 6 near West Los Angeles. MRZ-1-designated areas indicate that no significant mineral deposits are present or little likelihood exists for their presence.

Figure 10-11. Alternative 6: Mineral Resources



Source: CGS, 2021; HTA, 2024

10.4 Paleontological Resources

A Paleontological records search from the Natural History Museum of Los Angeles County (NHMLAC) revealed a fossil locality located directly within the Resource Study Area (RSA), indicating a high paleontological sensitivity in the area. Alternative 6 is a heavy rail system with an underground track configuration (Bell, 2023).

The records search found that Alternative 6 is mapped over LACM VP 1894. LACM VP 1894 is 0.25 miles south of the intersection of Sumac Drive and Beverly Glen Boulevard, on the west side of Beverly Glen Canyon. LACM VP 1894 produced a fossil bony fish (Osteichthyes) from within the Modelo Formation (Bell, 2023).

Underground components of Alternative 6 have increased impacts to paleontological resources. Deeper (older) portions of any paleontologically sensitive unit have the potential to produce rare or scientifically important taxa.

Additionally, 14 other fossil localities are located within 5 miles of the RSA that produced fossil vertebrates and invertebrates.

Paleontological sensitivity refers to the paleontological potential for a geologic unit to contain fossil remains, traces, and fossil-collecting localities. The following sensitivity ratings indicate the potential for containing significant paleontological resources.

- High paleontological sensitivity indicates that geologic units have a history of or are considered to have a high potential for paleontological resources (i.e., fossil remains).
- Moderate paleontological sensitivity indicates that fossil remains or traces have been found but are in poor condition, are a common paleontological resource, or do not have scientific significance.
- Low paleontological sensitivity indicates a low potential for containing fossil paleontological resources.
- No paleontological sensitivity indicates areas that are not conducive to significant paleontological resources due to environmental conditions.

For Alternative 6, it is difficult to quantify the number of sensitive formations and their sensitivity level with precision due to a blanket of soil that covers the entire RSA underground and current construction in the area. Appendix A to this technical report, the stand-alone Paleontological Technical Memorandum, contains a detailed analysis of paleontological resources.

10.5 Impacts Evaluation

10.5.1 Impact GEO-1: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map, issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.

10.5.1.1 Operational Impacts

As listed in Table 10-4 and shown on Figure 10-7, the Santa Monica Fault, designated as an Alquist-Priolo Earthquake Fault Zone, crosses the Alternative 6 alignment, which runs underground at this location. The fault intersects the alignment north of Massachusetts Avenue and I-405. The next nearest Alquist-Priolo Earthquake Fault Zones to Alternative 6 are the Hollywood Fault, located approximately 1.95 miles northeast of the mid-section of Alternative 6, and the Newport-Inglewood-Rose Canyon Fault, located approximately 3.14 miles northeast of the southern portion of Alternative 6.

The Alquist-Priolo Earthquake Fault Zoning Act prohibits the construction of structures for human occupancy (i.e., houses, apartments, offices, stations, etc.) on the surface trace of active faults.

However, the Alquist-Priolo Earthquake Fault Zoning Act does not prohibit the construction of non-habitable structures (i.e., not suitable to be lived in such as carport, roads, train tracks, bridges, etc.). Alternative 6 would construct a public transportation line with a fixed guideway within the Alquist-Priolo Earthquake Fault Zone. Because known active faults are capable of ground rupture under and in proximity to the proposed underground alignment, stations, and at-grade TPSS sites, fault rupture would present a risk, including the risk of loss, injury, or death to transit patrons and workers during operations. For Alternative 6, this could include damage to tunnel structures and stations, and at-grade TPSS site locations. Damage to these structures, in turn, could lead to operational and electrical hazards and compromise the safety and accessibility of Alternative 6. Despite these risks, transit structures have been and continue to be successfully designed and constructed based on mandatory design criteria as described in the following sections.

Alternative 6 is an HRT system with an underground track configuration and seven underground stations and TPSS sites. Operations of Alternative 6 would not directly or indirectly cause the rupture of a fault because the HRT trains would travel along a fixed guideway at a depth ranging between 40 to 470 feet below surface level which would not cause fault rupture. Therefore, operational impacts associated with substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault would be less than significant.

10.5.1.2 Construction Impacts

Construction of Alternative 6 would occur within the Santa Monica Fault zone, north of Santa Monica Boulevard and along I-405. A TBM would be used to construct the underground segment of the guideway. Tunneling depth would range between 60 feet to 750 feet. Underground stations would use a "cut-and-cover" construction method whereby the station structure would be constructed within a trench excavated from the surface that is covered by a temporary deck and backfilled during the later stages of station construction. In addition, portions of the Wilshire Boulevard/Metro D Line Station crossing underneath the Metro D Line Westwood/UCLA Station and underneath a mixed-use building at the north end of the station would be constructed using sequential excavation method (SEM) as it would not be possible to excavate the station from the surface.

Alternative 6 construction would not directly or indirectly exacerbate rupture of a known earthquake fault causing substantial adverse effects, including the risk of loss, injury, or death, because these elements do not reach a depth or be of an intensity that would affect geological processes such as faults. Therefore, construction impacts related to the rupture of a fault are less than significant.

10.5.1.3 Maintenance and Storage Facility

The proposed MSF would be situated east of the Van Nuys Metrolink Station, bounded by the Metrolink tracks on the north, Woodman Place on the south, Hazeltine Avenue on the west, and Woodman Avenue on the east. The proposed MSF would not be within an Alquist-Priolo Earthquake Fault Zone. The closest Alquist-Priolo Earthquake Fault Zone is the Hollywood fault located approximately 8.4 miles southeast from the proposed MSF. Therefore, there are no impacts related to loss, injury, or death involving the rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map during operations or construction.

10.5.2 Impact GEO-2: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking and/or seismic-related ground failure, including liquefaction?

10.5.2.1 Operational Impacts

Seismic-related ground failures include liquefaction, post-liquefaction settlements, and landslides. Hazards related to landslides is discussed in Section 10.5.3. Alternative 6, during operation activities would experience earthquake-induced ground-shaking activity because of its proximity to known active faults, as listed in Table 10-4 and shown on Figure 10-7 and Figure 10-8. Alternative 6 would be located in a seismically active region and would be subject to seismic ground shaking that could result in damage to structures or human injury or death. For Alternative 6, this could include damage to tunnel structures and stations, and at-grade TPSS sites. Seismic ground shaking could also injure humans using or working on the system from structural collapse. Therefore, Alternative 6 would experience moderate to high ground shaking from these fault zones, as well as some background shaking from other seismically active areas of the Southern California region.

Earthquakes are prevalent within Southern California, and potential to experience substantial seismic ground shaking is a common hazard for every project within the region. Alternative 6 would be designed and constructed consistent with the MRDC. Additionally, measures to minimize the risk of loss, injury, and death from the effects of earthquakes and seismic ground shaking for project elements would be designed and constructed in conformance with applicable portions of building and seismic code requirements, including the most recent edition of the CBC with specific provisions for seismic design, Metro's standard specifications, and industry standards.

Consistent with MRDC requirements, Alternative 6 structures would be designed to perform in accordance with the two-level seismic evaluation approach, based on the maximum design earthquake (MDE) and operating design earthquake (ODE) guidelines. A-grade structures would be designed and perform in accordance with federal, state, and local thresholds for seismicity. Additionally, compliance would be required with MRDC Section 5, Structural, which dictates that during final design, a geotechnical investigation must be conducted, including a detailed and site-specific evaluation of geotechnical hazards. The resulting final geotechnical engineering recommendations and any additional recommendations that come out of the review process would be incorporated into the final design plans, consistent with MRDC requirements and standard practice to address any unstable geologic and related conditions present along the alignment. Therefore, compliance with the latest earthquake-resistant building design standards and other seismic safety parameters would substantially reduce potential structural damage and the risk to public safety from seismic events by ensuring that strong seismic ground shaking would not cause potential substantial effects, including the risk of loss, injury, or death.

As mentioned in Section 10.2.7, liquefaction is considered most likely to occur within the first 50 feet below ground surface. The entire alignment would be significantly deeper than 50 feet below ground surface; therefore, the potential liquefaction impacts on the tunnel are low. As shown on Figure 10-9, Alternative 6 would have surface stations within a Liquefaction Zone at the Metro E Line, Santa Monica Boulevard, Wilshire/Metro D Line, Ventura Boulevard, and Metro G Line stations, and there is a high potential for liquefaction in these areas. Seismic-related ground failure and liquefaction could result in damage to structures and human injuries where the soil undergoes a temporary loss of strength. Ground instability could impact structural stability, which in turn could damage structures or injure humans occupying structures on unstable ground. The northern-most portion of the proposed alignment (near the northern terminus at the proposed Van Nuys Metrolink Station) and stations would be predominately in the younger alluvium where the potential for adverse impact due to liquefaction is considered moderate to high. However, the northern-most portion of the proposed alignment and the invert of stations would be about 80 to 90 feet below ground surface, deeper than where liquefaction commonly occurs, thereby minimizing the risk of liquefaction (Metro, 2024b).

Alternative 6 would be designed in accordance with design standards specific to ground stability. A site-specific geotechnical investigation would be performed during final design in compliance with the MRDC; the required design-level geotechnical investigation would provide information pertaining to the depths and areal extents of potential liquefaction and seismically induced settlement. During the design process, if it is determined that these hazards could result in an unacceptable soil or structural response, ground improvements such as dynamic compaction, stone columns, jet grouting, and cement deep soil mixing and compaction grouting or deep foundation support to account for liquefaction or seismically induced settlement potential would be implemented and would be consistent with the recommendations contained in the geotechnical investigation and design standards. Therefore, adherence to the provisions listed in the CBC and MRDC would substantially reduce potential structural damage and the risk to public safety from seismic events by ensuring that seismic-related ground failure and liquefaction would not cause potential substantial effects, including the risk of loss, injury, or death. As such, the potential impacts related to seismic-related ground failure and liquefaction would be less than significant during operations.

10.5.2.2 Construction Impacts

Alternative 6 would be located in a seismically active area. Active and potentially active faults in Southern California are capable of producing seismic ground shaking, and the Alternative 6 RSA would be anticipated to experience ground acceleration caused by these earthquakes. As stated previously, Alternative 6 would be surrounded by faults capable of generating a characteristic earthquake between M_W 6.0 and M_W 8.0. To reduce the risks associated with seismically induced ground shaking, which could include the risk of loss, injury, or death, the design of foundations and structures must consider the location and type of subsurface materials underlying Alternative 6. Because Alternative 6 would be located within the CBC, structures would be required to be designed in accordance with applicable parameters of the current CBC. PM GEO-1 and MM GEO-1, as defined in Section 10.6.2, would be implemented, as required by applicable local, state, or federal laws or regulations.

As shown on Figure 10-9, Alternative 6 traverses several Liquefaction Zones both within the San Fernando Valley and the Los Angeles Basin. Construction of Alternative 6 would occur within liquefaction zones, both within the San Fernando Valley and the Los Angeles Basin. A TBM would be used to construct the underground segment of the guideway. Tunneling depth would range between 60 feet to 750 feet. Underground stations would use a “cut-and-cover” construction method whereby the station structure would be constructed within a trench excavated from the surface that is covered by a temporary deck and backfilled during the later stages of station construction. In addition, portions of the Wilshire Boulevard/Metro D Line Station crossing underneath the Metro D Line Westwood/UCLA Station and underneath a mixed-use building at the north end of the station would be constructed using SEM as it would not be possible to excavate the station from the surface.

While TBM construction of the Alternative 6 would reach a depth that could cause ground disturbances thereby inducing liquefaction, construction of the underground alignment would not directly or indirectly cause strong seismic ground shaking and/or seismic-related ground failure. This is because construction activities of Alternative 6 do not reach a depth or be of an intensity that would affect geological processes such as faults. As such, impacts related to seismic ground shaking including liquefaction would be less than significant during construction activities.

Adherence to existing applicable regulations (i.e., the CBC, the MRDC, County of Los Angeles Building Code, and City of Los Angeles Building Code) would ensure that Alternative 6 remains with a less than significant impact associated with exposing people or structures to seismic ground shaking and liquefaction, including effects related to seismic-related ground failure during construction activities.

10.5.2.3 Maintenance and Storage Facility

The proposed MSF would be located east of the Van Nuys Metrolink Station and would encompass approximately 41 acres. The MSF would be designed to accommodate 94 vehicles and would be bounded by single-family residences to the south, the LOSSAN rail corridor to the north, Woodman Avenue to the east, and Hazeltine Avenue and industrial manufacturing enterprises to the west. Heavy rail trains would transition from underground to an at-grade configuration near the MSF, the northwest corner of the site. Trains would then travel southeast to maintenance facilities and storage tracks.

The site would include the following facilities:

- Two entrance gates with guard shacks
- Maintenance facility building
- MOW facility
- Storage tracks
- Carwash
- Cleaning platform
- Administrative offices
- Pedestrian bridge connecting the administrative offices to employee parking
- Two TPSSs

Operation and construction of the proposed HRT MSF do not involve extensive excavation and do not reach a depth or be of an intensity that would affect geological processes such as faults. As such, impacts related to seismic ground shaking including liquefaction would be less than significant during operations and construction.

10.5.3 Impact GEO-3: Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides?

10.5.3.1 Operational Impacts

As shown on Figure 10-10, Alternative 6 would traverse the Santa Monica Mountains, which are within a designated potential Landslide Hazard Zone (LHZ) and contain surface areas prone to landslides. Alternative 6 would construct a public transportation line with a fixed guideway.

According to the Caltrans Geotechnical Manual, the most adverse slope behavior is greatly influenced by water (Caltrans, 2020). Concentrated storm runoff can result in severe slope erosion leading to a loss of structural support and catastrophic failure. Perched groundwater and infiltration from irrigation, rainfall, or snowmelt frequently cause landslides. However, impacts related to topsoil erosion and water infiltration are managed separately and would not directly influence the operational impacts related to landslides.

Earthquake-induced landslides are slope failures/movements that occur from shaking during an earthquake event. Operational activities of Alternative 6 involve operating a public transportation line with a fixed guideway. Operational activities associated with Alternative 6 would not directly or indirectly cause strong seismic ground shaking including landslides as these activities would not involve interaction with geological processes such as faults or the alteration of natural slopes.

According to the USGS, certain human activities can cause landslides. They are commonly a result of building roads and structures without adequate grading of slopes, poorly planned alteration of drainage patterns, and disturbing old landslides (USGS, 2024). However, operational activities for Alternative 6 would not involve grading of slopes, modification of drainage systems, or disturbance of existing landslides. Additionally, the design of Alternative 6 would minimize interaction with natural slopes by employing an elevated guideway positioned above steep terrain and avoiding direct contact with unstable areas. The design would also incorporate drainage and erosion control measures to prevent water-related slope instability and comply with applicable geotechnical and engineering standards described in Section 2 Regulatory and Policy Framework. Therefore, Alternative 6 would have a less than significant impact related to landslides during operations.

10.5.3.2 Construction Impacts

As shown on Figure 10-10, the tunnel portal for Alternative 6 traverses through the Santa Monica Mountains which are within a designated LHZ making the stability of the tunnel and surrounding infrastructure during construction vulnerable during a landslide-related hazard. As such, the impacts associated with a landslide hazard within the Santa Monica Mountains are potentially significant.

Alternative 6 would be below ground surface and would traverse the Santa Monica Mountains but would be situated deep underground in a tunnel in this location and the risk of landslides would be low. The one location where the potential for landslides should be a consideration is at the proposed mid-mountain shaft site, including its existing access road to the location of the shaft site, which will be widened and graded; this location is within a CGS earthquake-induced LHZ (Metro, 2024c). No landslides are shown on any of the published geologic maps at the shaft location. Therefore, based on the available information, there does not appear to be a significant landslide hazard at the mid-mountain shaft site. Nevertheless, due to the steep terrain that characterizes the shaft site, there is some potential for a landslide. Future investigations to confirm the absence of a landslide at the shaft site would be required during the final design phase.

Construction of Alternative 6 would adhere to existing regulations and the provisions listed in the CBC and equivalent design criteria as the MRDC that require site-specific geotechnical evaluation during the final design phase that would include specific structural engineering recommendations. Grading and construction activities would be carried out in compliance with the regulatory requirements defined in Section 2 Regulatory and Policy Framework, including state regulations and the equivalent design criteria such as the MRDC, to account for the portion of Alternative 6 that would be within an LHZ.

The final design of the tunnel portal's retaining walls, and its temporary engineering would abide with structural engineering standards set forth in the provisions listed in the CBC. The CBC provisions that relate to the construction and design of the retaining walls include the requirements for foundation and soil investigations, excavation, grading, and fill-allowable, load-bearing values of soils. The CBC provision also relates to design of footings, foundations, and slope clearances, retaining walls, and pier, pile, driven, and CIP foundation support systems (Section 1810). Chapter 33 includes requirements for safeguards at work sites to ensure stable excavations and cut or fill slopes). Appendix J includes grading requirements for the design of excavations and fills (Sections J106 and J107) and for erosion control (Section J110). Construction activities are subject to occupational safety standards for excavation, shoring, and trenching as specified in Cal/OSHA regulations (CCR Title 8). Alternative 6 would require a site-specific slope-stability design to ensure adherence to the standards contained in the CBC and County of Los Angeles and City of Los Angeles guidelines, as well as by Cal/OSHA requirements for stabilization. The proposed Alternative 6 would include manufactured slopes in the retention basins, which would mostly occur on the perimeter of construction sites.

The combination of site-specific slope-stability design, compliance with applicable regulatory requirements, and the use of manufactured slopes and retention basins is anticipated to effectively manage constructed-slope instability such that impacts associated with constructed-slope instability, including landslides, are reduced, but may still be potentially significant.

This is particularly true for temporary slopes, as excavation activities for Alternative 6 within Landslide Zones could encounter unstable soils. Temporary slopes generally pose a higher risk of slope failure due to their steeper gradients compared to permanent, manufactured slopes. Similar to permanent slope construction, temporary slopes would be required to comply with Cal/OSHA requirements for shoring and stabilization.

To address these significant impacts MM GEO-2 would be implemented so that any excavations for the construction of the underground segment of Alternative 6 would shore excavation walls or flatten or "lay back" the excavation walls to a shallower gradient as required by applicable local, state, or federal laws or regulations to ensure stability of temporary slopes.

In addition, the construction of Alternative 6 would include a new vent shaft and access road in Stone Canyon, which is a sloped area that may be susceptible to landslides. Potential landslides during construction could cause injury or death to construction workers. With the implementation of MM GEO-2, the impacts associated with landslides and/or slope instability during construction activities would be reduced to less than significant.

10.5.3.3 Maintenance and Storage Facilities

The proposed MSF would be located west of Woodman Avenue and south of the LOSSAN rail corridor ROW. The proposed MSF would not be located on land designated as a LHZ Area shown on Figure 10-10, the closest landslide zone would be located approximately 4.10 miles south from the proposed MSF. Therefore, the proposed MSF would not directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides, and no impact would occur.

10.5.4 Impact GEO-4: Would the project result in substantial soil erosion or the loss of topsoil?

10.5.4.1 Operational Impacts

Implementation of Alternative 6 would not result in substantial soil erosion or the loss of topsoil during operations. Topsoil is the uppermost layer of soil — usually the top 6 to 8 inches —which has the highest concentration of organic matter and micro-organisms and is where most biological soil activity occurs. Plants generally concentrate their roots in, and obtain most of their nutrients from, this layer. Topsoil erosion is of concern when the topsoil layer is blown or washed away, which makes plant life or agricultural production impossible. In addition, significant erosion typically occurs on steep slopes where stormwater and high winds can carry topsoil down hillsides.

Some areas of pervious surfaces are associated with the open space areas within the adjacent Santa Monica Mountain region and a minimal extent of setbacks and residential yards along the Alternative 6 RSA. Since Alternative 6 would be entirely underground, operation of Alternative 6 would not result in substantial ground disturbance or an increase in the amount of exposed soil as compared to existing conditions and would not change the amount of erosion and spreading grounds within the Santa Monica Mountains and residential yards along the Alternative 6 RSA compared to existing conditions.

As described in the *Sepulveda Transit Corridor Project Water Resources Technical Report* (Metro, 2025), Alternative 6 would result in a net loss of impervious surface area. Most of Alternative 6 is underground and land surfaces with the proposed stations and other ancillary facilities in Alternative 6 are developed and covered by existing impervious surfaces. All seven stations would be underground, underneath existing impervious areas and would not require the creation of new impervious surfaces. The MSF would be constructed on existing impervious surfaces. Components that would slightly increase the existing impervious surface area include the mountain shaft facility, TPSS structures, and the access road. Alternative 6 is estimated to create approximately 146,596 square feet of impervious area. However, new pervious surface (approximately 542,135 square feet) would be created at the MSF on existing impervious surface. Therefore, Alternative 6 would result in a net increase of approximately 395,539 square feet of pervious area compared to existing conditions. Further details on new impervious surfaces and its impact on erosion resulting from Alternative 6 can be found in the *Sepulveda Transit Corridor Project Water Resources Technical Report* (Metro, 2025).

Alternative 6 would be designed to incorporate several sustainability features, such as native landscaping, rainwater cisterns for capture and reuse, permeable surfaces, soil improvements, increased vegetation, and on-site retention, in compliance with the *Low Impact Development Standards Manual* (LACDPW, 2014), which would serve to reduce impervious area and limit runoff that may cause erosion.

Alternative 6 would comply with post-construction measures in applicable National Pollutant Discharge Elimination System (NPDES) permits and Low Impact Development (LID) standards required by Los Angeles County and other local jurisdictions, which aim to minimize erosion impacts from development projects. With adherence to existing applicable regulations, Alternative 6 would result in a less than significant impact related to substantial soil erosion or the loss of topsoil during operations.

10.5.4.2 Construction Impacts

Ground-disturbing activities occurring during construction would temporarily expose surficial soils to wind and water erosion and have the potential to temporarily increase erosion and loss of topsoil. Construction work that would involve ground-disturbing activities would include installation of the emergency vent access road, utility relocations, mass excavation of the underground stations, and grading relating to these activities. The Santa Monica Mountains have areas of pervious surfaces at the proposed access road at the mid-mount facility at SCR. Construction of the access road would involve considerable earth-moving activities to grade and pave the roadway. However, construction activities would be required to comply with existing regulatory requirements, including implementation of best management practices and other erosion and sedimentation control measures that would ensure that grading, excavation, and other earth-moving activities would avoid a significant impact.

There would be a potential for temporary construction-related soil erosion because Alternative 6 would involve grading and excavation operations that could expose soils. Metro would be required to prepare a *Stormwater Pollution Prevention Plan*, and a site-specific *Standard Urban Storm Water Mitigation Plan* (SUSMP), which is part of the NPDES Municipal General Permit. Preparation of the site-specific SUSMP would describe the minimum required best management practices to be incorporated into the Alternative 6 design and on-going operation of the facilities. Prior to the initiation of grading activities associated with implementation of Alternative 6, Metro would submit a site-specific SUSMP to reduce the discharge of pollutants to the maximum extent practical using best management practices, control techniques and systems, design and engineering methods, and other provisions that are appropriate during construction activities. All development activities associated with Alternative 6 would comply with the site-specific SUSMP.

Preparation of a site-specific SUSMP and adherence to existing regulations would ensure the maximum practicable protection available for soils excavated and disposed during the construction of buildings and associated infrastructure. Compliance with existing applicable regulations would minimize effects from erosion through repair and rehabilitation of topsoil post-construction and ensure consistency with the *Regional Water Quality Control Board Water Quality Control Plan*. Therefore, Alternative 6 would have a less than significant impact associated with soil erosion or loss of topsoil during construction activities.

10.5.4.3 Maintenance and Storage Facilities

There would be a potential for temporary construction-related soil erosion because the proposed MSF would involve grading and excavation operations that could expose soils. Metro would be required to prepare a *Stormwater Pollution Prevention Plan* and a site-specific SUSMP, which is part of the NPDES Municipal General Permit. Preparation of the site-specific SUSMP would describe the minimum required best management practices to be incorporated into the proposed MSF design and on-going operation of the facilities. Prior to the initiation of grading activities associated with implementation of the proposed MSF, Metro would submit a site-specific SUSMP to reduce the discharge of pollutants to the maximum extent practical using best management practices, control techniques and systems, design and engineering methods, and other provisions that are appropriate during construction activities. All development activities associated with the proposed MSF would comply with the site-specific SUSMP. Preparation of a site-specific SUSMP and adherence to existing regulations would ensure the maximum practicable protection available for soils excavated and disposed during the construction of buildings and associated infrastructure. Compliance with existing applicable regulations would minimize effects from erosion through repair and rehabilitation of topsoil post-construction and ensure consistency with the *Regional Water Quality Control Board Water Quality Control Plan*. Therefore, the proposed MSF would have a less than significant impact associated with soil erosion or loss of topsoil during construction activities.

Operation of the proposed MSF would include the maintenance, cleaning, and storage of HRT vehicles. The proposed MSF site would be located within an urbanized area that is primarily impervious with no exposed soil. Operation of the proposed MSF would not result in ground disturbance or a change in the amount of exposed soil as compared to existing conditions and would adhere to existing regulations. The proposed MSF would comply with post-construction measures in applicable NPDES permits and LID standards required by Los Angeles County and the City of Los Angeles that aim to minimize erosion impacts from development projects. Therefore, the proposed MSF would result in a less than significant impact related to substantial soil erosion or the loss of topsoil during operations and construction.

10.5.5 Impact GEO-5: Would the project be located on a geographic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?

10.5.5.1 Operational Impacts

Section 10.5.2 addresses impacts related to liquefaction, and Section 10.5.3 addresses impacts related to landslides. The following analysis addresses impacts related to unstable soils as a result of subsidence, differential settlement, lateral spreading, or collapse.

Collapsible soils and the potential for lateral spreading to impact Alternative 6 is low because most of the areas with liquefaction potential are along relatively flat terrain and liquefiable layers are below the groundwater table, as identified in the *Sepulveda Transit Corridor Project, Preliminary Geotechnical Design and Data Report* (Metro, 2024c). Additionally, ground shaking leading to liquefaction of saturated soil could result in lateral spreading where the soil undergoes a temporary loss of strength, and if the liquefied soil is not contained laterally, it may result in deformation of the slope.

As mentioned in Section 10.2.7, liquefaction is considered most likely to occur within the first 50 feet below ground surface. The entire alignment would be significantly deeper than 50 feet below ground surface; therefore, the potential liquefaction impacts on the tunnel are low.

Using unsuitable materials for fill and/or foundation support would have the potential to create future heaving, subsidence, spreading, or collapse problems, which would lead to building settlement and/or utility line and pavement disruption. Structural engineering standards to address geological conditions are part of standard construction requirements and standard construction practices. Alternative 6 would be designed in accordance with MRDC Section 5, Structural; Metro's Supplemental Seismic Design Criteria (2017); and the California Seismic Hazards Mapping Act. Furthermore, Alternative 6 would be designed in accordance with recommendations developed in a detailed geotechnical report prepared during final design, which would provide site-specific information pertaining to the depths and areal extents of lateral spreading, subsidence, or collapse.

During the design process, if it is determined that these conditions identified in the geotechnical report could result in an unacceptable soil or structural response (to be defined during final design and dependent on the type of structure), the resulting final geotechnical engineering would include recommendations that would be incorporated into the final design plans, consistent with standard practice to address any unstable geologic and related conditions present along the alignment. Recommendations may include deep foundations and/or ground improvements such as dynamic compaction, stone columns, jet grouting, and cement deep soil mixing and compaction grouting.

Given compliance with these regulatory and design requirements, Alternative 6 would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils as a result of subsidence, differential settlement, lateral spreading, or collapse during operations.

10.5.5.2 Construction Impacts

Section 10.5.2 addresses impacts related to liquefaction, and Section 10.5.3 addresses impacts related to landslides. The following analysis addresses impacts related to unstable soils as a result of subsidence, differential settlement, lateral spreading, or collapse.

Excavation for construction of underground structures, such as station boxes, cut-and-cover tunnels, and tunnel portals would be reinforced by shoring systems to protect abutting buildings, utilities and other infrastructure. Tunneling using a TBM would result in ground volume loss and potential ground movements. Dewatering, when performed to create a dry work condition for construction of the underground structures, would result in compaction or consolidation of the subsurface soils and thus result in surface settlements. Additionally, the use of unsuitable materials for fill and/or foundation support would have the potential to create future heaving, subsidence, spreading, or collapse problems leading to foundation and pavement settlement. Using such materials exclusively for landscaping would not cause these problems. An acceptable degree of soil stability can be achieved for expansive or compressible material by the incorporation of soil treatment programs (replacement, grouting, compaction, drainage control, etc.) in the excavation and construction plans that will be prepared to address site-specific soil conditions. A site-specific evaluation of soil conditions is required and must contain recommendations for ground preparation and earthwork specific to the site.

As mentioned in Section 10.2.8, subsidence typically impacts surface level soils. Although the entire alignment is in a relatively deep subsurface tunnel, stations have surface level elements. Moreover, alluvial deposits are susceptible to subsidence, especially when they consist of loose, unconsolidated sediments. As shown on Figure 10-6, alluvial deposits are present at all of Alternative 6's stations and, as such, the hazard posed by subsidence is potentially high at those locations.

Alternative 6 would be in compliance with the regulatory requirements as defined in PM GEO-2 as described in Section 10.6. Under PM GEO-2, a site-specific evaluation of soil conditions that shall contain recommendations for ground preparation, earthwork, and compaction specification based on the geological conditions specific to the site. As described in Section 10.6, MM GEO-1 through MM GEO-5 would be implemented as part of Alternative 6. Implementing MM GEO-3 would ensure compliance with the recommendations of the final soils and geotechnical report, which would provide site-specific information pertaining to the depths and areal extents of lateral spreading, subsidence, or collapse. MM GEO-5 specifies that prior to construction, Metro shall prepare a *Construction Management Plan* (CMP) detailing how to address geologic constraints and minimize or avoid impacts to geologic hazards during construction.

Adherence to existing applicable regulations and policies, and implementation of MM GEO-1 through MM GEO-5, would ensure the maximum practicable protection available for users of buildings and infrastructure and associated trenches, slopes, and foundations. Therefore, Alternative 6 would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils.

10.5.5.3 Maintenance and Storage Facilities

As addressed in Section 10.5.2.2 and Section 10.5.5.2, the proposed MSF would be located on stable soils where no liquefaction or landslide zones are present. Construction and operations would not occur on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed MSF, and potentially result in on- or off-site landslides, lateral spreading, subsidence, liquefaction or collapse. The proposed MSF would be designed in compliance with applicable local, state, or federal laws or regulations, including recommendations on engineering and design considerations, as described in Section 10.5.5.2 and identified in MM GEO-1 through MM GEO-5. Thus, operations and construction of the proposed MSF would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

10.5.6 Impact GEO-6: Would the project be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property?

10.5.6.1 Operational Impacts

Expansive soils can be found almost anywhere, particularly in coastal plains and low-lying valleys such as the Los Angeles Basin and San Fernando Valley. Clay-rich soils may exist locally within alluvial soils present along Alternative 6 that could swell and shrink with wetting and drying. The change in soil volume is capable of exerting enough force on structures to damage foundations, structures, and underground utilities. Damage can also occur as these soils dry out and contract. As part of PM GEO-2, a

California-registered geologist and geotechnical engineer would submit to and conduct a site-specific evaluation of unstable soil conditions to confirm the existence of expansive soils.

While expansive soils could have an impact on project elements, operational activities of Alternative 6 do not directly or indirectly cause risks of life or property as operations would not involve wetting or drying of expansive soils. Therefore, impacts related to expansive soils are less than significant during operations.

10.5.6.2 Construction Impacts

Construction activities for Alternative 6 primarily involve building underground sections and its underground stations. The underground guideway will be constructed using a TBM. All stations would be constructed using a “cut-and-cover” method whereby the station structure would be constructed within a trench excavated from the surface that is covered by a temporary deck and backfilled during the later stages of station construction. In addition, portions of the Wilshire Boulevard/Metro D Line Station crossing underneath the Metro D Line Westwood/UCLA Station and underneath a mixed-use building at the north end of the station would be constructed using SEM as it would not be possible to excavate the station from the surface.

Expansive soils can be found almost anywhere, including the Los Angeles Basin, Santa Monica Mountains, and San Fernando Valley. Expansive soils could have an impact on project elements, including the proposed stations, guideway, and TPSS sites. Construction of Alternative 6 includes excavation and surface ground disturbances, if expansive soils do exist, construction activities have the potential to create substantial direct or indirect risks to life or property. As such, impacts related to construction activities could be potentially significant.

To reduce these risks, Alternative 6 would be designed in accordance with the equivalent seismic design criteria such as the MRDC, Los Angeles County and other applicable local building codes, and the CBC. This includes compliance with MRDC Section 5 (or equivalent seismic design criteria), which requires the preparation of a geotechnical investigation during final design (refer to Section 2 Regulatory and Policy Framework for additional information). This design-level geotechnical investigation must include a detailed evaluation of geologic hazards, including the depths and areal extents of liquefaction, soil expansiveness, lateral spread, and seismically induced settlement. This investigation would include collecting soil samples and performing tests to assess the potential for corrosion, consolidation, expansion, and collapse. Based on the investigation and test results, specific design recommendations, including potential remediation of expansive soils, would be developed to address any identified issues. Expansive soil remediation could include soil removal and replacement, chemical treatment, or structural enhancements.

Alternative 6 would be in compliance with the regulatory requirements as defined in PM GEO-2 which calls for a California-registered geologist and geotechnical engineer to submit to and conduct a site-specific evaluation of unstable soil conditions to confirm the existence of expansive soils. The evaluation would also provide recommendations for ground preparation and earthwork activities specific to the site.

Moreover, Alternative 6 would be required to comply with applicable provisions of the CBC and MRDC regarding to soil hazard-related design, as described by PM GEO-3. The MRDC and the County of Los Angeles and City of Los Angeles building codes require site-specific investigations and reports for each construction site. The reports must identify any unsuitable soil conditions and provide recommendations for foundation type and design criteria, consistent with the analysis and building code standards. Regulations exist to address weak soil issues, including expansion. PM GEO-3, as described in Section 10.6.2, would be implemented and as such, Alternative 6 would comply with applicable local, state, or federal laws or regulations to address any potential weak soil issues during construction.

Finally, prior to construction, the Project shall implement MM GEO-5, which requires preparation of a CMP which addresses geologic hazards such as soils with shrink-swell potential (expansive soils) and outlines strategies to minimize or avoid impacts.

With compliance with the regulatory requirements as defined PM GEO-2, PM GEO-3, and implementation of MM GEO-5, Alternative 6 would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils during construction.

10.5.6.3 Maintenance and Storage Facilities

Operations related to the proposed MSF do not involve grading, excavation, or other ground disturbances. Therefore, impacts related to operational activities are less than significant.

Construction of the proposed MSF may involve grading, excavation, or other ground disturbances. If expansive soils exist at these sites, construction activities have the potential to create substantial direct or indirect risks to life or property. As such, impacts related to construction activities could be potentially significant.

The proposed MSF would be in compliance with the regulatory requirements as defined in PM GEO-2 which calls for a California-registered geologist and geotechnical engineer to submit to and conduct a site-specific evaluation of unstable soil conditions to confirm the existence of expansive soils. The evaluation would also provide recommendations for ground preparation and earthwork activities specific to the site. Moreover, the proposed MSF would be required to comply with applicable provisions of the CBC and MRDC regarding soil hazard-related design, as described by PM GEO-3. Finally, prior to construction, the proposed MSF shall implement MM GEO-5, which requires the preparation of a CMP which addresses geologic hazards such as soils with shrink-swell potential (expansive soils) and outlines strategies to minimize or avoid impacts.

With compliance with the regulatory requirements as defined in PM GEO-2, PM GEO-3, and implementation of MM GEO-5, the proposed MSF would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils during construction.

10.5.7 Impact GEO-7: Would the project have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?

10.5.7.1 Operational Impacts

No septic systems or alternative wastewater disposal systems are proposed for Alternative 6. Alternative 6 would have no impacts associated with soils incapable of adequately supporting such systems during operations.

10.5.7.2 Construction Impacts

No septic systems or alternative wastewater disposal systems are proposed for Alternative 6. Alternative 6 would have no impacts associated with soils incapable of adequately supporting such systems during construction activities.

10.5.7.3 Maintenance and Storage Facilities

No septic systems or alternative wastewater disposal systems are proposed for the proposed MSF. Therefore, the proposed MSF would have no impacts associated with soils incapable of adequately supporting such systems during operations.

10.5.8 Impact GEO-8: Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

10.5.8.1 Operational Impacts

Operations of Alternative 6 would not include activities that involve ground disturbance. Therefore, there would be no operational impacts related to paleontological resources.

10.5.8.2 Construction Impacts

The geologic units mapped within the project footprint for Alternative 6 are young alluvium, unit 2 (Qya2), young alluvium fan deposits, unit 1 (Qyf1), young alluvium fan deposits, unit 2 (Qyf2), Modelo Formation undivided (Tm), Modelo Formation sandstone (Tms), Modelo Formation Topanga Group undivided (Tt), Modelo Formation diatomaceous shale (Tmd), Cretaceous tonalite (Kt), Santa Monica Slate spotted slate (Jsms), and Santa Monica Slate phyllite (Jsmp). Cretaceous tonalite (Kt) was formed by the cooling of molten rock and thus cannot contain fossils. The Santa Monica Slate phyllite (Jsmp) and artificial fill (af) have “No” paleontological sensitivity. As stated before, knowing for certain what geologic units will be impacted at depth is difficult to specify without on-site monitoring of the sediments in any given working area. However, the sediments mapped at the surface of where the tunnel system would go for Alternative 6 are mapped as Qya2, Qyf1, Qyf2, Tm, Tms, Tt, Tmd, Jsms, Santa Monica Slate undivided (Jsm), and Jsmp. Generally, geologic units such as the Santa Monica Slate (Jsms, Jsmp) do not have any paleontological sensitivity to preserve fossil material. The Santa Monica Slate is a geologic unit consisting of metamorphic rock, which undergoes intense pressure and temperature, chemically altering it from the original form. This metamorphic process usually destroys and deforms any fossil material that could have been located within; however, because of the relatively low grade of metamorphism, enough relevant features of the fossils were preserved in portions of the Santa Monica Slate. When the portion of the Santa Monica Slate with “Unknown” sensitivity (Jsms) is encountered, the project paleontologist would need to determine if low-grade metamorphic conditions are present. If that is the case, that portion of the unit (Jsms) may be considered “Low” paleontological sensitivity and monitored accordingly (Imlay, 1963). Additionally, the Qyf1, Qyf2, and Qya2 have a “Low” sensitivity for preserving fossil material because these units are too young to have preserved any significant fossil material. The geologic map units labelled as Tm, Tms, Tmd, and Tt all have a high sensitivity for preserving fossil material due to their age, as do the fossil localities found within the same map units nearby (Bell, 2023).

Possible construction impacts involved with Alternative 6 would all be a result of access, staging and lay down areas that would be required for placing the heavy rail track and excavating the tunnel. Additionally, there would also be potentially significant impacts to surrounding sediments for staging areas and access pathways for all seven of the underground stations that are planned for Alternative 6 (Metro E Line Expo/Bundy Station, Santa Monica Boulevard Station, Wilshire Boulevard/Metro D Line Station, UCLA Gateway Plaza Station, Ventura Boulevard/Van Nuys Boulevard Station, Metro G Line Van Nuys Station, and Van Nuys Metrolink Station).

An automated TBM would excavate the tunnels for the underground portion of Alternative 6. The TBM would excavate sediments to the dimensions of the finished tunnel, remove the sediments from the forward portion of the TBM via an internal conveyer belt, and erect the concrete walls of the tunnel. The operation of the TBM would not allow the monitor to view the sediments as they are being excavated, or the walls of the tunnel following removal of excess sediments and prior to the installation of the tunnel's concrete walls. For these reasons, monitoring paleontological resources adjacent to the TBM would not be possible. Thus, in consideration of the California Environmental Quality Act (CEQA), excavations for tunnel construction would result in significant and unavoidable impacts to paleontological resources in paleontologically sensitive geologic units (*Paleontological Technical Memorandum*, Attachment 1, Figure 5 of this report) (SVP, 2010; Scott and Springer, 2003).

When considering Quaternary aged deposits, deeper (i.e., older) portions of paleontologically sensitive geologic units are generally more sensitive from a scientific point of view. Thus, a mapped geologic unit considered to have low paleontological sensitivity at the surface has the potential to become more sensitive paleontologically, at depth. Therefore, the impact to paleontological resources at TBM launching and extracting sites would be significant (*Paleontological Technical Memorandum*, Attachment 1, Figure 5 of this report). However, when excavations take place to launch and extract the TBM in paleontologically sensitive units, MM GEO-6 through MM GEO-9 shall be implemented to reduce the impact to paleontological resources to less than significant (SVP, 2010; Scott and Springer, 2003).

10.5.8.3 Maintenance and Storage Facilities

The impacts involved with the MSF would include all administrative buildings, maintenance buildings, wash facilities, drive aisles, and storage tracks. The surface rocks in the underground portions of the proposed MSF are mapped as Qya2 but may be more paleontologically sensitive (older) than indicated at depth. There should be a qualified paleontologist to monitor ground disturbance when this unit is encountered (SVP, 1995; Bell, 2023). With implementation of MM GEO-6 through MM GEO-9, impacts associated with the MSF would be less than significant.

10.5.9 Impact GEO-9: Would the project result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state or result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?

10.5.9.1 Operational Impacts

Operation of Alternative 6 would not require excavation that may affect mineral resources. No mining operations are present within the Alternative 6 RSA, so operation of Alternative 6 would not disrupt mining operations. Therefore, Alternative 6 would have no operational impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

10.5.9.2 Construction Impacts

Construction of Alternative 6 would require excavation (cut and cover) for underground stations and the vent shaft in Stone Canyon, as well as TBM use for tunnel construction. However, Alternative 6 would not be located in an area with known mineral deposits. As mentioned in Section 10.3, Alternative 6 is located in areas designated as MRZ-1 and MRZ-3. The California Department of Conservation, Division of Mines and Geology has classified areas of regional significance as MRZ-2 (CGS, 2021). Alternative 6 would not be located within an area designated as MRZ-2. Alternative 6 would be located within areas designated as MRZ-1 in the northern portion of Alternative 6 in the San Fernando Valley as well as the southern portion of Alternative 6 near West Los Angeles. MRZ-1-designated areas indicate that no significant mineral deposits are present or little likelihood exists for their presence. No mining operations are present within the Alternative 6 RSA, so construction of Alternative 6 would not disrupt mining operations. Therefore, Alternative 6 would have no construction impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

10.5.9.3 Maintenance and Storage Facilities

Operation and construction of the MSF would not require excavation that may affect mineral resources. No mining operations are present within or in the vicinity of the MSF. Therefore, the MSF would have no operational or construction impacts related to the loss of availability of a known mineral resource or a locally important mineral resource recovery site.

10.6 Project and Mitigation Measures

10.6.1 Operational Impacts

No mitigation measures are required.

10.6.2 Construction Impacts

Alternative 6 would implement the following project and mitigation measures to ensure that impacts to the geology, soils, and seismicity remain less than significant during construction activities.

PM GEO-1: *The Project shall demonstrate to the County of Los Angeles and the City of Los Angeles that the design of the Project complies with all applicable provisions of the California Building Code with respect to seismic design. Compliance shall include the following:*

- *California Building Code Seismic Zone 4 Standards as the minimum seismic-resistant design for all proposed facilities*
- *Seismic-resistant earthwork and construction design criteria (i.e., for the construction of the tunnel below ground surface, liquefaction, landslide, etc.), based on the site-specific recommendations of a California Registered Geologist in cooperation with the Project Engineers.*
- *An engineering analysis to characterize site specific performance of alluvium or fill where either forms part or all of the support.*

PM GEO-2: *A California-registered geologist and geotechnical engineer shall submit to and have approval by the Project a site specific evaluation of unstable soil conditions, including recommendations for ground preparation and earthwork activities specific to the site and in conformance with City of Los Angeles Building Code, County of Los Angeles Building Code, the California Building Code, Metro Rail Design Criteria (as applicable), and Caltrans Structure Seismic Design Criteria.*

PM GEO-3: *The Project shall demonstrate that the design of the Project complies with all applicable provisions of the County of Los Angeles Building Code and City of Los Angeles Building Code.*

MM GEO-1: *The Project's design shall include integration and installation of early warning system to detect and respond to strong ground motion associated with ground rupture. Known active fault(s) (i.e., Santa Monica Fault) shall be monitored. Linear monitoring systems such as time domain reflectometers or equivalent or more effective* *technology shall be installed along fixed guideway in the zone of potential ground rupture.*

MM GEO-2: *Where excavations are made for the construction of the below surface tunnel, the Project shall either shore excavation walls with shoring designed to withstand additional loads or reduce the slope of the excavation walls to a shallower gradient. Excavation spoils shall not be placed immediately adjacent to excavation walls unless the excavation wall is shored to support the added load. Spoils should be stored at a safe distance from the excavation site to prevent undue pressure on the walls.*

MM GEO-3: *The Project shall comply with the recommendations of the final soils and geotechnical report. These recommendations shall be implemented in the design of the Project, including but not limited to measures associated with site preparation, fill placement, temporary shoring and permanent dewatering, groundwater seismic design features, excavation stability, foundations, soil stabilization, establishment of deep foundations, concrete slabs and pavements, surface drainage, cement type and corrosion measures, erosion control, shoring and internal bracing, and plan review.*

MM GEO-4: *In locations where soils have a potential to be corrosive to steel and concrete, the soils shall be removed, and buried structures shall be designed for corrosive conditions, and corrosion-protected materials shall be used in infrastructure.*

MM GEO-5: *Prior to construction, the Project shall prepare a Construction Management Plan (CMP) that addresses geologic constraints and outlines strategies to minimize or avoid impacts to geologic hazards during construction. The plan shall address the following geological and geotechnical constraints/resources and incorporate standard mitigation measures (shown in parentheses):*

- *Groundwater withdrawal (using dewatering pumps and proper disposal of contaminated groundwater according to legal requirements)*
- *Risk of ground failure from unstable soils (retaining walls and inserting soil stabilizers)*
- *Subsidence (retaining walls and shoring)*
- *Erosion control methods (netting on slopes, bioswales, sediment basins, re-vegetation)*
- *Soils with shrink-swell potential (inserting soil stabilizers)*
- *Soils with corrosive potential (protective coatings and protection for metal, steel or concrete structures, soil treatment, removal of corrosive soils and proper disposal of any corrosive soils)*
- *Impact to topsoils (netting, and dust control)*
- *The recommendations of the CMP would be incorporated into the project plans and specifications.*

MM GEO-6: *The potential to avoid impacts to previously unrecorded paleontological resources shall be avoided by having a qualified Paleontologist or Archaeologist cross-trained in paleontology, meeting the Society of Vertebrate Paleontology Standards retained as* *the project paleontologist, with a minimum of a bachelor's degree (B.S./B.A.) in geology, or related discipline with an emphasis in paleontology and demonstrated experience and competence in paleontological research, fieldwork, reporting, and curation. A paleontological monitor, under the guidance of the project paleontologist, shall be present as required by the type of earth-moving activities in the Project, specifically in areas south of Ventura Boulevard that have been deemed areas of high sensitivity for paleontological resources. The monitor shall be a trained paleontological monitor with experience and knowledge of sediments, geologic formations, and the identification and treatment of fossil resources.*

MM GEO-7: *A Paleontological Resources Impact Mitigation Program (PRIMP) shall be prepared by a qualified paleontologist. The PRIMP shall include guidelines for developing and implementing mitigation efforts, including minimum requirements, general fieldwork, and laboratory methods, threshold for assessing paleontological resources, threshold for excavation and documentation of significant or unique paleontological resources, reporting requirements, considerations for the curation of recovered paleontological resources into a relevant institution, and process of documents to Metro and peer review entities.*

MM GEO-8: *The project paleontologist or paleontological monitor shall perform a Workers Environmental Awareness Program training session for each worker on the project site to familiarize the worker with the procedures in the event a paleontological resource is discovered. Workers hired after the initial Workers Environmental Awareness Program training conducted at the pre-grade meeting shall be required to take additional Workers Environmental Awareness Program training as part of their site orientation.*

MM GEO-9: *To prevent damage to unanticipated paleontological resources, a paleontological monitor shall observe ground-disturbing activities including but not limited to grading, trenching, drilling, etc. Paleontological monitoring shall start at full time for geological units deemed to have "High" paleontological sensitivity. Geological units deemed to have "Low" paleontological sensitivity shall be monitored by spot checks. No monitoring is required for geologic units identified as having "No" paleontological sensitivity. "Unknown" paleontological sensitivity is assigned to the less metamorphosed portions of the Santa Monica Slate, as detailed below.*

- *The monitor shall be empowered to temporarily halt or redirect construction efforts if paleontological resources are discovered. The paleontological monitor shall flag an area 50 feet around the discovery and notify the construction crew immediately. No further disturbance in the flagged area shall occur until the qualified paleontologist has cleared the area. In consultation with the qualified paleontologist, the monitor shall quickly assess the nature and significance of the find. If the specimen is not significant, it shall be quickly removed, and the area cleared. In the event paleontological resources are discovered and deemed by the project paleontologist to be scientifically important, the paleontological resources shall be recovered by excavation (i.e., salvage and bulk sediment sample) or immediate removal if the resource is small enough and can be removed safely in this fashion without damage to the paleontological resource. If the discovery is significant, the qualified paleontologist shall notify Metro immediately. In* *consultation with Metro, the qualified paleontologist shall develop a plan of mitigation, which will likely include salvage excavation and removal of the find, removal of sediment from around the specimen (in the laboratory), research to identify and categorize the find, curation of the find in a local qualified repository, and preparation of a report summarizing the find.*

- *Generally, geologic units that have endured metamorphic processes (i.e., extreme heat and pressure over long periods of time) do not contain paleontological resources. The Santa Monica Slate, originally a fossiliferous shale, has been subjected to various levels of metamorphism and thus, in areas of "low-grade metamorphism," paleontological resources may be discovered. Due to the rarity of paleontological resources dating to the Mesozoic (between approximately 65.5 to 252 million years ago) of Southern California, any such materials have high importance to the paleontology of the region. When encountered, the project paleontologist shall assess the levels of metamorphism that portion of the Santa Monica Slate has experienced. The Santa Monica Slate shall be monitored part time where the project paleontologist has determined lower levels of metamorphism have taken place and the preservation of paleontological resources is possible. If exposures of the Santa Monica Slate have been subjected to high levels of metamorphism (i.e., phyllite components of Jsmp), paleontological monitoring in that portion of the formation is not necessary.*
- *Recovered paleontological resources shall be prepared, identified to the lowest taxonomic level possible, and curated into a recognized repository (i.e., Natural History Museum of Los Angeles County). Bulk sediment samples, if collected, shall be "screen-washed" to recover the contained paleontological resources, which will then be identified to the lowest taxonomic level possible, and curated (as above). The report and all relevant field notes shall be accessioned along with the paleontological resources.*

10.6.3 Impacts After Mitigation

Adherence to existing regulations and implementation of PM GEO-1 and MM GEO-1 would ensure that Alternative 6 remains with a less than significant impact associated with exposing people or structures to seismic ground shaking, including effects related to seismic-related ground failure during construction activities.

Adherence to existing regulations and implementation of PM GEO-1 and MM GEO-1 would result in a less than significant impact for Alternative 6.

With implementation of MM GEO-2 and adherence to existing regulations, Alternative 6 would have a less than significant impact associated with landslides and/or slope instability during construction activities.

Adherence to existing regulations and policies, and implementation of PM GEO-2 and MM GEO-3 through MM GEO-5, would ensure the maximum practicable protection available for users of buildings and infrastructure and associated trenches, slopes, and foundations. Therefore, Alternative 6 would have a less than significant impact associated with the exposure of people or structures to hazards associated with unstable geologic units or soils.

With implementation of PM GEO-3 and adherence to existing regulations, Alternative 6 would have a less than significant impact regarding the exposure of people or structures to hazards related to expansive soils.

Possible construction impacts involved with paleontological resources would all be a result of access, staging, and lay down areas that would be required for placing the heavy rail track and excavating the tunnel. With implementation of MM GEO-6 through MM GEO-9, impacts to surrounding sediments for staging areas and access pathways for all seven of the underground stations that are planned for Alternative 6 (Metro E Line Expo/Bundy Station, Santa Monica Boulevard Station, Wilshire Boulevard/Metro D Line Station, UCLA Gateway Plaza Station, Ventura Boulevard/Van Nuys Boulevard Station, Metro G Line Van Nuys Station, and Van Nuys Metrolink Station) would be reduced to less than significant.

11 PREPARERS OF THE TECHNICAL REPORT

Name	Title	Experience (Years)
Edgar Mejia	Transportation Planner	5
Jaime Guzman	Senior Transportation Project Manager	18
Rachel Seiberg	Transportation Planner	3
Jason Leung	Transportation Planner	2
Jennifer J, Lee	Transportation Project Manager	18
Brian Kussman	Principal Paleontologist	27

12 REFERENCES

Bell, A. 2023. Paleontological Record Search for the Sepulveda Corridor Transit Project. *Natural History Museum of Los Angeles County*.

California Building Standards Commission. 2022. *California Building Standards Code, 2022 Triennial Edition of Title 24.* dgs.ca.gov/BSC/Codes. Accessed March 27, 2023.

California Department of Conservation, Division of Mines and Geology. 1997. Seismic Hazard Zone Report for the Van Nuys 7.5-Minute Quadrangle, Los Angeles County, California. CGS Information Warehouse: Regulatory Maps (ca.gov).

California Department of Conservation, Division of Mines and Geology. 1998. Seismic Hazard Zone Report for the Beverly Hills 7.5-Minute Quadrangle, Los Angeles County, California. CGS Information Warehouse: Regulatory Maps (ca.gov).

California Department of Conservation, Mine Reclamation. 2023. SMARA Statutes and Regulations. Retrieved from: conservation.ca.gov/dmr/lawsandregulations. Accessed April 8, 2023.

California Department of Conservation, State Mining and Geology Board. 2022. Annual Report 2021-2022. conservation.ca.gov/smgb/reports/Documents/Annual_Reports/SMGB%20Annual%20Report%202020-2021_ADA.pdf#:~:text=The%20State%20Mining%20and%20Geology%20Board%20%28Board%29%20serves,mineral%20resources%2C%20and%20the%20reclamation%20of%20mined%20lands.

California Department of Water Resources, Southern District (CDWRSD). 1961. Planned utilization of the ground water basin of the coastal plain of Los Angeles County. Appendix A – Ground Water Geology. archive.org/details/appdxplannedutilizati104calirich/page/n5/mode/2up. Accessed April 3, 2023.

California Geological Survey (CGS). 2008. Special Publication 117A, Guidelines for Evaluating and Mitigating Seismic Hazards in California. conservation.ca.gov/cgs/shzp/webdocs/Documents/SP117.pdf.

California Geological Survey (CGS). 2021. Updated Mineral Resource Zones for Portland Cement Concrete Aggregate in the San Fernando Valley and Saugus-Newhall Production-Consumption Regions. conservation.ca.gov/cgs/Documents/Publications/Special-Reports/SR_254-MLC-SanFernandoValleySaugusNewhallPCR-2021-Plate01-MRZs-a11y.pdf.

California Geological Survey (CGS). 2023 California Earthquake Hazards Zone Application ("EQ Zapp"). maps.conservation.ca.gov/cgs/EQZApp/app/. Accessed March 31, 2023.

California Legislative Information. 2023a. California Public Resources Code Section 2762. leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml. Accessed April 8, 2023.

California Legislative Information. 2023b. California Public Resources Code Section 2761. leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml. Accessed April 8, 2023.

Campbell, R.H., C.J. Wills, P.J. Irvine, and B.J. Swanson. 2016. Preliminary geologic map of the Los Angeles 30' x 60' quadrangle, California, California Geological Survey, series unknown, 1:100,000.

City of Los Angeles. 2018. *City of Los Angeles 2018 Local Hazard Mitigation Plan*. emergency.lacity.gov/sites/g/files/wph1791/files/2021-10/2018_LA_HMP_Final_with_maps_2018-02-09.pdf.

City of Los Angeles. 2022. Los Angeles City Building Code 2022 (Volumes 1 and 2). up.codes/viewer/los_angeles/ca-building-code-2022. Accessed May 7, 2023.

City of Los Angeles Department of City Planning (DCP). 2001. Conservation Element of the *City of Los Angeles General Plan*. planning.lacity.org/odocument/28af7e21-ffdd-4f26-84e6-dfa967b2a1ee/Conservation_Element.pdf.

City of Los Angeles Department of City Planning (DCP). 2021. Safety Element of the *City of Los Angeles General Plan*. planning.lacity.org/odocument/31b07c9a-7eea-4694-9899-f00265b2dc0d/Safety_Element.pdf.

City of Los Angeles Department of Water and Power (LADWP). 1998. *Geotechnical Data Report Stone Canyon Bypass Tunnel Los Angeles, California*.

County of Los Angeles. 2023. County of Los Angeles Code, Title 26, Building Codes. library.municode.com/ca/los_angeles_county/codes/code_of_ordinances . Accessed May 7, 2023.

County of Los Angeles, Chief Executive Office – Office of Emergency Management (CoLA CEO). 2012. Los Angeles County Operational Area Emergency Response Plan. https://ceo.lacounty.gov/wp-content/uploads/2023/11/County-of-Los-Angeles-OAEOP-2023-Final-for-Website.pdf.

County of Los Angeles, Chief Executive Office – Office of Emergency Management (CoLA CEO) 2020. *2020 County of Los Angeles All-Hazards Mitigation Plan*. ceo.lacounty.gov/wp-content/uploads/2022/04/County-of-Los-Angeles-All-Hazards-Mitigation-Plan-APPROVED-05-2020.pdf.

Duke Cultural Resources Management. 2023. *Sepulveda Transit Corridor Project, Final Paleontological Technical Memorandum*.

Imlay, R. W. 1963. "Jurassic Fossils from Southern California." *Journal of Paleontology*, 37(1):97-101, pl. 14.

KCAL News. 2014. 7.5 Temblor on Puente Hills Thrust Fault Would Be 'The Quake From Hell.' cbsnews.com/losangeles/news/7-5-quake-on-puente-hills-thrust-fault-could-be-disastrous/. Accessed April 3, 2023.

Los Angeles County Department of Public Works (LADPW). 2014. *Low Impact Development Standards Manual.* February.

Los Angeles County Department of Regional Planning (LA County Planning). 2022a. Chapter 12: Safety Element of the *County of Los Angeles General Plan*. planning.lacounty.gov/wp-content/uploads/2022/11/12.1_gp_final-general-plan-ch12_updated_2022.pdf.

Los Angeles County Department of Regional Planning (LA County Planning). 2022b. Chapter 9: Conservation and Natural Resources Element of the *County of Los Angeles General Plan*. planning.lacounty.gov/wp-content/uploads/2022/11/9.0_gp_final-general-plan-ch9.pdf.

Los Angeles County Metropolitan Transportation Authority (Metro). 2008. *Measure R Expenditure Plan*. July. metro.net/about/measure-r/, dropbox.com/scl/fi/jzu11yppo8g1eeh16nzcl/2009-MeasureR-expenditure-plan.pdf. Amended July 2021.

Los Angeles County Metropolitan Transportation Authority (Metro). 2016. *Measure M Los Angeles County Traffic Improvement Plan. Attachment A, Measure M Expenditure Plan.* libraryarchives.metro.net/dpgtl/MeasureM/201609-proposed-ordinance-16-01-county-traffic%20improvement-plan.pdf.

Los Angeles County Metropolitan Transportation Authority (Metro). 2019. *Sepulveda Transit Corridor Project Final Feasibility Report.* November. libraryarchives.metro.net/dpgtl/pre-eir-eis-reports-and-studies/sepulveda-transit-corridor/2019-sepulveda-transit-corridor-final-feasibility-report.pdf.

Los Angeles County Metropolitan Transportation Authority (Metro). 2020. *Public Transportation Agency Safety Plan*. https://libraryarchives.metro.net/DB_Attachments/200401_Attachment%20B%20-%20PTASP.pdf.

Los Angeles County Metropolitan Transportation Authority (Metro). 2021. *Sepulveda Transit Corridor Project Notice of Preparation.* November 30. ceqanet.opr.ca.gov/2021110432. Accessed October 1, 2024.

Los Angeles County Metropolitan Transportation Authority (Metro). 2022. *Public Transportation Agency Safety Plan* (Version 1.2). transit.dot.gov/sites/fta.dot.gov/files/2024-02/LA-Metro-Public-Transportation-Agency-Safety-Plan_1.pdf.

Los Angeles County Metropolitan Transportation Authority (Metro). 2023a. *Sepulveda Transit Corridor Project, Detailed Geotechnical Exploration Plan*. Earth Mechanics, Inc.

Los Angeles County Metropolitan Transportation Authority (Metro). 2023b. *Sepulveda Transit Corridor Project, Final Draft Geotechnical Design Memorandum.* Sepulveda Transit Corridor Partners (STCP).

Los Angeles County Metropolitan Transportation Authority (Metro). 2024a. *Sepulveda Transit Corridor Project Alternative 2 Update*. July 3. boardarchives.metro.net/BoardBox/2024/240703_Sepulveda_Transit_Corridor_Alternative_2_Update.pdf.

Los Angeles County Metropolitan Transportation Authority (Metro). 2024b. *Public Transportation Agency Safety Plan* (Version 1.4).

Los Angeles County Metropolitan Transportation Authority Agency (Metro). 2024c. *Sepulveda Transit Corridor Project, Preliminary Geotechnical Design and Data Report*. HTA Partners.

Los Angeles County Metropolitan Transportation Authority (Metro). 2025. *Sepulveda Transit Corridor Project Water Resources Technical Report*.

Olson, B. 2015. Geomorphic evaluation of the Santa Monica Fault Zone, northwestern Los Angeles Basin, southern California. Poster Presentation at Seismological Society of America Annual Meeting, Pasadena, California, April 21-23, 2015. scec.org/publication/7326. Accessed April 3, 2023.

Scott, E., and K. Springer. 2003. CEQA and Fossil Preservation in California. *The Environmental Monitor, 2004 CEQA Workshop.*

Shaw, J. H., A. Plesch, J. F. Dolan, T. L. Pratt, and P. Fiore. 2002. "Puente Hills blind-thrust system, Los Angeles, California." *Bulletin of the Seismological Society of America*. January. usgs.gov/publications/puente-hills-blind-thrust-system-los-angeles-california. Accessed April 2, 2023.

Society of Vertebrate Paleontology (SVP). 1995. Assessment and mitigation of adverse impacts to nonrenewable paleontologic resources: standard guidelines. Society of Vertebrate Paleontology News Bulletin 163:22-27.

Society of Vertebrate Paleontology (SVP). 2010 (originally published in 1995). *Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources*. Society of Vertebrate Paleontology Impact Mitigation Guidelines Revision Committee. 11 pp.

Southern California Association of Governments (SCAG). 2020a. *Connect SoCal, 2020-2045 Regional Transportation Plan/Sustainable Communities Strategy.* September 3. scag.ca.gov/sites/main/files/file-attachments/0903fconnectsocal-plan_0.pdf.

Southern California Association of Governments (SCAG). 2020b. *Connect SoCal, 2020-2045 RTP/SCS Final Connect SoCal Project List Technical Report.* scag.ca.gov/sites/main/files/file-attachments/0903fconnectsocal_project-list_0.pdf.

Southern California Association of Governments (SCAG). 2021a. *Final 2021 Federal Transportation Improvement Program Technical Appendix*. Volume II of III. March. scag.ca.gov/sites/main/files/file-attachments/f2021-ftip-technical-appendix.pdf.

Southern California Association of Governments (SCAG). 2021b. *Final 2021 Federal Transportation Improvement Program. Consistency Amendment #21-05*. scag.ca.gov/sites/main/files/file-attachments/21-05-la-finalcomparison.pdf.

Southern California Earthquake Data Center (SCEDC). 2023a. Earthquake Information – Chatsworth Fault. scedc.caltech.edu/earthquake/chatsworth.html. Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023b. Earthquake Information – Clearwater Fault. scedc.caltech.edu/earthquake/clearwater.html. Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023c. Earthquake Information – Eagle Rock Fault. scedc.caltech.edu/earthquake/eaglerock.html. Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023d. Earthquake Information – Hollywood Fault. scedc.caltech.edu/earthquake/hollywood.html. Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023e. Earthquake Information – Holser Fault. scedc.caltech.edu/earthquake/holser.html. Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023f. Earthquake Information – Malibu Coast Fault. scedc.caltech.edu/earthquake/malibucoast.html. Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023g. Earthquake Information – Mission Hills Fault. scedc.caltech.edu/earthquake/missionhills.html. Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023h. Earthquake Information – Newport-Inglewood-Rose Canyon Fault Zone. *scedc.caltech.edu/earthquake/newportrose.html*. Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023i. Earthquake Information – Northridge Hills Fault. *scedc.caltech.edu/earthquake/northridgehills.html*. Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023j. Earthquake Information – Oak Ridge Fault (Northridge Blind Thrust). *scedc.caltech.edu/earthquake/oakridge.html.* Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023k. Earthquake Information – Palos Verdes Fault Zone. *scedc.caltech.edu/earthquake/palosverdes.html*. Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023l. Earthquake Information – Raymond Fault. *scedc.caltech.edu/earthquake/raymond.html.* Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023m. Earthquake Information – San Andreas Fault Zone. *scedc.caltech.edu/earthquake/sanandreas.html*. Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023n. Earthquake Information – San Gabriel Fault Zone. *scedc.caltech.edu/earthquake/sangabriel.html*. Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023o. Earthquake Information – Santa Monica Fault. *scedc.caltech.edu/earthquake/santamonica.html.* Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023p. Earthquake Information – Sierra Madre Fault Zone. *scedc.caltech.edu/earthquake/sierramadre.html*. Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023q. Earthquake Information – Simi Fault (also known as Santa Rosa Fault). *scedc.caltech.edu/earthquake/simi.html*. Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023r. Earthquake Information – Verdugo Fault. *scedc.caltech.edu/earthquake/verdugo.html.* Accessed April 2, 2023.

Southern California Earthquake Data Center (SCEDC). 2023s. Earthquake Information – Glossary. *scedc.caltech.edu/earthquake/glossary.html#holocene.* Accessed April 2, 2023.

State Water Resources Control Board (SWRCB). 2014. Water Quality Order No. 2014-0057-DWQ. *waterboards.ca.gov/water_issues/programs/stormwater/igp_20140057dwq.html.* Accessed April 2, 2023.

State Water Resources Control Board (SWRCB). 2022a*.* National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (General Permit). Order No. 2022-0057-DWQ, NPDES No. CAS000002. September. *waterboards.ca.gov*.

State Water Resources Control Board (SWRCB). 2022b. National Pollutant Discharge Elimination System Statewide Stormwater Permit and Waste Discharge Requirements for State of California Department of Transportation. Order No. 2022-0033-DWQ, NPDES No. CAS000003. June. *waterboards.ca.gov*.

U.S. Geological Survey (USGS). 1981. A Seismicity Study for Portions of the Los Angeles Basin, Santa Monica Basin, and Santa Monica, California. *pubs.usgs.gov/of/1981/0295/report.pdf.*

U.S. Geological Survey (USGS). 2009. Stream Channel Development in the Changing Mojave Climate. pubs.usgs.gov/of/2004/1007/streams.html. Accessed November 1, 2022.

U.S. Geological Survey (USGS). 2013. USGS Response to an Urban Earthquake – Northridge '94, Studying the Setting and Consequences of the Earthquake. pubs.usgs.gov/of/1996/ofr-96-0263/mainshk.htm. Accessed March 31, 2022.

U.S. Geological Survey (USGS). 2016. Preliminary Geologic Map of the Los Angeles 30' x 60' Quadrangle, Southern California. ngmdb.usgs.gov/Prodesc/proddesc_109250.htm. Accessed November 9, 2023.

U.S. Geological Survey (USGS). 2017a. Quaternary Fault and Fold Database of the United States - Charnock fault (Class A) No. 277. earthquake.usgs.gov/cfusion/qfault/show_report_AB_archive.cfm . Accessed April 2, 2023.

U.S. Geological Survey (USGS). 2017b. Quaternary Fault and Fold Database of the United States - Overland Avenue fault (Class A) No. 278. earthquake.usgs.gov/cfusion/qfault/show_report_AB_archive.cfm. Accessed April 2, 2023.

U.S. Geological Survey (USGS). 2017c. Quaternary Fault and Fold Database of the United States - Del Valle Fault (Class A) No. 269. landslides.usgs.gov/static/lfs/nshm/qfaults/Reports/269.pdf.

U.S. Geological Survey (USGS). 2017d. Quaternary Fault and Fold Database of the United States - Santa Felicia Fault (Class A) No. 281. earthquake.usgs.gov/cfusion/qfault/show_report_AB_archive.cfm. Accessed April 2, 2023.

U.S. Geological Survey (USGS). 2022. The Modified Mercalli Intensity Scale. usgs.gov/programs/earthquake-hazards/modified-mercalli-intensity-scale. Accessed March 31, 2022.

U.S. Geological Survey (USGS). 2023. Google Earth/KML Files, Quaternary Faults & Folds in the U.S. usgs.gov/programs/earthquake-hazards/google-earthtmkml-files. Accessed March 31,2023.

Yeats, Robert S., James W. McDougal, and Leonard T. Stitt. 1985. Cenozoic Structure of the Val Verde 7 1/2-minute Quadrangle and South Half of the Whitaker Peak 7 1/2-minute Quadrangle, California. pubs.usgs.gov/of/1985/0587/report.pdf.

Appendix A. Paleontological Technical Memorandum

Paleontological Technical Memorandum submitted under separate cover.