

Appendix H: Water Supply Assessment



Photo credit: Clearway Energy Group, LLC

Water Supply Assessment

Savira Solar Project

May 2025

Prepared for:



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Abbreviations and Acronyms

µg/L	micrograms per liter
AC	alternating current
AF	acre-feet
AFY	acre-feet per year
AGR	Agriculture Supply
amsl	above mean sea level
Argonne	Argonne National Laboratory
BESS	battery energy storage system
bgs	below ground surface
BLM	U.S. Bureau of Land Management
CEC	California Energy Commission
CGPS	Continuous Global Positioning System
CVGB	Chuckwalla Valley Groundwater Basin
DEW	Drier/Extreme Warming
DWR	California Department of Water Resources
EMPS	Eagle Mountain Pumped Storage
ET	evapotranspiration
GDE	groundwater-dependent ecosystem
gen-tie	generation-tie
GMRMP	Groundwater Monitoring, Reporting, and Mitigation Plan
IND	Industrial Service Supply
MCL	maximum contaminant levels
mg/L	milligrams per liter
Model	MODFLOW groundwater model
MUN	Municipal and Domestic Supply
MW	megawatt
NCCAG	Natural Communities Commonly Associated with Groundwater
POR	period of record
Project	Savira Solar Project
PV	photovoltaic
ROW	right-of-way
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SCE	Southern California Edison
SGMA	Sustainable Groundwater Management Act
TDS	total dissolved solids
TNC	The Nature Conservancy
UNAVCO	University NAVSTAR Consortium

USGS	U.S. Geological Survey
WMW	Wetter/Moderate Warming
WSA	Water Supply Assessment

1 Introduction

Savira Renewables, LLC, a wholly owned indirect subsidiary of Clearway Energy Group, LLC, proposes to develop and construct an up to a nominal 150-megawatt (MW) alternating current (AC) solar photovoltaic (PV) energy generating project and an up to 250-MW battery energy storage system (BESS) project known as the Savira Solar Project (Project).

The objective of this Water Supply Assessment (WSA) is to provide an evaluation of the effects of the proposed Project on groundwater and surface water resources, pursuant to the requirements of California Senate Bill (SB) 610.

2 Project Description

The Project includes an up to a nominal 150-MW solar facility, 250-MW BESS, and ancillary facilities. Project facilities include an operations and maintenance building, a Project substation, electrical collection system, high voltage generation tie (gen-tie) line, and access driveways. The Project would include approximately 535 acres, which would be located on private land within unincorporated Riverside County (Figure 1). The Project will include a new approximately 2-mile-long, 230 kilovolt gen-tie line to the existing Arica and Victory Pass substation. The energy would then be carried approximately 3 miles on the existing Arica and Victory Pass gen-tie line, to the existing Southern California Edison (SCE) Red Bluff substation (see Figure 2).

Project construction is scheduled to begin in June 2026 and be completed within 2 years.¹ The Project would operate for a minimum of 40 years (through 2067). At the end of its useful life, the Project would be decommissioned in accordance with applicable Project plans. Project decommissioning is scheduled to begin in 2068 and would be completed within 2 years. Water for the Project would be obtained from an existing well or a proposed onsite groundwater well to be located near the Project's operations and maintenance building and start of the gen-tie (see Figure 2).

Water use assumptions for the Project, by Project phase, include the following:

- **Construction.** During the construction phase, it is anticipated that a maximum of 100 acre-feet (AF) would be used for dust suppression, truck wheel washing, and other purposes during the 2-year construction timeframe (average of 50 acre-feet per year [AFY]). During construction, restroom facilities would be provided by portable units to be serviced by licensed providers.
- **Operation.** During operation, the solar array portion of the Project would require the use of approximately 10 AFY for panel washing and other uses. Savira Renewables, LLC, understands that the U.S. Bureau of Land Management (BLM) is considering issuing right-of-way (ROW) grants for durations longer than 30 years (BLM, 2023). Therefore, for the purpose of this WSA, the Project operational period will be 40 years.
- **Decommissioning.** Project decommissioning would require water for dust control and site restoration activities. For this WSA, water use for Project decommissioning is assumed to be up to 25 AFY for a duration of 2 years.

¹ The Project construction period is planned for June 2026 through August 2027, totaling 15 months. The tabular groundwater use presented in this WSA is projected in annual time-steps. Consequently, although the planned Project construction period is less than 2 years, where included in a tabular format or in-text discussion in reference to tabular data, the Project construction period is assumed to be 2 years.

Although SB 610 requires the evaluation of water supplies during a 20-year period, as described above, the total Project life is estimated to be 44 years (including construction, operation, and decommissioning). Therefore, estimated total water use over the life of the Project is approximately 550 AF. A projected period of 44 years and total Project water use of 550 AF are assumed in this WSA. A summary of the Project duration and water use is included in Table 1.

Table 1. Project Durations and Water Use

Project Phase	Duration (years)	Water Use (AFY)	Total Water Use (AF)
Construction	2	50	100
Operation	40	10	400
Decommissioning	2	25	50
Total	44	—	550

Notes

-- = not applicable

AF = acre-feet

AFY = acre-feet per year

Figure 1. Project Vicinity

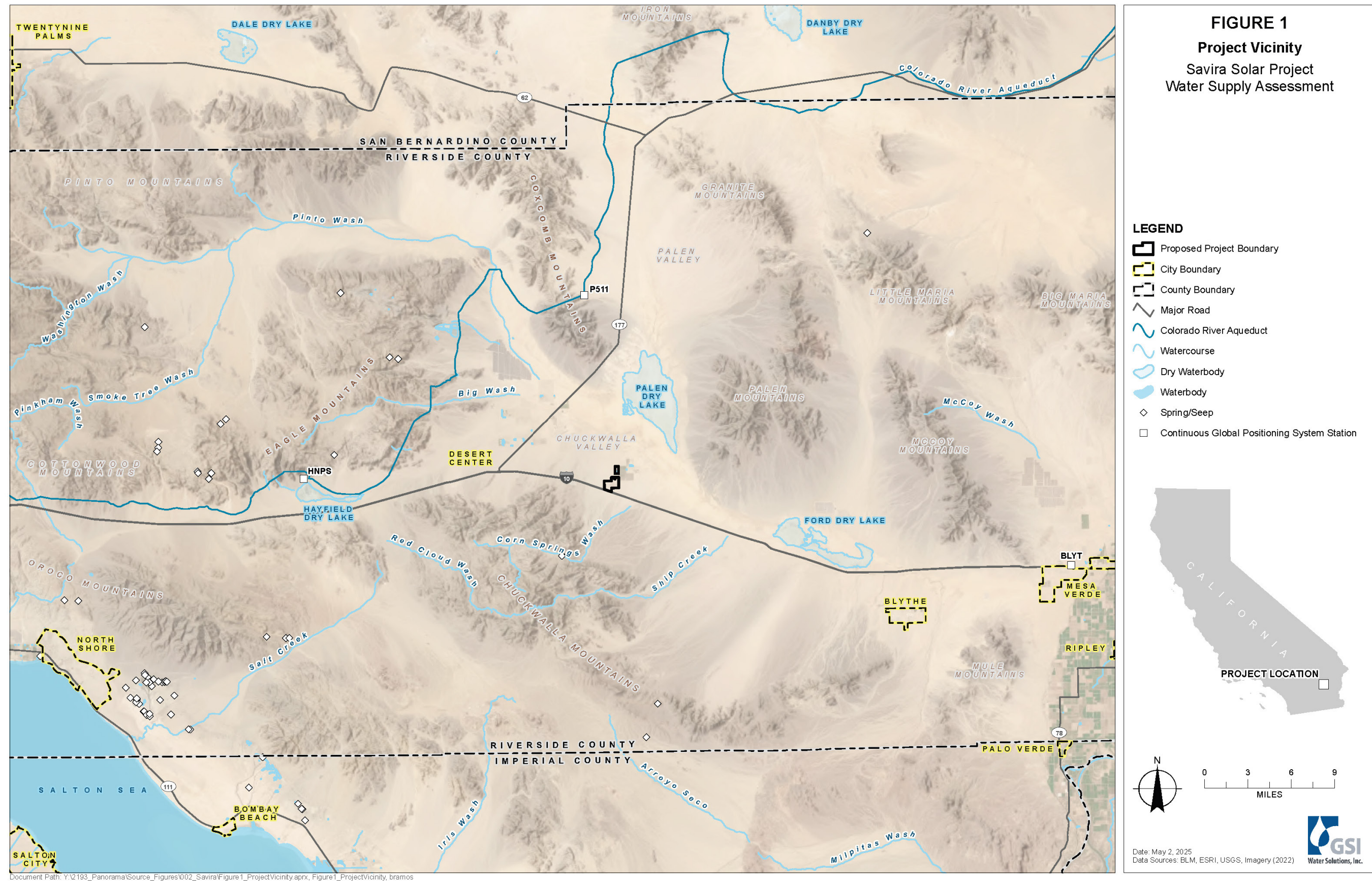
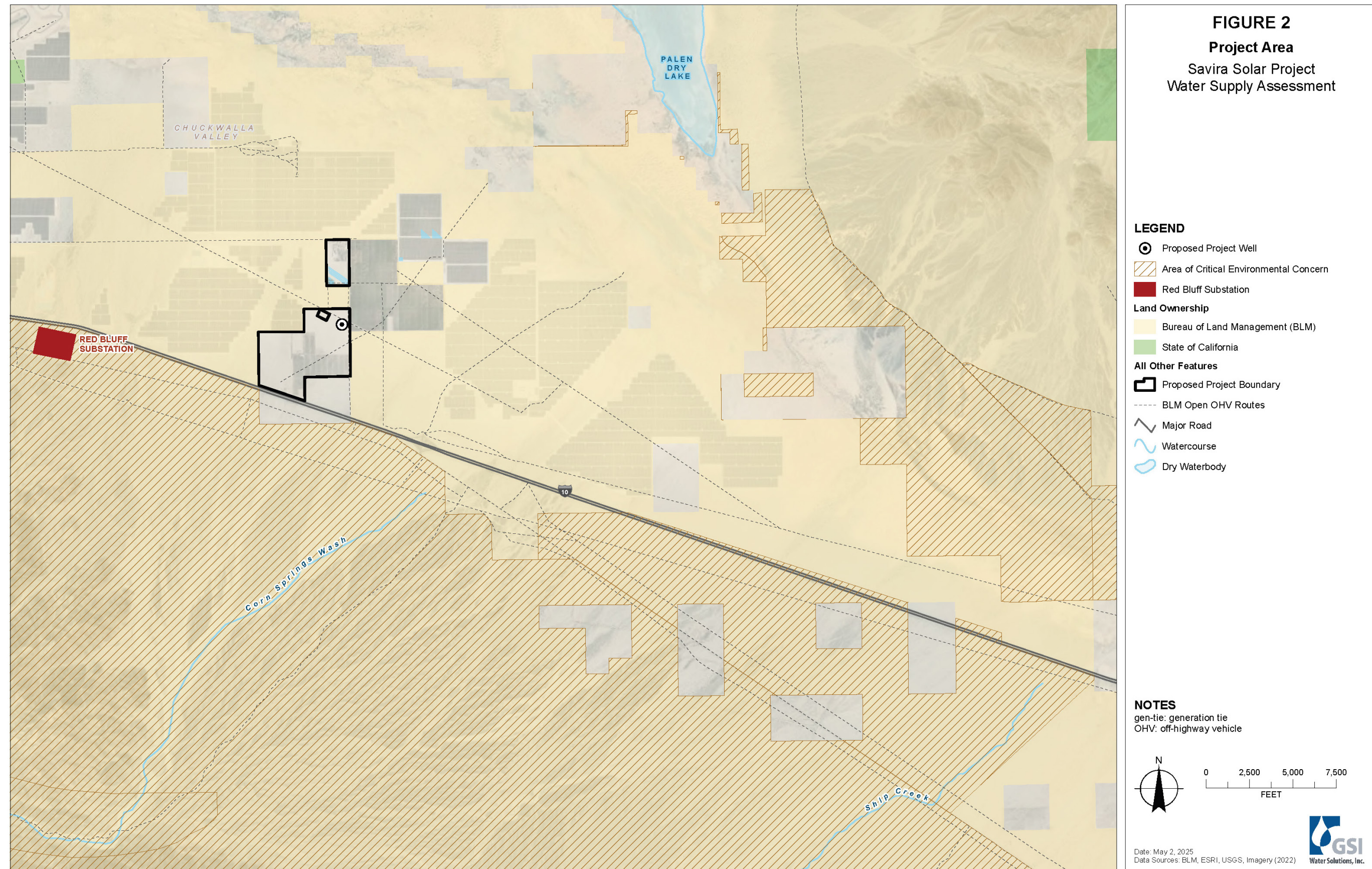


Figure 2. Project Area



3 Hydrologic Overview

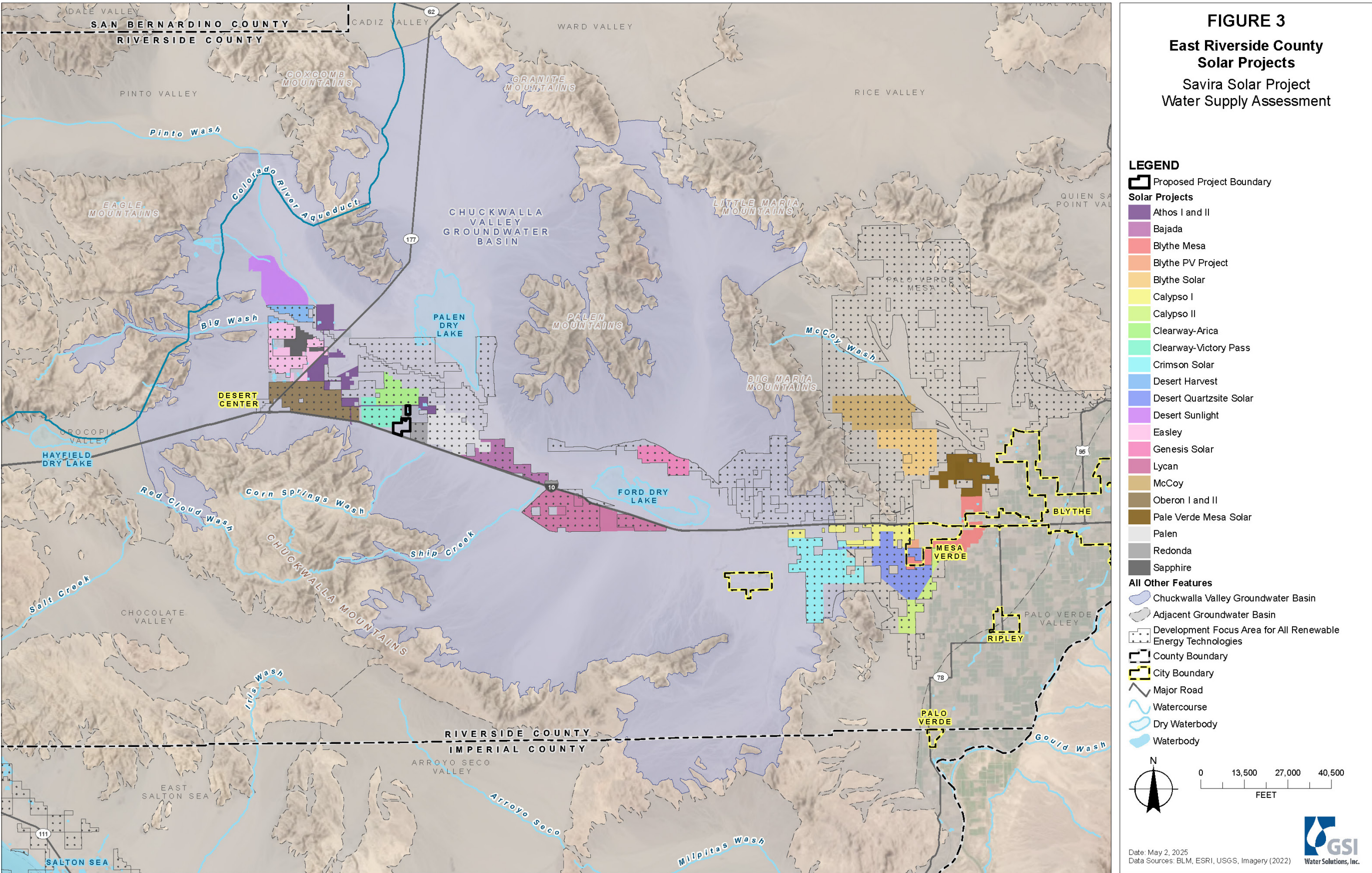
The Project is located in the California Department of Water Resources (DWR) Bulletin 118 Chuckwalla Valley Groundwater Basin (CVGB) (Basin No: 7-5), which is in eastern Riverside County and encompasses an area of approximately 940 square miles (DWR, 2004) (see Figure 3). Groundwater has been identified as the primary source of water in the CVGB. DWR has categorized the CVGB as a very low priority basin under the Sustainable Groundwater Management Act (SGMA) (DWR, 2020a).

The CVGB is located within the Southern Mojave watershed (Hydrologic Unit Code 8-18100100). The Chuckwalla Valley watershed, a subunit of the South Mojave watershed, contributes to the CVGB via percolation of precipitation. Percolation of precipitation occurs within the Chuckwalla Valley watershed via runoff from the surrounding mountains and from precipitation to the Chuckwalla Valley floor (DWR, 2004; CEC, 2010).

There are no perennial streams in the Chuckwalla Valley. Drainage in the valley is to Palen Dry Lake and Ford Dry Lake located in topographic low points (see Figure 1) (DWR, 2004). Surface water in the western portion of the valley generally flows toward Palen Dry Lake, located approximately 10 miles east of the community of Desert Center and 3 miles north of the Project area. Surface water in the eastern portion of the Chuckwalla Valley generally flows toward Ford Dry Lake, located approximately 10 miles southeast of the Palen Dry Lake (Aspen, 2021). Documented springs and seeps in the area are in the surrounding mountains.

The local climate is arid with high summer temperatures and mild winter temperatures. Average annual precipitation in the CVGB is 3.39 inches (NOAA, n.d.[a], n.d.[b]). Average summer maximum temperatures are above 100 degrees Fahrenheit (NOAA, n.d.[a]). Precipitation is seasonal.

Figure 3. East Riverside County Solar Projects



4 Chuckwalla Valley Groundwater Basin

4.1 Basin Overview and Storage

The CVGB underlies the Palen and Chuckwalla Valleys. The CVGB is bounded by the consolidated rocks of the Chuckwalla, Little Chuckwalla, and Mule Mountains on the south; the Eagle Mountains on the west; and the Mule and McCoy Mountains on the east. Rocks of the Coxcomb, Granite, Palen, and Little Maria Mountains bound the valley on the north (see Figure 1) (DWR, 2004).

Water-bearing units of the CVGB include Pliocene to Quaternary age continental deposits divided into Quaternary alluvium, the Pinto Formation, and the Bouse Formation (DWR, 2004). Bedrock is as deep as 5,000 feet below ground surface (bgs) in the eastern portion of the CVGB. Wells in the vicinity of the Project extend to depths of approximately 150 to 1,000 feet bgs, (USGS, n.d.) with water levels approximately 80 to 360 feet bgs (USGS, n.d.; Dudek, 2024a and 2024b). The groundwater in the CVGB has been dated to be 9,400 to 18,600 years old (USGS, 2013). A regional geological map and cross-section of the CVGB are included as Figures 4a, 4b, and 5.

Total groundwater storage capacity of the CVGB is estimated to be from 9.1 million to 15 million AF (DWR, 2004). A project-specific 2013 analysis estimated the storage capacity of the CVGB to be about 10 million AF (SWRCB, 2013).

The CVGB is bordered by the Pinto Valley, Cadiz Valley, Rice Valley, and Ward Valley Groundwater Basins on the north; the Palo Verde Mesa Groundwater Basin on the east; the Arroyo Seco Valley and Chocolate Valley Groundwater Basins on the south; and the Orocopia Valley Groundwater Basin on the west (see Figure 3).

4.1.1 Groundwater Management

The CVGB is an unadjudicated groundwater basin. Owners of property overlying the CVGB have the right to pump groundwater from the CVGB for reasonable and beneficial use, provided that the water rights are neither severed nor reserved. Groundwater production in the CVGB is not managed by a specific entity and a groundwater sustainability plan has not been prepared and is not required, per SGMA, to be submitted to DWR based on its basin prioritization (very low priority). An Urban Water Management Plan and Integrated Regional Water Management Plan do not exist for the area.

The CVGB is located within the jurisdiction of the Colorado River Basin Regional Water Quality Control Board (RWQCB) and is subject to management direction of the *Water Quality Control Plan for the Colorado River Basin* (Region 7) (RWQCB, 2019).

Figure 4a. Regional Geology of the Chuckwalla Valley Groundwater Basin

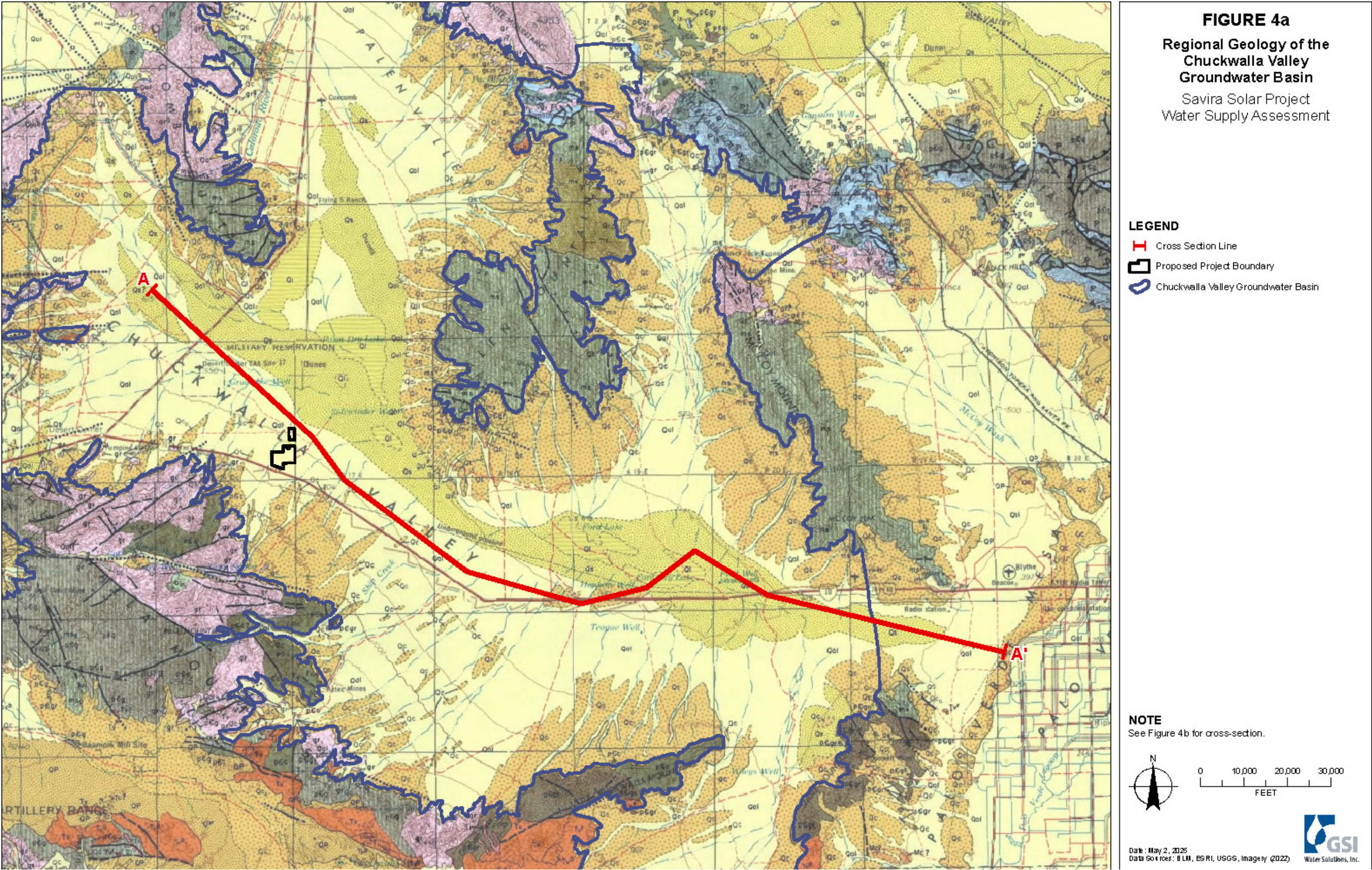


Figure 4b. Regional Geology of the Chuckwalla Valley Groundwater Basin

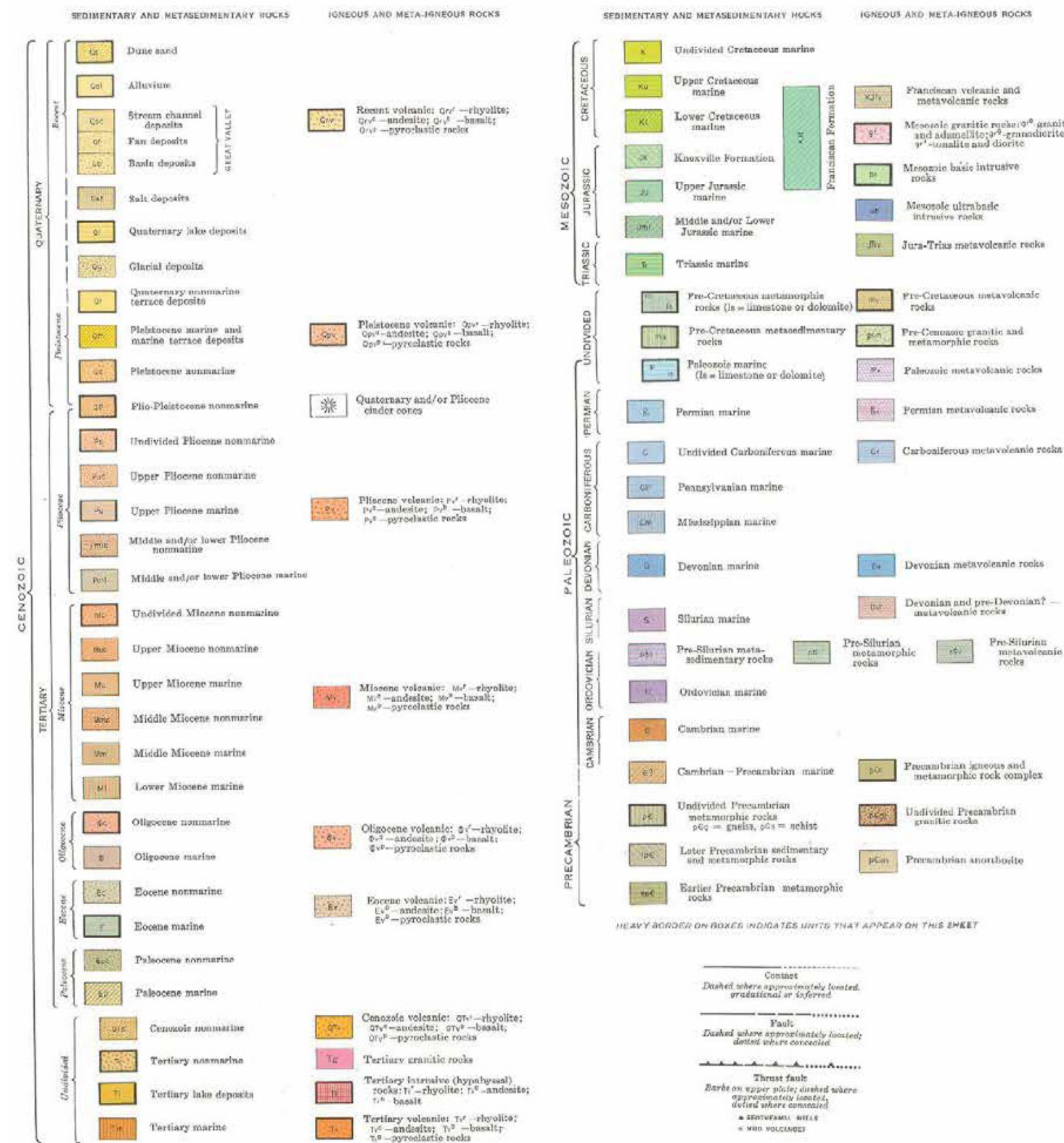


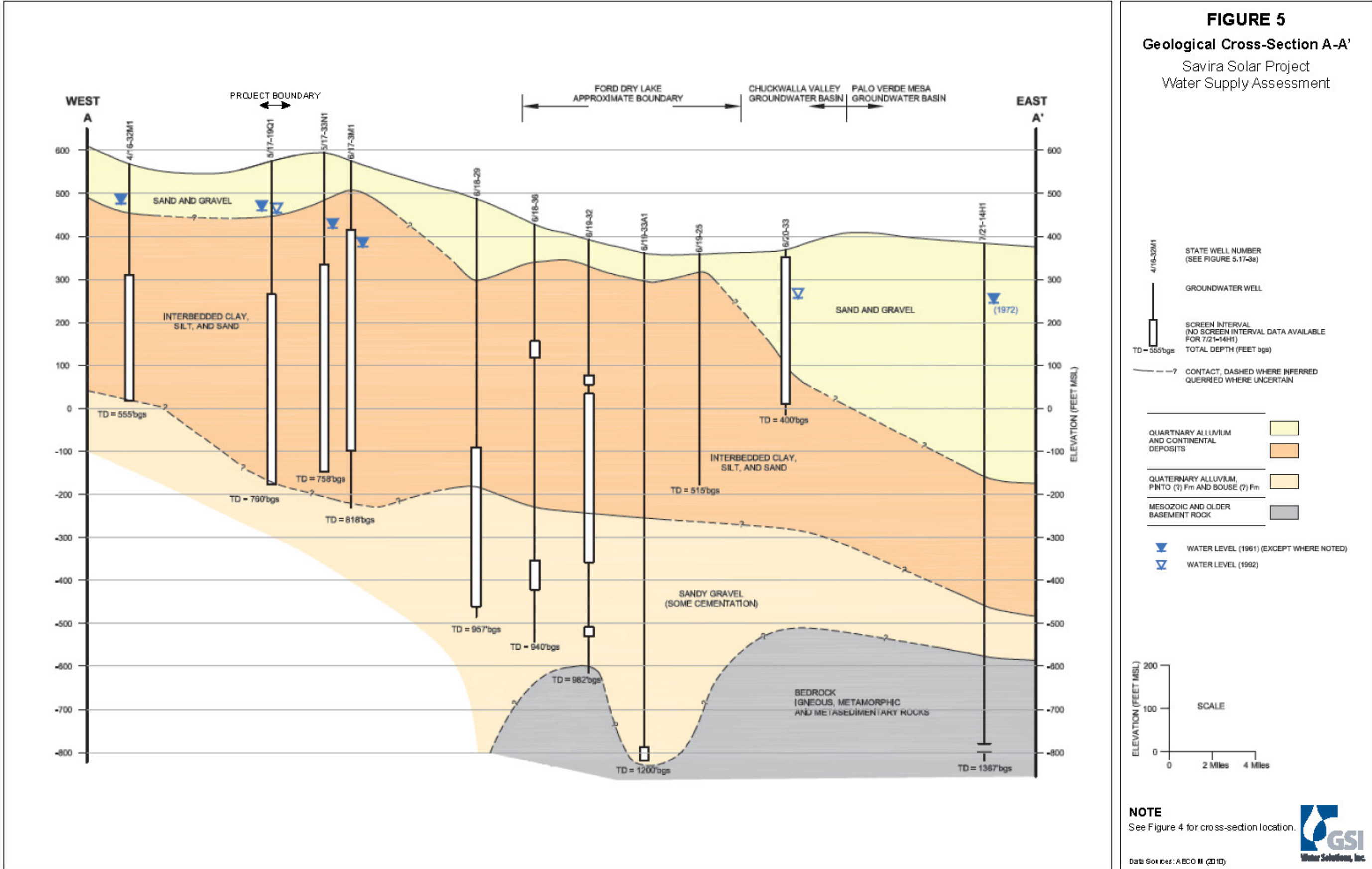
FIGURE 4b
Regional Geology
of the Chuckwalla Valley
Groundwater Basin
Savira Solar Project
Water Supply Assessment

NOTE
See Figure 4a for cross-section.

Data Sources : USGS



Figure 5. Geological Cross-Section A-A'



4.2 Groundwater Conditions

A discussion of historical and current groundwater conditions, including groundwater levels, groundwater quality, and subsidence, is included in the following subsections.

4.2.1 Groundwater Levels

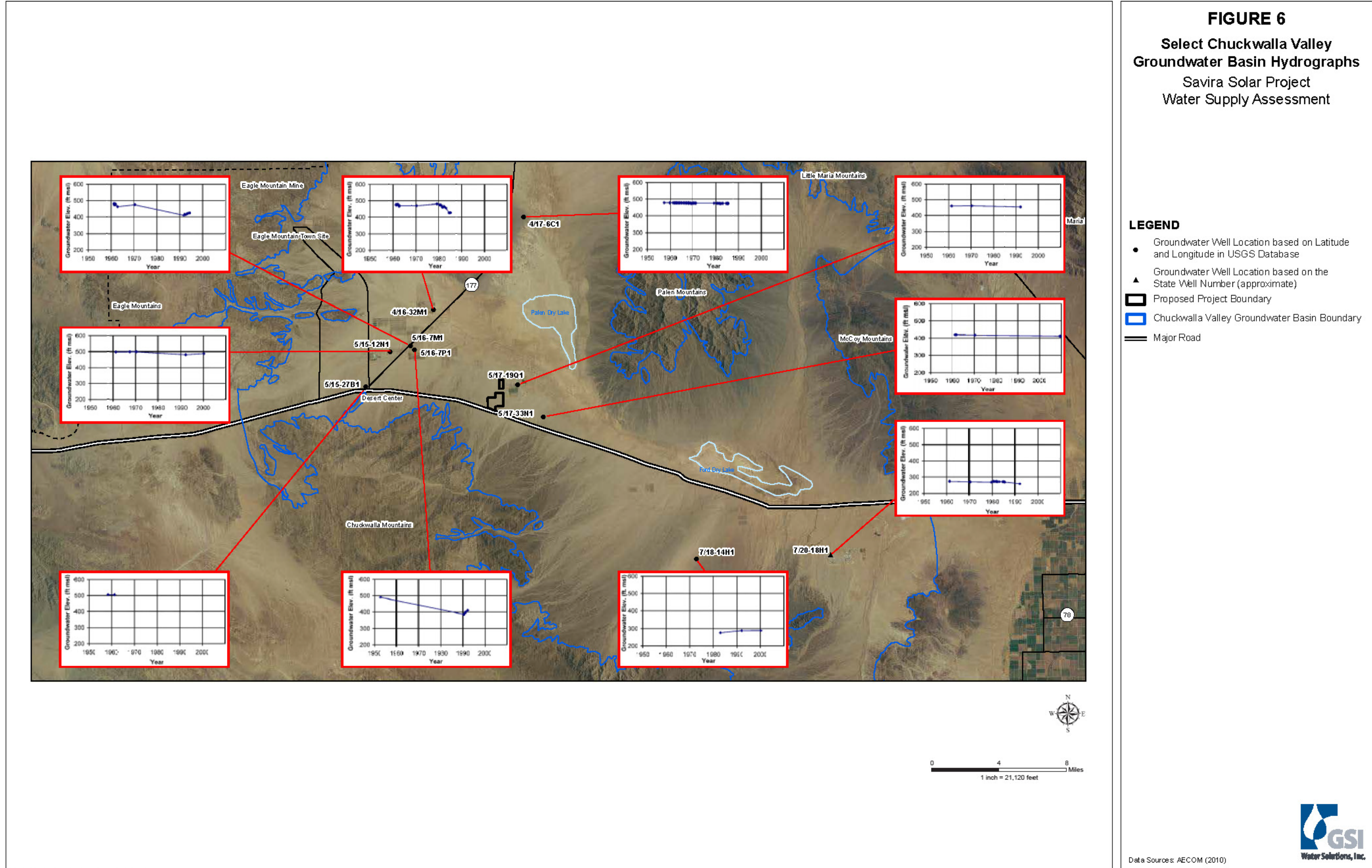
Depths to groundwater are as deep as about 400 feet bgs in many parts of the CVGB (RWQCB, 2019). Groundwater in the CVGB moves from the north and west toward the gap between the Mule and McCoy Mountains at the southeastern end of the Chuckwalla Valley (AECOM, 2010a; DWR, 2004). Available data indicate groundwater levels were stable as of 1963 and that a total groundwater extraction of 9,100 AFY was obtained in 1966 and 9,023 AF in water year 2018 (DWR, 2004; DWR, 2018). Historically, there have been notable changes in groundwater levels, especially localized around areas of increased extraction. For example, data from wells in the Desert Center area show a period of water level decline from the mid-1980s through the early 1990s during periods of expanded agricultural operations. During the mid-1980s, combined pumping exceeded 21,000 AFY, which is well above historical water usage for the Desert Center area of the CVGB (AECOM, 2011; GEI, 2010a).

Since the cessation of most agricultural pumping in the 1980s, available historical groundwater level data show generally stable groundwater levels in the CVGB. More recent (since 2000) available groundwater level data indicate lowering of groundwater levels (approximately 5 to 10 feet) in select wells (AECOM, 2010a; Ludwig and Godfrey, 2021). The lowering of groundwater levels was measured during a period of approximately 4 and 10 years, and occurred during periods of predominately below normal to critical water year types.² The 2019 SGMA Basin Prioritization (DWR, 2018) noted no documentation of groundwater level declines in the CVGB. Figure 6 includes select hydrographs from CVGB groundwater wells with available (continuous) historical groundwater level data.

Available recent groundwater levels near the Project are available from adjacent renewable energy projects' groundwater monitoring reports from 2019 to 2024. These data generally indicate a groundwater flow direction consistent with regional flow, temporary localized cones of depression around project production wells, and temporally stable groundwater levels. Northwest of the Project, the groundwater elevation is approximately 450 to 470 feet above mean sea level (amsl). Southeast of the Project, the groundwater elevation is approximately 400 feet amsl.

² Water year types are defined by DWR (2021) using precipitation data from the meteorological station in Blythe, California.

Figure 6. Select Chuckwalla Valley Groundwater Basin Hydrographs



4.2.2 Groundwater Quality

The Water Quality Control Plan developed by the Colorado River Basin RWQCB establishes water quality objectives, including narrative and numerical standards, to protect the beneficial uses of surface water and groundwater in the region. The Water Quality Control Plan describes implementation plans and other control measures designed to ensure compliance with Statewide plans and policies and documents comprehensive water quality planning.

Beneficial uses of waters, designated by the RWQCB, are of two types: consumptive and non-consumptive. Consumptive uses are those normally associated with people's activities, primarily municipal, industrial, and irrigation uses that consume water and cause corresponding reduction and/or depletion of water supply. Non-consumptive uses include swimming, boating, waterskiing, fishing, hydropower generation, and other uses that do not significantly deplete water supplies. Historical beneficial uses of water within the Colorado River Basin Region have largely been associated with irrigated agriculture and mining. Industrial use of water has become increasingly important in the Region, particularly in the agricultural areas (RWQCB, 2019). The RWQCB Water Quality Control Plan for the Colorado River Basin Region (RWQCB, 2019) lists specific beneficial uses for groundwater. Beneficial uses of the groundwater in the CVGB are Municipal and Domestic Supply (MUN), Industrial Service Supply (IND), and Agriculture Supply (AGR).

Total dissolved solids (TDS) concentrations across the CVGB range from 274 milligrams per liter (mg/L) to 12,300 mg/L. The lowest TDS concentrations are in the western portion of the CVGB, where TDS concentrations range from 275 to 730 mg/L (DWR, 2004). In the northwestern portions of the CVGB, arsenic concentrations have ranged from 9 micrograms per liter (µg/L) to 25 µg/L (GEI, 2010a). Water in the CVGB has concentrations of sulfate, chloride, fluoride, and TDS that are higher than recommended levels for drinking water use. Likewise, elevated concentrations of boron, TDS, and percent sodium impair groundwater for irrigation use. In general, groundwater in the CVGB is sodium chloride to sodium sulfate-chloride in character (DWR, 2004).

Reported groundwater quality results from adjacent renewable energy projects' groundwater monitoring networks indicate constituent concentrations that exceed drinking water maximum contaminant levels (MCLs) for electrical conductivity, pH, TDS, fluoride, sulfate, and arsenic (Dudek, 2021a, 2024a, and 2024b). There are no known contaminant plumes near the Project (SWRCB, 2025). Therefore, there are no known contaminants in groundwater near the Project as a result of a release of potential contaminants from a discrete source (e.g., discharge pipe or leaking underground storage tank). Groundwater quality can largely be associated with the aquifer rock type. Minerals within the host rock can leach into the groundwater (USGS, 2019). For example, the dissolution of fluoride-bearing minerals from geological formations can introduce fluoride into the groundwater.

4.2.3 Subsidence

There is one Continuous Global Positioning System (CGPS) station located in the CVGB. The University NAVSTAR Consortium (UNAVCO)-maintained CGPS Station P511 is located adjacent to the Colorado River Aqueduct, northwest of the Project, west of California State Highway 177, and east of the Coxcomb Mountains. CGPS Station P511 has a period of record (POR) from 2005 through present. During the available POR, no significant land subsidence in the CVGB has been recorded at CGPS Station P511 (the last measured displacement was 0.011 foot). Likewise, based on available data from CGPS stations located in the Orocopia Valley (POR from 1999 through present) and Palo Verde Mesa (POR from 1996 through present) Groundwater Basins, no significant land subsidence has been recorded (last measured displacements were 0.02 and 0.079 foot, respectively).³ See Figure 1 for the locations of the three UNAVCO CGPS stations.

There is no reported evidence of subsidence in the CVGB as a result of historical groundwater pumping (GEI, 2010a). The 2019 SGMA Basin Prioritization (DWR, 2018) noted no documented groundwater extraction induced inelastic subsidence in the CVGB. The Project is not anticipated to cause lowering of groundwater levels to levels below recorded historical low groundwater levels. Therefore, the Project is not anticipated to cause subsidence, or increase the rate of subsidence, in the CVGB.

4.3 Groundwater Pumping

Current and historical groundwater pumping in the CVGB includes agricultural water demand, pumping for the Chuckwalla and Ironwood State Prisons, pumping for the Tamarisk Lake development and golf course, domestic pumping, and a minor amount of pumping by Southern California Gas Company. In addition, historical pumping included water supply for the Kaiser Corporation Eagle Mountain Mine. Except for pumping for Chuckwalla Valley and Ironwood State Prisons, most of the current groundwater pumping occurs in the western portion of the CVGB, near Desert Center. The reported total urban groundwater use in water year 2018 was 2,395 AF (DWR, 2018).

The total number of irrigated acres in the CVGB has decreased since 2007. There were reportedly 1,108 irrigated acres in 2007 and approximately 871 irrigated acres in water year 2018 (GEI, 2010a; DWR, 2018). Groundwater extraction from agricultural irrigation is estimated at 6,628 AFY and comprises approximately 73 percent of all groundwater pumped from the CVGB (DWR, 2018).

³ UNAVCO CGPS data were accessed via the DWR SGMA Data Viewer, available at <https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#landsub> (accessed May 5, 2025).

4.4 Potential Groundwater-Dependent Ecosystems

Groundwater-dependent ecosystems (GDEs) are defined as ecological communities or species that depend on groundwater emerging from aquifers or on groundwater present near the ground surface. The following datasets were used to identify the distribution of potential GDEs occurring in the CVGB.

1. Natural Communities Commonly Associated with Groundwater (NCCAG). Three different wetland types and three potentially groundwater-dependent vegetation types are identified in the CVGB. These are discussed in more detail below.
2. The National Hydrography Dataset was evaluated for the occurrence of springs. The documented springs and seeps in the area are in the surrounding mountains (see Figure 1); the mountainous areas are not part of the CVGB.
3. The U.S. Fish and Wildlife Service Critical Habitat spatial dataset was evaluated. There are no critical habitat areas identified in the CVGB for species reliant on groundwater.⁴

Principal plant types of the CVGB include palo verde (*Parkinsonia florida*), shrubby seepweed (*Suaeda moquinii*), honey mesquite (*Prosopis glandulosa*), desert lavender (*Condea emoryi*), creosote-bush (*Larrea tridentata*), iodine bush (*Allenrolfea occidentalis*), and ironwood (*Olneya tesota*). There are no identified springs located in the CVGB and there are no known special-status species (e.g., threatened or endangered) occurring in the CVGB that are dependent on groundwater.

The NCCAG dataset is a compilation of 48 publicly available state and federal agency datasets that map vegetation, wetlands, springs, and seeps in California. A working group that includes DWR, California Department of Fish and Wildlife, and The Nature Conservancy (TNC) reviewed the compiled dataset and conducted a screening process to exclude vegetation and wetland types less likely to be associated with groundwater and to retain types commonly associated with groundwater as described in Klausmeyer et al. (2018). Two habitat classes are included in the NCCAG dataset statewide:

- Wetland features commonly associated with the surface expression of groundwater under natural, unmodified conditions
- Vegetation types commonly associated with the subsurface presence of groundwater (phreatophytes)

The data included in the NCCAG dataset do not represent the determination of a GDE by DWR, only the potential existence of a GDE. The potential GDE areas identified in the CVGB from the NCCAG dataset are summarized in Tables 2 and 3.

Table 2. Potential Groundwater-Dependent Vegetation Areas in the Chuckwalla Valley Groundwater Basin Identified in the Natural Communities Commonly Associated with Groundwater (NCCAG) Dataset

Natural Communities Vegetation Classification	Acres
Honey Mesquite (<i>Prosopis glandulosa</i>)	3,118
Iodine Bush (<i>Allenrolfea occidentalis</i>)	1,102
Shrubby Seepweed (<i>Suaeda moquinii</i>)	9,150
Total	13,370

⁴ Critical habitat area for the desert tortoise is identified in portions of the CVGB.

Table 3. Wetland Areas in the Chuckwalla Valley Groundwater Basin Identified in Natural Communities Commonly Associated with Groundwater (NCCAG) Dataset

Natural Communities Wetland Classification	Acres
Palustrine, Scrub-Shrub, Broad-Leaved- Evergreen, Seasonally Saturated	3
Riverine, Unknown Perennial, Unconsolidated Bottom, Semi-permanently Flooded	1,025
Riverine, Upper Perennial, Unconsolidated Bottom, Semi-permanently Flooded	48
Total	1,076

The Palustrine and Riverine NCCAG wetland areas are classified as Seasonally Saturated and Semi-permanently Flooded. However, upon inspection of Google Earth historical imagery, the areas identified as Semi-permanently Flooded are mis-classified. The Palustrine and Riverine areas inspected in Google Earth appear to contain water only rarely. In addition, the identified NCCAG wetland areas coincide with NCCAG vegetation areas mapped as palo verde, a non-groundwater-dependent vegetation type. Based on these findings, the NCCAG wetland areas identified in the CVGB are removed from further consideration as containing potential GDEs.

Shrubby seepweed, honey mesquite, and iodine bush are the only plants identified in the CVGB that may have some degree of dependence on groundwater. The aerial extent of each plant as mapped in the NCCAG dataset is presented in Figure 7. The extent of these plant communities is generally coincident with the extent of Palen Dry Lake. All three plants are facultative phreatophytes,⁵ which extract moisture from a large volume of soil through a well-developed root system (Lichvar and Dixon, 2007; Steinberg, 2001). There is no readily available information regarding rooting depth for shrubby seepweed. The maximum observed rooting depth for iodine bush is 5.91 feet (TNC, 2020). Honey mesquite's taproot commonly reaches depths of 40 feet when subsurface water is available, although a taproot 190 feet deep has been observed (Steinberg, 2001). In areas where the soil is shallow, where water does not penetrate deeply, or where a distinct calcium carbonate layer is present, the taproot seldom extends more than 3 to 6 feet, and an extensive system of lateral roots often extends up to 60 feet away from the plant base (Steinberg, 2001). Most active lateral roots occur in the upper 2.5 feet of soil and sprouting from lateral roots is common (Steinberg, 2001). These adaptations allow honey mesquite to retain most leaves in all but the most severe droughts (Steinberg, 2001).

An analysis of depth to groundwater in the regional aquifer in the western portion of the CVGB was used to screen areas in which honey mesquite and iodine bush could potentially gain access to groundwater from the regional aquifer. Water level measurements taken in spring 2023⁶ were converted to groundwater elevations and gridded using Surfer®. This grid was then subtracted from the regional U.S. Geological Survey (USGS) digital elevation model to produce an extrapolated depth-to-water coverage (Figure 8). There are no areas within the CVGB identified with depths to groundwater less than 25 feet in the regional aquifer. Areas having less than 190 feet depth to water are considered areas where honey mesquite trees could gain access to groundwater from the regional aquifer (this includes the entire area mapped as honey mesquite [Figure 7]). This is a conservative approach considering that honey mesquite tree tap roots are on average only 40 feet deep (Steinberg, 2001). The occurrence of iodine bush in the CVGB is contained mostly within

⁵ Facultative phreatophytes require groundwater at some stage of their life cycle, and although not requiring continuous access as do obligate phreatophytes, the availability of groundwater at those times may be critical for their survival (Hose et al., 2022).

⁶ Based on recent precipitation records, spring 2023 water levels are likely to be the highest experienced in years. Use of spring 2023 water levels for this WSA is considered conservative for this reason. Ambient water levels are likely to be lower during average/normal water year conditions.

an area with spring 2023 water levels of less than 50 feet bgs. However, there are no areas indicated with depth to water in the regional aquifer within reach of the maximum documented rooting depth of iodine bush (5.91 feet). Therefore, it is assumed that the iodine bush communities in the CVGB are supported by seasonal precipitation and potentially a perched alluvial aquifer that is disconnected from the regional aquifer system. Shrubby seepweed is excluded from this groundwater level screening analysis as there is no available information regarding its rooting depth.

Figure 7. Areas Containing Potential Groundwater Dependent Ecosystems

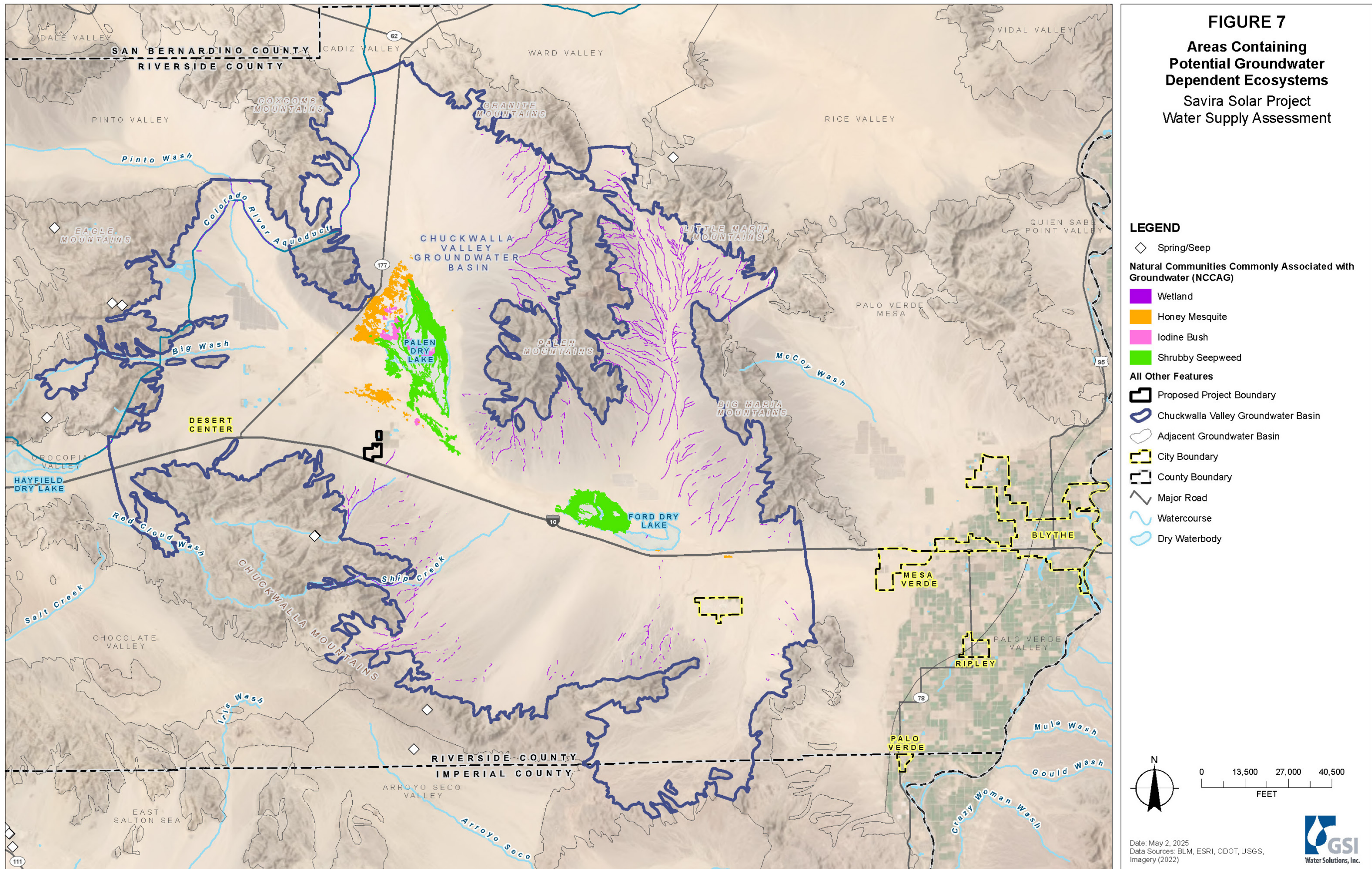
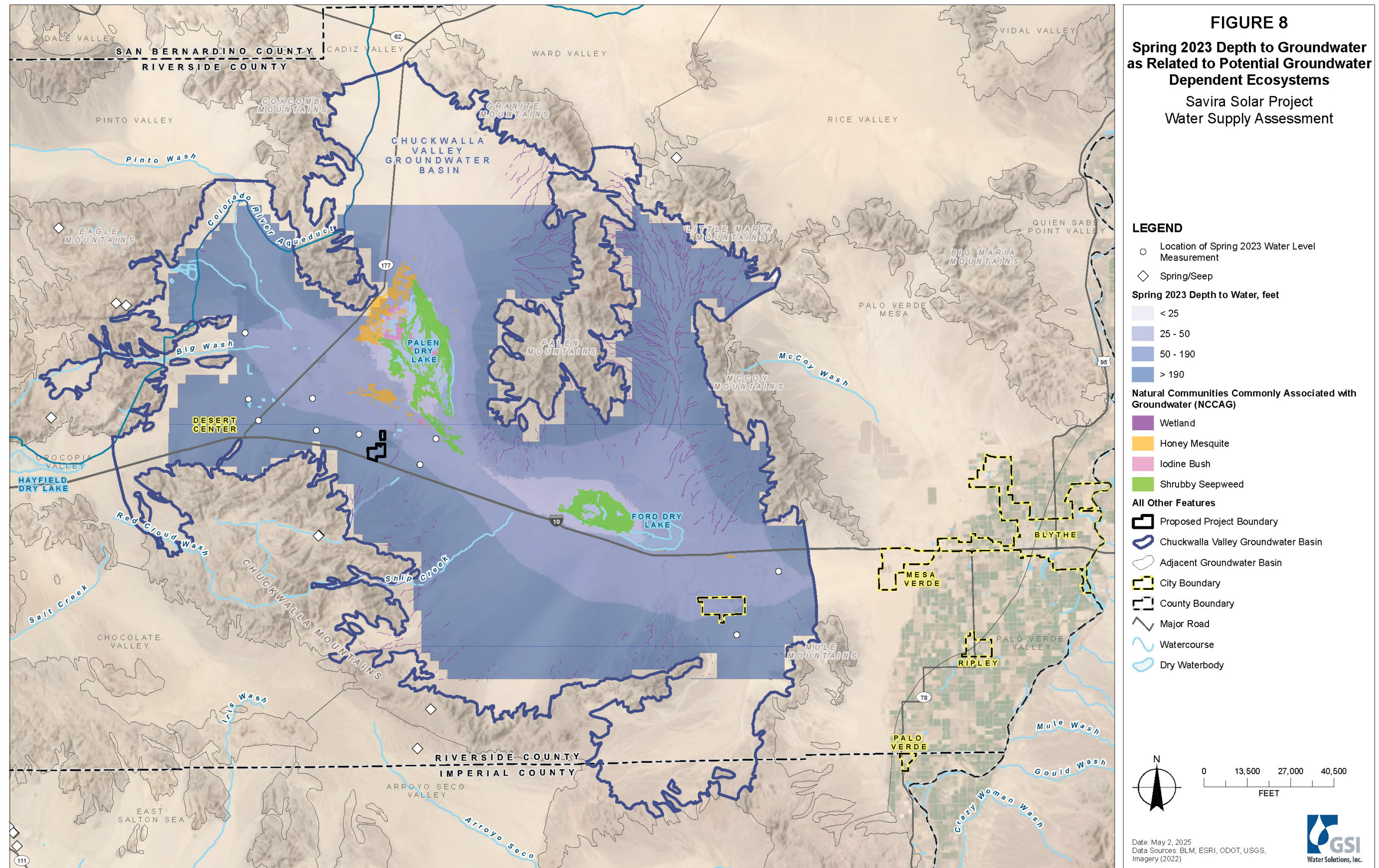


Figure 8. Spring 2023 Depth to Groundwater as Related to Potential Groundwater Dependent Ecosystems

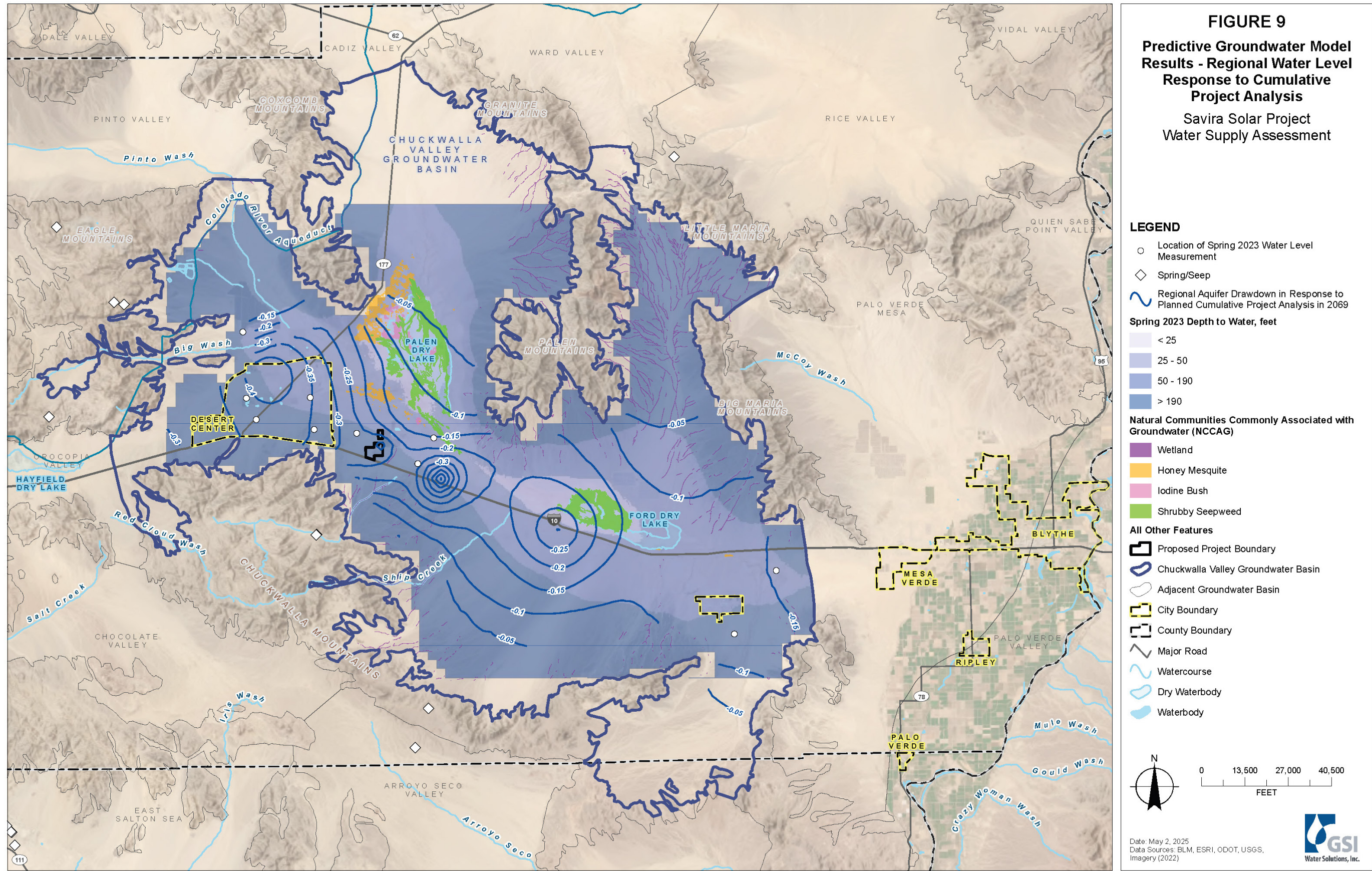


The groundwater model was used to simulate changes in regional water levels in response to cumulative project development through expected Project decommissioning in the year 2069. The modeling results indicate that minor changes in regional groundwater levels would result from development of the cumulative projects (see Table 8 for cumulative projects) compared to modeled 2069 baseline conditions. Figure 9 indicates that regional aquifer water levels would drop 0.25 foot or less as a result of development of the cumulative projects within the area of honey mesquite, iodine bush, and shrubby seepweed occurrence.

Based on the analyses presented above, it is concluded that the groundwater level changes associated with development of the cumulative projects in the CVGB will not have an effect on the ability of either iodine bush or honey mesquite to access groundwater.

Potential effects on shrubby seepweed are difficult to assess because there is no readily available rooting depth information for this plant. However, considering that the occurrence of shrubby seepweed is entirely within the Palen Dry Lake bed (see Figure 7), it is assumed that, similar to iodine bush, the shrubby seepweed is likely supported by seasonal precipitation and potentially a perched alluvial aquifer that is disconnected from the regional aquifer system. Alternatively, the shrubby seepweed may be supported by the regional aquifer, which generally has spring 2023 water levels within 50 feet of ground surface. Within the area of shrubby seepweed occurrence, the predicted drop in water levels is generally less than 0.25 foot and this minor change could be accommodated by the plants.

Figure 9. Predictive Groundwater Model Results – Regional Water Level Response to Cumulative Project Analysis



4.5 Projected Effects of Climate Change

Precipitation, evapotranspiration (ET), and streamflow climate change factors for two future climate periods (2030 and 2070) are available on 6-kilometer resolution grids from DWR. The climate datasets were processed by a soil moisture accounting model known as the Variable Infiltration Capacity hydrology model developed by Hamman et al. (2018) and Liang et al. (1994) and routed to the outlet of basins or subbasins contributing water to the basin. The resulting downscaled hydrologic time series are available on the SGMA Data Viewer hosted by DWR.⁷ Precipitation and ET data used in this WSA were downloaded from the SGMA Data Viewer for climate grid cells within the CVGB. Streamflow data were not downloaded and used in this WSA because of the arid climate of the CVGB and lack of perennial streams. Monthly time series change factors were then developed for the CVGB. Mean monthly and annual values were computed from the basin time series to show projected patterns of change under 2030 and 2070 conditions.

The DWR-provided climate change data are based on the California Water Commission's Water Storage Investment Program climate change analysis results, which used the global climate models and radiative forcing scenarios recommended for hydrologic studies in California by the Climate Change Technical Advisory Group. Climate data from the recommended General Circulation Model models and scenarios have also been downscaled and aggregated to generate an ensemble time series of change factors that describe the projected change in precipitation, ET, and streamflow values for climate conditions that are expected to prevail at mid-century and late century, centered around 2030 and 2070, respectively. The DWR dataset also includes two additional simulation results for extreme climate scenarios (Drier/Extreme Warming [DEW] and Wetter/Moderate Warming [WMW]) under 2070 conditions.

In a warmer climate, such as that of the CVGB, native vegetation and crops require more water to sustain growth, and this increased water requirement is characterized in climate models using the rate of ET. Under 2030 conditions, the CVGB is projected to experience average annual ET increases of approximately 4 percent relative to the baseline period (1915–2011). The largest monthly changes are projected to occur in the winter, with projected average increases of approximately 6 percent and 7 percent in December and January, respectively. Under 2070 conditions, annual ET is projected to increase by approximately 8 percent relative to the baseline period. The largest monthly changes are projected to occur in winter, with projected average increases of 14 percent in December and January. Under 2070 DEW conditions, annual ET is projected to increase by approximately 12 percent relative to the baseline period. The largest monthly changes are projected to occur in winter, with projected average increases of 19, 22, and 19 percent in December, January, and February, respectively. Under 2070 WMW conditions, annual ET is projected to increase by approximately 3 percent relative to the baseline period. The largest monthly changes are projected to occur in winter, with projected average increases of 8 and 10 percent in December and January, respectively. The DWR-provided climate change data does not include descriptions regarding precipitation intensity.

The seasonal timing and amount of precipitation in the CVGB is projected to change. Under 2030 conditions, the largest monthly changes are projected to occur in December with projected decreases of 16 percent, while the largest monthly increase of approximately 8 percent is projected to occur in January. Under 2070 conditions, the largest monthly decrease is projected to occur in April with a projected decrease of approximately 25 percent, while the largest monthly increase of approximately 43 percent is projected to occur in September. Under 2070 DEW conditions, the largest monthly decrease is projected to occur in April with a projected decrease of approximately 41 percent, while the largest monthly increase of approximately 30 percent is projected to occur in September. Under 2070 WMW conditions, the largest monthly decrease is projected to occur in October with a projected decrease of approximately 39 percent, while the largest

⁷ The SGMA Data Viewer is available at [the DWR web map viewer](#) (accessed May 5, 2025).

monthly increase of approximately 103 percent is projected to occur in September. Projected changes in total annual precipitation are a decrease of approximately 4 percent under 2030 conditions, a decrease of 3 percent under 2070 conditions, a decrease of 9 percent under 2070 DEW conditions, and an increase of 12 percent under 2070 WMW conditions.

4.6 Numerical Groundwater Models

Several numerical groundwater models have been developed for, or including, the CVGB. Select groundwater models developed in support of renewable energy projects in the CVGB include Eagle Mountain Pump Storage (EMPS) Project (GEI, 2010b), Desert Sunlight Solar (AECOM, 2010b), Genesis Solar (WorleyParsons, 2009), and Blythe Solar (AECOM, 2010c). Select groundwater models developed to assess a cumulative analysis of renewable energy projects on the CVGB include Leake et al. (2008), Greer et al. (2013), Shen et al. (2017), and Fang et al. (2021). Based on CVGB stakeholder and BLM feedback during the Environmental Impact Report process for a nearby renewable energy project (Aspen, 2024), the Shen et al. (2017) and Fang et al. (2021) models were primary references in the development of this WSA.

Water budget inflow and outflow volumes included in Shen et al. (2017) and Fang et al. (2021) have been considered and are incorporated into the Project's water budget in this WSA, as appropriate (see Sections 4.7, 4.8, and 5.1). The Fang et al. (2021) model was adapted to simulate future Project groundwater use and cumulative projects scenarios (see Section 6).

4.7 Groundwater Recharge

The following is an explanation of select water budget terms:

- A **Water Budget** is “an accounting of the total groundwater and surface water entering and leaving a basin including the changes in the amount of water stored” (California Water Code 107121). It is an identification, estimate, and comparison of the groundwater inputs and outputs that affect the overall trend of groundwater balance in the CVGB. Inputs, such as recharge from precipitation, underflow from other groundwater basins, and other sources, are compared to outputs, such as loss to other groundwater basins, extractions by humans, and ET. Total inflow minus total outflow equals change in groundwater in storage.
- **Basin Yield**⁸ is the volume of pumping that can be extracted from the basin on a long-term basis without creating a chronic and continued lowering of groundwater levels and the associated reduction in the volume of groundwater in storage. Basin yield is not a fixed constant value but a dynamic value that fluctuates over time as the balance of the groundwater inputs and outputs change. In this WSA, the basin yield is calculated for the CVGB as a whole.
- **Groundwater Overdraft** is the condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of many years during which water supply conditions approximate average conditions (DWR, 2020b). In this WSA, groundwater overdraft is estimated for the CVGB as a whole. Groundwater overdraft can result in a chronic lowering of groundwater levels and a deletion of available groundwater in storage.

⁸ Basin yield is not the same as sustainable yield. Sustainable yield is defined in SGMA as “the maximum quantity of water, calculated over a period representative of long-term conditions in the basin and including any temporary surplus that can be withdrawn annually from a groundwater supply without causing an undesirable result” (California Water Code 10721).

Recharge to the CVGB occurs from subsurface inflow from other groundwater basins (Section 4.7.1), infiltration of precipitation (Section 4.7.2), irrigation return flow (Section 4.7.3), and wastewater return (Section 4.7.4). Leakage from the Colorado River Aqueduct has also been identified as a possible source of inflow (Section 4.7.5) (Greer et al., 2013).

Groundwater recharge components listed in Fang et al. (2021) include soil and wash recharge, Pinto Valley Groundwater Basin underflow, and mountain front recharge. Groundwater recharge components, such as irrigation return flow, wastewater return flow, and seepage from the Colorado River Aqueduct, described in this WSA, are not known to be included in Fang et al. (2021). The total annual groundwater recharge used in this WSA was developed to be consistent with the Fang et al. (2021) total annual groundwater recharge. Therefore, some groundwater recharge components, such as recharge from precipitation, were reduced in the groundwater budget developed for this WSA (see Section 5) to offset the non-precipitation-related groundwater recharge components (see Sections 4.7.3 through 4.7.5) and remain consistent with the Fang et al. (2021) total annual groundwater recharge.

4.7.1 Subsurface Inflow and Mountain Front Recharge

Groundwater in the CVGB generally flows west to east. Subsurface inflow originates from the Pinto Valley and Orocopia Valley Groundwater Basins, which are west of the CVGB (DWR, 2004; BLM, 2011). The amount of inflow from the Pinto Valley and Orocopia Valley Groundwater Basins is uncertain, and there have been a range of estimates from different publications that include a low of 372 AFY to a high of 6,575 AFY (Aspen, 2018; Fang et al., 2021). For this WSA, the groundwater budget uses 877 AFY as established in Fang et al. (2021) as the upper bound of the groundwater inflow estimates from the Pinto Valley Groundwater Basin. The subsurface inflow used for this WSA (877 AFY) represents a conservative assumption, as groundwater budgets in WSAs for nearby projects in the recent past have used 3,500 AFY (Aspen, 2021), which is approximately in the middle of the range of estimates.

Mountain front subsurface recharge is recorded as lateral subsurface flow that passes from thin mountain soil to the aquifer at the mountain foot (Fang et al., 2021). For this WSA, the groundwater budget uses 210 AFY, established in Fang et al. (2021) as the upper bound for mountain front recharge.

4.7.2 Recharge from Precipitation

Previous estimates of recharge from precipitation in the CVGB have ranged from 2,060 to 11,501 AFY (Aspen, 2018; Fang et al., 2021). Precipitation recharge has been estimated by previous CVGB studies as a percentage of total precipitation. The CVGB receives a total precipitation of approximately 205,376 AFY (Fang et al., 2021) to 258,000 AFY (CEC, 2010). The BLM estimates that 7 to 8 percent of the precipitation that falls on the bedrock formations present in the mountain areas of the CVGB contributes to groundwater recharge (BLM, 2012), while a smaller percentage of the valley floor precipitation infiltrates and recharges the groundwater basin. For the CVGB, 7 to 8 percent of the precipitation that falls on the mountain fronts would be equivalent to 3 percent of the total precipitation that falls on the total Chuckwalla Valley watershed (BLM, 2012). The California Energy Commission (CEC) calculated precipitation-related recharge by applying estimates of 3 percent, 5 percent, and 7 percent of total incident precipitation contributing to groundwater recharge along with isohyetal precipitation maps for the Chuckwalla Valley watershed (to calculate precipitation distribution and bedrock characteristics by sector).⁹

The results of these calculations determined that precipitation-related recharge for the 3 percent, 5 percent, and 7 percent of the CEC-estimated CVGB annual precipitation is 8,588 AFY; 14,313 AFY; and 20,038 AFY, respectively. The CEC recommended using 8,588 AFY (about 3 percent of total precipitation) for a

⁹ An isohyetal is an estimated line of equal rainfall over an area based on point measurements (NOAA, n.d.[c]).

conservative groundwater budget analysis (CEC, 2010). These results are supported by the findings of a study included in a USGS report on groundwater recharge in the arid and semi-arid southwestern United States (USGS, 2007), which identified a range of approximately 3 to 7 percent of total precipitation for the Mojave Desert, depending on the amount of precipitation received. Fang et al. (2021) (using the CVGB precipitation estimate of 205,376 AFY) estimates a range of approximately 3.4 percent to 5.6 percent of precipitation that falls within the CVGB watershed contributes to groundwater; resulting in a groundwater recharge from precipitation range of approximately 6,983 to 11,501 AFY.

For purposes of this WSA, an estimate of 8,846 AFY of recharge from precipitation is used for the groundwater budget. The recharge from precipitation estimate is approximately 4.3 percent of the Fang et al. (2021) estimated annual CVGB watershed precipitation. The 5.6 percent recharge from precipitation from Fang et al. (2021) could not be used in conjunction with all of the inflow water budget components included in this WSA (see Section 4.7). The resulting groundwater inflow estimate would have exceeded the upper bounds of the Fang et al. (2021) total recharge estimate.

Changes to average annual precipitation and recharge from precipitation for the CVGB are based on 2030 and 2070 DWR climate change data (see Section 5.3) and are summarized below:

- Under 2030 conditions, using Fang et al. (2021) estimated total annual CVGB watershed precipitation, the total average annual precipitation would decrease by approximately 8,200 AF and the associated recharge from precipitation used for the groundwater budget under normal climatic conditions would decrease by approximately 20 AFY.
- Under 2070 conditions, the total average annual precipitation would decrease by approximately 6,200 AF and the associated recharge from precipitation used for the groundwater budget under normal climatic conditions would decrease by approximately 18 AFY.
- Under 2070 DEW conditions, the total average annual precipitation would decrease by approximately 18,500 AF and the associated recharge from precipitation used for the groundwater budget under normal climatic conditions would decrease by approximately 17 AFY.
- Under 2070 WMW conditions, the total average annual precipitation would increase by approximately 24,600 AF and the associated recharge from precipitation used for the groundwater budget under normal climatic conditions would increase by approximately 21 AFY.

4.7.3 Irrigation Return Flow

Irrigation water applied to crops in the CVGB has the potential to infiltrate to groundwater depending on the amount and method of irrigation, soil, crop type, and climate. The CEC estimated irrigation return flow recharge as 10 percent of total irrigation volume as determined by WorleyParsons (2009) and calculated that 800 AFY would reach the CVGB (CEC, 2010). This was based on a total irrigation volume of 7,705 AFY (6,400 AFY for agriculture, 215 AFY for aquaculture pumping, and 1,090 AFY for Lake Tamarisk).¹⁰

¹⁰ As described in Section 4.3, groundwater extraction for agricultural irrigation was estimated at 6,628 AF in 2019 (DWR, 2018). Therefore, the 6,400 AFY estimated by WorleyParsons (2009) and used in this WSA for agricultural irrigation return may be underestimated.

4.7.4 Wastewater Return Flow

Wastewater return flow in the CVGB originates from the Chuckwalla State Prison, the Ironwood State Prison, and the Lake Tamarisk development near Desert Center (CEC, 2010; WorleyParsons, 2009). The two prisons use an unlined pond to dispose of treated wastewater, and it is estimated that 795 AFY infiltrates to the CVGB (WorleyParsons, 2009). Another 36 AFY of return flows are estimated to originate from Lake Tamarisk, for a total of 831 AFY (WorleyParsons, 2009).

4.7.5 Colorado River Aqueduct

Leakage from the Colorado River Aqueduct, which runs across the western edge of the CVGB, has not been documented, but was hypothesized by the Argonne National Laboratory (Argonne) in a 2013 study of the Riverside East Solar Energy Zone (Greer et al., 2013). Argonne estimated a 2,000 AFY contribution to the CVGB from the aqueduct based on measured leakage rates from the Central Arizona Project in Arizona (Greer et al., 2013). This recharge component is not well documented, and the use of Colorado River water would require an entitlement; therefore, it is not used in this WSA.

4.8 Groundwater Demand/Outflow

Outflow from the CVGB occurs from subsurface outflow to the Palo Verde Mesa Groundwater Basin (Section 4.8.1), groundwater extraction for agriculture and other uses (Section 4.8.2), and ET from Palen Dry Lake (Section 4.8.3). Outflow as consumptive use of groundwater also occurs, or would occur, from the Project and other similar existing and proposed projects.

Groundwater discharge components listed in Fang et al. (2021) include “annualized pumping,” which is described further in a table titled “Pumping sources from the solar plants.” The table lists several solar projects and “Existing pumping,” but it is unclear what is included in “Existing pumping.” Based on Fang et al. (2021) it cannot be determined whether groundwater discharge components, such as subsurface outflow, non-solar project groundwater pumping, and ET, are included. The total annual groundwater pumping estimated by Fang et al. (2021) is 8,101 AFY. Total annual groundwater demand/outflow for the CVGB estimated in this WSA includes additional groundwater budget components and is greater than the Fang et al. (2021) estimate (see Section 5).

4.8.1 Subsurface Outflow

Subsurface outflow calculations from the CVGB to the Palo Verde Mesa Groundwater Basin have included zero AFY (Greer et al., 2013), 400 AFY (Metzger et al., 1973), 870 AFY (Woodward Clyde, 1986), 988 AFY (Genesis Solar and WorleyParsons, 2010), and 1,162 AFY (Engineering Science, 1990). The Metzger et al. (1973) calculation was based on a cross-sectional profile of the boundary between the two basins derived using geophysical methods and regional data regarding groundwater gradients and hydraulic conductivity. Woodward Clyde (1986) revised this estimate based on the same cross-sectional area and hydraulic gradient, but with an updated hydraulic conductivity derived from a pumping test conducted at the Chuckwalla State Prison. Engineering Science (1990) updated this estimate to 1,162 AFY using updated gradient information that considered the results of monitoring and return flow from prison effluent disposal. Wilson and Owens-Joyce (1994), using existing gravity data from the USGS, identified a bedrock ridge underlying the CVGB fill east of the cross section produced by Metzger et al. (1973), indicating the area through which discharge occurs is more limited than assumed in previous studies (CEC, 2010; Genesis Solar and WorleyParsons, 2010). Because of uncertainties in the calculations of the preceding estimates, Genesis Solar and WorleyParsons (2010) evaluated the width and topography of the bedrock section underlying the narrows, the stratigraphy and hydraulic conductivity of the basin fill sediments in the narrows, and the hydraulic gradient, and estimated an underflow of 988 AFY.

The Genesis Solar and WorleyParsons (2010) calculation of 988 AFY was adopted for this WSA. The Genesis Solar and WorleyParsons (2010) estimate was derived from the most comprehensive data set and is based on reported water level data.

4.8.2 Groundwater Extraction

Current and historical groundwater extraction in the CVGB includes agricultural water use, pumping for Chuckwalla and Ironwood State Prisons, pumping for the Lake Tamarisk development and golf course, domestic pumping, and a minor amount of pumping by Southern California Gas Company (CEC, 2010). Using data from 2005 to 2010, DWR (2015) estimated the total amount of pumping at 5,000 AFY for the entire CVGB. Argonne (Greer et al., 2013), using DWR data, estimated 5,100 AFY. Other studies have calculated higher estimates. Specifically, the *Palen Solar Project Environmental Impact Study* and CEC staff assessment for the Palen Solar Project, both used 10,361 AFY (BLM, 2011; CEC, 2010). In a WSA for the Palen Solar Power Project, AECOM estimated 5,745 AFY to 7,415 AFY (AECOM, 2010a). DWR (2018) estimated 9,023 AF total annual groundwater use in the CVGB in 2019. For the purposes of this WSA, the estimate of 9,023 AFY is used as the estimate of total groundwater extraction, as is the most recent estimate and was used by DWR for SGMA Basin Prioritization.

Since the reporting of DWR (2018), an additional approximately 161 AFY of groundwater extraction has occurred in the CVGB from qualifying projects.¹¹ Therefore, the total baseline groundwater extraction amount determined for purposes of this WSA, starting in 2026 (start of Project construction), is 9,184 AFY. As discussed in Section 4.8, annualized total pumping used in Fang et al. (2021) was 8,101 AF. Qualifying projects that are currently operational are assumed to operate in accordance with the BLM 30-year ROW grant. Consequently, pumping for those qualifying projects is no longer included in the baseline groundwater extraction when the respective projects' 30-year ROW period ends. Qualifying projects that begin construction or become operational after 2026 are assumed to have a BLM ROW grant of 42 years,

¹¹ Qualifying completed projects (i.e., operational groundwater uses only) contributing to the baseline groundwater extraction include Arica Solar Project (10 AFY), Victory Pass Solar Project (10 AFY), Oberon Renewable Energy Project (40 AFY), Palen Solar Project (41 AFY), Desert Harvest Solar Project (20 AFY), and Athos Renewable Energy Project (40 AFY) (Aspen, 2018; Dudek, 2021b; Aspen, 2021). Qualifying and Cumulative can be used synonymously with respect to projects incorporated into this WSA. The term "qualifying" is specific to SB 610.

equivalent to the Project's total operational and decommissioning periods, except Easley Renewable Energy Project, which has a total operational and decommissioning period of 52 years (see Section 5.2.3) (Aspen, 2024).

4.8.3 Evapotranspiration at Palen Dry Lake

WorleyParsons used hand-auger borings in 2009 to identify the presence of the groundwater table at a depth of 8 feet bgs at the Palen Dry Lake (WorleyParsons, 2009). This suggests that groundwater could be close enough to rise through capillary action and be lost through evaporation (CEC, 2010).

The CEC (2010) estimated groundwater discharge rates from Palen Dry Lake using measured evaporation rates at Franklin Lake Playa in Death Valley, adjusted for differences in the characteristics of the two dry lakes, as a reference. The result was 0.0583 foot of ET per month, for 3 months of the year. In the 2,000-acre area considered susceptible to groundwater ET, this amounts to 350 AFY (CEC, 2010).

Changes to average ET for the CVGB are based on 2030 and 2070 DWR climate change data (see Section 5.3) and are summarized below:

- Under 2030 conditions, the groundwater ET volume of 350 AFY used in the Project water budget is projected to increase by approximately 10 AFY.
- Under 2070 conditions, the groundwater ET volume is projected to increase by approximately 30 AFY.
- Under 2070 DEW conditions, the groundwater ET volume is projected to increase by approximately 40 AFY.
- Under 2070 WMW conditions, the groundwater ET volume is projected to increase by approximately 10 AFY.

5 Groundwater Budget

In accordance with SB 610, the Project is a qualifying project and requires the development of a WSA because of the acreage of the Project and estimated water usage during the construction phase of the Project. Pursuant to SB 610, qualifying projects must analyze “whether the total projected water supplies, determined to be available by the city or county for the project during normal, single dry, and multiple dry water years during a 20-year projection, will meet the projected water demand associated with the proposed project, in addition to existing and planned future uses, including agricultural and manufacturing uses” (California Water Code Section 10910(c)(4)). The Project operational period will be 40 years, with a total projected Project duration of 44 years, including a 2-year construction and decommissioning periods. A summary of the Project duration and water use is included in Table 1.

This section uses the information presented in Section 5 to provide a baseline normal-year groundwater budget for the CVGB.¹² This section also includes a normal-year groundwater budget assuming the Project is in place, and a normal-year groundwater budget assuming the Project and all known qualifying cumulative projects are in place. The water budgets are also presented for single and multiple dry-year scenarios.

5.1 Baseline Groundwater Budget

The baseline groundwater budget is the groundwater budget for the CVGB in the absence of the Project and all other known cumulative projects not already in place. For the purposes of this WSA, agricultural uses and existing cumulative projects are considered as part of the baseline budget. There are no manufacturing water uses in the area.

5.1.1 Normal (Average) Year

Table 4 provides a baseline groundwater budget during normal climatic conditions for the CVGB based on the adopted information presented in Sections 4.7 and 4.8. The 2026 baseline basin yield for the CVGB is estimated at 1,100 AFY, resulting in a total surplus of approximately 53,600 AF at the end of the 44-year period (2069) (see Section 4.8.1 for explanation of variability of the projected basin annual yield).¹³ Groundwater levels and groundwater in storage in the CVGB would be expected to gradually increase during the 44-year period.

¹² Normal year or conditions refers to average climatic conditions during a given year.

¹³ The 44-year period is equivalent to the Project’s approximate 2-year construction period, assumed 40-year operational period, and estimated 2-year decommissioning period.

Table 4. Chuckwalla Valley Groundwater Basin Normal Conditions Groundwater Budget

Budget Components	Acre-Feet per Year
Inflow	
Recharge from Precipitation	8,846
Underflow from Pinto Valley and Orocopia Valley Groundwater Basins	877
Mountain Front Recharge	210
Irrigation Return Flow	800
Wastewater Return Flow	831
Total Inflow ¹	11,600
Outflow	
Groundwater Extraction ²	-9,184
Underflow to Palo Verde Mesa Groundwater Basin	-988
Evapotranspiration at Palen Dry Lake	-350
Total Outflow ¹	-10,500
Budget Balance (Inflow – Outflow)¹	1,100

Notes

¹ Because of rounding, the total does not correspond to the exact sum of all figures shown.

² Baseline annual groundwater pumping as of 2026, including pumping from operational qualifying projects (see Section 4.8.2).

5.1.2 Dry Year

According to SB 610 guidelines, a dry year can be considered a year with a precipitation amount that is at 10 percent probability of occurrence, meaning 10 percent of the years would be drier. A critical dry year would be a year with a 3 percent probability of occurrence.

The average annual precipitation from 1893 to 2023 at the Blythe meteorological station was 3.39 inches (NOAA, n.d.[a], n.d.[b]). The 10 percent probability dry year was estimated by ranking precipitation years from 1893 to 2023 from lowest to highest and giving them ranking numbers 1 to 131 with the lowest precipitation year number 1 and the highest precipitation year number 131. Dividing the ranking number by the total (131) gives a relative probability of the precipitation in any given year being less than the corresponding precipitation for the ranking number. For example, the precipitation for 2009 was 1.15 inches and ranked #13. Dividing 13 by 129 and converting to percent gives 10.1 percent. Consequently, 1.15 inches of rain, or about 34 percent of average annual precipitation at Blythe, was considered the 10 percent probability dry year. The critical dry year was estimated in the same way and determined to be approximately 0.72 inch of precipitation, or 21 percent of average precipitation (reference precipitation year 2000, ranking #4 of 131 giving 3.1 percent relative probability).

This section provides a revised baseline groundwater budget based on dry year and critical dry year conditions. The following assumptions were used:

- Recharge from precipitation is the primary factor in determining the dry year and critical dry year groundwater budgets. Dry years produce less recharge from precipitation because less runoff would generally be expected to occur in dry years, resulting in less percolation of precipitation. Runoff and recharge from precipitation is also dependent on the pattern, intensity, and distribution of precipitation. Based on *Ground-Water Recharge in the Arid and Semiarid Southwestern United States* (USGS, 2007), lower precipitation years may in general give a lower percentage of precipitation ending up as recharge,

but results were reportedly inconsistent, and data presented provides no information below 3 percent (the percentage used as a basis for the infiltration rate used in this WSA). Therefore, for the purposes of this WSA, the reduction in infiltration to groundwater is assumed to be in direct proportion to the reduction in precipitation. Additionally, a dry year recharge is estimated as 8,846 AFY multiplied by 0.34 (the ratio of dry year to average year precipitation). This calculation indicates 3,008 AFY precipitation recharge for a dry year. Similarly, a critical dry year recharge is estimated as 8,846 AFY multiplied by 0.21 (the ratio of critical dry year to average year precipitation). This calculation indicates 1,858 AFY of precipitation recharge for a critical dry year.

- Mountain front recharge is assumed to be affected proportionally to recharge from precipitation. Therefore, a dry year recharge is estimated as 210 AFY multiplied by 0.34 (the ratio of dry year to average year precipitation). This calculation indicates 71 AFY mountain front recharge for a dry year. Similarly, a critical dry year recharge is estimated as 210 AFY multiplied by 0.21 (the ratio of critical dry year to average year precipitation). This calculation indicates 44 AFY of mountain front recharge for a critical dry year.
- Underflow from the Pinto Valley and Orocopia Groundwater Basins is assumed to be unaffected by water year type. Some dry-year effect could occur, especially in the case of multiple dry years, but groundwater response would likely be delayed following a recharge event, and the magnitude of the effect reduced because of the low volume of groundwater outflowing from the basins.
- Irrigation return flow is assumed to be unaffected by water year type. The region's climate is arid with infrequent precipitation. It is assumed that any precipitation is considered de minimis when determining annual irrigation needs.
- Based on the same rationale as irrigation return flow, wastewater return flow is unaffected by water year type.
- Based on the same rationale as irrigation return flow, groundwater pumping is unaffected by water year type.
- Based on the same rationale as inflow from the Pinto Valley and Orocopia Groundwater Basins, underflow to Palo Verde Mesa Groundwater Basin is unaffected by water year type.
- ET at Palen Dry Lake is unaffected by water year type because a single dry year, or critical dry year, would result in a reduction of a maximum of 6,000 AF of recharge. Given the size of the CVGB (940 square miles) a 1-year reduction of this magnitude would reduce the average groundwater level by only about 0.14 inch (Aspen, 2021). ET could be affected by a significant, long-term groundwater deficit, but, for the purposes of this WSA, ET was assumed to remain constant.

Tables 5 and 6 provide the baseline groundwater budgets for a dry year and critical dry year. Both water budgets indicate an annual groundwater deficit, meaning groundwater outflow would exceed groundwater inflow. A dry year is expected to have a deficit of approximately 4,900 AF, increasing to 6,100 AF for a critical dry year.

As discussed above, a dry year and a critical dry year are considered a year with a precipitation amount that is at 10 percent and 3 percent probability of occurrence, respectively. It is important to note that although dry and critical dry years do occur, historically they have not occurred in multiple consecutive years. Therefore, the CVGB may experience an annual groundwater deficit, not overdraft (see Section 4.7), during dry and critical dry years, but the groundwater balance would recover during subsequent years of average and above-average precipitation.

Table 5. Chuckwalla Valley Groundwater Basin Dry Year Groundwater Budget

Budget Components	Acre-Feet per Year
Inflow	
Recharge from Precipitation	3,008
Underflow from Pinto Valley and Orocopia Valley Groundwater Basins	877
Mountain Front Recharge	71
Irrigation Return Flow	800
Wastewater Return Flow	831
Total Inflow ¹	5,600
Outflow	
Groundwater Extraction	-9,184
Underflow to Palo Verde Mesa Groundwater Basin	-988
Evapotranspiration at Palen Dry Lake	-350
Total Outflow	-10,500
Budget Balance (Inflow – Outflow)¹	-4,900

Note

¹ Because of rounding, the total does not correspond to the exact sum of all figures shown.

Table 6. Chuckwalla Valley Groundwater Basin Critical Dry Year Groundwater Budget

Budget Components	Acre-Feet per Year
Inflow	
Recharge from Precipitation	1,858
Underflow from Pinto Valley and Orocopia Valley Groundwater Basins	877
Mountain Front Recharge	44
Irrigation Return Flow	800
Wastewater Return Flow	831
Total Inflow ¹	4,400
Outflow	
Groundwater Extraction	-9,184
Underflow to Palo Verde Mesa Groundwater Basin	-988
Evapotranspiration at Palen Dry Lake	-350
Total Outflow	-10,500
Budget Balance (Inflow – Outflow)¹	-6,100

Note

¹ Because of rounding, the total does not correspond to the exact sum of all figures shown.

5.1.3 Multiple Dry Years

Historical precipitation data (NOAA, n.d.[a], n.d.[b]) show that in the 131 years of record from 1893 to 2023, the longest consecutive series of dry (10 percent) years on record is two. There are no consecutive critical dry years on record. A 2-year string of dry years would result in a baseline groundwater deficit of twice the amount given in Table 5, or 9,800 AF. A 3-year string of dry years would result in a baseline groundwater deficit of 14,700 AF.

The longest consecutive series of years with below average precipitation on record was 12 years, from 1893 to 1904 (NOAA, n.d.[a], n.d.[b]). During this period, the average annual precipitation was 1.42 inches, or about 42 percent of average annual precipitation for the period of record (1893 to 2023). This period is considered to be representative of a series of multiple dry years for the purposes of this WSA.

Table 7 presents the results of an estimated 12-year groundwater budget, assuming a repeat of the 1893 to 1904 climatic conditions, without the Project or cumulative projects in place. The results indicate that at the end of the 12-year period, the groundwater deficit would be approximately 48,900 AF. Similar to the discussion in Section 5.1.2, although the CVGB will experience periods of below average precipitation resulting in multi-year groundwater deficits, the cumulative groundwater deficit would recover during subsequent periods of average and above average precipitation.

Table 7. Chuckwalla Valley Groundwater Basin Multiple Dry Year Groundwater Budget

Year	1	2	3	4	5	6
Dry Year Reference Year	1893	1894	1895	1896	1897	1898
Precipitation (inches)	1.75	2.16	1.84	1.29	2.84	1.30
Precipitation as Percentage of Average	52%	64%	54%	38%	84%	38%
Normal Recharge from Precipitation (AF)	8,846	8,846	8,846	8,846	8,846	8,846
Dry Year Adjusted Recharge from Precipitation (AF)	4,567	5,636	4,801	3,366	7,411	3,392
Other Groundwater Recharge (All Sources) (AF)	2,718	2,718	2,718	2,718	2,718	2,718
Total Groundwater Recharge (AF)	7,285	8,354	7,519	6,084	10,129	6,110
Groundwater Outflow (All Sources) (AF)	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500
Budget Balance (Inflow – Outflow) (AF)	-3,215	-2,146	-2,981	-4,416	-371	-4,390
Cumulative Budget Balance (Inflow – Outflow) (AF)¹	-3,200	-5,400	-8,300	-12,800	-13,100	-17,500
Year	7	8	9	10	11	12
Dry Year Reference Year	1899	1900	1901	1902	1903	1904
Precipitation (inches)	0.75	0.56	1.21	1.12	0.88	1.33
Precipitation as Percentage of Average	22%	17%	36%	33%	26%	39%
Normal Recharge from Precipitation (AF)	8,846	8,846	8,846	8,846	8,846	8,846
Dry Year Adjusted Recharge from Precipitation (AF)	1,957	1,461	3,157	2,923	2,296	3,471
Other Groundwater Recharge (All Sources) (AF)	2,718	2,718	2,718	2,718	2,718	2,718
Total Groundwater Recharge (AF)	4,675	4,179	5,875	5,641	5,014	6,189
Groundwater Outflow (All Sources) (AF)	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500
Budget Balance (Inflow – Outflow) (AF)	-5,825	-6,321	-4,625	-4,859	-5,486	-4,311
Cumulative Budget Balance (Inflow – Outflow) (AF)¹	-23,300	-29,700	-34,300	-39,100	-44,600	-48,900

Notes

¹ Because of rounding, the total does not correspond to the exact sum of all figures shown.

AF = acre-feet

5.2 Groundwater Budget with the Savira Solar Project and Cumulative Projects

5.2.1 Normal (Average) Year

For purposes of the WSA, water for the Project is assumed to be sourced from a proposed onsite groundwater well to be located near the Project's operations and maintenance building and start of the gen-tie (see Figure 2). Total water use by the Project will be up to 100 AF for the 2-year construction period, up to 10 AFY for the 40-year operational period, and 25 AFY for the 2-year decommissioning period (see Section 2).

Based on the groundwater budget balance presented in Table 4, the CVGB during normal year conditions would have a surplus of 54,900 AF after the 44-year period. The net CVGB surplus with the Project in place would therefore be 54,400 AF, or 99 percent of the surplus that would exist without the Project. Therefore, with the Project in place, groundwater in storage and groundwater levels in the CVGB would be expected to increase over the life of the Project.

5.2.2 Dry Year

If a single dry year or single critical dry year occurred during the construction period of the Project (assumed to be 2026 through 2027), the CVGB annual deficit would be approximately 4,950 AF and 6,150 AF, respectively. The Project would increase the dry year and critical dry year deficit by 1 percent if one of those year types were to occur during the construction period of the Project. Assuming normal precipitation returns, this total deficit (dry year or critical dry year plus Project use) would be recovered in approximately 5 and 6 years, respectively (including continued Project pumping).¹⁴

5.2.3 Cumulative Projects

Table 8 lists cumulative projects that are planned or currently being constructed. Cumulative project details included in Table 8 are consistent with assumptions made in the Project water budgets (see Section 5) and Cumulative Drawdown Analysis (see Section 6). Based on the cumulative project water use assumptions included in Table 8, the Project comprises approximately 0.5 percent of the total cumulative projects' groundwater extractions.¹⁵

¹⁴ Continued Project pumping includes 1 year of construction pumping and 4 to 5 years (dependent on dry year or critical dry year scenario) of operational pumping.

¹⁵ Cumulative projects that have been proposed and not yet approved could be altered or cancelled in the future. Additional cumulative projects, not included in this WSA, could be proposed, and could propose to use water sources other than from the CVGB. Likewise, advances in technology could reduce project water use.

As discussed in Section 4.8.2, qualifying projects that are currently operational are assumed to operate in accordance with the BLM 30-year ROW grant. Consequently, pumping for those qualifying projects is no longer included in the baseline groundwater extraction when the respective projects' 30-year ROW period ends. Qualifying projects that begin construction or become operational after 2026 are assumed to have a BLM ROW grant of 42 years, equivalent to the Project's total operational and decommissioning periods, except the Easley Renewable Energy Project, which has a total operational and decommissioning period of 52 years (Aspen, 2024).

Table 8. Chuckwalla Valley Groundwater Basin Summary of Cumulative Projects

Project Name	Construction Start (years)	Construction Duration (years)	Project Area Size (acres)	Construction Groundwater Use (AFY)	Operational Groundwater Use (AFY)	Decommissioning Groundwater Use (AFY) ¹
Desert Sunlight	2011	4	4,100	650	0.2	92 ²
Genesis Solar Project	2011	2	1,800	1,348	114	114
Palen Solar Project	2020	2	4,200	332	41	41
Desert Harvest	2020	1	1,208	91	20	20
Athos	2021	2	3,228	500	40	40
Arica Solar Project	2022	2	1,355	65	10	10
Victory Pass Solar Project	2022	2	1,310	104	10	10
Oberon Renewable Energy Project	2023	2	5,000	82	40	40
Lycan Solar Project ³	2024	2	6,944	780	40	40
Calypso I Solar Project ³	2024	2	3,271	370	40	40
Easley Renewable Energy Project	2024	2	3,727	500	50	50
Sapphire Solar Project	2025	2	1,123	300	9	100
Redonda Solar Project	2026	2	868	85	10	25
Savira Solar Project	2026	2	535	50	10	25
Eagle Mountain Pumped Storage Project ⁴	2027	4	90	4,460	2,050	2,050
Bajada Solar Project	2028	2	2,600	200	20	25

Notes

¹ Decommissioning water use is assumed to be equal to the project's operational water use for a duration equal to the project's construction period (assumed to be approximately 2 years for most projects).

² Desert Sunlight decommissioning water use was calculated based on the acre-foot per megawatt decommissioning water usage ratio for the Savira Solar Project (0.17 acre-feet/megawatt), which is based on water use assumptions for other projects in the Desert Center region.

³ No public information on construction schedule, duration, and water usage is known. This information was calculated based on acreage of project and general solar development assumptions.

⁴ On June 15, 2023, the Federal Energy Regulatory Commission issued an order granting an extension of the Eagle Mountain Pumped Storage Project construction deadlines to commence project construction by June 19, 2028, and the extended deadline to complete project construction is June 19, 2031. As no additional public information is known about the potential start date for construction of this project, 2027 was assumed.

Gray shading indicates project operational and decommissioning pumping is accounted for in the baseline groundwater budget (see Table 4).

AFY = acre feet per year

Table 9 provides a 44-year groundwater budget projection for average years with the Project and all cumulative projects in place and assuming the Project begins using water in 2026. After 2026, there would be an initial groundwater surplus of 500 AF, followed by a cumulative deficit of approximately 3,200 AF after 2027. The cumulative groundwater deficit would increase to approximately 53,000 AF by the end of the 44-year period; nearly equal to the groundwater surplus that would accumulate after the 44-year period with no cumulative projects in place (53,600 AF). The cumulative groundwater deficit would begin to recover after 2074, following decommissioning of the remaining cumulative projects.¹⁶

The estimated water demand of the EMPS Project is 4,460 AFY during the projected 4-year construction phase and 2,050 AFY during the operational and decommissioning phases of the project. EMPS Project pumping constitutes 88 percent of the total 44-year cumulative project pumping. If EMPS Project groundwater use was not included in the cumulative project scenario, there would be a 44,800-AF groundwater surplus at the end of the 44-year period. Similarly, if the EMPS Project groundwater use was not included in the driest 44-year period cumulative project scenario, the cumulative groundwater surplus would be approximately 25,200 AF at the end of the 44-year period (see Section 5.2.4).

¹⁶ Eagle Mountain Pumped Storage Project decommissioning is assumed to be from 2071 through 2074.

Table 9. Chuckwalla Valley Groundwater Basin 44-Year Groundwater Budget with All Cumulative Projects In-Place

Year	2026	2027	2028	2027	2029	2030	2031	2032	2033	2069
Normal Recharge from Precipitation	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846
Other Groundwater Recharge (All Sources)	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718
Total Groundwater Recharge	11,564	11,564	11,564	11,564	11,564	11,564	11,564	11,564	11,564	11,564
Non-Project Groundwater Outflow (All Sources)	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,186
Project Groundwater Use (All Projects)	-565	-4,734	-4,819	-4,819	-4,639	-2,229	-2,229	-2,229	-4,734	-2,170
Total Groundwater Outflow	-11,065	-15,234	-15,319	-15,319	-15,139	-12,729	-12,729	-12,729	-15,234	-12,356
Budget Balance (Inflow - Outflow)	499	-3,670	-3,755	-3,755	-3,575	-1,165	-1,165	-1,165	-3,670	-792
Cumulative Budget Balance (Inflow - Outflow)¹	500	-3,200	-6,900	-10,700	-14,300	-15,400	-16,600	-17,800	-3,200	-53,000

Notes

¹ Because of rounding, the total does not correspond to the exact sum of all figures shown.

This table begins in the year 2026, the first year of Savira Solar Project (Project) construction. The projected 44-year period consists of the Project construction, operational, and decommissioning phases.

All values are reported in acre-feet (AF).

A negative value indicates groundwater extraction or a groundwater deficit.

5.2.4 Multiple Dry Years

Table 10 provides a summary of the multiple dry year analysis (most consecutive below average precipitation years [12] on record [see Section 5.1.3]), and assuming the Project and all cumulative projects are in place. At the end of the 12-year period, the cumulative groundwater deficit would be 84,100 AF. The Project would contribute 200 AF, approximately 0.2 percent, to this deficit.

The precipitation record indicates that a series of dry years has typically been followed by a series of years with above-average precipitation. To assess the probable effect of this during the 44-year life of the Project, a 44-year running average analysis was made using the 132-year precipitation period of record. This analysis, including the 44-year multiple-dry-year baseline calculation, is summarized in Tables 11 and 12.

The driest 44-year period was the period beginning in 1893 and ending in 1936. Average annual precipitation during this period was 3.22 inches, or about 5 percent below normal. Table 11 indicates that if a repeat of this 44-year period occurs under current (no qualifying projects not already in place) conditions, at the end of the 44-year period the CVGB would have a surplus of approximately 34,000 AF. The greatest groundwater deficit during the repeated historical period would occur during 2037, in which the total deficit would be approximately 48,900 AF. The same analysis with the Project in place, but with no other cumulative projects, produces similar results as Table 11, with a total groundwater surplus of approximately 33,500 AF at the end of 44-year period.

Table 12 provides the cumulative project analysis. With all cumulative projects in place, the CVGB total groundwater deficit at the end of the 44-year period would be approximately 72,600 AF. If pumping from EMPS Project were not included in the cumulative project scenario, the CVGB would have a total groundwater surplus of approximately 25,200 AF at the end of the 44-year period.

The available water supplies during normal, single dry, and multiple dry water years from the CVGB would meet the projected water demands of the Project, in addition to existing uses and planned future uses. Although there would be a temporary groundwater deficit during single dry and multiple dry years, the deficit would be recovered when periods of normal precipitation returned.

Although the cumulative scenario presented in Table 12 indicates a groundwater deficit at the end of the 44-year period (with the greatest deficit occurring in 2041), the available water supplies during normal, single dry, and multiple dry water years from the CVGB, would also meet the projected water demands of the cumulative project uses, in addition to existing uses and planned future uses. This is a result of the storage capacity and hydrogeologic properties of the CVGB, and the relatively low water demand for most of the cumulative projects.

This WSA also includes an analysis that calculated the groundwater drawdown caused by groundwater use by the cumulative projects (see Section 6). The results indicate that impacts to groundwater levels as a result of Project and cumulative project pumping are confined to the western part of the CVGB and will not adversely affect existing water users and water rights claimants in the CVGB resulting from the limited magnitude of the modeled drawdown. The cumulative groundwater deficit would begin to recover following decommissioning of the cumulative projects.

Table 10. Chuckwalla Valley Groundwater Basin Multiple Dry Year Groundwater Budget Analysis with All Cumulative Project In-Place

Year	2026	2027	2028	2029	2030	2031
Dry Precipitation Reference Year	1893	1894	1895	1896	1897	1898
Precipitation (inches)	1.75	2.16	1.84	1.29	2.84	1.3
Precipitation as Percentage of Average	52%	64%	54%	38%	84%	38%
Normal Recharge from Precipitation (AF)	8,846	8,846	8,846	8,846	8,846	8,846
Adjusted Recharge from Precipitation (AF)	4,567	5,636	4,801	3,366	7,411	3,392
Other Groundwater Recharge (All Sources) (AF)	2,718	2,718	2,718	2,718	2,718	2,718
Total Groundwater Recharge (AF) ¹	7,285	8,354	7,519	6,084	10,129	6,110
Non-Project Groundwater Outflow (All Sources) (AF)	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500
Cumulative Project Groundwater Use (AF)	-565	-4,734	-4,819	-4,819	-4,639	-2,229
Total Groundwater Outflow (AF)	-11,065	-15,234	-15,319	-15,319	-15,139	-12,729
Budget Balance (Recharge + Outflow) (AF)	-3,780	-6,880	-7,800	-9,235	-5,010	-6,619
Cumulative Budget Balance (AF) ¹	-3,800	-10,700	-18,500	-27,700	-32,700	-39,300
Year	2032	2033	2034	2035	2036	2037
Dry Precipitation Reference Year	1899	1900	1901	1902	1903	1904
Precipitation (inches)	0.75	0.56	1.21	1.12	0.88	1.33
Precipitation as Percentage of Average	22%	17%	36%	33%	26%	39%
Normal Recharge from Precipitation (AF)	8,846	8,846	8,846	8,846	8,846	8,846
Dry Year Adjusted Recharge from Precipitation (AF)	1,957	1,461	3,157	2,923	2,296	3,471
Other Groundwater Recharge (All Sources) (AF)	2,718	2,718	2,718	2,718	2,718	2,718
Total Groundwater Recharge (AF) ¹	4,675	4,179	5,875	5,641	5,014	6,189
Non-Project Groundwater Outflow (All Sources) (AF)	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500
Cumulative Project Groundwater Use (AF)	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229
Total Groundwater Outflow (AF)	-12,729	-12,729	-12,729	-12,729	-12,729	-12,729
Budget Balance (Recharge + Outflow) (AF)	-8,054	-8,550	-6,854	-7,088	-7,715	-6,540
Cumulative Budget Balance (AF) ¹	-47,400	-55,900	-62,800	-69,900	-77,600	-84,100

Notes

¹ Because of rounding, the total does not correspond to the exact sum of all figures shown.

AF = acre-feet

Table 11. Chuckwalla Valley Groundwater Basin Dry 44-Year Projected Groundwater Budget with No Cumulative Projects In-Place

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Precipitation Reference Year	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905
Precipitation (inches)	1.75	2.16	1.84	1.29	2.84	1.3	0.75	0.56	1.21	1.12	0.88	1.33	4.29
Precipitation as Percentage of Average	52%	64%	54%	38%	84%	38%	22%	17%	36%	33%	26%	39%	127%
Normal Recharge from Precipitation (AF)	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846
Adjusted Recharge from Precipitation (AF)	4,567	5,636	4,801	3,366	7,411	3,392	1,957	1,461	3,157	2,923	2,296	3,471	11,194
Other Groundwater Recharge (All Sources) (AF)	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718
Total Groundwater Recharge (AF)	7,285	8,354	7,519	6,084	10,129	6,110	4,675	4,179	5,875	5,641	5,014	6,189	13,912
Non-Project Groundwater Outflow (All Sources) (AF)	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500
Total Groundwater Outflow (AF)	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500
Budget Balance (Inflow – Outflow) (AF)	-3,215	-2,146	-2,981	-4,416	-371	-4,390	-5,825	-6,321	-4,625	-4,859	-5,486	-4,311	3,412
Cumulative Budget Balance (Inflow – Outflow) (AF) ¹	-3,200	-5,400	-8,300	-12,800	-13,100	-17,500	-23,300	-29,700	-34,300	-39,100	-44,600	-48,900	-45,500
Year	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
Precipitation Reference Year	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Precipitation (inches)	2.55	2.18	3.21	5.51	4.66	3.58	4.44	4.8	5.82	3.88	3.64	1.82	6.64
Precipitation as Percentage of Average	75%	64%	95%	163%	137%	106%	131%	142%	172%	114%	107%	54%	196%
Normal Recharge from Precipitation (AF)	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846
Adjusted Recharge from Precipitation (AF)	6,654	5,689	8,376	14,378	12,160	9,342	11,586	12,525	15,187	10,125	9,498	4,749	17,327
Other Groundwater Recharge (All Sources) (AF)	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718
Total Groundwater Recharge (AF)	9,372	8,407	11,094	17,096	14,878	12,060	14,304	15,243	17,905	12,843	12,216	7,467	20,045
Non-Project Groundwater Outflow (All Sources) (AF)	-10,500	-10,500	-10,500	-10,500	-10,386	-10,386	-10,294	-10,347	-10,347	-10,347	-10,347	-10,327	-10,327
Total Groundwater Outflow (AF)	-10,500	-10,500	-10,500	-10,500	-10,386	-10,386	-10,274	-10,347	-10,347	-10,347	-10,347	-10,327	-10,327
Budget Balance (Inflow – Outflow) (AF)	-1,128	-2,093	594	6,596	4,492	1,674	4,030	4,897	7,558	2,496	1,870	-2,860	9,718
Cumulative Budget Balance (Inflow – Outflow) (AF) ¹	-46,700	-48,800	-48,200	-41,600	-37,100	-35,400	-31,400	-26,500	-19,000	-16,500	-14,600	-17,500	-7,700

Year	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064
Precipitation Reference Year	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
Precipitation (inches)	3.66	4.51	7.08	2.11	4.15	1.29	6.1	5.14	4.09	0.96	1.07	2.5	7.21
Precipitation as Percentage of Average	108%	133%	209%	62%	122%	38%	180%	152%	121%	28%	32%	74%	213%
Normal Recharge from Precipitation (AF)	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846
Adjusted Recharge from Precipitation (AF)	9,551	11,769	18,475	5,506	10,829	3,366	15,918	13,413	10,673	2,505	2,792	6,524	18,814
Other Groundwater Recharge (All Sources) (AF)	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718
Total Groundwater Recharge (AF)	12,269	14,487	21,193	8,224	13,547	6,084	18,636	16,131	13,391	5,223	5,510	9,242	21,532
Non-Project Groundwater Outflow (All Sources) (AF)	-10,286	-10,246	-10,226	-10,186	-10,186	-10,186	-10,186	-10,186	-10,186	-10,186	-10,186	-10,186	-10,186
Total Groundwater Outflow (AF)	-10,286	-10,246	-10,226	-10,186	-10,186	-10,186	-10,186	-10,186	-10,186	-10,186	-10,186	-10,186	-10,186
Budget Balance (Inflow – Outflow) (AF)	1,983	4,241	10,967	-1,962	3,361	-4,102	8,450	5,945	3,205	-4,963	-4,676	-944	11,346
Cumulative Budget Balance (Inflow – Outflow) (AF) ¹	-5,800	-1,500	9,400	7,500	10,800	6,700	15,200	21,100	24,300	19,400	14,700	13,800	25,100

Year	2065	2066	2067	2068	2069
Precipitation Reference Year	1932	1933	1934	1935	1936
Precipitation (inches)	4.7	1.91	3.57	4.6	2.95
Precipitation as Percentage of Average	139%	56%	105%	136%	87%
Normal Recharge from Precipitation (AF)	8,846	8,846	8,846	8,846	8,846
Adjusted Recharge from Precipitation (AF)	12,264	4,984	9,316	12,003	7,698
Other Groundwater Recharge (All Sources) (AF)	2,718	2,718	2,718	2,718	2,718
Total Groundwater Recharge (AF)	14,982	7,702	12,034	14,721	10,416
Non-Project Groundwater Outflow (All Sources) (AF)	-10,186	-10,186	-10,186	-10,186	-10,186
Total Groundwater Outflow (AF)	-10,186	-10,186	-10,186	-10,186	-10,186
Budget Balance (Inflow – Outflow) (AF)	4,797	-2,484	1,848	4,536	230
Cumulative Budget Balance (Inflow – Outflow) (AF) ¹	29,900	27,400	29,300	33,800	34,000

Notes

¹ Because of rounding, the total does not correspond to the exact sum of all figures shown.

AF = acre-feet

Table 12. Chuckwalla Valley Groundwater Basin Dry 44-Year Projected Groundwater Budget with All Cumulative Projects in Place

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Precipitation Reference Year	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905
Precipitation (inches)	1.75	2.16	1.84	1.29	2.84	1.3	0.75	0.56	1.21	1.12	0.88	1.33	4.29
Precipitation as Percentage of Average	52%	64%	54%	38%	84%	38%	22%	17%	36%	33%	26%	39%	127%
Normal Recharge from Precipitation (AF)	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846
Adjusted Recharge from Precipitation (AF)	4,567	5,636	4,801	3,366	7,411	3,392	1,957	1,461	3,157	2,923	2,296	3,471	11,194
Other Groundwater Recharge (All Sources) (AF)	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718
Total Groundwater Recharge (AF)	7,285	8,354	7,519	6,084	10,129	6,110	4,675	4,179	5,875	5,641	5,014	6,189	13,912
Non-Project Groundwater Outflow (All Sources) (AF)	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500	-10,500
Project Groundwater Outflow (All Cumulative Projects) (AF)	-565	-4,734	-4,819	-4,819	-4,639	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229
Total Groundwater Outflow (AF)	-11,065	-15,234	-15,319	-15,319	-15,139	-12,729	-12,729	-12,729	-12,729	-12,729	-12,729	-12,729	-12,729
Budget Balance (Inflow – Outflow) (AF)	-3,780	-6,880	-7,800	-9,235	-5,010	-6,619	-8,054	-8,550	-6,854	-7,088	-7,715	-6,540	1,183
Cumulative Budget Balance (Inflow – Outflow) (AF) ¹	-3,800	-10,700	-18,500	-27,700	-32,700	-39,300	-47,400	-55,900	-62,800	-69,900	-77,600	-84,100	-82,900
Year	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
Precipitation Reference Year	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Precipitation (inches)	2.55	2.18	3.21	5.51	4.66	3.58	4.44	4.8	5.82	3.88	3.64	1.82	6.64
Precipitation as Percentage of Average	75%	64%	95%	163%	137%	106%	131%	142%	172%	114%	107%	54%	196%
Normal Recharge from Precipitation (AF)	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846
Adjusted Recharge from Precipitation (AF)	6,654	5,689	8,376	14,378	12,160	9,342	11,586	12,525	15,187	10,125	9,498	4,749	17,327
Other Groundwater Recharge (All Sources) (AF)	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718
Total Groundwater Recharge (AF)	9,372	8,407	11,094	17,096	14,878	12,060	14,304	15,243	17,905	12,843	12,216	7,467	20,045
Non-Project Groundwater Outflow (All Sources) (AF)	-10,500	-10,500	-10,500	-10,500	-10,386	-10,386	-10,347	-10,347	-10,347	-10,347	-10,347	-10,327	-10,327
Project Groundwater Outflow (All Cumulative Projects) (AF)	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229
Total Groundwater Outflow (AF)	-12,729	-12,729	-12,729	-12,729	-12,615	-12,615	-12,576	-12,576	-12,576	-12,576	-12,576	-12,556	-12,556
Budget Balance (Inflow – Outflow) (AF)	-3,357	-4,322	-1,635	4,367	2,263	-555	1,728	2,668	5,329	267	-359	-5,089	7,489
Cumulative Budget Balance (Inflow – Outflow) (AF) ¹	-86,300	-90,600	-92,300	-87,900	-85,600	-86,200	-84,500	-81,800	-76,500	-76,200	-76,500	-81,600	-74,100

Year	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064
Precipitation Reference Year	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
Precipitation (inches)	3.66	4.51	7.08	2.11	4.15	1.29	6.1	5.14	4.09	0.96	1.07	2.5	7.21
Precipitation as Percentage of Average	108%	133%	209%	62%	122%	38%	180%	152%	121%	28%	32%	74%	213%
Normal Recharge from Precipitation (AF)	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846	8,846
Adjusted Recharge from Precipitation (AF)	9,551	11,769	18,475	5,506	10,829	3,366	15,918	13,413	10,673	2,505	2,792	6,524	18,814
Other Groundwater Recharge (All Sources) (AF)	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718	2,718
Total Groundwater Recharge (AF)	12,269	14,487	21,193	8,224	13,547	6,084	18,636	16,131	13,391	5,223	5,510	9,242	21,532
Non-Project Groundwater Outflow (All Sources) (AF)	-10,286	-10,246	-10,226	-10,186	-10,186	-10,186	-10,186	-10,186	-10,186	-10,186	-10,186	-10,186	-10,186
Project Groundwater Outflow (All Cumulative Projects) (AF)	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229	-2,229
Total Groundwater Outflow (AF)	-12,515	-12,475	-12,455	-12,415	-12,415	-12,415	-12,415	-12,415	-12,415	-12,415	-12,415	-12,415	-12,415
Budget Balance (Inflow – Outflow) (AF)	-246	2,012	8,738	-4,191	1,132	-6,331	6,221	3,716	976	-7,192	-6,905	-3,173	9,117
Cumulative Budget Balance (Inflow – Outflow) (AF) ¹	-74,400	-72,400	-63,600	-67,800	-66,700	-73,000	-66,800	-63,100	-62,100	-69,300	-76,200	-79,400	-70,300
Year	2065	2066	2067	2068	2069								
Precipitation Reference Year	1932	1933	1934	1935	1936								
Precipitation (inches)	4.7	1.91	3.57	4.6	2.95								
Precipitation as Percentage of Average	139%	56%	105%	136%	87%								
Normal Recharge from Precipitation (AF)	8,846	8,846	8,846	8,846	8,846								
Adjusted Recharge from Precipitation (AF)	12,264	4,984	9,316	12,003	7,698								
Other Groundwater Recharge (All Sources) (AF)	2,718	2,718	2,718	2,718	2,718								
Total Groundwater Recharge (AF)	14,982	7,702	12,034	14,721	10,416								
Non-Project Groundwater Outflow (All Sources) (AF)	-10,186	-10,186	-10,186	-10,186	-10,186								
Project Groundwater Outflow (All Cumulative Projects) (AF)	-2,229	-2,229	-2,320	-2,270	-2,170								
Total Groundwater Outflow (AF)	-12,415	-12,415	-12,506	-12,456	-12,356								
Budget Balance (Inflow - Outflow) (AF)	2,568	-4,713	-472	2,266	-1,940								
Cumulative Budget Balance (Inflow - Outflow) (AF) ¹	-67,700	-72,400	-72,900	-70,600	-72,600								

Notes

¹ Because of rounding, the total does not correspond to the exact sum of all figures shown.

AF = acre-feet

6 Cone of Depression and Cumulative Drawdown Analysis

To evaluate the potential cone of depression induced by proposed Project groundwater pumping and cumulative drawdown from all cumulative projects (see Table 9), a predictive MODFLOW groundwater model (Model) was developed and projected for the 44-year duration of the Project. The Model incorporated estimated inflow and outflow terms consistent with the Project water budget presented in Section 5 as well as hydrogeological properties used in the Fang et al. (2021) numerical groundwater model. A summary of the Model parameters and results is included below.

6.1 Numerical Groundwater Model Parameters and Results

The Model consists of two layers, the upper layer represents the alluvium and the lower layer represents the Bouse Formation (Fang et al., 2021). The water table is typically located in the alluvial sediments throughout the CVGB where both the alluvium and Bouse Formation are productive aquifers. The elevations of the basement or underlying bedrock were adopted from Fang et al. (2021). Mountain ranges bordering the CVGB were modeled as no-flow boundaries. The Basin's natural recharge from precipitation and mountain front runoff was modeled using the MODFLOW Recharge Package. Recharge from wastewater and agricultural return flows were modeled using the MODFLOW Well Package. Groundwater discharge from pumping was also modeled with the MODFLOW Well Package. The discharge from Palen Dry Lake was modeled with the MODFLOW Evapotranspiration Package.

Aquifer parameters are based on the previous modeling work performed by Fang et al. (2021); however, some adjustments were made to improve model calibration. The hydraulic conductivity generally ranges from approximately 0.5 foot per day in the central part of the CVGB to 50 feet per day closer to the mountain fronts. Groundwater storage in the unconfined aquifers is modeled with a specific yield of 20 percent.

Model calibration demonstrates that the Model is capable of accurately simulating field-measured heads and flows (Anderson and Woessner, 1992). The groundwater model is evaluated primarily on the statistical evaluation of residuals (measured groundwater elevations minus observed groundwater elevations) in target wells across the Model domain. The primary calibration goal is to achieve a relative error of less than 10 percent (ESI, 2000–2020; Spitz and Moreno, 1996). The CVGB part of the Model has a relative error of 6.57 percent.

The Model was set up with monthly stress periods starting from 2000 and modeled into the future through the end of 2075. The modeled future period includes Project construction pumping starting in June 2026 (15 months), operational pumping starting in September 2027 (40 years), and decommissioning pumping starting in 2068 (2 years). To assess the impact of the Project, two predictive modeling scenarios were run: a baseline scenario without Project pumping or pumping from cumulative projects (see Table 8), and a cumulative pumping scenario that includes Project pumping and all cumulative project pumping. The difference in groundwater elevations between these two scenarios is a result of the pumping effects associated with all of the cumulative projects, including the Project.

The CVGB water budget (see Section 5) includes the period from 2026 (start of Project construction) through 2069 (end of Project decommissioning) and assumes the CVGB is in equilibrium (i.e., no groundwater deficit or surplus) at the beginning of 2026. The Model simulates the period from 2000 through 2075. The modeled water levels were compared to observed groundwater elevations during the period from 2000 through 2023 as part of the Model calibration. The modeled period from 2000 through 2023 includes construction and operational groundwater pumping from qualifying completed projects (see Section 4.8.2). The modeled conditions also include known qualifying project pumping in 2024 and 2025. Therefore, the modeled 2026 conditions, with respect change in groundwater in storage, are not in equilibrium.

The Project impacts are discussed in terms of the zones of influence of the total cone of depression considering cumulative drawdown as a result of the Project, cumulative projects, and the CVGB projected agricultural, municipal, and domestic pumping. Figures 10 through 12 present the cumulative zone of influence caused by cumulative project and Project pumping after Project construction (15 months), Project operation (40 years), and Project decommissioning (2 years), respectively.¹⁷ The zone of influence after 15 months of Project construction pumping (100 AF) is an approximately 1.5-mile radius cone of depression out to 0.5 feet of drawdown. Project operational pumping for 40 years (400 AF) has a cumulative drawdown with an approximate 0.8-mile radius out to 0.5 feet of drawdown, and Project decommissioning (50 AF) has cumulative drawdown with an approximate 1.4-mile radius out to 0.5 feet of drawdown. This zone of influence also includes pumping from cumulative projects.

The modeling results indicate that impacts to groundwater levels as a result of Project and cumulative project pumping are relatively confined to the Project vicinity in the western portion of the CVGB. Although most of the non-cumulative project pumping (see Section 4.8.2) in the CVGB occurs in the western portion of the CVGB (the total agricultural, municipal, and domestic pumping is limited to approximately 7,900 AFY [CEC, 2010]), cumulative Project pumping will not adversely affect existing water users and water rights claimants in the CVGB as a result of the limited magnitude of the modeled drawdown.

¹⁷ Cumulative project groundwater pumping includes pumping for the adjacent Redonda Solar Project from the Project well. The Project and the Redonda Solar Project construction, operation, and decommissioning schedule is the same. Therefore, the cone of depression at the Project well is greater than if the analysis only simulated Project groundwater pumping from the Project well.

Figure 10. Cumulative Projects Water Demand Analysis Project Construction (End of Month 15)

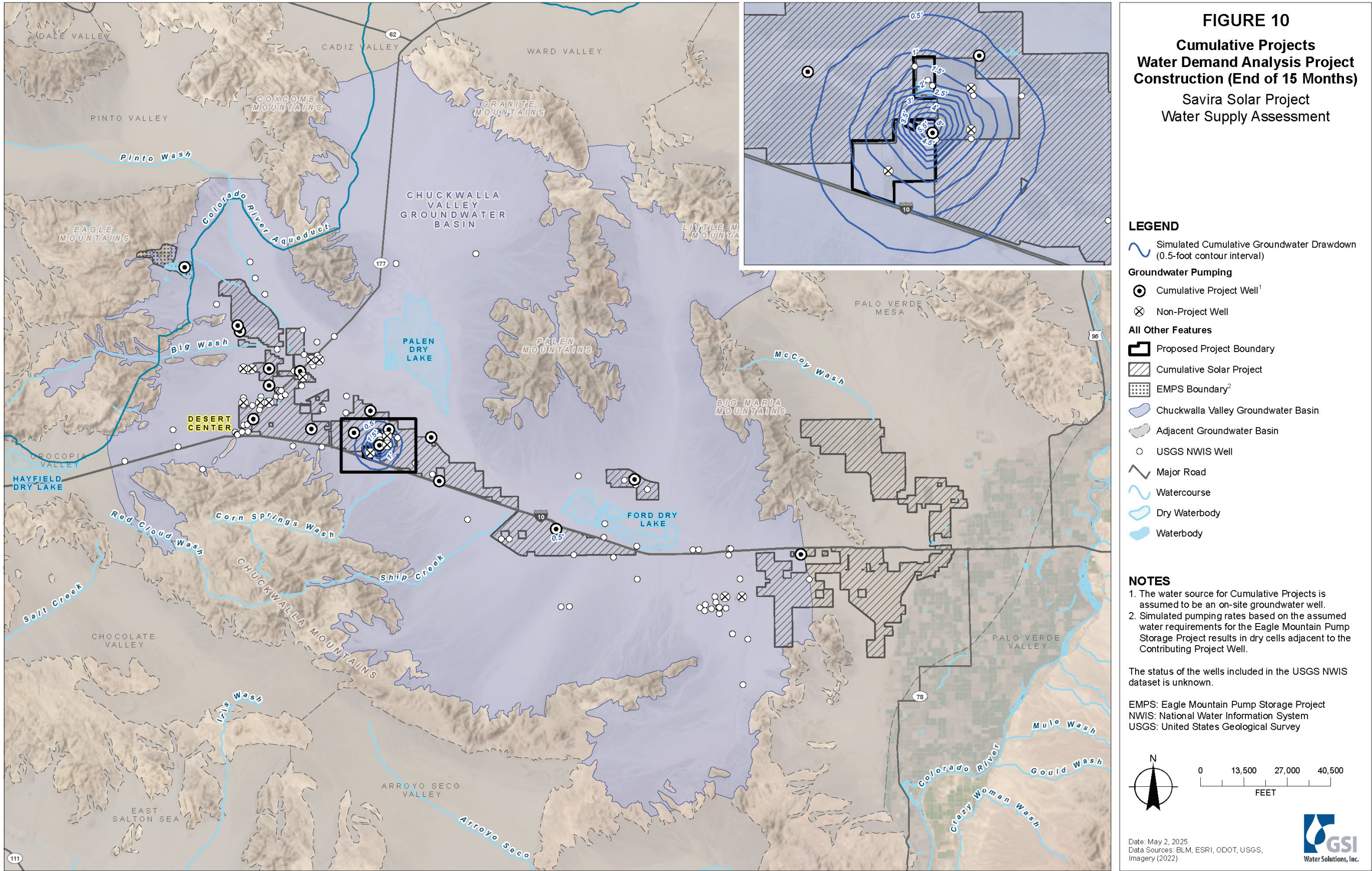


Figure 11. Cumulative Projects Water Demand Analysis Project Construction (End of Year 42)

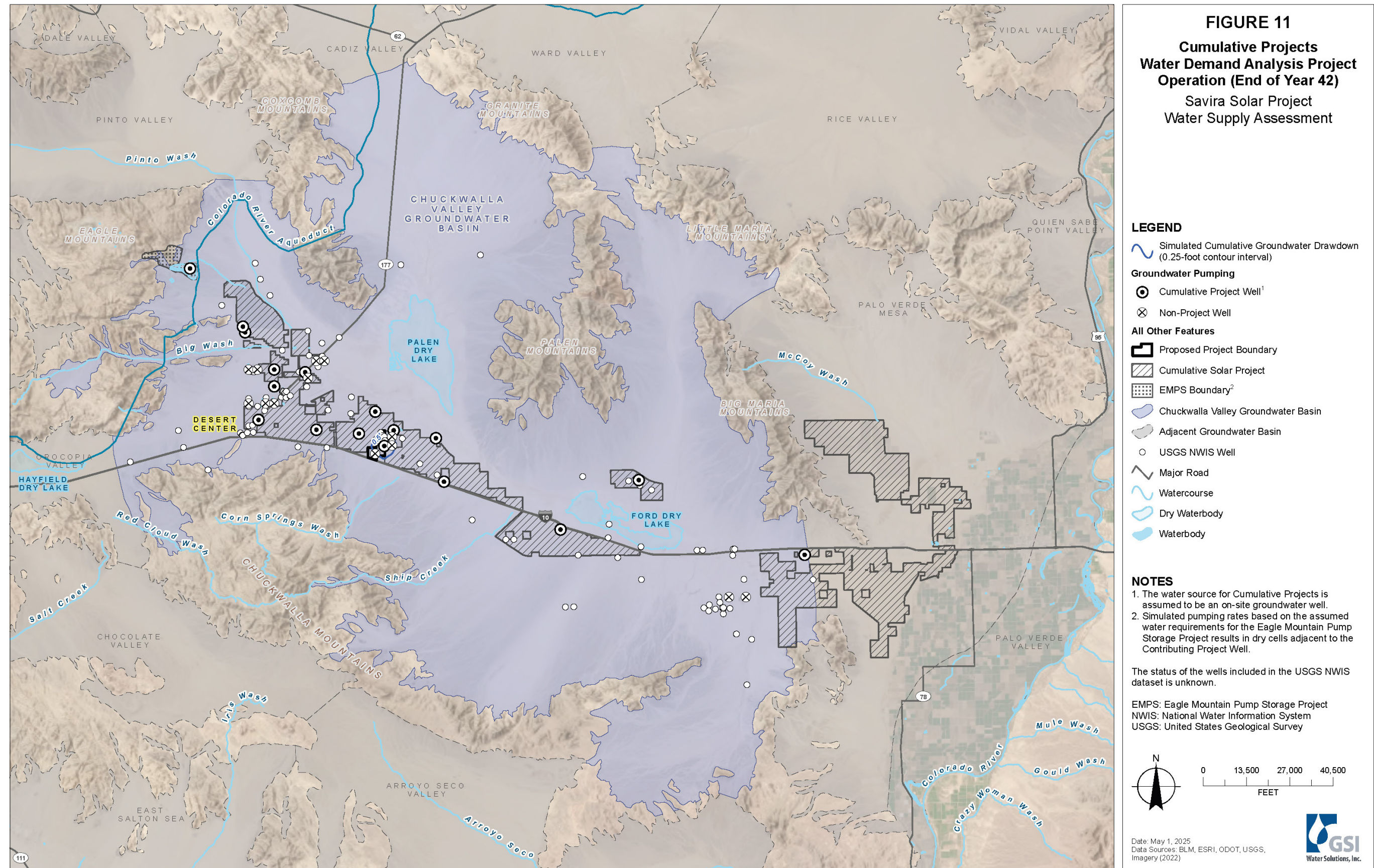
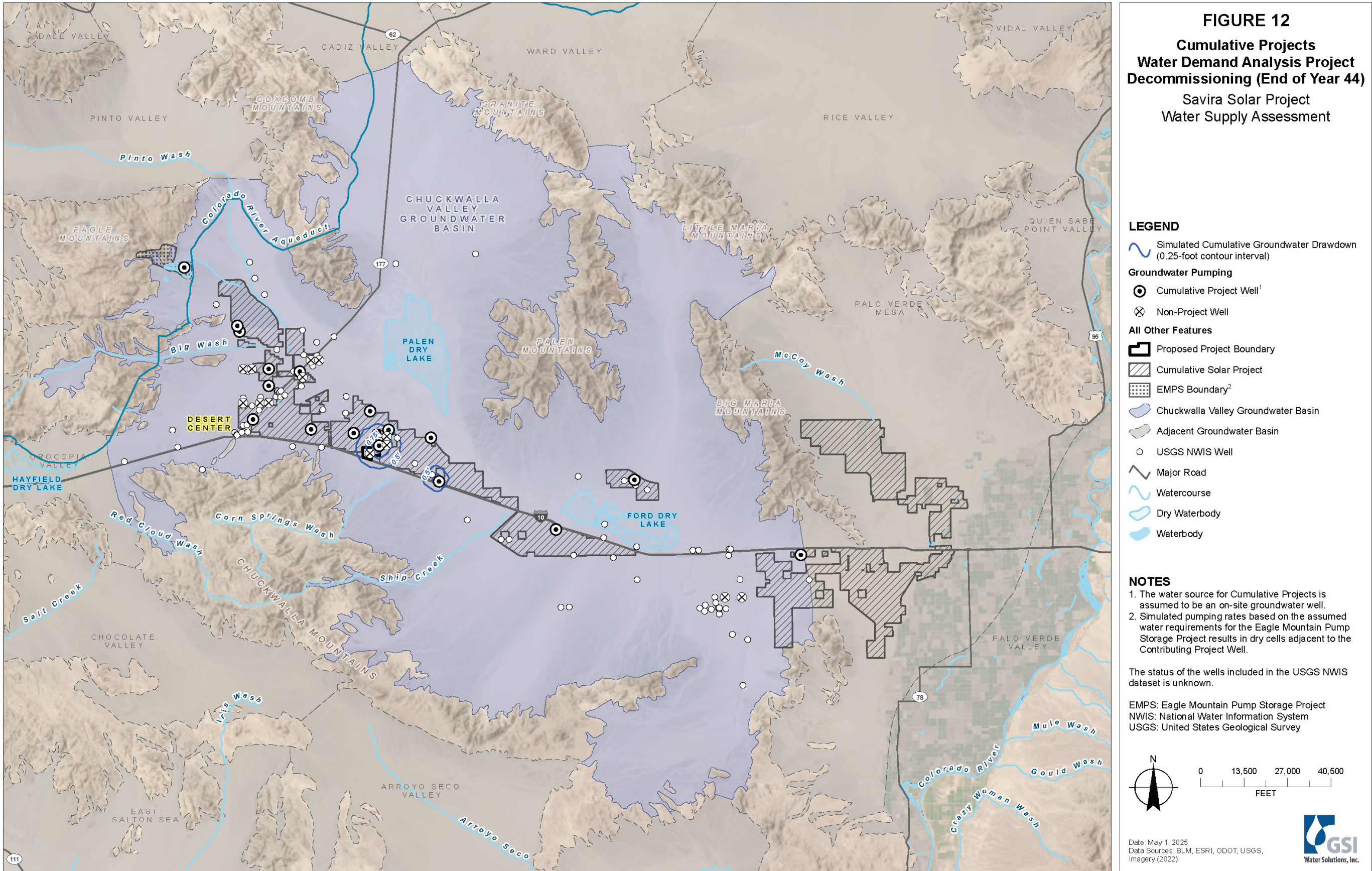


Figure 12. Cumulative Projects Water Demand Analysis Project Decommissioning (End of Year 44)



7 Conclusion

Based on the groundwater budget terms presented in this WSA, the CVGB's 2026 annual change in groundwater in storage is a surplus of approximately 1,100 AFY, and all estimated groundwater demand for the Project could be sourced from the CVGB without resulting in a cumulative groundwater deficit under average climatic conditions. The calculated normal-year groundwater budget surplus for the CVGB is greater than the estimated water use for the approximate 2-year construction phase of the Project, as well as the estimated annual water requirements for the operational and decommissioning phases of the Project. Consequently, assuming a normal year projected groundwater budget, an annual deficit of groundwater in storage would not occur during the 44-year period.¹⁸ Additionally, based on the 2030 and 2070 DWR climate change data (see Section 4.5), decreased average precipitation and increased ET would decrease the baseline groundwater budget by approximately 30 and 50 AFY, respectively—this relatively small change does not substantially affect the projected groundwater budgets.

The available water supplies during normal, single dry, and multiple dry water years from the CVGB would meet the projected water demands of the Project, in addition to existing uses and planned future uses. Although there would be a temporary groundwater deficit during single dry and multiple dry years, the deficit would be recovered when periods of normal precipitation returned. The cumulative scenario presented in Table 12 indicates a groundwater deficit at the end of the 44-year period (with the greatest deficit occurring in 2041), the available water supplies during normal, single dry, and multiple dry water years from the CVGB, would also meet the projected water demands of the cumulative project uses, in addition to existing uses and planned future uses. This is a result of the storage capacity and hydrogeologic properties of the CVGB, and the relatively low water demand for most of the cumulative projects. The cumulative groundwater deficit would begin to recover following decommissioning of the cumulative projects. This WSA also includes an analysis that calculated the groundwater drawdown caused by groundwater use by the cumulative projects (see Section 6).

The modeled Project impacts are discussed in terms of the zones of influence of the total cone of depression considering cumulative drawdown as a result of the Project, cumulative projects, and the CVGB projected agricultural, municipal, and domestic pumping. The zone of influence after 15 months of Project construction pumping (100 AF) is represented by a cone of depression with a radius of approximately 1.5-mile radius cone of depression out to 0.5 feet of drawdown. Project operational pumping for 40 years (400 AF) has a cumulative drawdown with an approximate 0.8-mile radius out to 0.5 foot of drawdown; Project decommissioning (50 AF) has cumulative drawdown with an approximate 1.4-mile radius out to 0.5 feet of drawdown. This zone of influence also includes pumping from cumulative projects. The modeling results indicate that impacts to groundwater levels as a result of Project and cumulative project pumping are confined to the Project vicinity in the western portion of the CVGB. Although most of the non-cumulative project pumping (see Section 4.8.2) in the CVGB occurs in the western portion of the CVGB (the total agricultural, municipal, and domestic pumping is limited to approximately 7,900 AFY [CEC, 2010]), cumulative Project pumping is not anticipated to adversely affect existing water users and water rights claimants in the CVGB resulting from the limited magnitude of the modeled regional drawdown.

¹⁸ The 44-year period is equivalent to the Project's approximate 2-year construction period, assumed 40-year operational period, and estimated 2-year decommissioning period.

Based on the limited magnitude of the modeled drawdown resulting from Project and cumulative project pumping, groundwater levels would not be lowered to a level that would cause a degradation of groundwater quality that affect other beneficial uses. Furthermore, groundwater levels would not be lowered to a level that causes pumping wells near the Project to begin to capture deeper/older groundwater in the CVGB. Deeper/older groundwater can contain increased salts and nutrients as a result of prolonged exposure to the aquifer material (leaching of minerals from the host rock into groundwater) (USGS, 2019). There are no known point source plumes near the Project (SWRCB, 2025). Therefore, there are no known contaminant plumes that Project pumping or cumulative pumping could potentially mobilize.

The Project is not anticipated to cause lowering of groundwater levels greater than recorded historical lows. There is no reported evidence of subsidence in the CVGB as a result of historical or present pumping (GEI, 2010a; DWR, 2018). Based on available data from CGPS stations located in the CVGB, Orocopia Valley Groundwater Basin, and Palo Verde Mesa (POR from 1996 through present) Groundwater Basin, no significant land subsidence has been recorded. Additionally, DWR (2018) noted no documented groundwater extraction induced inelastic subsidence in the CVGB. Therefore, the Project is not anticipated to cause subsidence, increase the rate of subsidence, or cause loss of aquifer storage capacity in the CVGB.

Comparison of available water level data and the modeling analysis are presented in Section 6. The Project is not anticipated to adversely affect groundwater-dependent vegetation or groundwater discharge to surface water resources, such as streams, springs, seeps, wetlands, and playas, that could affect biological resources or habitat, or resources that are culturally important to Native Americans. Specifically, Project and cumulative project groundwater use will not have an adverse effect on the ability of either iodine bush or honey mesquite to access groundwater.

Similarly, there are no perennial streams in the CVGB, and documented springs and seeps in the Project area are located in the surrounding mountains (Aspen, 2021). Therefore, no effects on groundwater discharge to surface water resources are anticipated as a result of the cumulative projects.

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