Appendix G

Water Supply Assessment

Athos Renewable Energy Project
Water Supply Assessment

Prepared by
Philip Lowe, P.E.

Aspen
environmental group

May 2019

Contents

Tables

1. Introduction

The objective of this report is to provide a Water Supply Assessment (WSA) pursuant to the requirements of California Senate Bill (SB) 610/221, for the Athos Renewable Energy Project (AREP).

SB 610, passed in 2002, amended the California Water Code to require detailed analysis of water supply availability for certain types of development projects, and to improve the link between information on water supply availability and certain land use decisions made by cities and counties. SB 610 requires detailed information regarding water availability to be provided to the city and county decision-makers prior to approval of specified large development projects. This information is to be included in the administrative record that serves as the evidentiary basis for an approval action by the city or county on such projects. The companion measure to SB 610, SB 221, applies to residential subdivisions, and does not apply to the AREP. Both measures recognize local control and decision making regarding the availability of water for projects and the approval of projects.

2. Project Location and Description

The AREP would be in Riverside County, California approximately 2.5 to 10 miles east and northeast of the unincorporated community of Desert Center and north of Interstate 10. The project is within Riverside East Solar Energy Zone (Riverside East SEZ). The project location is shown in Figure 1. The project layout is shown in Figure 2. All figures are included at the end of the document.

The AREP consists of 65 parcels on private land for the solar facility, and 25 parcels located on BLM-administered and private land for the gen-tie lines. It is located on primarily disturbed lands to minimize ground disturbance and impacts to resources.

The proposed solar facility would generate up to 500 megawatts (MW) of renewable energy using photovoltaic (PV) technology and would include up to 500 MW of integrated energy storage. Construction is anticipated to occur over a 30-month period with construction activities occurring simultaneously. The Project may be phased. The project would cover an area of 3,228 acres and include a solar facility and new 220 kV Gen-tie line.

Water for construction-related dust control and operations would be obtained from several potential sources, including an on-site or off-site groundwater well, or trucked from an offsite water purveyor. During the construction phase, it is anticipated that a total of up to 500 acre-feet would be used for dust suppression (including truck wheel washing) and other purposes during the 30-month construction timeframe. During the operation and maintenance phase water would be required for panel washing and maintenance, and for substation restroom facilities. During operation, the Project would require panel washing up to four times per year resulting in the use of approximately 15 to 40 acre-feet annually (afy) for panel washing and other uses.

3. SB 610 Overview and Applicability

SB 610 requires that a project be supported by a WSA if the project is subject to the California Environmental Quality Act, and would demand an amount of water equivalent to, or greater than, the amount of water required by a 500-dwelling unit project. According to SB 610 Guidelines, one dwelling unit typically consumes 0.3 to 0.5 afy, which would amount to 150 to 250 afy for 500 units. Projects must analyze whether the total projected water supplies determined to be available 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. Averaged over the 30-year project lifespan, the AREP would use 52.3 acre feet per year.

Senate Bill 267 (SB 267), signed into law in 2011, amended California's Water Law to revise the definition of "project" specified in SB 610. Under SB 267, wind and solar photovoltaic projects which consume less than 75 afy of water are not considered to be a "project" under SB 610, in which case a WSA would not be required. The Project's average 30-year water use of 52.3 afy (40 afy for operations) would be below this threshold. It is therefore assumed that the AREP operations is exempted from SB 610 by SB 267. However, because the 75 afy threshold would be exceeded during the 30-month construction period, Riverside County has requested preparation of this Water Supply Assessment.

4. Regional Overview and Water Supply Sources

The AREP is located within the Chuckwalla Valley Drainage Basin. All surface water in the western portion of the valley flows to Palen Dry Lake, located approximately 10 miles east of the community of Desert Center. Surface water in the eastern portion of the valley flows to Ford Dry Lake, located approximately 10 miles southeast of the Palen Dry Lake. All the AREP parcels drain to the Palen Dry Lake.

The local climate is arid with high summer temperatures and mild winter temperatures. Average annual precipitation in the project area, based on the gauging station at the nearby Blythe, California, airport, is 3.42 inches (USHCN, 2016). Average summer maximum temperatures are above 100 degrees. Precipitation is seasonal.

Off-site stormwater flows are from a series of desert washes originating from the Coxcomb Mountains, Eagle Mountains, and Chuckwalla Mountains. Major named drainage courses affecting the project include the Pinto Wash, which flows southeastward into the Chuckwalla Valley from between the Eagle and Coxcomb Mountains, the Big Wash, which flows eastward into the Chuckwalla Valley from the Eagle Mountains, and the Corn Springs Wash, which flows northeastward into the Chuckwalla Valley from the Chuckwalla Mountains. Numerous other unnamed watercourses drain into the Chuckwalla Valley from these same mountain ranges. Due to the aridity of the area, there are no perennial streams which could serve as water supply for the AREP.

Springs and seeps in the area include Corn Springs, Box Spring, Crystal Spring, Old Woman Spring, Cove Spring, Mitchell Caverns Spring, Bonanza Spring, Agua Caliente Spring, Kleinfelter Spring, Von Trigger Spring, Malpais Spring, and Sunflower Spring (Aspen, 2018). All these springs are in the surrounding mountains and none are located such that they could serve as water supply for the AREP.

All water for the AREP, whether derived from onsite wells or offsite water purveyor, will come from the Chuckwalla Valley Groundwater Basin (CVGB).

5. Chuckwalla Valley Groundwater Basin

5.1 Basin Overview and Storage

The CVGB covers an area of 940 square miles in eastern Riverside County, California. The basin underlies the Palen and Chuckwalla Valleys and is bounded by consolidated rocks of the Chuckwalla, Little Chuckwalla, and Mule Mountains on the south, of the Eagle Mountains on the west, and of the Mule and McCoy Mountains on the east. The Coxcomb, Granite, Palen, and Little Maria Mountains bound the valley on the north and extend ridges into the valley. There are no perennial streams in Chuckwalla Valley. Palen, Ford, and several smaller dry lakes are found in topographic low-points (CDWR, 2004). The surface watershed contributing to the area of the CVGB is 1,344 square miles (CEC, 2010), comprised of the Chuckwalla Valley (940 square miles) and the surrounding bedrock mountains (404 square miles).

Water-bearing units of the CVGB include Pliocene to Quaternary age continental deposits divided into Quaternary alluvium, the Pinto Formation, and the Bouse Formation. Bedrock is as deep as 5,000 feet below ground surface in the eastern portion of the CVGB. Wells near Parcels A and G extend to depths of approximately 550 to 875 feet below ground level with water levels approximately 100 to 150 feet below ground level (Aspen, 2018) Total groundwater storage available to wells was originally estimated at 9,100,000 acre-feet (af), and more recently at 15,000,000 af (CDWR, 2004, CDWR, 1979). The estimate of 15,000,000 af was made by the CDWR based on multiplying specific yield times saturated thickness times basin size. Saturated thickness was obtained by subtracting the average depth to water from the average thickness of alluvial sediments, or 500 feet, whichever is smaller (CDWR, 1979). The 15,000,000 estimate, being the more recent, is used in this analysis.

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 (Basin Plan) for the Colorado River Basin (Region 7). The CVGB is bordered by the Orocopia Valley groundwater basin on the west, the Palo Verde Mesa Groundwater Basin on the east, the Cadiz Valley, Rice Valley and Ward Valley Groundwater Basins on the north, and the Pinto Valley Groundwater Basin on the northwest (Figure 3).

5.2 Groundwater Management

The CVGB is an unadjudicated groundwater basin. Owners of property overlying the basin have the right to pump groundwater from the basin for reasonable and beneficial use, provided that the water rights were never severed or reserved. Groundwater production in the basin is not managed by an entity and no groundwater management plan has been submitted to the California Department of Water Resources (CDWR, 2016). There is no Urban Water Management Plan for the area, and there is no Integrated Regional Water Management Plan.

5.3 Groundwater Trends

Groundwater levels range from the ground surface to about 400 feet below ground surface (RWQCB, 2006). Groundwater contour data from 1979 shows that CVGB groundwater moves from the north and west toward the gap between the Mule and McCoy Mountains at the southeastern end of the valley. Groundwater levels were stable up to about 1963 (CDWR, 2004). The CDWR reported total groundwater extraction of 9,100 afy in 1966.

The direction of groundwater movement is not expected to have changed since 1979, but there have been changes in groundwater levels, especially localized around areas of significant extraction. For example, data from wells within 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 when combined pumping exceeded 20,000 afy, well above historic water usage for the western portion of the basin (AECOM, 2011).

The National Park Service has noted that groundwater levels throughout the CVGB appear to have been trending downward for several decades (BLM, 2012). Most wells in the CVGB have not been used for monitoring data such as groundwater level trends since the 1980s; however, several wells have been used to collect groundwater data for the past 25 years, and these data show that groundwater level trends have been fairly stable in the eastern CVGB, and rising slowly back towards pre-agricultural pumping groundwater levels in the western CVGB, while dropping slowly but steadily only in the central CVGB (Aspen, 2018).

In general, the well data show a relatively stable groundwater surface, interrupted locally in the past mainly by agricultural pumping. Local groundwater levels show evidence of rising after the agriculture-related drawdown of the 1980s ended, indicating that local extraction rates have not exceeded recharge. Since groundwater levels were reported as stable in 1963 (CDWR, 2004), an extraction rate of roughly 9,100 afy may be a sustainable safe yield.

5.4 Groundwater Recharge

Recharge to the CVGB occurs from subsurface inflow from other groundwater basins, infiltration of precipitation, irrigation return flow, and wastewater return. Leakage from the Colorado River Aqueduct has also been identified as a possible source of inflow.

Subsurface Inflow

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. Although the California Department of Water Resources has hypothesized that underflow from the Cadiz Valley Groundwater Basin may enter the CVGB (CDWR, 2004), Cadiz Valley, Rice Valley and Ward Valley Groundwater Basins are not considered to contribute to the CVGB (BLM, 2011).

The amount of inflow from the Pinto Valley and Orocopia Valley Groundwater Basins is uncertain, and there have been a wide range of estimates from different experts. The results of several studies on CVGB recharge from subsurface inflow are shown in Table 1.

Overall, there is substantial uncertainty regarding inflow from the adjacent groundwater basins. For purposes of this analysis, the groundwater budget uses 3,500 afy. This estimate has been used for other projects in the past and is approximately in the middle of the range of estimates given in Table 1. The analysis herein also applies the NPS low estimate of 953 afy to provide a probable range for the groundwater budget given the uncertainties involved.

Table 1. Subsurface Inflow Recharge Estimates for the Chuckwalla Valley Groundwater Basin

Study	Recharge from Inflow from Pinto Valley and Orocopia Valley Groundwater Basins (acre-feet per year)
Genesis Solar Project EIS[1]	3,500
Eagle Mountain Draft EIR[1]	6,700
Palen Solar Power Project EIS[1]	3,500
Eagle Mountain Draft EIS[1]	6,575
National Park Service (NPS)[1]	953–1,906
Argonne National Laboratory[2]	1,595

1 - Source: BLM, 2012
2 - Source: Argonne, 2013

Recharge from Precipitation

Infiltration recharge to the CVGB by precipitation is difficult to assess due to lack of reliable data and the aridity of the area. There has been a wide range of estimates by experts in support of other projects or agencies. The CDWR has not published an estimate.

Generally, precipitation recharge has been estimated as a percentage of total precipitation. The CVGB receives annually about 258,000 afy total rain (CEC, 2015). Most analysts note that studies published by the BLM indicate that 7 to 8 percent of the precipitation that falls on the bedrock mountain fronts ends up as groundwater recharge (BLM, 2012), while a smaller percentage of the valley floor precipitation makes it to the groundwater. 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 CVGB watershed (BLM, 2012). The CEC, using estimates of 3, 5 and 7% of total incident precipitation ending up as groundwater recharge, and overlaying isohyetal precipitation maps over the entire CVGB watershed to estimate precipitation distribution and bedrock characteristics by sector, estimated precipitation-related recharge to be 8,588, 14,313, and 20,038 afy, respectively, and recommended using 8,588 afy (about 3% of total precipitation) for a groundwater budget analysis (CEC, 2015). These results are supported by the findings of a study presented in a USGS report on groundwater recharge in the arid and semiarid southwestern United States (USGS 2007), which gave a range of approximately 3 to 7 percent of total precipitation for the Mojave Desert, depending on the amount of precipitation received. In the 2007 study by the USGS, the lower (3 percent) estimate represented years with below-average precipitation, with the higher (7 percent) estimate for above-average precipitation. The percentage changes with the amount of precipitation because most recharge occurs from runoff, and runoff is generally higher in years with greater precipitation.

The results of several studies on CVGB recharge from precipitation are shown in Table 2.

The NPS study in Table 2 was based on groundwater modeling by the U.S. Geological Survey (USGS) on the Warren, Joshua Tree, and Copper Mountain groundwater basins described above. These results are subject to a high level of uncertainty due to simplified assumptions and model inputs, and the fact that the modeled basins are not adjacent to the CVGB. The results of the study were extrapolated to the CVGB, which was not studied directly (BLM, 2012).

Table 2. Precipitation Recharge Estimates for the Chuckwalla Valley Groundwater Basin

Study	Recharge from Precipitation (acre-feet per year)
Genesis Solar Project EIS[1]	9,448
Eagle Mountain Draft EIR[1]	5,500
Palen Solar Project EIS[1]	8,588
Eagle Mountain Draft EIS[1]	6,125
National Park Service (NPS)[1]	2,060–6,125
Argonne National Laboratory[2]	3,200

1 - Source: BLM, 2012
2 - Source: Argonne, 2013

There is high uncertainty regarding the amount of precipitation-related recharge to the CVGB, and substantial disagreements among experts, with estimates presented herein ranging from 2,060 afy to 9,448 afy, and possibly even lower, or higher. For purposes of this analysis, the groundwater budget uses 8,588 afy as was used for the nearby Palen Solar Project. This is approximately equivalent to 3 percent of the total average precipitation of 258,000 af and is supported by the USGS 2007 study for which 3 percent would represent the estimated recharge for a below-average precipitation year. The analysis herein also applies the NPS low estimate of 2,060 afy, representing about (0.7 percent of average annual precipitation) to provide a probable range for the groundwater budget given the uncertainties involved.

Irrigation Return Discharge

Irrigation water applied to crops within the CVGB has the potential to infiltrate to groundwater depending on the amount and method of irrigation, soils, crop type, and climate. The CEC estimated irrigation return recharge as 10% of total irrigation volume as determined by a 2010 study (WorleyParsons, 2009), and determined that 800 afy would reach the CVGB (CEC, 2010). This was based on a total irrigation volume of 7,700 afy (6,400 afy for agriculture, 215 afy for aquaculture pumping, and 1,090 afy for Tamarisk Lake).

Wastewater Return Flow

Wastewater return flow within 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 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 is estimated to originate from Lake Tamarisk, for a total of 831 afy (WorleyParsons, 2009).

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 in a 2013 study of the Riverside East Solar Energy Zone (Argonne, 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. Since this recharge component is not well documented, and if it does occur the use of it would require entitlement, it is not used in this analysis.

5.5 Groundwater Demand/Outflow

Outflow from the CVGB occurs from subsurface outflow to the Palo Verde Mesa Groundwater Basin, groundwater extraction for agriculture and other uses, and evapotranspiration from Palen Dry Lake. Outflow also occurs, or will occur, from the AREP and other existing and proposed projects.

Subsurface Outflow

Subsurface outflow from the CVGB is to the Palo Verde Mesa Groundwater Basin and has been variously estimated as ranging from 400 afy to 1,162 afy (CEC, 2015). Argonne (Argonne, 2013), in their 2013 study of the basin, assumed zero subsurface outflow, with no justification given. Using gravity data, Wilson and Owens-Joyce (1994) found that the area through which discharge occurs is significantly more limited than previously thought due to the presence of a buried bedrock ridge, though the discharge pathway was not indicated to be completely closed. Since this discovery was made after the 1,162 afy estimate was made (which was in 1990), the lower estimate of 400 afy outflow was adopted for this study.

Groundwater Extraction

Current and historical groundwater extraction in the CVGB includes agricultural water use, pumping for 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 (CEC, 2010). The California Department of Water Resources, using data from 2005 to 2010, estimated the total amount of pumping at 4,700 afy for the entire CVGB (CDWR, 2015). Argonne (Argonne, 2013), also using California Department of Water Resources data, estimated 5,100 afy. Other recent studies have given higher estimates. Specifically, the Palen Solar Project EIS and CEC staff assessment for the Palen Solar Project, both used 10,361 afy (BLM, 2011, CEC, 2015). AECOM, in a previous WSA for the Palen Solar Power Project (AECOM, 2010) estimated 5,745 to 7,415 afy, with no source given. For purposes of this analysis, the most-recent estimate of 10,361 afy is used as a reasonable upper estimate of total extraction, as was used by the BLM and CEC.

The Genesis Solar Electric Plant and the First Solar Desert Sunlight Solar Farm have been recently completed in the area, and these projects will use 218 afy groundwater for operations (218 afy for Genesis1, and 0.3 afy for First Solar, with the total rounded to 218). Total baseline groundwater extraction is therefore 10,579 afy for purposes of this study.

Evapotranspiration at Palen Dry Lake

In 2009, Worley-Parsons, using hand-augur borings, found free groundwater at a depth of 8 feet below the ground surface at the Palen Dry Lake. This suggests that groundwater could be close enough to rise through capillary action and be lost through evaporation (CEC, 2015).

The CEC (CEC, 2015) estimated groundwater discharge rates from the 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 feet of evapotranspiration per month, for three months of the year. Over the 2,000-acre area thought susceptible to groundwater evapotranspiration, this amounts to 350 afy (CEC, 2015).

6. Groundwater Budget

The primary question to be answered in a WSA that is compliant with SB 610 requirements is:

> *Will the total projected water supply available during normal, single dry, and multiple dry water years during a 20-year projection meet the projected water demand of the proposed project, in addition to existing and planned future uses of the identified water supplies, including agricultural and manufacturing uses?*

In order to determine whether there are sufficient supplies to serve the project over the next twenty years, this section provides a baseline normal-year groundwater budget for the CVGB, based on the information provided in Section 5. This section also includes a normal-year groundwater budget assuming the AREP is in place, and a normal-year groundwater budget assuming the AREP and all known cumulative projects are in place. The same is repeated for single and multiple dry-year scenarios. The following is an explanation of water budget terms used in this document.

A **Water Budget** 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 evapotranspiration. Total inflow minus total outflow equals change in storage.

A **Safe Yield** is the amount of water that can be withdrawn from the groundwater basin for human use without depleting the groundwater resource. A safe yield occurs if the groundwater extractions, plus other natural outputs, do not exceed inputs. In this case, there would be no net depletion of the groundwater in storage. In this report, the safe yield is calculated for the basin as a whole.

An **Overdraft** occurs if extractions plus other outputs exceed total inputs, in which case there will be a net loss of groundwater storage over time. In this report, an overdraft, also referred to herein as a deficit, is estimated for the CVGB basin as a whole. Long-term overdraft conditions will result in a protracted diminishment of the groundwater resource that could have effects on the environment and the sustainability of the groundwater use.

The CVGB has a lack of long-term monitoring data for performing a detailed analysis. Wells have been in only a few areas of the basin, are not well documented, and the available data are incomplete and localized. It is known that extractions were 11 afy in 1952 (CDWR, 2004), rising to about 9,100 afy in 1966 (same source), and then peaking at around 20,000 afy for agriculture in the Desert Center area, as described above, resulting in local drawdowns that have since appeared to recover.

As a result of the scarcity of available data, there is substantial uncertainty regarding some of the primary inputs to a groundwater budget. Several studies in recent years for projects such as the AREP have used the best available information do draw conclusions, summarized in Table 3. The conclusions herein are based on the same best available information and should be considered in the context of the overall uncertainty regarding the CVGB basin. Because of the uncertainties involved, the analysis uses two groundwater budgets. The first is a best estimate using data that has been widely reported and used in previous studies of this kind as described in Section 5. These adopted data are presented in Table 3. The second uses lower input estimates that have been made by U.S. Government agencies entrusted with management of natural resources in the area, also described in Section 5. Specifically, the second budget uses a recharge from precipitation estimate of 2,060 afy, and an underflow from Pinto Valley and Orocopia Valley Groundwater Basins of 953 afy as recommended by the NPS (BLM, 2012). All other inflow/outflow estimates are the same for both budgets. The two together provide insight into a range of potential outcomes related to groundwater use in the CVGB.

Table 3. CVGB Inflow/Outflow Summary

Inflow/Outflow Component	Range (afy)*	Adopted for This Study (afy)*	Reason for Adoption/Source
Recharge from Precipitation	+206 to +20,038	+8,588	3 Percent of Total Precipitation USGS (2007), BLM, (2012)
Underflow from Pinto Valley and Orocopia Valley Groundwater Basins	+953 to +6,575	+3,500	Used Previously for Palen and Genesis Projects
Irrigation Return Flow	+800	+800	WorleyParsons (2009)
Wastewater Return Flow	+831	+831	WorleyParsons (2009)
Groundwater Extraction	–4,700 to –10,579	–10,579	Recent Estimate: –10,361 (CEC, 2015) + –218 (Genesis; WorleyParsons, 2009)
Underflow to Palo Verde Mesa Groundwater Basin	–400	–400	CEC (2015). Used lower estimate due to restricted discharge area (Wilson and Owens-Joyce, 1994)
Evapotranspiration at Palen Dry Lake	–350	–350	CEC (2015) estimate from Franklin Playa study.

*Inflow is depicted by a '+' sign; outflow is depicted by a '–' sign.

6.1 Baseline Groundwater Budget

The baseline groundwater budget is the groundwater budget for the CVGB in the absence of the proposed project and all other known cumulative projects not already in place. For the purposes of this analysis, agricultural uses are considered as part of the baseline budget, as is the Prison Water Use, and the Genesis Solar Project. There are no manufacturing water uses in the area.

Normal (Average) Year

Table 4 provides a baseline normal groundwater budget for the CVGB based on the adopted information presented in Sections 4.4 and 4.5 and Table 3. This budget indicates a safe yield, which is the maximum quantity of water that can be continuously withdrawn from a groundwater basin without adverse effect. The baseline safe yield for the CVGB is estimated at 2,390 afy (total from Table 4), meaning the basin is currently close to capacity in terms of groundwater extraction. This budget would be for a normal (average) year, in terms of precipitation and water use.

Table 5 provides the same analysis using the lower NPS estimates of precipitation and underflow recharge described in Section 4. This baseline budget shows the CVGB to be in deficit, with a loss of approximately 6,685 afy in the groundwater resource, meaning groundwater levels would be expected to drop as the resource is depleted over the years.

Assuming a 2,390 afy average year surplus, the CVGB would have a surplus of approximately 71,700 af at the end of the 30-year period (the life of the Athos project not including the 2.5 years of construction), meaning the groundwater basin would slowly recover from any deficits that may have been created by high agricultural pumping in the past. A 30-year period is used because that is the expected life of the project. With the NPS infiltration and underflow estimates (Table 5), at the end of the 30-year period the cumulative deficit would be 200,550 af. The basin would not recover losses during that period if the NPS estimates are correct. However, the amount of groundwater available in the CVGB is large, and this cumulative deficit after 30 years would amount to only about one percent of the total estimated storage.

Table 4. Estimated Baseline Groundwater Budget for the Chuckwalla Valley Groundwater Basin

Budget Components	Acre-Feet per Year
Inflow	
Recharge from Precipitation[1]	8,588
Underflow from Pinto Valley and Orocopia Valley Groundwater Basins[2]	3,500
Irrigation Return Flow[3]	800
Wastewater Return Flow[4]	831
Total Inflow	13,719
Outflow	
Groundwater Extraction[5]	-10,579
Underflow to Palo Verde Mesa Groundwater Basin[6]	-400
Evapotranspiration at Palen Dry Lake[7]	-350
Total Outflow	-11,329
Budget Balance (Inflow – Outflow)	2,390 (+ 0.02% of total storage)

1 - BLM, 2012
2 - BLM, 2012
3 - CEC, 2015
4 - WorleyParsons, 2009
5 - Based on CEC, 2015 plus extractions of Genesis Solar Electric Plant (WorleyParsons, 2009)
6 - CEC, 2010
7 - CEC, 2010

Table 5. Estimated Baseline Groundwater Budget for the Chuckwalla Valley Groundwater Basin Using NPS Estimates of Precipitation and Subsurface Inflow

Budget Components	Acre-Feet per Year
Inflow	
Recharge from Precipitation[1]	2,060
Underflow from Pinto Valley and Orocopia Valley Groundwater Basins[2]	953
Irrigation Return Flow[3]	800
Wastewater Return Flow[4]	831
Total Inflow	4,644

Table 5. Estimated Baseline Groundwater Budget for the Chuckwalla Valley Groundwater Basin Using NPS Estimates of Precipitation and Subsurface Inflow

Budget Components	Acre-Feet per Year
Outflow	
Groundwater Extraction[5]	–10,579
Underflow to Palo Verde Mesa Groundwater Basin[6]	–400
Evapotranspiration at Palen Dry Lake[7]	–350
Total Outflow	–11,329
Budget Balance (Inflow – Outflow)	–6,685 (–0.04% of total storage)

1 - BLM, 2012
2 - BLM, 2012
3 - CEC, 2015
4 - WorleyParsons, 2009
5 - Based on CEC, 2015 plus extractions of Genesis Solar Electric Plant (WorleyParsons, 2009)
6 - CEC, 2010
7 - CEC, 2010

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 3 percent probability. The historic precipitation data at Blythe, California, approximately 35 miles east of the project and at a similar elevation with similar climate, was used as a reference. Historical precipitation data for Blythe, dating from 1893 to 2014, is available from the United States Historical Climatology Network (USHCN, 2016).

The average of the annual precipitation from 1893 to 2014 at Blythe was 3.42 inches. The 10- percent probability dry year was estimated by ranking precipitation years from 1893 to 2014 from lowest to highest and giving them ranking numbers 1 to 122 with the lowest precipitation year number 1 and the highest precipitation year number 122. Dividing the ranking number by the total (122) gives a relative probability of the precipitation in any given year being less than the corresponding precipitation for the ranking number. For instance, the precipitation for Year 2009 was 1.15 inches and ranked #13. Dividing 13 by 122 and converting to percent gives 10.7%. 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 found to be approximately 0.72 inches of precipitation, or 21 percent of average precipitation (reference precipitation year 2000, ranking #4 of 122 giving 3.3 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 groundwater budgets. Dry years are expected to produce less recharge from precipitation, due to the fact that less runoff would generally be expected to occur in dry years, resulting in less runoff leading to infiltration. This would depend, of course, on the pattern, intensity and distribution of precipitation in a dry year, which is difficult to predict for the future. There is some evidence (USGS, 2007) that lower precipitation years may in general give a lower percentage of precipitation ending up as recharge, but the evidence is apparently not consistent, and data presented by the USGS (USGS, 2007) provides no information below 3 percent, which is the percentage used as a basis for the infiltration rate used in this analysis. Therefore, for purposes of this analysis a simplifying assumption was made that the reduction in infiltration to groundwater is in direct proportion to the reduction in precipitation. A dry year recharge is therefore estimated as 8,588 afy multiplied by 0.34 (the ratio of dry year to average year precipitation). This calculation gives 2,920 afy precipitation recharge for a dry year, and 1,803 afy for a critical dry year.

- Underflow from the Pinto Valley and Orocopia Groundwater Basins is assumed to be unaffected. Some dry-year effect could occur, especially in the case of multiple dry years, but the timing of the effect would probably be delayed, and the magnitude of the effect much reduced due to the volume of existing groundwater already in these basins.
- Irrigation return flow is assumed to be unaffected. The area is naturally very arid, and it is assumed that natural precipitation, which in normal years is infrequent, is of minor or negligible consideration in the determination of the amount of irrigation water needed yearly.
- Wastewater return flow is assumed to be unaffected for similar reasons as for precipitation.
- Groundwater extraction is assumed to be unaffected by dry years for the same reasons the irrigation return flow and wastewater return flow were assumed to be unaffected.
- Underflow to Palo Verde Mesa Groundwater Basin was assumed to be unaffected for the same reasons the inflow from the Pinto Valley and Orocopia Groundwater Basins was assumed to be unaffected.
- Evapotranspiration at Palen Dry Lake was assumed to be unaffected for the reason that a single dry year, or critical dry year, would result in a reduction of a maximum of 6,782 acre feet of recharge. Given the size of the CVGB (940 square miles) a one-year reduction of this magnitude would only reduce the average groundwater level by about 0.14 inches. Evapotranspiration could be affected by a significant, long-term groundwater deficit, but for purposes of this analysis evapotranspiration was assumed to remain constant.

Tables 6 and 7 provide the assumed baseline groundwater budgets for a dry year and critical dry year. In both cases, a groundwater deficit is expected for the year, meaning groundwater withdrawals would exceed groundwater input. A dry year is expected to have a deficit of approximately 3,278 acre feet, increasing to 4,395 acre feet for a critical dry year.

Tables 8 and 9 provide the results of the same analysis using the NPS estimates of precipitation and underflow recharge. Each scenario, dry year and critical dry year, would have groundwater deficits, amounting to 8,045 afy and 8,312 afy, respectively.

Table 6. Estimated Dry Year Groundwater Budget for the Chuckwalla Valley Groundwater Basin

Budget Components	Acre-Feet per Year
Inflow	
Recharge from Precipitation	2,920
Underflow from Pinto Valley and Orocopia Valley Groundwater Basins	3,500
Irrigation Return Flow	800
Wastewater Return Flow	831
Total Inflow	8,051
Outflow	
Groundwater Extraction	–10,579
Underflow to Palo Verde Mesa Groundwater Basin	–400
Evapotranspiration at Palen Dry Lake	–350

Table 6. Estimated Dry Year Groundwater Budget for the Chuckwalla Valley Groundwater Basin

Budget Components	Acre-Feet per Year
Total Outflow	–11,329
Budget Balance (Inflow – Outflow)	–3,278 (–0.02% of total storage)

Table 7. Estimated Critical Dry Year Groundwater Budget for the Chuckwalla Valley Groundwater Basin

Budget Components	Acre-Feet per Year
Inflow	
Recharge from Precipitation	1,803
Underflow from Pinto Valley and Orocopia Valley Groundwater Basins	3,500
Irrigation Return Flow	800
Wastewater Return Flow	831
Total Inflow	6,934
Outflow	
Groundwater Extraction	–10,579
Underflow to Palo Verde Mesa Groundwater Basin	–400
Evapotranspiration at Palen Dry Lake	–350
Total Outflow	–11,329
Budget Balance (Inflow – Outflow)	–4,395 (–0.02% of total storage)

Table 8. Estimated Dry Year Groundwater Budget for the Chuckwalla Valley Groundwater Basin Using NPS Estimates of Precipitation and Subsurface Inflow

Budget Components	Acre-Feet per Year
Inflow	
Recharge from Precipitation	700
Underflow from Pinto Valley and Orocopia Valley Groundwater Basins	953
Irrigation Return Flow	800
Wastewater Return Flow	831
Total Inflow	3,284
Outflow	
Groundwater Extraction	-10,579
Underflow to Palo Verde Mesa Groundwater Basin	-400
Evapotranspiration at Palen Dry Lake	-350
Total Outflow	-11,329
Budget Balance (Inflow – Outflow)	–8,045 (–0.05% of total storage)

Table 9. Estimated Critical Dry Year Groundwater Budget for the Chuckwalla Valley Groundwater Basin Using NPS Estimates of Precipitation and Subsurface Inflow

Budget Components	Acre-Feet per Year
Inflow	
Recharge from Precipitation	433
Underflow from Pinto Valley and Orocopia Valley Groundwater Basins	953
Irrigation Return Flow	800
Wastewater Return Flow	831
Total Inflow	3,017
Outflow	
Groundwater Extraction	–10,579
Underflow to Palo Verde Mesa Groundwater Basin	–400
Evapotranspiration at Palen Dry Lake	–350
Total Outflow	–11,329
Budget Balance (Inflow – Outflow)	–8,312 (–0.06% of total storage)

Multiple Dry Years

The Blythe precipitation data shows that in the 122 years of record from 1893 to 2014, the longest consecutive series of dry (10 percent) years on record is two. There are no consecutive critical dry years on record. A two-year string of dry years would result in a baseline groundwater deficit of twice the amount given in Table 6, or 6,556 acre feet. A three-year string of dry years would result in a baseline groundwater deficit of 9,834 acre feet (0.07% of total storage). The longest consecutive series of years with below average precipitation on record at Blythe was 12 years, from 1893 to 1904. This period was considered to be representative of a series of multiple dry years for the purposes of this analysis.

Table 10 presents the results of an estimated 12-year groundwater budget assuming a repeat of the 1893-1904 drought at Blythe, assuming without-project conditions. The results show that at the end of the 12-year period, the cumulative groundwater deficit would be approximately 31,612 acre feet (0.2% of total storage). Table 11 shows the same analysis using NPS estimates of precipitation and subsurface recharge. In that scenario, at the end of the 12-year period the cumulative groundwater deficit would be more than 94,682 acre feet (0.6% of total storage).

Table 10. Baseline Multiple Dry Year Groundwater Budget

Year	1	2	3	4	5	6
Dry Year Reference Year	1893	1894	1895	1896	1897	1898
Precipitation, in Inches	1.75	2.16	1.84	1.29	2.84	1.30
Precipitation as Percentage of Average	51%	63%	54%	38%	83%	38%
Normal Recharge from Precipitation	8,588	8,588	8,588	8,588	8,588	8,588
Dry Year Adjusted Recharge from Precipitation	4,394	5,424	4,620	3,239	7,132	3,264
Other Groundwater Recharge (All Sources)	5,131	5,131	5,131	5,131	5,131	5,131
Total Groundwater Recharge	9,525	10,555	9,751	8,370	12,263	8,395
Groundwater Outflow (All Sources)	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329
Budget Balance (Inflow – Outflow)	–1,804	–774	–1,578	–2,959	934	–2,934
Cumulative Budget Balance (Inflow – Outflow)	–1,804	–2,578	–4,155	–7,114	–6,180	–9,114

Table 10. Baseline Multiple Dry Year Groundwater Budget

Year	7	8	9	10	11	12
Dry Year Reference Year	1899	1900	1901	1902	1903	1904
Precipitation, in Inches	0.75	0.56	1.21	1.12	0.88	1.33
Precipitation as Percentage of Average	22%	16%	35%	33%	26%	39%
Normal Recharge from Precipitation	8,588	8,588	8,588	8,588	8,588	8,588
Dry Year Adjusted Recharge from Precipitation	1,883	1,406	3,038	2,812	2,210	3,340
Other Groundwater Recharge (All Sources)	5,131	5,131	5,131	5,131	5,131	5,131
Total Groundwater Recharge	7,014	6,537	8,169	7,943	7,341	8,471
Groundwater Outflow (All Sources)	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329
Budget Balance (Inflow – Outflow)	–4,315	–4,792	–3,160	–3,386	–3,988	–2,858
Cumulative Budget Balance (Inflow – Outflow)	–13,428	–18,220	–21,380	–24,765	–28,754	–31,612

Table 11. Baseline Multiple Dry Year Groundwater Budget Using NPS Estimates of Precipitation and Subsurface Inflow

Year	1	2	3	4	5	6
Dry Year Reference Year	1893	1894	1895	1896	1897	1898
Precipitation, in Inches	1.75	2.16	1.84	1.29	2.84	1.30
Precipitation as Percentage of Average	51%	63%	54%	38%	83%	38%
Normal Recharge from Precipitation	2,060	2,060	2,060	2,060	2,060	2,060
Dry Year Adjusted Recharge from Precipitation	1,054	1,301	1,108	777	1,711	783
Other Groundwater Recharge (All Sources)	2,584	2,584	2,584	2,584	2,584	2,584
Total Groundwater Recharge	3,638	3,885	3,692	3,361	4,295	3,367
Groundwater Outflow (All Sources)	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329
Budget Balance (Inflow – Outflow)	–7,691	–7,444	–7,637	–7,968	–7,034	–7,962
Cumulative Budget Balance (Inflow – Outflow)	–7,691	–15,135	–22,772	–30,740	–37,774	–45,736
Year	7	8	9	10	11	12
Dry Year Reference Year	1899	1900	1901	1902	1903	1904
Precipitation, in Inches	0.75	0.56	1.21	1.12	0.88	1.33
Precipitation as Percentage of Average	22%	16%	35%	33%	26%	39%
Normal Recharge from Precipitation	2,060	2,060	2,060	2,060	2,060	2,060
Dry Year Adjusted Recharge from Precipitation	452	337	729	675	530	801
Other Groundwater Recharge (All Sources)	2,584	2,584	2,584	2,584	2,584	2,584
Total Groundwater Recharge	3,036	2,921	3,313	3,259	3,114	3,385
Groundwater Outflow (All Sources)	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329
Budget Balance (Inflow – Outflow)	–8,293	–8,408	–8,016	–8,070	–8,215	–7,944
Cumulative Budget Balance (Inflow – Outflow)	–54,029	–62,437	–70,453	–78,523	–86,738	–94,682

6.2 Groundwater Budget with Athos Renewable Energy and Cumulative Projects

Normal (Average) Year

All water for the project would be derived from the CVGB. Total water use by the AREP will be up to 200 afy for the 30 months of construction, and up to 40 afy for all subsequent 30 years of operation, for a total of 1,700 acre feet of water used by the project over the project life. Based on the budget balance given in Table 4, the CVGB under average-year conditions would have a cumulative surplus of 77,675 acre feet during the same time period. The net CVGB surplus, with the AREP in place, would therefore be 75,975 acre feet, or 98 percent of the surplus that would exist without the Athos project. By contrast, using the NPS recharge rates for precipitation and underflow (Table 5), the 32.5-year deficit without the AREP would be 217,263 acre feet, increased to 218,962 acre feet by the AREP. The AREP would contribute about one percent to this cumulative deficit.

For a single dry year and single critical dry year with the AREP in place, the worst-case scenario is for one of those years, dry or critical dry, to occur during the first year of construction. During the first year of construction the CVGB annual groundwater deficit if a dry year or critical dry year occurs would be 3,478 and 4,595 acre feet, respectively. By comparison to Tables 6 and 7, the AREP would increase the dry year deficit by 4 to 6 percent if a dry year or critical dry year occurs during the first year of construction. Assuming normal precipitation returns, this deficit would be completely recovered in the second year under both (dry or critical dry) scenarios.

Using NPS inflow data, the single-year deficits depicted in Tables 8 and 9 are 8,045 afy for dry and 8,312 afy for critical dry years without the project. These deficits would increase to 8,245 and 8,512 afy for dry and critical dry years during the first year of construction (2 percent deficit increases. Assuming normal precipitation returns after the dry year, this deficit would not be recovered during the project lifespan, with or without the project.

Cumulative projects that are projected or already constructed are listed in Table 12, with their projected water use. Water used for agriculture is not anticipated to increase so was not included in the cumulative projects. Peak agriculture in the Desert Center region occurred in 1994 with an estimated 6,100 acres under cultivation. Since then, agriculture has continued to decline with an estimated 2,100 acres under cultivation in 2016.

Table 12. Cumulative Projects – Water Use Summary

Project Name	Construction Start (year)	Construction Duration (years)	Annual Construction Water Use (afy)	Annual Operational Water Use (afy)
Palen Solar PV Project	2018[1]	2.5	7002[2]	41
First Solar Desert Sunlight Solar Farm	Completed	2.2	600–650[2]	0.3
Red Bluff Substation	Completed	2.2	150[2]	0
Eagle Mountain Gen-tie line	2020[1]	1	6.25[2]	0
AREP	2020[1]	2.5	200	40
Eagle Mountain Pumped Storage Project	2020[1]	4	4,456[3]	2,050[4]
Victory Pass Solar	2021[1]	1	75[4]	15
California Jupiter	2020[1]	1	110[4]	22
Desert Harvest Solar PV Project	2018[1]	2	400-500[2]	26-39

Table 12. Cumulative Projects – Water Use Summary

Project Name	Construction Start (year)	Construction Duration (years)	Annual Construction Water Use (afy)	Annual Operational Water Use (afy)
DC 50 Solar Project (450 acres) (50 MW)	2019[1]	1	100[2]	2.5
SunEdison Origination3, LLC (1,800 acres) (250 MW – calculated)	2019[1]	2	275[b]	12.5
First Solar Development, LLC (3,500 acres) (500 MW – calculated)	2019[1]	2.5	440[b]	25

1 - Assumed date of construction start and construction duration.
2 - Aspen (2018)
3 - BLM Estimate (FERC, 2014). Of this amount, 600 cfs is expected to seep back into the groundwater (ECEC, 2008), then pumped back out and reused.
4 - Water use estimated based on project size and Athos Renewable Energy water use.

Table 12 shows that the AREP contributes about two percent of the total operational extractions, long-term. The Eagle Mountain Pumped Storage Project would use more than 5 times the operational groundwater of all other future projects combined.

Table 13 provides a 30-year groundwater budget projection for average years with AREP and all cumulative projects in place. Only those cumulative projects that would withdraw groundwater during the assumed 2020 to 2049 period of analysis are included. Assuming an average precipitation year, there would be an initial groundwater overdraft of up to 12,679 af in the year 2023. The groundwater basin would then begin to slowly recover. By the end of the 30-year period, the cumulative groundwater deficit would be approximately 10,607 acre feet (approximately 0.07% of total storage). Without the AREP and all other cumulative projects in place, there would be a surplus of 71,700 acre feet at the end of the 30-year period (Approximately 0.48% of total storage).

The same analysis using NPS infiltration and underflow estimates results in a total cumulative deficit of about 282,857 acre feet (1.9% of total storage), of which the AREP would contribute about 0.6 percent, or 1,600 af. Using these inflow estimates, the CVGB would not recover the overdraft within 30-years period, with or without the project.

Table 13. 30-Year Projected CVGB Groundwater Budget for Athos Renewable Energy Project Plus Cumulative Projects Using Adopted Precipitation and Underflow Recharge Estimates

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Palen Solar PV Project	371	41	41	41	41	41	41	41	41	41
First Solar Desert Sunlight Solar Farm	0	0	0	0	0	0	0	0	0	0
AREP	200	200	120	40	40	40	40	40	40	40
Eagle Mountain Pumped Storage Project	4,462	4,456	4,456	4,456	2,050	2,050	2,050	2,050	2,050	2,050
Victory Pass Solar	0	75	15	15	15	15	15	15	15	15
California Jupiter	110	22	22	22	22	22	22	22	22	22
Desert Harvest Solar PV Project	500	39	39	39	39	39	39	39	39	39
DC 50 Solar Project	3	3	3	3	3	3	3	3	3	3
SunEdison Origination	275	13	13	13	13	13	13	13	13	13
First Solar Development	440	245	25	25	25	25	25	25	25	25
Clearway	440	230	20	20	20	20	20	20	20	20
Total Used	7,016	5,538	4,968	4,716	2,310	2,310	2,310	2,310	2,310	2,310

Table 13. 30-Year Projected CVGB Groundwater Budget for Athos Renewable Energy Project Plus Cumulative Projects Using Adopted Precipitation and Underflow Recharge Estimates

CVGB Baseline Surplus	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390
CVGB Surplus Minus Total Use	-4,626	-3,148	-2,578	-2,326	80	80	80	80	80	80
Cumulative CGVB Surplus/Deficit	-4,626	-7,774	-10,353	-12,679	-12,599	-12,520	-12,440	-12,360	-12,280	-12,201
Year	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Palen Solar PV Project	41	41	41	41	41	41	41	41	41	41
First Solar Desert Sunlight Solar Farm	0	0	0	0	0	0	0	0	0	0
AREP	40	40	40	40	40	40	40	40	40	40
Eagle Mountain Pumped Storage Project	2,050	2,050	2,050	2,050	2,050	2,050	2,050	2,050	2,050	2,050
Victory Pass Solar	15	15	15	15	15	15	15	15	15	15
California Jupiter	22	22	22	22	22	22	22	22	22	22
Desert Harvest Solar PV Project	39	39	39	39	39	39	39	39	39	39
DC 50 Solar Project	3	3	3	3	3	3	3	3	3	3
SunEdison Origination	13	13	13	13	13	13	13	13	13	13
First Solar Development	25	25	25	25	25	25	25	25	25	25
Clearway	20	20	20	20	20	20	20	20	20	20
Total Used	2,310	2,310	2,310	2,310	2,310	2,310	2,310	2,310	2,310	2,310
CVGB Baseline Surplus	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390
CVGB Surplus Minus Total Use	80	80	80	80	80	80	80	80	80	80
Cumulative CGVB Surplus/Deficit	-12,121	-12,041	-11,962	-11,882	-11,802	-11,723	-11,643	-11,563	-11,483	-11,404
Year	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
Palen Solar PV Project	41	41	41	41	41	41	41	41	41	41
First Solar Desert Sunlight Solar Farm	0	0	0	0	0	0	0	0	0	0
AREP	40	40	40	40	40	40	40	40	40	40
Eagle Mountain Pumped Storage Project	2,050	2,050	2,050	2,050	2,050	2,050	2,050	2,050	2,050	2,050
Victory Pass Solar	15	15	15	15	15	15	15	15	15	15
California Jupiter	22	22	22	22	22	22	22	22	22	22
Desert Harvest Solar PV Project	39	39	39	39	39	39	39	39	39	39
DC 50 Solar Project	3	3	3	3	3	3	3	3	3	3
SunEdison Origination	13	13	13	13	13	13	13	13	13	13
First Solar Development	25	25	25	25	25	25	25	25	25	25
Clearway	20	20	20	20	20	20	20	20	20	20
Total Used	2,310	2,310	2,310	2,310	2,310	2,310	2,310	2,310	2,310	2,310
CVGB Baseline Surplus	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390
CVGB Surplus Minus Total Use	80	80	80	80	80	80	80	80	80	80
Cumulative CGVB Surplus/Deficit	-11,324	-11,244	-11,165	-11,085	-11,005	-10,926	-10,846	-10,766	-10,686	-10,607

Dry Year

From the analysis in Table 13, the year with the highest groundwater deficit would be 2023. For that year, assuming dry year and critical dry year precipitation, the CVGB cumulative groundwater deficit would be

18,341 af (0.12% of total storage) and 19,458 af (0.13% of total storage) respectively, if all cumulative projects are in place and assuming adopted recharge inputs and four previous years of normal precipitation. Using NPS recharge estimates, the deficits would be 23,108 af and 23,375 af, respectively (0.15% and 0.16% of total storage).

Multiple Dry Years

Table 14 provides a summary of the multiple dry year analysis using the same methods as described for Table 13, and assuming the AREP plus all cumulative projects are in place. At the end of the 12-year period representing the longest consecutive series of years with below average precipitation on record at Blythe, the cumulative groundwater deficit would be 72,327 acre feet (0.5% of total storage). AREP would contribute 880 acre feet to this deficit, or about 1.2 percent of the deficit. The same analysis using the NPS estimates of recharge and outflow result in a cumulative deficit of 135,397 acre feet (0.9% of total storage). AREP would cause about 0.6 percent of this deficit.

Table 14. Multiple Dry Year Groundwater Budget Analysis with AREP and All Cumulative Projects in Place, Assuming Adopted Recharge and Inflow Estimates

Assumed Project Year	2020	2021	2022	2023	2024	2025
Dry Precipitation Reference Year	1893	1894	1895	1896	1897	1898
Precipitation, in Inches	1.75	2.16	1.84	1.29	2.84	1.30
Precipitation as Percentage of Average	51%	63%	54%	38%	83%	38%
Normal Recharge from Precipitation, in Acre Feet	8,588	8,588	8,588	8,588	8,588	8,588
Dry Year Adjusted Recharge from Precipitation, in Acre Feet	4,394	5,424	4,620	3,239	7,132	3,264
Other Groundwater Recharge (All Sources), in Acre Feet	5,131	5,131	5,131	5,131	5,131	5,131
Total Groundwater Recharge, in Acre Feet	9,525	10,555	9,751	8,370	12,263	8,395
Baseline Groundwater Outflow, in Acre Feet	-11,329	-11,329	-11,329	-11,329	-11,329	-11,329
Cumulative Project Groundwater Use, in Acre Feet	-7,016	-5,538	-4,968	-4,716	-2,310	-2,310
Total Groundwater Outflow, in Acre Feet	-18,345	-16,867	-16,297	-16,045	-13,639	-13,639
Budget Balance (Recharge + Outflow), in Acre Feet	-8,820	-6,312	-6,546	-7,675	-1,377	-5,244
Cumulative Budget Balance, in Acre Feet	-8,820	-15,132	-21,678	-29,353	-30,729	-35,973
Assumed Project Year	2020	2021	2022	2023	2024	2025
Dry Precipitation Reference Year	1899	1900	1901	1902	1903	1904
Precipitation, in Inches	0.75	0.56	1.21	1.12	0.88	1.33
Precipitation as Percentage of Average	22%	16%	35%	33%	26%	39%
Normal Recharge from Precipitation, in Acre Feet	8,588	8,588	8,588	8,588	8,588	8,588
Dry Year Adjusted Recharge from Precipitation, in Acre Feet	1,883	1,406	3,038	2,812	2,210	3,340
Other Groundwater Recharge (All Sources), in Acre Feet	5,131	5,131	5,131	5,131	5,131	5,131
Total Groundwater Recharge, in Acre Feet	7,014	6,537	8,169	7,943	7,341	8,471
Baseline Groundwater Outflow, in Acre Feet	-11,329	-11,329	-11,329	-11,329	-11,329	-11,329
Cumulative Project Groundwater Use, in Acre Feet	-2,310	-2,310	-2,310	-2,310	-2,310	-2,310

Table 14. Multiple Dry Year Groundwater Budget Analysis with AREP and All Cumulative Projects in Place, Assuming Adopted Recharge and Inflow Estimates

Total Groundwater Outflow, in Acre Feet	-13,639	-13,639	-13,639	-13,639	-13,639	-13,639
Budget Balance (Recharge + Outflow), in Acre Feet	-6,625	-7,102	-5,470	-5,696	-6,299	-5,169
Cumulative Budget Balance, in Acre Feet	-42,598	-49,700	-55,170	-60,866	-67,165	-72,333

The rainfall record shows that a series of dry years has been followed by a series of years with above-average rainfall. To assess the probable effect of this over the 30-year life of the project, a 30-year running average analysis was made of the 121 years of record. This analysis, including the 30-year multiple-dry-year baseline calculation, is summarized in Tables 15 through 17.

The driest 30-year period was the period beginning in 1893 and ending in 1922. Average annual rainfall during this period was 3.05 inches, or about 89% of normal. Table 15 shows that if a repeat of this 30-year period occurs under current (no project) conditions, at the end of the 30-year period the CVGB would have a surplus of 43,601 af assuming adopted rainfall and infiltration conditions. The worst year of the drought-induced deficit in the CVGB would be year 12, in which the total deficit would be 31,612 af. Recovery would then begin with total recovery by year 21, and there would be a groundwater surplus of 43,601 af by the end of the 30 years. Using NPS recharge data, the same analysis results in a continually-increasing groundwater deficit ending at 207,290 af after 30 years.

Table 16 provides the same analysis with the AREP in place but no other cumulative project. The results are similar to the without-project condition, with total groundwater recovery occurring in year 22, and recovery to a surplus of 42,001 af at the end of 30 years. Using NPS recharge data, the same analysis, with the AREP in place, results in a continually- increasing groundwater deficit ending at 208,890 af after 30 years.

Table 17 provides the cumulative-project analysis. With all cumulative projects in place, the greatest CVGB deficit would occur in year 12, after which recovery would begin, but full recovery would not occur during the 30-year period. The CVGB would end the period with a 38,700-af deficit. Using NPS recharge data, the 30-year deficit would be 289,591 af.

Table 15. 30-Year Projected CVGB Groundwater Budget in Acre Feet for Baseline (No Project) Conditions Using Adopted Precipitation and Underflow Recharge Estimates and Assuming a Repeat of the Driest 30 Years on Record at Blythe

Year	1	2	3	4	5	6	7	8	9	10
Precipitation Reference Year	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902
Rainfall, in Inches	1.75	2.16	1.84	1.29	2.84	1.3	0.75	0.56	1.21	1.12
Precipitation as Percentage of Average	51%	63%	54%	38%	83%	38%	22%	16%	35%	33%
Normal Recharge from Precipitation	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588
Adjusted Recharge from Precipitation	4,394	5,424	4,620	3,239	7,132	3,264	1,883	1,406	3,038	2,812
Other Groundwater Recharge (All Sources)	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131
Total Groundwater Recharge	9,525	10,555	9,751	8,370	12,263	8,395	7,014	6,537	8,169	7,943
Non-Project Groundwater Outflow (All Sources)	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329
Total Groundwater Outflow	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329
Budget Balance (Inflow – Outflow)	–1,804	–774	–1,578	–2,959	934	–2,934	–4,315	–4,792	–3,160	–3,386

Table 15. 30-Year Projected CVGB Groundwater Budget in Acre Feet for Baseline (No Project) Conditions Using Adopted Precipitation and Underflow Recharge Estimates and Assuming a Repeat of the Driest 30 Years on Record at Blythe

Cumulative Budget Balance (Inflow – Outflow)	–1,804	–2,578	–4,155	–7,114	–6,180	–9,114	–13,428	–18,220	–21,380	–24,765
Year	11	12	13	14	15	16	17	18	19	20
Precipitation Reference Year	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912
Rainfall, in Inches	0.88	1.33	4.29	2.55	2.18	3.21	5.51	4.66	3.58	4.44
Precipitation as Percentage of Average	26%	39%	125%	75%	64%	94%	161%	136%	105%	130%
Normal Recharge from Precipitation	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588
Adjusted Recharge from Precipitation	2,210	3,340	10,773	6,403	5,474	8,061	13,836	11,702	8,990	11,149
Other Groundwater Recharge (All Sources)	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131
Total Groundwater Recharge	7,341	8,471	15,904	11,534	10,605	13,192	18,967	16,833	14,121	16,280
Non-Project Groundwater Outflow (All Sources)	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329
Total Groundwater Outflow	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329
Budget Balance (Inflow – Outflow)	–3,988	–2,858	4,575	205	–724	1,863	7,638	5,504	2,792	4,951
Cumulative Budget Balance (Inflow – Outflow)	–28,754	–31,612	–27,037	–26,832	–27,556	–25,693	–18,055	–12,551	–9,759	–4,808
Year	21	22	23	24	25	26	27	28	29	30
Precipitation Reference Year	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Rainfall, in Inches	4.8	5.82	3.88	3.64	1.82	6.64	3.66	4.51	7.08	2.11
Precipitation as Percentage of Average	140%	170%	113%	106%	53%	194%	107%	132%	207%	62%
Normal Recharge from Precipitation	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588
Adjusted Recharge from Precipitation	12,053	14,615	9,743	9,140	4,570	16,674	9,191	11,325	17,779	5,298
Other Groundwater Recharge (All Sources)	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131
Total Groundwater Recharge	17,184	19,746	14,874	14,271	9,701	21,805	14,322	16,456	22,910	10,429
Non-Project Groundwater Outflow (All Sources)	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329
Total Groundwater Outflow	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329
Budget Balance (Inflow – Outflow)	5,855	8,417	3,545	2,942	–1,628	10,476	2,993	5,127	11,581	–900
Cumulative Budget Balance (Inflow – Outflow)	1,048	9,464	13,009	15,952	14,324	24,800	27,792	32,920	44,500	43,601

Table 16. 30-Year Projected CVGB Groundwater Budget in Acre Feet Using Adopted Precipitation and Underflow Recharge Estimates and Assuming a Repeat of the Driest 30 Years on Record at Blythe, with the Athos Renewable Energy Project in Place

Year	1	2	3	4	5	6	7	8	9	10
Precipitation Reference Year	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902
Rainfall, in Inches	1.75	2.16	1.84	1.29	2.84	1.3	0.75	0.56	1.21	1.12
Precipitation as Percentage of Average	51%	63%	54%	38%	83%	38%	22%	16%	35%	33%
Normal Recharge from Precipitation	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588

Table 16. 30-Year Projected CVGB Groundwater Budget in Acre Feet Using Adopted Precipitation and Underflow Recharge Estimates and Assuming a Repeat of the Driest 30 Years on Record at Blythe, with the Athos Renewable Energy Project in Place

Adjusted Recharge from Precipitation	4,394	5,424	4,620	3,239	7,132	3,264	1,883	1,406	3,038	2,812
Other Groundwater Recharge (All Sources)	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131
Total Groundwater Recharge	9,525	10,555	9,751	8,370	12,263	8,395	7,014	6,537	8,169	7,943
Non–Project Groundwater Outflow (All Sources)	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329
Project Groundwater Outflow (AREP only)	–200	–200	–120	–40	–40	–40	–40	–40	–40	–40
Total Groundwater Outflow	–11,529	–11,529	–11,449	–11,369	–11,369	–11,369	–11,369	–11,369	–11,369	–11,369
Budget Balance (Inflow – Outflow)	–2,004	–974	–1,698	–2,999	894	–2,974	–4,355	–4,832	–3,200	–3,426
Cumulative Budget Balance (Inflow – Outflow)	–2,004	–2,978	–4,675	–7,674	–6,780	–9,754	–14,108	–18,940	–22,140	–25,565
Year	11	12	13	14	15	16	17	18	19	20
Precipitation Reference Year	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912
Rainfall, in Inches	0.88	1.33	4.29	2.55	2.18	3.21	5.51	4.66	3.58	4.44
Precipitation as Percentage of Average	26%	39%	125%	75%	64%	94%	161%	136%	105%	130%
Normal Recharge from Precipitation	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588
Adjusted Recharge from Precipitation	2,210	3,340	10,773	6,403	5,474	8,061	13,836	11,702	8,990	11,149
Other Groundwater Recharge (All Sources)	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131
Total Groundwater Recharge	7,341	8,471	15,904	11,534	10,605	13,192	18,967	16,833	14,121	16,280
Non–Project Groundwater Outflow (All Sources)	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329
Project Groundwater Outflow (AREP only)	–40	–40	–40	–40	–40	–40	–40	–40	–40	–40
Total Groundwater Outflow	–11,369	–11,369	–11,369	–11,369	–11,369	–11,369	–11,369	–11,369	–11,369	–11,369
Budget Balance (Inflow – Outflow)	–4,028	–2,898	4,535	165	–764	1,823	7,598	5,464	2,752	4,911
Cumulative Budget Balance (Inflow – Outflow)	–29,594	–32,492	–27,957	–27,792	–28,556	–26,733	–19,135	–13,671	–10,919	–6,008
Year	21	22	23	24	25	26	27	28	29	30
Precipitation Reference Year	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Rainfall, in Inches	4.8	5.82	3.88	3.64	1.82	6.64	3.66	4.51	7.08	2.11
Precipitation as Percentage of Average	140%	170%	113%	106%	53%	194%	107%	132%	207%	62%
Normal Recharge from Precipitation	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588
Adjusted Recharge from Precipitation	12,053	14,615	9,743	9,140	4,570	16,674	9,191	11,325	17,779	5,298
Other Groundwater Recharge (All Sources)	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131
Total Groundwater Recharge	17,184	19,746	14,874	14,271	9,701	21,805	14,322	16,456	22,910	10,429
Non–Project Groundwater Outflow (All Sources)	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329
Project Groundwater Outflow (AREP only)	–40	–40	–40	–40	–40	–40	–40	–40	–40	–40

Table 16. 30-Year Projected CVGB Groundwater Budget in Acre Feet Using Adopted Precipitation and Underflow Recharge Estimates and Assuming a Repeat of the Driest 30 Years on Record at Blythe, with the Athos Renewable Energy Project in Place

Total Groundwater Outflow	–11,369	–11,369	–11,369	–11,369	–11,369	–11,369	–11,369	–11,369	–11,369	–11,369
Budget Balance (Inflow – Outflow)	5,815	8,377	3,505	2,902	–1,668	10,436	2,953	5,087	11,541	–940
Cumulative Budget Balance (Inflow – Outflow)	–192	8,184	11,689	14,592	12,924	23,360	26,312	31,400	42,940	42,001

Table 17. 30-Year Projected CVGB Groundwater Budget in Acre Feet Using Adopted Precipitation and Underflow Recharge Estimates and Assuming a Repeat of the Driest 30 Years on Record at Blythe, with all Cumulative Projects in Place

Year	1	2	3	4	5	6	7	8	9	10
Precipitation Reference Year	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902
Rainfall, in Inches	1.75	2.16	1.84	1.29	2.84	1.3	0.75	0.56	1.21	1.12
Precipitation as Percentage of Average	51%	63%	54%	38%	83%	38%	22%	16%	35%	33%
Normal Recharge from Precipitation	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588
Adjusted Recharge from Precipitation	4,394	5,424	4,620	3,239	7,132	3,264	1,883	1,406	3,038	2,812
Other Groundwater Recharge (All Sources)	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131
Total Groundwater Recharge	9,525	10,555	9,751	8,370	12,263	8,395	7,014	6,537	8,169	7,943
Non-Project Groundwater Outflow (All Sources)	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329
Project Groundwater Outflow (All Cumulative Projects)	–7,010	–5,538	–4,968	–4,716	–2,310	–2,310	–2,310	–2,310	–2,310	–2,310
Total Groundwater Outflow	–18,339	–16,867	–16,297	–16,045	–13,639	–13,639	–13,639	–13,639	–13,639	–13,639
Budget Balance (Inflow – Outflow)	–8,813	–6,312	–6,546	–7,675	–1,377	–5,244	–6,625	–7,102	–5,470	–5,696
Cumulative Budget Balance (Inflow – Outflow)	–8,813	–15,126	–21,672	–29,346	–30,723	–35,967	–42,592	–49,694	–55,164	–60,860
Year	11	12	13	14	15	16	17	18	19	20
Precipitation Reference Year	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912
Rainfall, in Inches	0.88	1.33	4.29	2.55	2.18	3.21	5.51	4.66	3.58	4.44
Precipitation as Percentage of Average	26%	39%	125%	75%	64%	94%	161%	136%	105%	130%
Normal Recharge from Precipitation	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588
Adjusted Recharge from Precipitation	2,210	3,340	10,773	6,403	5,474	8,061	13,836	11,702	8,990	11,149
Other Groundwater Recharge (All Sources)	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131
Total Groundwater Recharge	7,341	8,471	15,904	11,534	10,605	13,192	18,967	16,833	14,121	16,280
Non-Project Groundwater Outflow (All Sources)	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329
Project Groundwater Outflow (All Cumulative Projects)	–2,310	–2,310	–2,310	–2,310	–2,310	–2,310	–2,310	–2,310	–2,310	–2,310
Total Groundwater Outflow	–13,639	–13,639	–13,639	–13,639	–13,639	–13,639	–13,639	–13,639	–13,639	–13,639
Budget Balance (Inflow – Outflow)	–6,299	–5,169	2,264	–2,105	–3,034	–448	5,328	3,193	481	2,641
Cumulative Budget Balance (Inflow – Outflow)	–67,158	–72,327	–70,063	–72,167	–75,202	–75,649	–70,321	–67,128	–66,646	–64,005

Table 17. 30-Year Projected CVGB Groundwater Budget in Acre Feet Using Adopted Precipitation and Underflow Recharge Estimates and Assuming a Repeat of the Driest 30 Years on Record at Blythe, with all Cumulative Projects in Place

Year	21	22	23	24	25	26	27	28	29	30
Precipitation Reference Year	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Rainfall, in Inches	4.8	5.82	3.88	3.64	1.82	6.64	3.66	4.51	7.08	2.11
Precipitation as Percentage of Average	140%	170%	113%	106%	53%	194%	107%	132%	207%	62%
Normal Recharge from Precipitation	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588	8,588
Adjusted Recharge from Precipitation	12,053	14,615	9,743	9,140	4,570	16,674	9,191	11,325	17,779	5,298
Other Groundwater Recharge (All Sources)	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131
Total Groundwater Recharge	17,184	19,746	14,874	14,271	9,701	21,805	14,322	16,456	22,910	10,429
Non-Project Groundwater Outflow (All Sources)	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329	–11,329
Project Groundwater Outflow (All Cumulative Projects)	–2,310	–2,310	–2,310	–2,310	–2,310	–2,310	–2,310	–2,310	–2,310	–2,310
Total Groundwater Outflow	–13,639	–13,639	–13,639	–13,639	–13,639	–13,639	–13,639	–13,639	–13,639	–13,639
Budget Balance (Inflow – Outflow)	3,545	6,106	1,235	632	–3,938	8,165	682	2,817	9,270	–3,210
Cumulative Budget Balance (Inflow – Outflow)	–60,460	–54,354	–53,119	–52,487	–56,425	–48,260	–47,577	–44,760	–35,490	–38,700

7. Analysis Summary and Conclusions

The following provides a summary of the results of the analysis presented above.

- Table 4 shows that under normal precipitation conditions and using precipitation recharge and the adopted subsurface inflow recharge estimates, the CVGB would have a baseline surplus of approximately 2,390 afy, which means there could be a sustainable yield of groundwater extraction in that amount. Table 5, based on lower precipitation and subsurface inflow estimates (the NPS recharge estimates), shows that the CVGB could already be in an overdraft condition of 6,685 afy, and is and will continue to lose groundwater unless current pumping is curtailed. In this case, any additional extractions would increase the overdraft unless replaced by additional inflow.
- Tables 6 through 9 show that there will be a groundwater deficit in dry years and critical dry years (10 percent and 3 percent probability) under current conditions. The magnitude of the deficit depends on the recharge input assumptions.
- Tables 10 and 11 show that under current extraction conditions a repeat of the worst sustained drought on record at Blythe, 12 years of below-average precipitation, will likely result in cumulative groundwater overdrafts of 31,612 af to 94,682 af. Unless compensated by subsequent high-precipitation years, this would likely become a new baseline groundwater level. This cumulative overdraft would represent roughly 0.2 percent to 0.6 percent of the total groundwater in the basin.
- The addition of the AREP alone to the existing condition would not create an overdraft in the CVGB, assuming adopted recharge estimates, and would have little effect on the cumulative surplus that is expected. Assuming NPS recharge estimates, the AREP would contribute about 1 percent to a 30-year projected overdraft.

- Table 13 shows that with all cumulative projects in place, and using adopted recharge estimates, the CVGB would suffer an initial overdraft of about 12,673 af in 2023, due to the higher use of water during project construction, and then begin to recover. In other words, after construction is complete, operation water use will be slightly less than the safe yield estimate of 2,390 afy. Long-term cumulative operational use is estimated at 2,310 afy, to which the AREP would contribute about 1.7 percent. This AREP contribution would have little effect on the rate of groundwater use or recovery. At the end of 30 years, the total cumulative deficit would be about 10,601 af.
- Using NPS recharge estimates the CVGB, now in overdraft, would be in more severe overdraft with cumulative projects in place, resulting in a cumulative 30-year overdraft of 282,851 af, to which the AREP would contribute about 0.6 percent.
- Table 14 shows that under a repeat of the multiple dry year scenario based on the 1893 to 1904 drought, cumulative projects would exacerbate the cumulative overdraft shown in Table 10. With projects in place and adopted recharge estimates, the cumulative overdraft would be 72,327 af to which the AREP would contribute about 1.2 percent. Using NPS recharge estimates, there would be a cumulative overdraft of 135,397 af at the end of the drought, to which the AREP would contribute about 0.6 percent.

7.1 Groundwater Budget Reliability Considerations

The groundwater budgets presented in this section are based on assumptions that could affect the reliability of the budget projections. These assumptions are based on the best available data from the sources cited in this document. The following is a discussion of these assumptions, and other considerations, and their implications on the groundwater budgets.

Recharge from precipitation is an important component of the groundwater budget, and alone can make a difference whether the groundwater basin is in a condition of surplus or overdraft. The amount of recharge from precipitation is difficult to estimate. The estimate used in this analysis, 8,588 afy, represents 3% of the total average annual precipitation on the CVGB watershed, and is considered a reasonable estimate of the reported recharge range from previous studies. The overall groundwater budget is very sensitive to the precipitation input. For instance, if the recharge by precipitation is as low as 2.4% of total annual precipitation (6,198 afy), the baseline groundwater budget would give a net budget balance of zero, and all project scenarios presented above would result in a groundwater deficit. If recharge from precipitation is as high as 6% of total rainfall, which is within the probable range of recharge estimated by the USGS (USGS, 2007) and CEC (CEC, 2015), there would be no groundwater deficit in any year under the cumulative scenario except under the lower subsurface inflow estimates of the NPS, for which the 30-year cumulative deficit would be only about 25,000 acre feet (less than 0.2 percent of total storage).

Precipitation reliability could be uncertain should there be shifts in the future climate of the area.

All other groundwater budget input parameters are best estimates subject to uncertainty. The cumulative project list includes projects that are still under consideration and which could be altered or cancelled in the future. Other projects could be proposed, and projects could use other water sources than the CVGB. Changes in future projects could have substantial effects on the groundwater budget.

7.2 Conclusions

It is determined that the AREP, as a stand-alone project, can draw all its anticipated water needs from the CVGB without resulting in an overdraft of the groundwater basin under normal (average precipitation) conditions using adopted inflow rates. The normal-year baseline groundwater budget for the CVGB shows a surplus of 2,390 acre feet, which is more than the total yearly need for construction by the AREP, and far more than the annual operating water needs. The total 30-year projected water use of the AREP is less than the annual baseline water surplus for the CVGB.

8. References

AECOM (AECOM Environment). 2011. Desert Sunlight Solar Farm Project: Response to Public Comments Regarding Potential Relationship Between Groundwater Pumping Levels and Impacts to the Colorado River. Appendix O – Accounting Surface Technical Memorandum. Prepared for Bureau of Land Management, Palm Springs–South Coast Field Office. January 5. http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/palmsprings/desert_sunlight.Par.92719.File.dat/Desert%20Sunlight%20FEIS%20 appendix%20N-O.pdf. Accessed July 25, 2016.

_____. 2010. Water Supply Assessment, Palen Solar Power Project, Riverside County, California. California Energy Commission.

Argonne (Argonne National Laboratory). 2013, A Groundwater Model to Assess Water Resource Impacts at the Riverside East Solar Energy Zone. Environmental Science Division, U.S. Department of Energy, Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN. ANL/EVS/R-13/8.

Aspen (Aspen Environmental Group). 2018. Palen Solar Project Water Supply Assessment. Appendix G. Final Supplemental Environmental Impact Statement/Environmental Impact Report/Land Use Plan Amendment. Index No. BLM/CA/PL-2017/012+1793+2050, CA State Clearinghouse No. 2011054002

BLM (Bureau of Land Management). 2012. Desert Harvest Solar Project Final Environmental Impact Statement and Proposed California Desert Conservation Area Plan Amendment. United States Department of the Interior Bureau of Land Management, Palm Springs– South Coast Field Office, Palm Springs, CA. CACA-49491.

_____. 2011. Plan Amendment Final EIS for the Palen Solar Power Project. United States Department of the Interior Bureau of Land Management, Palm Springs–South Coast Field Office, Palm Springs, CA. DOI Control No. FES 11-06.

CDWR (California Department of Water Resources). 2016. Groundwater Information Center Interactive Map Application.

_____. 2015. California's Groundwater Update 2013. A Compilation of Enhanced Content for California Water Plan Update 2013. Colorado River Hydrologic Region.

_____. 2004. Chuckwalla Valley Groundwater Basin Description. California's Groundwater Bulletin 118.

_____. 1979. Sources of Powerplant Cooling Water in the Desert Area of Southern California – Reconnaissance Study. Bulletin 91-24.

CEC (California Energy Commission). 2015. Palen Solar Power Project Revised Staff Assessment Part II. CEC-700-2010-007-REV-PT2, Docket Number 09-AFC-07.

_____. 2010. ECE Pump Storage Presentation. Eagle Mountain Pumped Storage Project. Docket Number 15-MISC-05.

RWQCB (California Regional Water Quality Control Board). 2006. Water Quality Control Plan, Colorado River Basin, Region 7.

ECEC (Eagle Crest Energy Company). 2008. Eagle Mountain Pumped Storage Project Draft License Application Exhibit E, Volume 1, Public Information. Submitted to Federal Energy Regulatory Commission.

FERC (Federal Energy Regulatory Commission). 2014. Order Issuing Original License, Eagle Crest Energy Company, Project No. 13123-002. June 19, 2014.

USGS (United States Geological Survey). 2007. Ground-Water Recharge in the Arid and Semiarid Southwestern United States. Professional Paper 1703.

USHCN (U.S. Historical Climatology Network). 2016. Monthly Data Site 040924. Blythe, California. http://cdiac.ornl.gov/cgi-bin/broker?PROGRAM=prog.climsite_monthly.sas&SERVICE=default&id=040924&DEBUG=0. Accessed June 30, 2016.

Wilson, Richard P., and Owen-Joyce, Sandra J. 1994. Method to Identify Wells That Yield Water That Will Be Replaced by Colorado River Water in Arizona, California, Nevada, and Utah. U.S. Geological Survey Water-Resources Investigations Report 94-4005.

WorleyParsons. 2009. Groundwater Resources Investigation Genesis Solar Energy Project, Riverside County, California WorleyParsons Infrastructure and Environment, 2330 East Bidwell St, Suite 150, Folsom, CA.

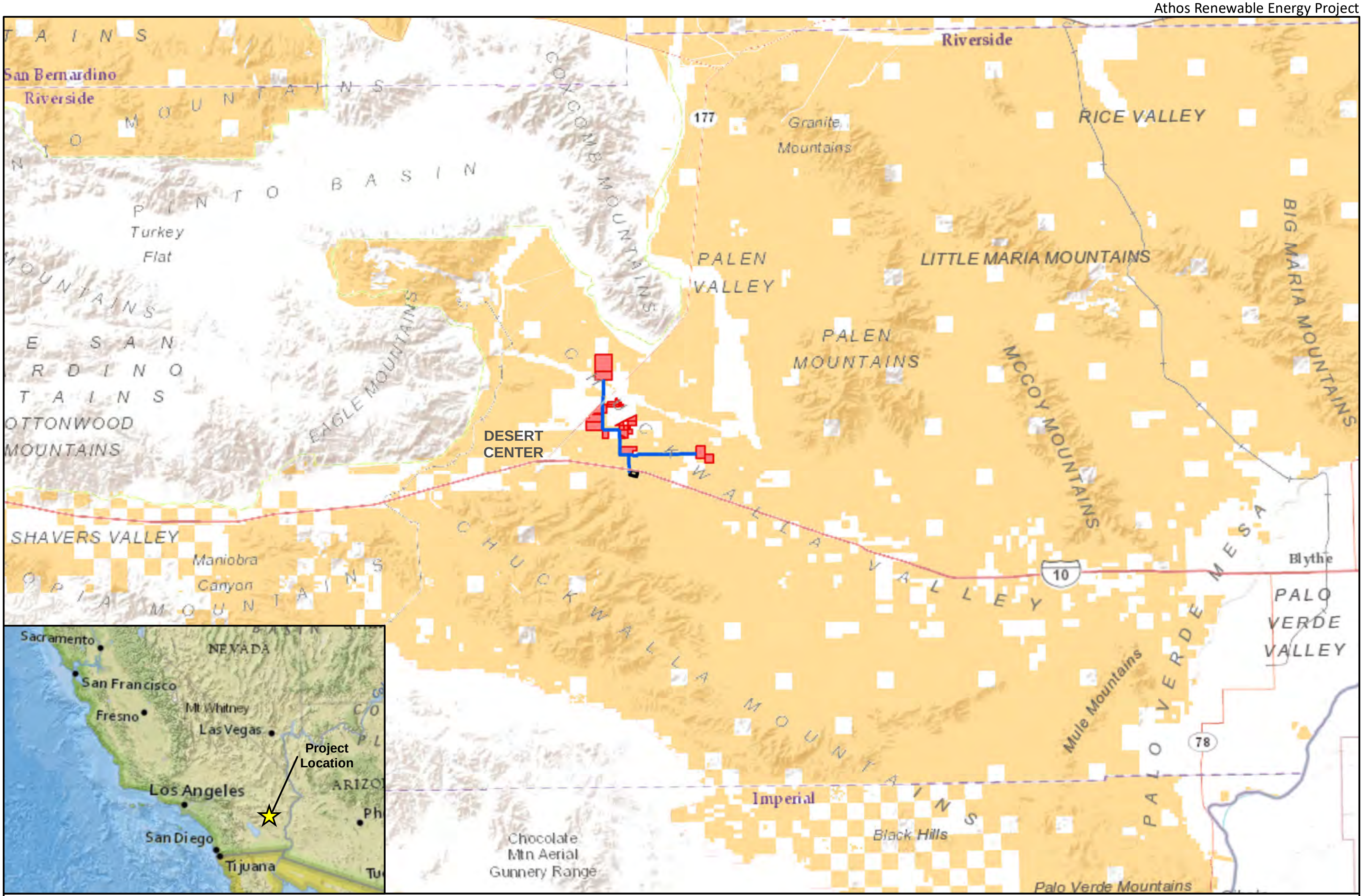

Figure 1

Project Vicinity

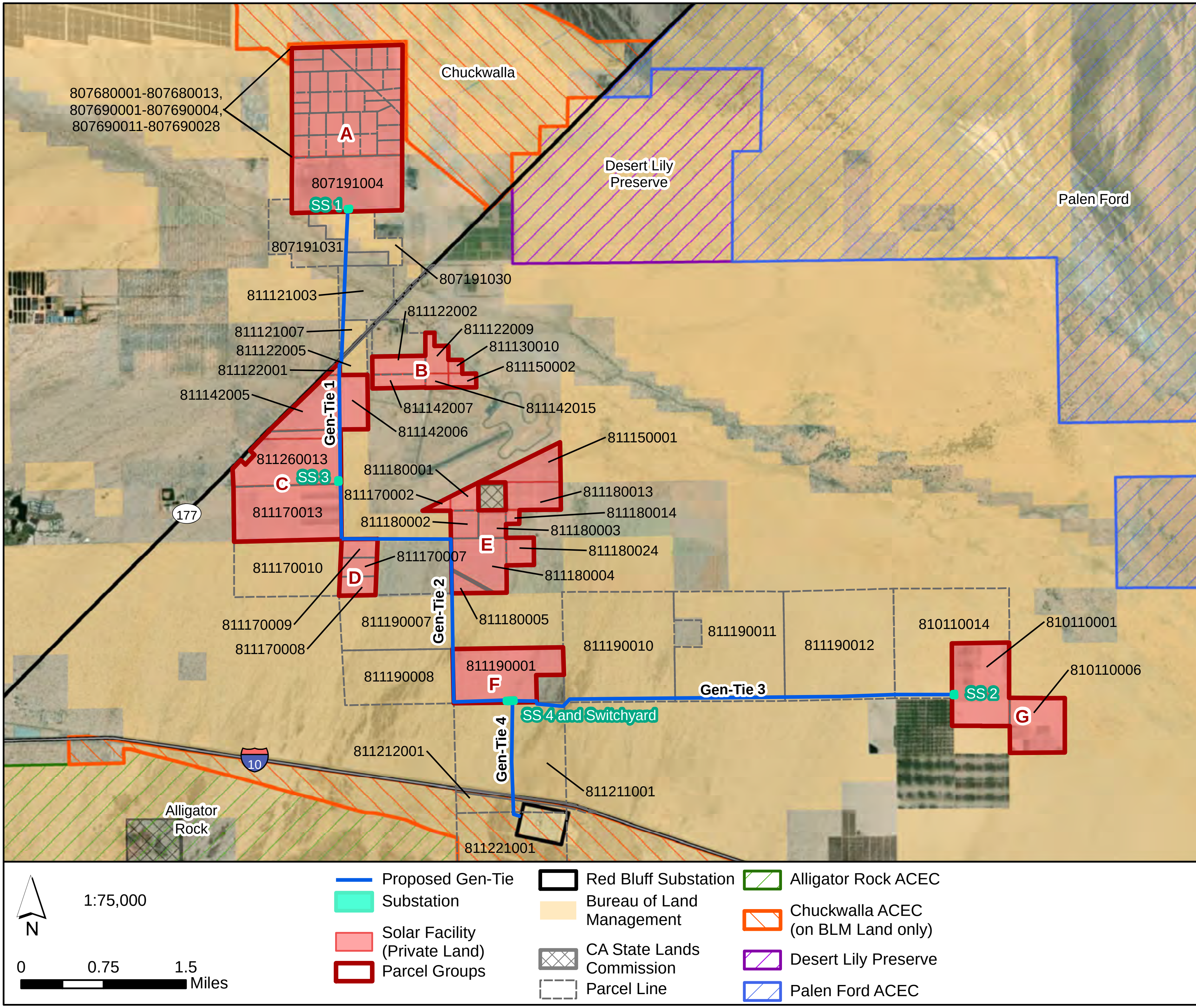

Figure 2

Project Area

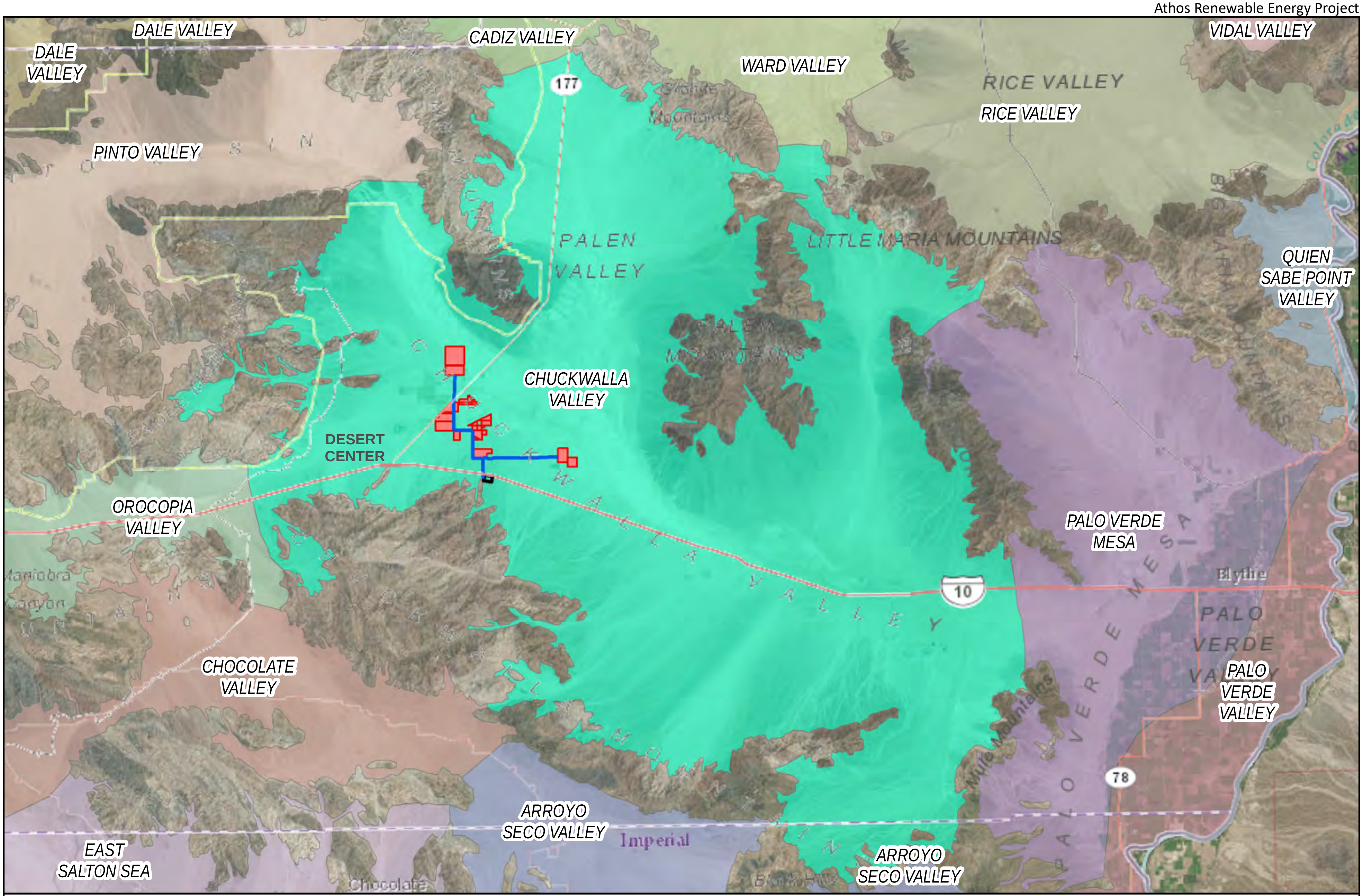

Figure 3

Chuckwalla Valley Groundwater Basin