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APPENDIX H-3
Hydrogeologic Conditions and Groundwater Modeling Report Addendum

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Soda Mountain Solar Project

BLM Case No. CACA 49584

May 2013

Hydrogeological Conditions and Groundwater Modeling Report Addendum

Soda Mountain Solar Project

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Submitted by:

Soda Mountain Solar, LLC
5275 Westview Drive
Frederick, MD 21703-8306
301-228-8110

Prepared by:

TRC Solutions
707 Wilshire Blvd., Suite 3250
Los Angeles, CA 90017
213-213-7400

for

Panorama Environmental, Inc.
One Embarcadero Center, Suite 740
San Francisco, CA 94111
650-373-1200

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1 BACKGROUND

The Soda Mountain Solar Project (project) will include the installation, operation, and maintenance of a 350-megawatt electric generating facility (Caithness 2011). The project area is located in a small valley on federal lands managed by the U.S. Department of the Interior, Bureau of Land Management (BLM), approximately 6 miles southwest of the town of Baker in San Bernardino County, California (Figure 1). Groundwater modeling was used to help evaluate whether the hydrogeologic conditions at the Project site could sustain the withdrawal of water needed during construction, operation, and maintenance of the proposed solar facility, without causing impacts to nearby water users or environmental resources located within the Mojave National Preserve. The initial groundwater modeling results were presented in *Hydrogeologic Conditions and Groundwater Modeling Report* (RMT 2011) ("Model Report").

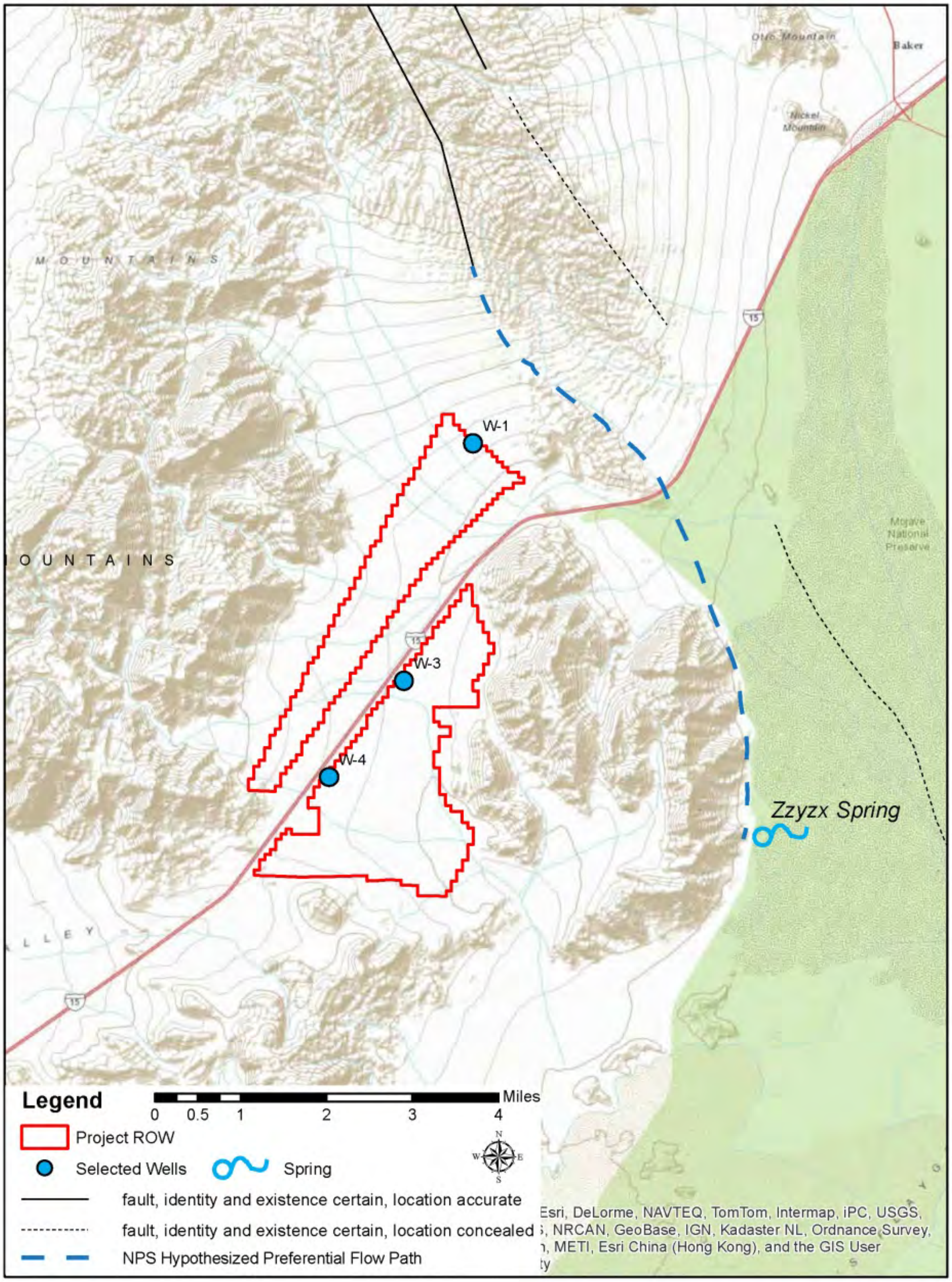
This addendum to the Model Report has been prepared to address:

1. Revised water use estimate for construction from 61 acre feet per year (AFY) to 192 AFY
2. Modeling of water use for project operation
3. Possible use of up to three groundwater wells
4. National Park Service (NPS) comments on the Model Report

NPS, Mojave National Preserve, presented scoping comments on the project in a letter dated November 21, 2012 (NPS 2012) addressed to San Bernardino County Land Services Department, Planning Division, and to the BLM, California Desert District Office, Moreno Valley (Appendix A). NPS comments on the Model Report, included:

- The modeling assumed an overly high recharge rate.
- The model did not account for the possibility of permeable bedrock to the east of the project area. NPS suggested one potential source from which Soda Springs at Zzyzx might derive significant flow is a potential preferential groundwater flow path extending from known fracture traces north and south of the Soda Springs at Zzyzx. The NPS's hypothesized preferential flow path is illustrated in Figure 1.
- The analysis did not adequately addresses potential impacts to the springs at Zzyzx.

Figure 1: Project Location



2 HYDROGEOLOGIC CROSS SECTIONS

A cross section location map is presented in Figure 2. Revised cross sections A–A′, B–B′, and C–C′ are presented in Figure 3. These cross sections were previously presented in RMT's 2011 Model Report. The revised cross sections do not display the vertical exaggeration used in the Model Report (which caused potential confusion over the distance between the springs at Zzyzx and the proposed groundwater wells). The revised cross sections also include the type and extent of bedrock units. The following discussion is derived largely from the Model Report, with additional discussion of the bedrock geology.

2.1 CROSS SECTION A–A'

Cross section A–A′ extends west to east and incorporates geophysical data from TEM-09 and TEM-11, which are located near the southern end of the valley (Figure 3). The cross section extends eastward across the mountain range to Soda Springs at Zzyzx, located on the eastern slope of the eastern Soda Mountains, above Soda Lake. Bedrock occurs at depths of 500 feet or more below ground surface (bgs) at TEM-09 and 436 feet bgs at TEM-11. The bedrock outcrops on the slopes of the Soda Mountains. Geologic mapping from Jenkins (1962) and Wilson (2011) indicates that Mesozoic granitic rocks make up much of the subsurface bedrock, with Jurassic-Triassic metavolcanic rocks forming significant portions and higher reaches of the Soda Mountains. A localized outcrop of carbonate rock is present in the vicinity of Soda Springs at Zzyzx, but its mapped extent appears to be limited to the vicinity of the spring (Jenkins 1962).

The water table occurs at an elevation of approximately 1,170 feet amsl at TEM-09, and appears to be below an elevation of approximately 922 feet amsl at TEM-11. The apparently much lower water table at TEM-11 suggests that there is an outlet for groundwater southeast of TEM-11 that allows the water table to drain to this lower elevation. A surface-water outlet is present in the southeast portion of the valley (Figure 2), and it is reasonable to assume an alluvium valley fill bedrock cut exists at this location. This conceptual model satisfies the need for a groundwater outlet to occur in the southeast portion of the valley, where the water table is apparently much lower than elsewhere, as seen at TEM-11.

2.2 CROSS SECTION B–B'

Cross section B–B′ extends west to east along the northern boundary of the project area, and shows a similar topographic slope to the east as was shown on cross section A–A′, paralleling the surface water outlet to the east (Figure 3). Drainages from large alluvial fans converge into the surface water outlet that flows through a relatively narrow valley between low mountains to the north and south (Figure 2). The funneling of the surface water outflow suggests that, as for

Figure 2: Locations of Geologic Cross Sections

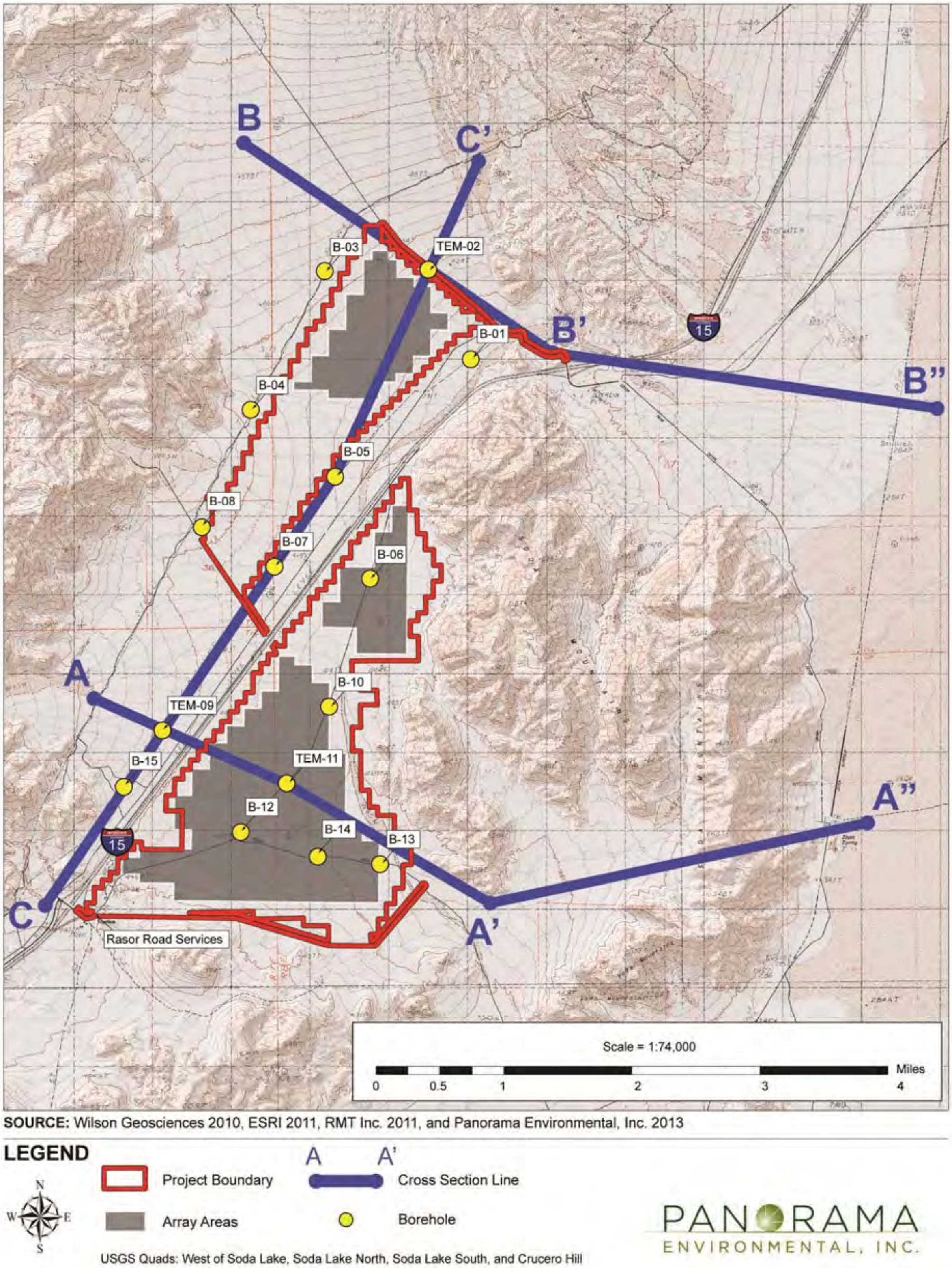
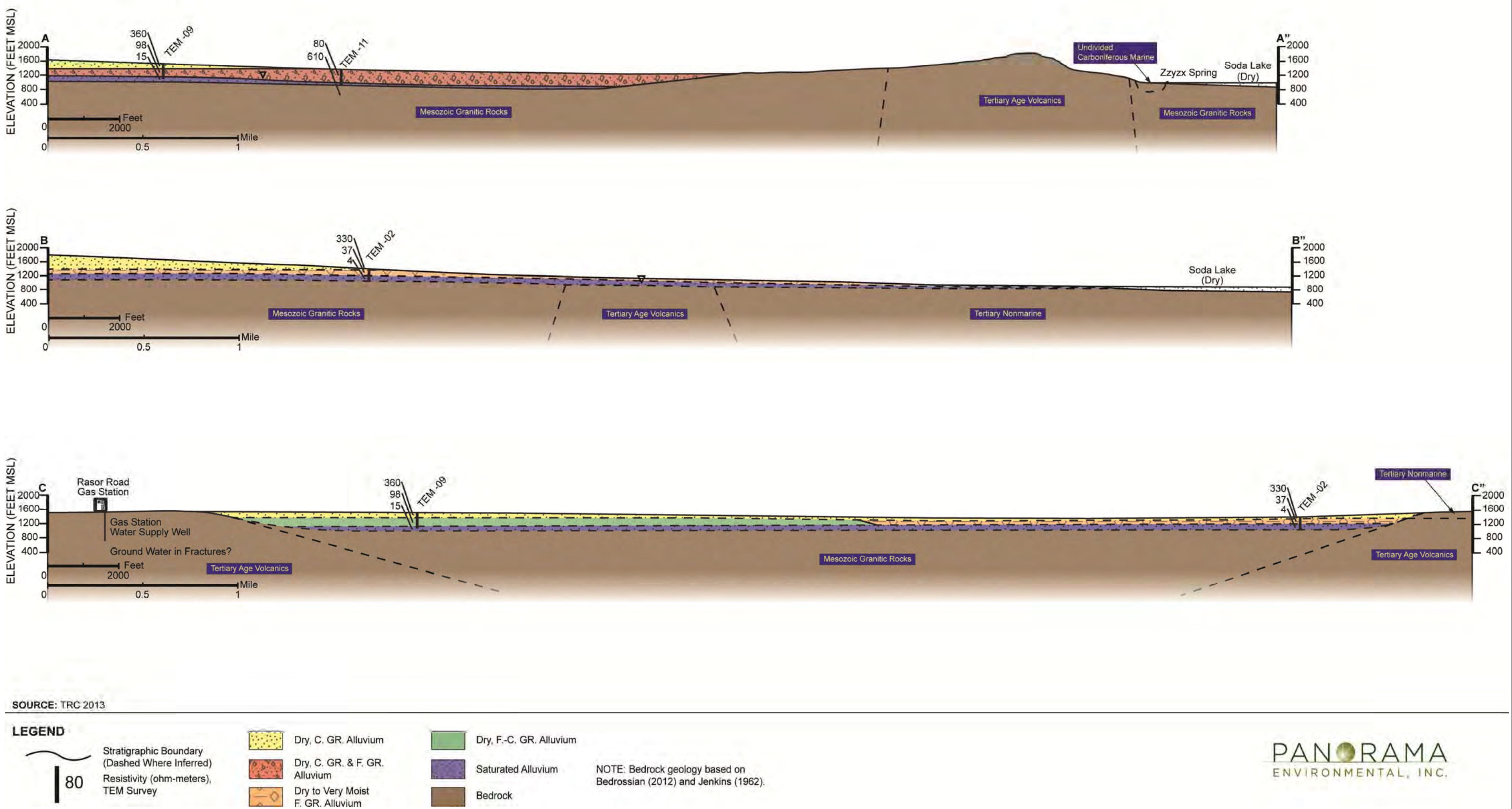


Figure 3: Geologic Cross Sections



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cross section A–A′, there may be a buried bedrock valley at this location. The funneling of surface water through this narrow gap suggests that there may be coarser sediments in the valley fill at this location. A small outcrop of limestone present near Zzyzx east of Soda Mountain on cross section point A is labeled as Undivided Carboniferous Marine. Extrapolation of mapped bedrock units into the subsurface indicates that Mesozoic granitic rocks predominate in the western portion of cross section point B, and Tertiary volcanic rocks form the central portion of the cross section. Tertiary nonmarine rocks are mapped in the eastern portion of the cross section, extending to the areas beneath Soda Lake.

The water table is interpreted to be at a depth of approximately 182 feet bgs at TEM-02 (elevation of 1,232 feet amsl), the shallowest groundwater occurrence of any of the three TEM locations. The groundwater elevation at TEM-02 is approximately 300 feet higher than the water table in the Soda Lake Valley located east of the project area (Figure 2). Groundwater elevations in the Soda Lake Valley range from 945 feet amsl to 958 feet amsl based on available U.S. Geological Survey (USGS) data (USGS 2013). Soda Springs at Zzyzx is located at an elevation of 948 feet approximately 200 to 300 feet below the groundwater elevation in the Soda Mountain Valley. The conceptual model illustrated on cross section B–B′ is that the water table slopes steadily eastward from the upper reaches of the alluvial fans to the base of the valley. Groundwater is channeled through the relatively narrow buried valley outlet located near the northeast corner of the project area, flowing eastward toward the Soda Lake lowlands.

2.3 CROSS SECTION C–C’

Cross section C–C′ extends northeast to southwest down the longitudinal axis of the valley (Figure 3). From south to north, bedrock units represented in the valley include Tertiary volcanic rocks (rhyolite, andesite), Mesozoic granitic rocks, and Jurassic-Triassic metavolcanic rocks.

A surface water divide located approximately 1.5 miles north of TEM-11 separates water flowing to the northeast outlet from water flowing to the southeast outlet (Figure 2). It is likely that groundwater flow approximately mimics the surface water flow, flowing northward in the northern half of the valley, and southward in the southern half.

TEM data indicate that the saturated subsurface resistivity differs between the northern and southern portions of the valley, consistent with the interpretation of different groundwater flow directions in the two portions of the valley. Groundwater at TEM-02 has very low resistivity (i.e., 4 ohm-meters), indicating a high concentration of total dissolved solids (TDS). Groundwater in the southern portion of the valley exhibits higher resistivity values at TEM-09 (i.e., 15 ohm-meters), indicating high TDS concentrations but lower concentrations than at TEM-02.

3 MODEL REVISIONS

The existing three-dimensional MODFLOW (MacDonald and Harbaugh 1988) groundwater flow model (RMT 2011) was revised through consideration of comments by staff at NPS and BLM as well as updated water use estimates. Model revisions included the following:

- Reduction of recharge values for the high-end parameter set from 0.5 inches per year to 0.4 inches per year (10 percent of rainfall, which averages 4 inches per year), and accompanying reduction of hydraulic conductivity (K) from 4.0 to 3.2 feet/day (ft/d) for the majority of the site (see Table 1). Equivalent reductions were made in the focused recharge at the boundary nodes, simulating mountain front runoff. The rationale for the selected recharge values is presented in Section 5.1.
- Revision of recharge value for the low-end parameter set from 0.125 inches per year to 0.12 inches per year (3 percent of rainfall), and accompanying reduction of K from 1.0 ft/d to 0.86 ft/d for majority of site (Table 1). Equivalent reductions were made in the focused recharge at the boundary nodes, simulating mountain front runoff.
- Increase in estimated groundwater extraction rates during a 3-year period of construction from 61 to 192 AFY.
- Increase in estimated groundwater extraction rates during operation from 7 to 33 AFY to allow for water use in dust control mitigation during operation of the project.
- Extraction from a single well in the southern portion of the site.
- Extraction from three wells located at select locations across the site.
- Refinement of grid spacing in the vicinity of well locations for greater accuracy.

Table 1: Revised Model Parameters

Aquifer Parameters			
Parameter Set Name	***Hydraulic Conductivity (K) (ft/d)***	***Groundwater Recharge (R) (inches/year) [AFY]***	***Storage Coefficient (unitless)***
High End	3.2	0.4 in/yr [1,330 AFY]	0.1
Low End	0.86	0.12 in/yr [376 AFY]	0.1
Note: Values given are for main body of model domain. Nodes at the model boundaries have higher R values. Nodes near the northeast and southeast outlets have higher K values.			

4 MODEL RESULTS

4.1 CALIBRATION

The revised model grid and model domain are shown in Figure 4. Figure 5 presents the steady-state hydraulic head distribution for the calibrated model for the revised high-end set of hydraulic conductivity (K) and recharge (R), with values of 0.4 inches per year (total of 1,330 AFY) for recharge. Figure 6 portrays the head distribution for the low-end set of K and R, with values of 0.12 inches recharge per year (total of 376 AFY). The steady-state head distributions are virtually identical for the high-end and low-end model runs. Table 2 shows the results of the calibration, comparing model results to heads estimated from TEM results.

For the high-end parameter set (10 percent recharge), predicted head values at TEM-02 were 1,233 feet amsl, nearly matching the 1,232 value estimated based on TEM results. The predicted head value for TEM-09 in the model (1,157 feet amsl) was well within the range of uncertainty for the estimated value based on TEM results (1,170 ± 30 feet amsl).

For the low-end parameter set (3 percent recharge), predicted head values at TEM-02 were 1,235 feet amsl, nearly matching the 1,232 value estimated based on TEM results. The predicted head value for TEM-09 in the model (1,157 feet amsl) was well within the range of uncertainty for the estimated value based on TEM results (1,170 ± 30 feet amsl).

Mass balance errors were low for the calibrated model, at 0.02 percent and 0.03 percent respectively for the high-end and low-end parameter sets. All water entering the model is derived from areal recharge. Outflow is through the northeast and southeast outlets, through general head boundary (GHB) nodes assigned to those locations. In general, the match of the model values to the two values interpreted from geophysical data is considered adequate for an area with such sparse hydrogeologic data.

Table 2: Predicted Hydraulic Heads Versus "Measured" Heads from TEM Results

	High-End Parameter Set		Low-End Parameter Set	
Measurement Location	***Predicted Head (feet amsl)***	***Measured Head (feet amsl)***	***Predicted Head (feet amsl)***	***Measured Head (feet amsl)***
TEM-02	1,233	1,232±13	1,235	1,232±13
TEM-09	1,157	1,170±30	1,164	1,170±30

Note: Measured head values were estimated based on TEM survey results from Terra Physics (2010).

Figure 4: Model Grid and Model Domain[1]

[1] Blue nodes represent general-head boundary conditions where groundwater is allowed to flow out of the model domain.

Figure 5: Steady State Calibration, High-End Parameters

Figure 6: Steady State Calibration, Low-End Parameters

4.2 EFFECTS OF PROPOSED GROUNDWATER EXTRACTION - PREDICTIVE SIMULATIONS

4.2.1 Pumping Rates Needed for Construction and Operation

Water needs for construction were revised from earlier estimates and are now estimated to be approximately 192 AFY for two to three years (Soda Mountain Solar 2013). Water needs for operation and maintenance (i.e., for PV panel cleaning, potable water use, and dust control during operation) are estimated to be approximately 33 AFY (Soda Mountain Solar 2013).

Water supply wells were simulated as operating under the conditions expected during construction and operation. Specifically, one and three wells were simulated to be pumping continuously at a combined rate of 192 AFY to accommodate the proposed water use of 200,000 gallons per day, 6 days per week (average continuous withdrawal of 171,000 gallons/day, or 22,913 ft^3/day) for a period of three years, the upper estimate of construction duration. Subsequently, one and three wells were simulated with combined extraction of 33 AFY for an additional 27 years (total simulation time of 30 years, the anticipated life of the project).

4.2.2 Selected Location of Water Supply Wells

Three potential locations for groundwater extraction wells have been selected, based on existing hydrogeologic data from TEM locations and borings and based on proximity to project operational facilities. The three locations are shown on Figure 1 and are named W-1, W-3, and W-4. W-4 was selected as the optimal location for simulation of a single water supply well; however, it is likely that two to three wells will be constructed to provide backup water supply and allow for well maintenance. Simulations were conducted for single well and three-well scenarios to evaluate the feasibility of obtaining sufficient water with acceptable drawdown under these scenarios.

4.2.3 Results of Simulated Groundwater Withdrawals

Three Wells, High-End Parameter Set (10 Percent Recharge)

Figure 7 shows the resulting drawdown and radius of influence predicted around a water supply well after three years of pumping at three wells, with a combined total of 171,000 gallons per day, or 192 AFY (representing the construction phase), for the high-end parameter set (10 percent recharge). The results of the model run (SM237transient) indicate a predicted maximum drawdown of about 28 feet, 20 feet, and 25 feet in the nodes representing Wells 1, 3, and 4 respectively after three years of pumping at 171,000 gallons per day (Table 3). Extraction rates would lower to 33 AFY during operation, and the cones of depression become much less steep but slightly wider in extent (Figure 8). The maximum drawdown would be approximately 1 foot at the closest bedrock interface east of the wells. The model results also indicate groundwater flow through the northeast outlet would be diminished by only one percent (from 424.8 AFY to 420.2 AFY, as shown in Table 4). This reduced flow through the northeast outlet would occur primarily during project operations.

Figure 7: Three Wells, 3 Years, High-end Parameters

Figure 8: Three Wells, 30 Years, High-End Parameters

Table 3: Summary of Results at Each Well Point			
Scenario	**Well 1 Drawdown (ft)**	**Well 3 Drawdown (ft)**	**Well 4 Drawdown (ft)**
3 Wells, 3 Years, High End	28	20	25
3 Wells, 30 Years, High End	5	4	5
3 Wells, 3 Years, Low End	110	68	91
3 Wells, 30 Years, Low End	16	12	15
1 Well, 3 years, High End	N/A	N/A	80
1 Well, 30 Years, High End	N/A	N/A	13
1 Well, 3 Years, Low End	N/A	N/A	Dry
1 Well, 30 Years, Low End	N/A	N/A	Not Modeled

Note: Model predicts declines in hydraulic head and does not account for well loss (head losses due to friction flowing through the well screen). Actual drawdown in the well is expected to be greater due to well loss.

Table 4: Groundwater Discharge at Northeast Outlet of Soda Mountain Valley				
Model Scenario	**Discharge (AFY), After 3 Years**	**Reduction (AFY)**	**Discharge (AFY), After 30 Years**	**Reduction (AFY)**
High Recharge, Existing Conditions	**424.8**	**N/A**	**424.8**	**N/A**
High Recharge, 3 wells	422.2	2.6	420.2	4.6
High Recharge, 1 well	424.8	ND	424.3	0.5
Low Recharge, Current Conditions	**121.2**	**N/A**	**121.2**	**N/A**
Low Recharge, 3 wells	121.2	ND	118.9	2.3

Notes:

ND = Not detectable. No change from existing conditions was measured by the model

Three Wells, Low-End Parameter Set (3 Percent Recharge)

Figure 9 shows the drawdown predicted after three years of pumping at three wells, with a combined withdrawal of 192 AFY for the low-end parameter set (3 percent recharge). With low-end values of K and R, the predicted drawdown is much higher at the well point than with the high-end parameter set. The maximum predicted drawdown is approximately 110 feet, 68 feet, and 91 feet in the nodes for Wells 1, 3, and 4 respectively (Table 3). The model run (SM240transient2) indicates the maximum drawdown at the closest bedrock interface east of the wells would be less than 1 foot after 3 years of construction. The cones of depression would become much less steep and would not spread significantly during operation (Figure 10).

Figure 9: Three Wells, 3 Years, Low-End Parameters

Figure 10: Three Wells, 30 Years, Low-End Parameters

The maximum predicted drawdown is less than 1 foot at the closest bedrock interface to the east of the wells. The model also predicts that there would be an approximately 2 percent reduction in groundwater flow through the northeast outlet during operation (from 121.2 AFY to 118.9 AFY).

One Well, High-End Parameter Set (10 Percent Recharge)

Figure 11 shows the resulting drawdown predicted around a water supply well after three years of pumping at one well (W-4) of 192 AFY with the high-end parameter set (10 percent recharge). The results from the model run (SM250hiR-tr) indicate a predicted maximum drawdown of about 80 feet in the node representing Well 4 after three years of pumping at 171,000 gallons/day during the construction phase (Table 3). The cone of depression would become much less steep but somewhat wider in extent during operation (Figure 12). The results indicate the maximum drawdown at the closest bedrock interface east of the wells would be approximately 2.2 feet. The model also indicates groundwater flow through the northeast outlet would decrease by approximately 0.1 percent from 424.8 AFY to 424.3 AFY. This reduced flow through the northeast outlet would occur primarily during the period of operations.

One Well, Low-End Parameter Set (3 Percent Recharge)

The model results indicate that with the low-end parameter set, the node containing the well would go dry quickly once pumping begins. The results of the model run (SM260) indicate a single well would not be able to sustain the required extraction rate of 192 AFY during the construction phase. The 30-year, one-well scenario was therefore not modeled.

Figure 11: One Well, 3 Years, High-End Parameters

Figure 12: One Well, 30 Years, High-End Parameters

5 DISCUSSION

5.1 RECHARGE

NPS stated that recharge estimates used in the MODFLOW model were too high and could underestimate the potential impacts of groundwater withdrawals associated with the project. NPS suggested using the Maxey-Eakin method for estimating recharge would determine zero recharge and this should be used as the model input for the site.

The rationale for recharge values used in the original model, 0.125 inches per year to 0.5 inches per year, was discussed in detail in Section 3.2 of the Model Report (RMT 2011). Average annual precipitation was estimated to be 4 inches per year or more, based on data from PRISM Climate Group (2012) and Western Regional Climate Center (2013).

NPS's assertion that the Maxey-Eakin method should be used to estimate recharge has been questioned by other researchers. Bredehoeft (2007) notes that, while the Maxey-Eakin method is still useful in Nevada, it has many uncertainties. Davisson and Rose (2013) point out that the Maxey-Eakin method was calibrated to a drier climate in Arizona rather than areas in southern California, similar to the study area, and thus could lead to underestimates of recharge in this area. NPS's assertion that the recharge rate could be zero are unreasonable because a zero recharge rate in a basin this small would result in a dry basin with no groundwater. Geophysical evidence from this valley shows the presence of up to several hundred feet of saturated alluvium in the valley floor, which directly contradicts a recharge rate of zero (TerraPhysics 2010; Wilson 2011).

With relatively coarse-grained sediments overlying much of the valley floor (Wilson 2011; Diaz-Yourman and Associates 2010) and approximately 4 inches of rainfall per year in the valley and mountains (PRISM Climate Group 2012), it is estimated that 7.8 to 8.8 percent of the precipitation in the mountains becomes mountain front recharge (Panorama Environmental 2012). This estimate is comparable to the value of approximately 10 percent of runoff becoming recharge in the Mojave Desert (Izbicki 2002). Recharge rates presented in the project well permit application were estimated to be approximately 641 to 723 acre-feet per year (AFY), with much of it derived from mountain front runoff (Panorama Environmental 2012).

BLM staff suggested recharge rates ranging from 3 percent to 10 percent of precipitation (0.12 to 0.4 inches recharge per year) should be used in the revised model based on their experience elsewhere in arid and semi-arid regions of southern California. These estimates of recharge are slightly lower than the previous estimates of 0.125 to 0.5 inch used in the Model Report (RMT 2011). The low-end (3 percent) and high-end (10 percent) recharge rates used in the model provide a total input of 376 to 1,330 AFY of recharge (corresponding to 0.12 to 0.4 inches of recharge per year).

5.2 MODEL BOUNDARIES CONSIDER OUTFLOW TO EAST

NPS commented that the model incorrectly assumed impermeable boundaries that precluded flow to the east beyond the Soda Mountains.

The model boundaries were defined using geologic data and geophysical information. The Soda Mountain Valley is surrounded by low-permeability granitic and volcanic rock. The model covers the alluvium within the valley. The low permeability rocks define the model boundaries. The cross sections in the Model Report have been updated with geologic information from existing published geologic maps (Figure 3). The geologic cross sections illustrate the nature and extent of bedrock that forms the mountains in the area, and verifies that carbonate rocks, which might have solution openings and be more permeable than the typical bedrock, are not pervasive in the area. The model domain reflects the geologic conditions in the area by assuming no flow through the granitic and volcanic rock to the east and flow through an outlet to the east and an outlet to the south where alluvium is present.

Observed conditions at the site and in the regional groundwater system support the presence of low permeability through fractured bedrock in the Soda Mountain. The water table in the valley is situated approximately 200 to 300 feet above the surface of Soda Lake and substantial fracturing and groundwater discharge through the mountains would have drained the Soda Mountain Valley groundwater basin. As discussed previously, geophysical evidence shows the presence of several hundred feet of saturated alluvium in the valley (Terra Physics 2010).

The existing model incorporated focused discharge through two outlets from the valley, the northeast and the southeast outlets, that allowed groundwater to flow from the model domain to the east. The model simulated groundwater discharge into Soda Lake through these two outlets. The model was therefore not surrounded entirely with impermeable boundaries.

5.3 POTENTIAL FOR IMPACTS TO SODA SPRINGS AT ZZYZX AND MOHAVE TUI CHUB

NPS commented that the model did not adequately address potential impacts to Soda Springs at Zzyzx, habitat for the Mohave tui chub (*Siphateles bicolor* ssp. *Mohavensis*).

The U.S. Fish and Wildlife Service (USFWS) listed the tui chub as endangered in 1970. California Department of Fish and Wildlife (CDFW) lists the species as endangered and a fully protected species. The revised modeling presented in this addendum evaluated groundwater drawdown at two locations to assess potential impacts on Soda Springs at Zzyzx and associated tui chub habitat:

1. NPS's hypothesized preferential flow path (Figure 1)
2. The western edge of the Soda Mountains

5.3.1 Mohave Tui Chub Habitat Requirements

There are specific requirements for suitable Mohave tui chub habitat, including pool configuration, water temperature, water quality, and food sources. Pools should be at least 4 feet deep to resist cattails and to stabilize temperature and dissolved oxygen content. Aquatic plants are needed for attachment of eggs and to prevent anoxic conditions in the water. Vegetation (aquatic and riparian) also provides shade to protect the fish from extreme temperatures Temperature tolerance ranges from 37 to 97 degrees Fahrenheit (3 to 36 degrees Celsius). The tui chub cannot tolerate high salt content; therefore, there must be a flow of fresh water into the pool to counteract high evaporation rates in the desert. Insufficient water supply to existing populations is a threat to the viability of Mohave tui chub populations. Mohave tui chub feed on aquatic invertebrates (USFWS 2009).

5.3.2 Mohave Tui Chub Habitat Locations

The Mohave tui chub historically existed in the Mojave River. Today, there are only four known populations: China Lake, Soda Springs and Lake Tuendae at Zzyzx, CDFW's Camp Cady Wildlife Area, and the Deppe Pond. There is no suitable habitat for Mohave tui chub within the Soda Mountain Valley.

Lake Tuendae

Lake Tuendae is an approximately 1.5-acre man-made lake approximately 800 feet northwest of Soda Springs. Evapotranspiration rates at the Lake were measured by Barthel (2008) based on groundwater withdrawal to support the lake. The pumping rate to support the Lake and adjacent vegetation is 9.27 million gallons per year (28.5 AFY) (Barthel 2008). The Lake is located within an approximately 2 acre watershed and the rate of evapotranspiration was therefore estimated to be 14.25 feet per year over each acre (28.5 AFY/2 acres = 14.25 feet per year) (Barthel 2008). Lake Tuendae supports a population of 1,318 Mohave tui chub (Barthel 2008). This population was introduced to the Lake. The Lake is approximately 3.1 feet deep and the level is managed by the Desert Studies Center to ensure adequate water depth for the tui chub and Saratoga Springs pupfish (also introduced) (Barthel 2008). Lake Tuendae is a managed system and lake levels are maintained by pumping groundwater rather than natural groundwater discharge.

Soda Springs at Zzyzx

Soda Springs at Zzyzx is a natural spring that discharges into an oval shape pond which supports a population of 255 Mohave tui chub. The pond at the spring outlet is approximately 13 feet by 16 feet wide (0.005 acre) and supports vegetation within a 0.4-acre watershed (Barthel 2008). The depth of the spring is approximately 6.5 feet with a total volume of 8,300 gallons. The estimated evapotranspiration from Soda Springs at Zzyzx and the surrounding phreatophytic vegetation is approximately 5.7 AFY (0.4 acre x 14.25 feet per year = 5.7 AFY of evapotranspiration) with approximately 0.07 AFY of evaporation from the pond surface (0.005 acre x 14.25 feet per year = 0.07 AFY).

Observations by Barthel (2008) indicate the water level in the pond has been constant during a year of measurements, apparently unaffected by pumping in the alluvial aquifer production well located near the spring. This finding is consistent with results of the production well testing at up to 200 gallons per minute that indicate the alluvial aquifer is highly permeable and transmissive, at approximately 400,000 gpd/ft^2 (Archbold 1994). This also suggests that there is ample flow of water in the permeable alluvial aquifer to sustain water levels in Soda Springs.

5.3.3 Groundwater Outflows

Groundwater outflows at Lake Tuendae, Soda Springs, and the Desert Studies Center are summarized in Table 5.

Table 5: Groundwater Use at Zzyzx

Location	Use	Amount (acre-feet per year)
Lake Tuendae	Evapotranspiration from approximately 2-acre watershed	28.5
Desert Studies Center	Pumped into pool and reservoir	4.0
Soda Springs at Zzyzx	Evapotranspiration from 0.4-acre watershed	5.7
Total		**38.2**
Note: Evapotranspiration rate is 14.25 feet per year		

Source: Barthel 2008

5.3.4 Source of Soda Springs at Zzyzx

Local Recharge

Research conducted at the Desert Studies Center indicates that Soda Springs at Zzyzx is recharged locally by water flow from alluvial fan deposits. Vargas (2012) showed that water from the spring was similar in stable isotopes and inorganic chemistry to water on the alluvial fan on the east side of the Soda Mountains. The determination was made after analysis of water quality samples from a well located approximately 500 feet west of the spring. The spring water differs substantially from shallow groundwater from the nearby playa of Soda Lake in isotope geochemistry and major ion chemistry. The spring thus does not appear to be recharged from groundwater from the playa area.

The water quality data indicate that the spring is sustained by water that originates locally on the eastern side of the Soda Mountains, infiltrating the alluvial fan sediments and flowing toward the spring under semi-confined conditions (Barthel 2008; Vargas 2012). It is likely that a broad area of alluvial fan sediments on the eastern edge of the Soda Mountains contributes recharge water to the spring flow, based on the age of the water (mostly pre-1950 based on tritium data [Vargas 2012]). The area of local recharge along the eastern face of the South Soda Mountains is approximately 2,600 acres. Assuming that 3 to 10 percent of rainfall becomes recharge, local recharge is in the range of 26 AFY to 86.7 AFY. The combined groundwater withdrawal at the Desert Studies Center, Lake Tuendae, and discharge at Soda Springs is approximately 38.2 AFY (Table 5). Local recharge is therefore sufficient to support all, or the majority of groundwater withdrawal and discharge at Soda Springs and Lake Tuendae.

Soda Mountain Valley Groundwater Outflow

Groundwater outflow through the northeast and southeast outlets of the Soda Mountain Valley is also thought to contribute additional recharge to the alluvial fans east of the Soda Mountains (Hughson 2013). This outflow from the valley may flow towards the Soda Lake Playa and evaporate off the playa, or it may combine with local recharge on the east side of the South Soda Mountains and flow towards Soda Springs. NPS hypothesizes that there is a mountain-front fault on the eastern side of the south Soda Mountains. Discharge from the valley may follow permeable rocks along the fault line as a preferential flow path, shown in Figure 1 (Appendix A). Groundwater outflow from the eastern outlet of the Soda Mountain Valley is estimated in the groundwater flow model for existing (steady-state) conditions to be 121.2 AFY with low-end recharge and 424.8 AFY with high-end recharge. Assuming that this flow contributes to local recharge and flows to the spring, the total combined groundwater flow from the eastern side of the Soda Mountains and Soda Mountain Valley groundwater outflow that is available at the spring is 147.2 AFY to 511.5 AFY.

5.3.5 Potential Impacts to Soda Springs Groundwater Levels

Reduced Flow out of the Soda Mountain Valley

Model results indicate that under any scenario, the discharge of groundwater from the Soda Mountain Valley through the northeast outlet would be diminished only slightly by the Project. The maximum potential reduction in flow is modeled to be 4.6 AFY or less after 30 years of pumping three wells under high recharge, equivalent to about 2 percent or less of the current outflow[1]) as shown in Table 4, with a lower level of reduction of 2.6 AFY (0.6 percent reduction) or less during the three-year construction period for the Project. The groundwater discharge from the Soda Mountain Valley would continue to follow the current flowpath, including potential flow down the alluvial fans along the east side of the Soda Mountains.

A groundwater budget for Soda Springs and Lake Tuendae was prepared to estimate the impact of the reduced outflow from the Soda Mountain Valley on Soda Springs (refer to Table 6). It is assumed in the groundwater budget that the Soda Mountain Valley is a source of groundwater for Soda Springs and Lake Tuendae. The groundwater budget indicates there is more than adequate groundwater flow from local recharge and outflow from the Soda Mountain Valley under project conditions to support existing groundwater use at Soda Springs and Lake Tuendae. There is surplus groundwater flow in excess of 100 AFY that drains to the Soda Lake playa under all scenarios. This analysis is supported by aquifer test results at Zzyzx that indicate there is ample flow of water in the permeable alluvial aquifer to sustain water levels in Soda Springs, as discussed previously. The minor reduction in outflow from the Soda

[1] Discharge was determined as an output of the calibrated model and each model scenario.

Mountain Valley as a result of project groundwater use would therefore have no impact on groundwater flow at Soda Springs or groundwater withdrawal for Lake Tuendae.

Table 6: Groundwater Budget

Element	Low-End Recharge Scenario (AFY)	High-End Recharge Scenario (AFY)
Potential Inflows to Soda Springs and Lake Tuendae		
Local Recharge	26.0	86.7
Soda Mountain Outflow	121.2	424.8
Direct Precipitation on Soda Springs and Lake Tuendae	0.7*	0.7*
Subtotal Inflows	147.9	512.2
Outflows		
Groundwater Use at Zzyzx	38.2*	38.2*
Reduction in Groundwater Flow Due to Project Pumping	2.3	4.6
Subtotal Outflows	40.5	42.8
Surplus Groundwater Flow (Flows to Soda Lake)	**107.4**	**469.4**
*Source: Barthel 2008		

Potential Impacts from Groundwater Table Decline at Western Edge of South Soda Mountains

It is highly unlikely that the volcanic bedrock forming the Soda Mountains and sidewalls of the Soda Mountain Valley are permeable enough to allow for a significant outflow of groundwater from the valley. Groundwater levels in the valley are approximately 1232 feet amsl at TEM-02, and 1170 feet amsl at TEM-09, and thus are over 200 feet higher than groundwater levels near Soda Springs (Barthel 2008; Vargas 2012). If there were substantial discharge through the bedrock, elevated groundwater levels could not be maintained in the valley over 200 feet higher than the water level near Soda Springs adjacent to the Soda Lake playa; the Soda Mountain Valley groundwater basin would drain.

Groundwater modeling results presented here indicate that drawdown of water levels near the edge of the valley adjacent to the west flank of the south Soda Mountains would generally be less than 2 feet at any time during construction or operation. The small drawdown at the edge of the valley would attenuate to negligible levels over the 3 miles of bedrock separating the valley from the Soda Springs area at Zzyzx. In comparison, groundwater levels in monitoring wells near Zzyzx fluctuate naturally by 1 to 2 feet with no effect on the level of Soda Springs (Barthel 2008).

5.3.6 Potential Impacts to Groundwater Quality

The withdrawal of groundwater for the project would not affect groundwater quality in the Soda Mountain Valley or at Zzyzx. Groundwater use would have a minor impact on groundwater levels in the Soda Mountain Valley (as discussed previously) and would not introduce contaminants to the groundwater system or change the chemistry of the groundwater. Construction and operation of the project would involve the use of hazardous materials that could potentially impact water quality (e.g., diesel fuel, solvents, etc.). These hazardous materials would be contained and managed in accordance with State regulations to prevent spills.

6 CONCLUSIONS

6.1 WATER AVAILABILITY AND NUMBER OF WELLS

The groundwater pumping simulations show that that there is adequate groundwater in the Soda Mountain Valley to support construction and operation of the solar project without adversely affecting nearby wells or sensitive resources. The model scenarios included scenarios with use of one well and scenarios with use of three water supply wells; however, current plans are to have two or three extraction wells to provide adequate water supply and a backup well for reliability. The results of the single-well scenario indicate that a single well could support construction water demand with high-end recharge but would be inadequate under a low-end recharge and low-end hydraulic conductivity scenario. The simulations show that three wells would supply an adequate amount of water for construction under all scenarios. It is recommended that an aquifer test be completed after construction of the first well to assess hydraulic properties of the aquifer. If the hydraulic properties are towards the lower end of the modeled range, three wells should be constructed for project water supply. If the hydraulic properties are towards the upper end of the modeled range, only two wells would be needed for the project.

6.2 EFFECTS OF GROUNDWATER PUMPING

The proposed use of water for construction and operation of the project is within the safe yield of the Soda Mountain Valley (Panorama 2013). The low-end recharge rate of 376 AFY would exceed annual project water demand of 192 AFY for the 3 years of construction. The operation pumping of 33 AFY is also within the safe yield with the low-end recharge rate. Groundwater pumping simulations conducted using both the low-end and high-end recharge rates and hydraulic conductivity values indicate a decline in the groundwater table of less than 1 foot to approximately 2 feet at the nearest bedrock interface east of the wells after 3 years of construction and over the operational period of the project.

This groundwater level decline would attenuate over the 3 miles of bedrock between the project wells and Soda Springs and is expected to be negligible at Soda Springs. Moreover, model results indicate the outflow of groundwater from the Soda Mountain Valley northeast outlet would be reduced during construction and operation by 4.6 AFY or less due to groundwater use for the project. Groundwater outflow from the Soda Mountain Valley would return to pre-existing conditions after decommissioning of the project.

6.3 EFFECTS TO SODA SPRINGS AT ZZYZX

There are approximately 3 to 4 miles of bedrock separating the project groundwater wells from Soda Springs. A drawdown of 2.2 feet or less at the nearest bedrock interface is not expected to propagate to a distance of over 3 to 4 miles, particularly through the granitic and volcanic bedrock that comprises the South Soda Mountains. The presence of low permeability bedrock between Soda Springs and the project valley indicate that there would be no change in groundwater levels at Soda Springs as a result of 2.2 feet or less of drawdown at the bedrock interface on the west side of the South Soda Mountains. Modeling results presented in Section 4 indicate the reduction in groundwater flow out of the northeast outlet of the Soda Mountain Valley to a preferential flow path along the east face of the south Soda Mountains would be less than two percent of current outflow (reduction of approximately 4.6 AFY or less) under all model scenarios (Table 4). The analysis of local recharge presented in Section 5.1.3 showed that there is likely sufficient local recharge on the east side of the South Soda Mountains to support discharge at Soda Springs and current groundwater withdrawal at the Desert Studies Center. It is uncertain whether the outflow from the Soda Mountain Valley contributes to groundwater flow at Soda Springs or whether the source of groundwater for Soda Springs is entirely local recharge on the east side of the south Soda Mountains. The outflow from the Soda Mountain Valley may flow east towards the Soda Lake playa rather than south towards Soda Springs at Zzyzx.

Approximately 5.7 AFY of groundwater inflow are needed to balance the evapotranspiration rate in Soda Springs, and 32.5 AFY of groundwater pumping to support Lake Tuendae and groundwater use at the Desert Studies Center Barthel (2008). Assuming that outflow from the Soda Mountain Valley contributes to groundwater flow at Zzyzx, there is a surplus of over 100 AFY of groundwater needed to support current groundwater use at Zzyzx under all model scenarios (Table 6). The potential impact from the project groundwater pumping on Soda Springs would therefore not be measurable or discernible from baseline water level in the Springs.

Pumping of groundwater into Lake Tuendae, located close to Soda Springs, has apparently had no significant effect on spring flow. Barthel (2008) reports that 32.5 AFY of groundwater was pumped from a well in the alluvial aquifer during a 1-year period. During this period, there was no impact to the water level in Soda Springs, which is located approximately 800 feet from the well. This also indicates that the natural flow of groundwater to Soda Springs is robust (Barthel, 2008). The results of the revised groundwater modeling support the conclusion that potential impacts of groundwater extraction for the project on Soda Springs would be negligible.

7 RECOMMENDATIONS

The following measures were developed based on the results of groundwater modeling for the Soda Mountain Solar Project.

Groundwater 1: Soda Mountain Solar will construct a test well within observation wells and a distance observation well within the project ROW prior to project construction. The distance observation well shall be located approximately 1,000 feet from the test well and within the alluvial aquifer underlying the project site. The exact location of the test and observation wells will be determined by a professional hydrogeologist or geologist. A test plan will be submitted to San Bernardino County and BLM a minimum of 14 days prior to performing the aquifer test. The aquifer test shall be conducted upon completion of the test and observation wells for a minimum of 72-hours, or as determined by the professional hydrogeologist or geologist. During the aquifer test, groundwater shall be discharged from the test well at a rate of approximately 200gpm (equivalent to maximum project demand of 300,000 gpd). The necessary permit(s) shall be obtained from the Regional Water Quality Control Board prior to the discharge of groundwater.

Groundwater 2: The aquifer test data shall be analyzed by a professional hydrogeologist or geologist. The professional hydrogeologist or geologist will determine the number of project water supply wells required for the project by calculating the estimated drawdown in two wells using the actual aquifer parameters from the 72-hour aquifer test (see Groundwater 1, above) and the maximum pumping rate of approximately 300,000 gpd for a period of 3 years. If one or more of the wells are expected to run dry at the maximum pumping rate, a third well will be required for the project.

Groundwater 3: A water quality sample will be collected from the test well and analyzed for total dissolved solids (TDS) by a State of California certified laboratory. The results will be evaluated by the project engineer to determine the need for a reverse osmosis facility to treat the water for panel washing.

Groundwater 4: The groundwater model will be recalibrated using the measured aquifer properties resulting from the 72-hour aquifer test (see Groundwater 1, above). If the results of the recalibrated model indicate that reduction in outflow from the valley would be less than 50 AFY under proposed project conditions, then no further action will be taken. If the recalibrated model predicts reduced outflow from the northeast outlet of the Valley in excess of 50 AFY, Groundwater 5 will be implemented.

Groundwater 5: The Applicant will hire a professional hydrogeologist or geologist to develop a groundwater monitoring plan for submittal to and acceptance of BLM and San Bernardino County if the recalibrated model predicts reduced outflow from the northeast outlet of the

Valley in excess of 50 AFY, as described in Groundwater 4. The groundwater monitoring plan would include monitoring and quarterly reporting of groundwater levels within the Soda Mountain Valley, in the alluvial aquifer adjacent to Soda Springs at Zzyzx, and at Soda Springs at Zzyzx during construction of the project. If the project is shown to cause a decline in groundwater levels is 5 feet or more in the alluvial aquifer near Soda Springs or there is a decrease in groundwater discharge at Soda Springs that threatens the tui chub as a result of project groundwater withdrawal, an evaluation would be conducted to determine if the project is causing reduced groundwater discharge at Soda Springs. If it is determined that the project has caused a decrease in the volume of groundwater discharged at Soda Springs then the project shall curtail or, if necessary, cease withdrawal of groundwater and import a corresponding amount of water from outside of the Soda Mountain Valley.

Groundwater level measurements in the monitoring wells located in the Soda Mountain Valley would be compared to the model predictions on an annual basis during construction and every 5 years during project operation. The groundwater model would be recalibrated if the measured drawdown values in the monitoring wells exceed the predicted values by more than 15 percent. Monitoring would cease after 5 years of operational monitoring if two conditions are met:

- The monitoring data support the model predictions.
- The model predicts the reduction in outflow from the northeast outlet will be less than 50 AFY under proposed project conditions, as detailed in Groundwater 4.

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Appendix A

United States Department of the Interior

NATIONAL PARK SERVICE
Mojave National Preserve
2701 Barstow Road
Barstow, California 92311

RECEIVED
BUREAU OF LAND
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CALIF. DESERT DISTRICT
MORENO VALLEY, CA

In Reply Refer To:
1.B. Temporary (long-term) (Formerly L3215) (MOJA)

November 21, 2012

Mr. Matthew Slowik
Senior Planner
San Bernardino County
Land Use Services Dept., Planning Division
385 N. Arrowhead Avenue, First Floor
San Bernardino, CA 92415-0182

Mr. Jeffrey Childers
Project Manager
Bureau of Land Management
California Desert District Office
22835 Calle San Juan de Los Lagos
Moreno Valley, CA 92553

Dear Mr. Slowik:

Dear Mr. Childers:

The National Park Service (NPS) appreciates the opportunity to comment on the Notice of Intent/Preparation (NOI/NOP) of the Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the Soda Mountain Solar Project (project). NPS supports renewable energy projects on public lands as long as such projects can be constructed and operated in an environmentally responsible manner that serves the public interest, protects natural resources, and protects our treasured landscapes. It is the role of NPS to contribute to the process and the analysis of renewable energy projects to help ensure that they meet the Secretary's goal that such projects on public lands are "Smart from the Start." Our goal is to provide expertise and practical and specific feedback in order to avoid significant adverse impacts to the resources of Mojave National Preserve (Preserve).

NPS has reviewed the project description, location, and potential environmental effects as described in your NOI/NOP dated October 23, 2012, and October 26, 2012. Our comments are as follows:

NPS has significant concerns related to potential project impacts to two federally listed endangered species, one California species of special concern, loss of wildlife connectivity and potential habitat de-fragmentation, viewshed degradation, air quality, storm water management, and hydrogeology and groundwater. The proximity of the proposed Soda Mountain Solar Project to the Preserve is less than one mile. Direct and indirect impacts associated with the project have potential to impact park resources significantly that have been mandated by Congress in the Organic Act of 1916 and the California Desert Protection Act of 1994 (PL 103-433 §2) to be protected by the Preserve.

Hydrogeology and Groundwater

During construction, the project proponent intends to pump approximately 60 acre-feet per year followed by approximately 6 acre-feet per year for operations during the life of the project. The

Hydrogeologic Conditions and Groundwater Modeling Report (RMT Inc. 2011) submitted by the project proponent inadequately addresses potential impacts to the springs at Zzyzx that are habitat for the endangered Mohave tui chub. The report supports the proposal to pump groundwater from the alluvial sediments underlying the project site and lacks subsurface data from boreholes on groundwater levels or geologic formation properties. It assumes an overly high recharge rate for this low-elevation area, incorporates unsupported assumptions in the model, does not account for the possibility of permeable bedrock, and neglects to account for potentially adverse impacts to the springs at Zzyxz that are habitat for the endangered Mohave tui chub.

The groundwater flow model employed a distributed recharge rate ranging between 0.125 and 0.5 inches per year (3.5% - 14% of direct precipitation) and a recharge rate 26 times greater at the boundary nodes on the assumption that mountainous areas act as precipitation collectors and funnel precipitation directly into the subsurface. Based on these assumptions, total recharge was calculated at a range of 343 to 1,373 acre-feet per year (af/y) over an area of 33,000 acres. These assumptions likely substantially overestimate the actual recharge rate for the project area. For example, the Maxey-Eakin method commonly used for estimating recharge in this arid region, would predict about zero recharge at this low an elevation. Recharge efficiency (percent of total precipitation that enters the subsurface as aquifer recharge) for total annual precipitation in the range of 10 cm/year that occurs in the project area is likely less than 3% and probably closer to zero (Dettinger 1989). Other groundwater studies in the eastern Mojave Desert (e.g. Izbicki et al. 1995) show groundwater with carbon-14 dates in the range of 20,000 years before present; this indicates very low to no modern recharge. The model used to estimate impacts from groundwater pumping for this project (RMT Inc. 2011), however, simply assumed a recharge rate and used it to calibrate the parameters of a flow model with no actual measured formation properties for comparison or analyses of recharge using accepted methodologies. The baseline model assumes impermeable, no-flow boundaries in the Soda Mountains and underlying bedrock. The only subsurface data presented in the report, however, comes from an existing well in fractured bedrock, which does not support the assumption of impermeable bedrock. This well near Rasor was drilled to 760 feet and produces up to 1,500 gallons per day (RMT Inc. 2011).

The Soda Springs at Zzyzx lie less than one mile from the Soda Mountain Solar project site and include MC Spring, which is habitat for the source population of the endangered Mohave tui chub (*Siphateles mohavensis bicolor*). The Mohave tui chub is listed as endangered under both the federal Endangered Species Act and the California Endangered Species Act. The no-flow boundary assumptions used in the model preclude analyses of potential effects of groundwater pumping on this spring-fed habitat. For example, one possible source of recharge for Soda Springs is the mountains west of the project site. One possible flow path for this recharge is through the location of the proposed pumping, along the northerly end of the Soda Mountains, and then along the westerly edge of Soda Dry Lake following the permeable beach and colluvial sediments at the playa margin. Pumping at the proposed project location might extract groundwater that would otherwise discharge from the springs. Estimates of groundwater discharge at Zzyzx are in the range of 50 af/y (Barthel 2008), less than the amount proposed to be pumped by the project during the construction phase. The groundwater modeling report does not address this potential flow path, and data used to support the model are limited to surface electrical resistivity surveys. The groundwater modeling and analyses need to be based on actual field data, including recharge estimates obtained by accepted methods (e.g. chloride mass balance) and subsurface data from boreholes on groundwater levels and aquifer formation properties. Project analysis should consider alternatives to the water use described in the project proposal. The proponent should consider alternatives to groundwater pumping, such as use of dust palliatives, panel cleaning by air blowing, dust cloths, or other means.

For each facility site with a drainage system crossing it, the proponent should include a map identifying all surface water resources within the vicinity and include a narrative discussion of the delineation methods used to discern those surface waters in the field and what modifications would occur from project implementation. Specific information regarding the potential impacts to surface waters should be addressed, including both permanent and temporary impacts. Alternatives and mitigation measures to reduce and/or eliminate such impacts should be addressed. If impacts are unavoidable, then impacts need to be minimized, with the project designed such that it would maintain existing hydrologic features and patterns. All unavoidable impacts should be mitigated to ensure no net loss of function and value as the result of project implementation.

Storm water management needs to be considered as a significant component in the project design and implementation. In particular, storm water runoff collects into channels and natural drainage systems. Without adequate design, the consequences of combining these flows will likely be aggradation and head-cutting upstream of the confluence and channel incision, increased sediment transport, and eventual widening downstream of the confluence. The proponent needs to evaluate all potential storm water impacts, describe controls needed during construction, mitigation necessary for potential post-construction hydrologic impacts, and describe specific best-management practices that, when implemented, would reduce those potential impacts to insignificant levels. Where feasible, consideration should be given to design alternatives that maintain the existing hydrology of the site and/or redirect excess flows created by hardscapes and reduced permeability from surface waters to areas where they will dissipate by percolation into the landscape. All potential impacts associated with changes in drainage patterns, changes in water volume, velocity, quantity, quality, soil erosion and sedimentation in streams and water courses on or near the project site need to be modeled and analyzed. Mitigation measures to alleviate such impacts shall be included in the project proposal and environmental documents. The practice of channelizing, straightening, and lining streambeds would change a stream's hydrology by decreasing water storage capacity and increasing water flow velocity, and this, in turn, would lead to increases in the severity of peak discharges. These hydrologic changes can exacerbate flooding, erosion, scouring, and sedimentation, and could lead to loss of natural functions and values.

Biological Resources

The construction site for the proposed project includes desert tortoise habitat modeled by the U.S. Geological Survey to be high quality, in the range of 0.7 to 0.9 on a scale of 0 to 1 (Nussear et al. 2009). Recent population collapses, perhaps due to disease and/or drought (Tracy et al. 2004), make location of cryptic desert tortoises (*Gopherus agassizii*) even more difficult. Thus, absence of live tortoise observations during relatively brief field surveys, as reported by the project proponent, should not be used as justification for destruction of otherwise high-quality habitat as this would preclude the possibility for recovery of tortoise populations in the area and reoccupation of habitat.

The Soda Mountains are habitat for a recently established herd of desert bighorn sheep (*Ovis canadensis nelsoni*). This herd established itself at the Soda Mountains without human intervention with the source population unknown. Even in the absence of an active sheep population, however, the Soda Mountains are a high priority for desert bighorn sheep conservation (John Wehausen, personal communication, 2012) due to the presence of a number of significant bridges under Interstate 15 that serve as rare and important opportunities for gene flow between the northern and north-central bighorn sheep metapopulation segments (Epps et al. 2007). Construction of the proposed solar energy project would preclude desert bighorn sheep gene flow to the north under Interstate 15 as well as to the south with the population in the Cady Mountains. Further fragmentation of the habitat is likely to irreversibly harm the viability of species metapopulations. High mountain habitat is no longer adequate to support permanent populations of sheep (Bleich et al. 2005). All areas used by sheep, including the lower elevation habitat connecting mountain ranges, are essential for the long-term survival of the species.

The Soda Mountain Solar project might also impact other wildlife, including raptors, song birds, and bats. A two-year or longer inventory, depending on environmental conditions, utilizing accepted protocols is needed to identify all potentially impacted species. Modeling techniques should be used to estimate flight patterns and periods of use of birds and bats and to identify potential impacts and potential mitigations. The project should identify significant direct and indirect loss of plant and wildlife habitat from all aspects of the project, including installing towers, constructing, improving, or re-routing roads, burying lines, and constructing ancillary facilities. This analysis needs to identify impacts to all species during each season. Species should include locally unique species, rare natural communities, wetlands, threatened and endangered species, California threatened, endangered, and species of special concern. The inventory needs to list all species present in the project area and include a distribution map with potential migratory and dispersal routes. It should demonstrate how the project will affect wildlife and plant distributions under each alternative. The analysis needs to address the potential loss of wildlife connectivity, include impacts from non-native and invasive plants, and address the association of invasive plants with disturbance, including the cumulative effects of the Rasor Off-Highway Vehicle Area and other disturbed areas.

The project proponent needs to develop a salvage plan for any special-status plants or species associated with habitat loss in the project area. Plant salvage needs to address, at a minimum, location of the mitigation site, plant species, schematic of the mitigation area, schedule, exotic vegetation control, planned monitoring, and plans for long-term conservation of the mitigation site.

Physical Resources

Mojave National Preserve is renowned for its dark night skies. NPS manages the Preserve to protect this valued and increasingly rare resource. The General Management Plan for the Preserve identifies as a resource protection goal "to partner with communities and local government agencies to minimize reflected light and artificial light intrusion on the dark night sky". All exterior lighting should comply with International Dark-Skies standards and should be hooded to prevent light from shining up into the sky and shielded and directed to aim it at the places where it is needed to prevent light from spilling off the site. Low-pressure sodium lamps and fixtures of a non-glare type are required.

Potential impacts to all visual and natural sound need to be evaluated and analyzed. The scenic vistas associated with Mojave National Preserve are considered unique, as described in the California Desert Protection Act of 1994 (PL 103-433 §2). An assessment of visual impacts must include analyses of scenic vistas from specific key observation points, both towards the Preserve and from the Preserve towards the project site. In order to protect the natural soundscapes of Mojave National Preserve, analyses are needed of noises created during both the construction and operation phases of the project, including timing, intensity, duration, frequency spectrum, and impacts to both people and wildlife. Soundscape assessment needs to address the number of vehicle trips per day for delivering personnel, equipment, and supplies to the project during both construction and operational phases of the project. Construction and operation traffic could affect wildlife, soundscapes, and air quality. A traffic study needs to address project impacts to the roads and surrounding environment and to address mitigation measures needed to reduce the impacts. Such analysis should be consistent with the California Department of Transportation's Guide for the Preparation of Traffic Impact Studies.

An analysis of ambient air quality according to the National Ambient Air Quality Standards is needed, including potential air quality impacts of the proposed project (cumulative and indirect impacts). The analysis needs to identify all potential impacts from temporary or cumulative degradation of air quality. It should describe and estimate air emissions from potential construction and maintenance activities and propose avoidance or minimization measures. Emission sources should be identified by pollutant from mobile sources, stationary sources, and ground disturbance. The environmental analyses should include a Construction Emissions Mitigation Plan that addresses degradation of air quality and wilderness values.

A Fugitive Dust Control Plan should be prepared. Dust is the primary source of PM-10 (Particulate Matter 10 microns or smaller) pollution in the Mojave Desert. The environmental analyses needs to model the sources of dust that presently occur from the project area, then show their timing, duration, and transport on- and off-site. Modeling should also identify variations during construction and operational phases of the project for each alternative. Human health and the environment of sensitive receptors should be protected during any construction or demolition activities. If necessary, a health risk assessment should be conducted to determine if there are, have been, or will be, any releases of hazardous materials that might pose a risk to human health or the environment.

Cumulative Impacts

Direct and indirect cumulative impacts need to be analyzed as they apply to both the project site and the greater vicinity. Plans for past, present, and anticipated future projects should all be analyzed relative to their impacts to Mojave National Preserve.

The Soda Mountain Solar project has potential for causing significant impacts to Mojave National Preserve. Potential impacts include decreased spring discharge at Zzyzx as a consequence of groundwater pumping, loss of habitat for the endangered Mohave tui chub, loss of high-quality desert tortoise habitat, increased habitat fragmentation for desert bighorn sheep, and loss of important conservation opportunities. In addition, there are potential impacts from the project to air quality, storm water management, and scenic vistas. We believe that the environmental analysis of these potential impacts has been inadequately addressed in the documents provided by the project proponent.

If you have any questions, feel free to contact Mr. Ted Weasma at (760) 252-6106 or at ted_weasma@nps.gov.

Sincerely,

Stephanie R Dubois

Stephanie R. Dubois
Superintendent

cc:
Greg Miller, BLM, California Desert District
Teri Raml, BLM, California Desert District
Katrina Symons, BLM Barstow Field Office
Sarah Quinn, NPS WASO
Amee R. Howard, NPS PWR
Alan Schmierer, NPS PWR

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