Appendix H

Water Supply Assessment

Water Supply Assessment for the RE Slate Solar Project, Kings County, California

Prepared for:

HELIX Environmental Planning, Inc.

Prepared by:

Balance Hydrologics, Inc.®

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A REPORT PREPARED FOR:

HELIX Environmental Planning, Inc.
11 Natoma Street, Suite 155
Folsom, California 95630
(928) 357-2562
catherines@helixepi.com

By:

Scott Brown

PROFESSIONAL GEOLOGIST
SCOTT BROWN
No. 8722
STATE OF CALIFORNIA

Scott Brown, P.G.
Senior Geologist/Geomorphologist

Reviewed by:

Mark Woyshner

Mark Woyshner
Senior Consultant, Hydrology/Hydrogeology

Balance
Hydrologics, Inc.®

Project Assignment: 216038

800 Bancroft Way, Suite 101 ~ Berkeley, California 94710 ~
(510) 704-1000 ~office@balancehydro.com

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1 INTRODUCTION

This report analyzes the projected water supply and demand for the RE Slate Solar Project (or "Project") in unincorporated Kings County, California. The Water Supply Assessment (WSA) is intended to support environmental planning documentation for the project.

1.1 Regulatory Background

Section 10910 of the California Water Code (as revised by Senate Bill 610, or SB610) requires: "the city or county, at the time that it determines whether an environmental impact report, a negative declaration, or a mitigated negative declaration is required for any project as defined by Water Code Section 10912 and subject to the California Environmental Quality Act pursuant to Section 21080.1 of the Public Resources Code, … [to] identify any water system…that may supply water for the project" and to prepare a WSA to address the increased water use over existing conditions. The WSA is intended to:

- Identify the water system or systems that would (or may) supply water to the project;
- Compare project water demands with those projections included in the most-recently adopted Urban Water Management Plan (UWMP) for those service providers, or to assess supply and demand based on available information where no UWMP is available; and
- Assess whether the water system's total projected water availability for the entire system(s) during normal, single dry, and multiple dry years over a 20-year period will meet the projected water demand associated with the proposed project, in addition to the public water system's existing and planned future uses (including agricultural and manufacturing uses).

Within this assessment, California Water Code Section 10910(4)(d) requires a discussion of existing water supply entitlements, water rights, or water service contracts relevant to the public water system(s). Also, Section 10910 (2)(f) requires that "If a water supply for a proposed project includes groundwater, the following additional information shall be included in the water supply assessment: (1) a review of any information contained in the urban water management plan relevant to the identified water supply for the proposed project (2) a description of any groundwater basin or basins from which the proposed project will be supplied."

Section 10912(a) of the California Water Code outlines the types of projects requiring a Water Supply Assessment, as follows:

- A proposed residential development of more than 500 dwelling units;
- A proposed shopping center or other business establishment employing more than 1,000 persons or having more than 500,000 square feet of floor space;
- A proposed commercial office building employing more than 1,000 persons or having more than 250,000 square feet of floor space;
- A proposed hotel or motel, or both, having more than 500 rooms;
- A proposed industrial, manufacturing, or processing plant or industrial park planned to house more than 1,000 persons, occupying more than 40 acres of land, or having more than 650,000 square feet of floor area;
- A mixed-use project that includes one or more of the projects specified in this subdivision; or
- A project that would demand an amount of water equivalent to, or greater than, the amount of water required by a 500-dwelling unit project.

Senate Bill 267 (SB267) was authorized in 2011 to clarify the Water Supply Assessment requirements for renewable energy projects. SB267 revised the WSA definition of a project to “exclude a proposed photovoltaic or wind energy generation facility… that would demand no more than 75 acre-feet of water annually” until January 1, 2017. Assembly Bill 2561 extended the above-described exemption of photovoltaic or wind energy generation facilities from the definition of “project” through January 1, 2018. As both SB267 and AB2561 have expired, proposed photovoltaic projects requiring less than 75 acre-feet of water annually are no longer exempt from a WSA analysis and review by the Water District.

The RE Slate project is a photovoltaic electricity generation and storage facility proposed on approximately 2,490 acres of existing agricultural land. As presented in Section 3.1, the proposed project would demand up to 15 acre-feet (af) of water per year during the operational phase of the project, and as much as 260 af of water during the construction phase. The project is considered an industrial project for the purposes of WSA determination, and because it will occupy more than 40 acres, a water supply assessment is required.

1.2 Project Location

The RE Slate project is proposed for a 2,490-acre set of parcels in northwestern Kings County, California. The project site is located just west of the Kings River, bounded by Avenal Cutoff Road to the northwest, the Mustang II Solar Project to the west, Jackson Avenue to the north, Laurel Avenue to the South and agricultural fields adjacent to the Kings River to the east **Figure 1-1**). The project site is surrounded predominantly by parcels zoned agricultural on all sides; the adjacent, previously approved Mustang II solar field has not yet been constructed.

1.3 Existing Conditions

The project site is agricultural land that has been used for various purposes in the recent past, including irrigated crops, grazing, and left fallow depending on the year. Since 2014, most of the site has been used as pastureland or left fallow. As recently as 2012 and 2013, portions of the site were irrigated, based on aerial photographs of the site (**Figure 1-2**)[1].

1.4 Proposed Project

The proposed project would construct and operate a photovoltaic electricity generating and storage facility (‘solar facility’) on the 2,490-acre site that would include solar arrays, an energy storage system, and a shared operations/maintenance building. Associated infrastructure would include access roads, a septic system, fencing, and buried conduit. Periodic sheep grazing would continue at the site for maintaining rangeland and for consistency with the existing zoning, though no irrigation would be applied to maintain the grassland areas for that purpose.

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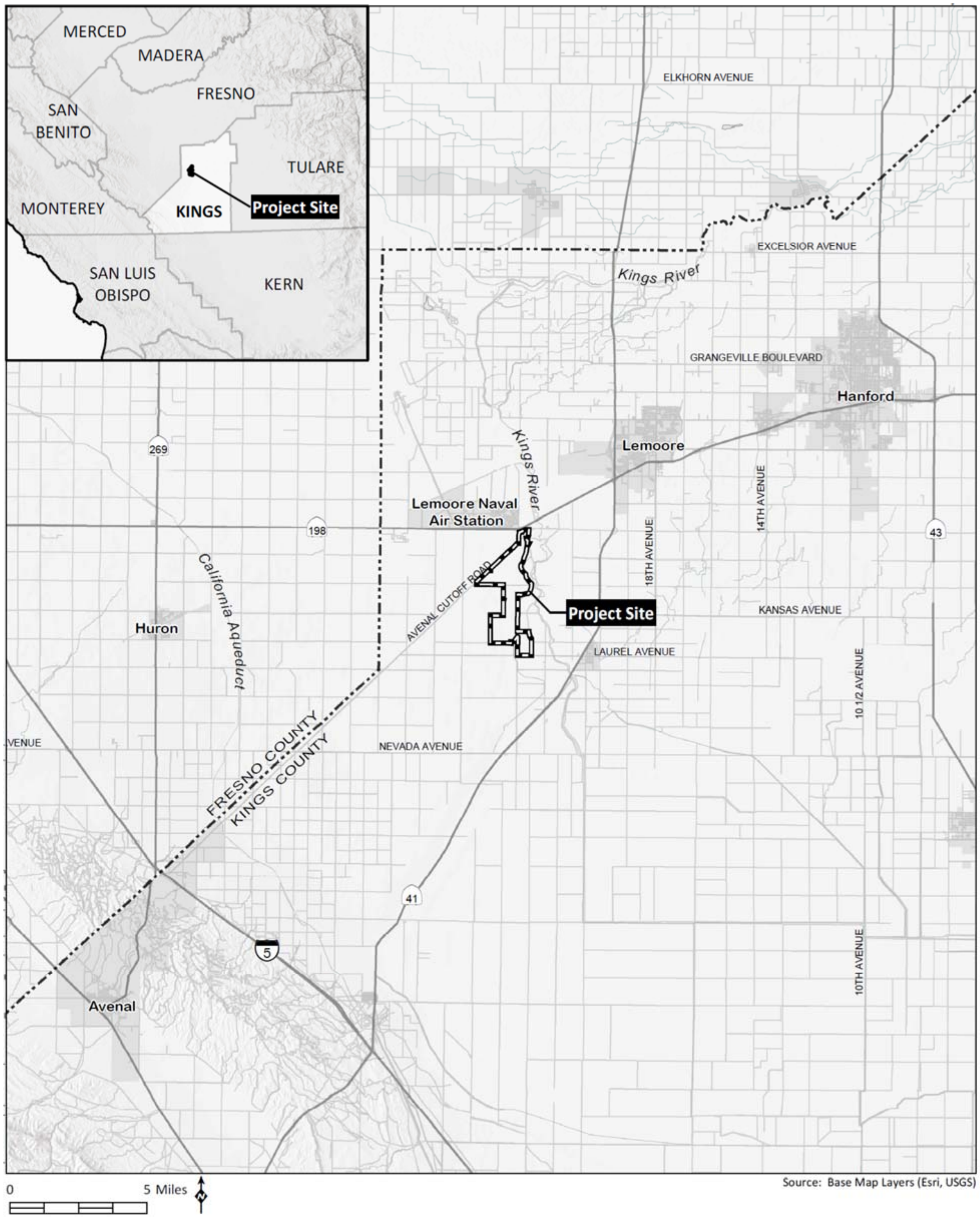
[1] No aerial photographs were available for 2014 or 2016, so the irrigation state of the property could not be assessed for those years. Aerial photographs confirm that the site was not irrigated in 2015 or 2017.



Source: Base Map Layers (Esri, USGS)

Figure 1-1 Project site and regional location map for the RE Slate Solar Project, Kings County, California.

Figure 1-2 **Aerial photograph of the RE Slate project site from April 13, 2013, showing partially-irrigated conditions.** Project boundary outlined in orange. Dark green areas show that approximately 30 percent of the project site was irrigated in 2013. Photos downloaded from Google Earth.

2 WATER SUPPLY

The proposed project site is situated on the divide of two administering districts. The western portion of the proposed project site is located within the boundary of the agricultural Westlands Water District (WWD), an agency that, among other functions, administers and distributes water from the Central Valley Project (CVP) to farming operations within portions of its service area, and implements the groundwater management plan within the Westside groundwater subbasin (see Section 2.1.2; WWD, 1996). The eastern portion of the project site is located within the Empire West Side Irrigation District, a small agency managing irrigation infrastructure within a small area of land between the WWD and the Kings River[2].

The project site itself is approximately bisected by the boundary between two San Joaquin Valley groundwater subbasins (**Figure 2-1**), the Westside and Tulare Lake subbasins, as defined by the California Department of Water Resources (CA DWR, 2016)[3]. Even though the subbasins are classified separately, the basins are hydrogeologically connected, and have a relatively complex sedimentary structure of interfingered layers of sand, silt, and clay in the subsurface.

Several sources of water supply are being considered for both the construction and operational phase of the project. The current options for water supply are as follows:

1. Pumping from an on-site or adjacent site WWD well, both of which draw groundwater from the underlying Westside groundwater subbasin (see description in Section 2.1).
2. Groundwater pumped from a well located at the Tranquility Solar Project site, located approximately 50 miles northwest of the project site. This well also draws water from the Westside groundwater subbasin (see description in Section 2.1).
3. Purchase of water from a private well located on-site or on an adjacent property, which draws water either from the Westside groundwater subbasin

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[2] Neither WWD nor Empire West Site Irrigation District are public water systems, nor do they regulate groundwater extraction. Their primary function is to administer imported irrigation water and manage irrigation canals within the area.

[3] Earlier incarnations of DWR's groundwater basin map (CA DWR 2003), also showed the property overlying a small portion of third subbasin, the Kings subbasin. Boundary adjustments made in 2016, however, eliminated the small extension of the Kings subbasin that stretched to the project site, simplifying the boundary map in this area.

(Section 2.1) or from the northwestern portion of the Tulare Lake subbasin (Water Management Area C1, as described in Section 2.2).

4. Imported water from the City of Lemoore, which obtains its supply solely from the underlying Tulare Lake subbasin (Water Management Area C, as described in Section 2.2).
5. Potable bottled water service for construction workers during the establishment phase, and for on-site staff during the operational phase.

The project would not necessarily be tied to one particular source through the life of the project, which allows operational flexibility for consideration of pricing and water quality. Different sources may be used for construction versus operational phases.

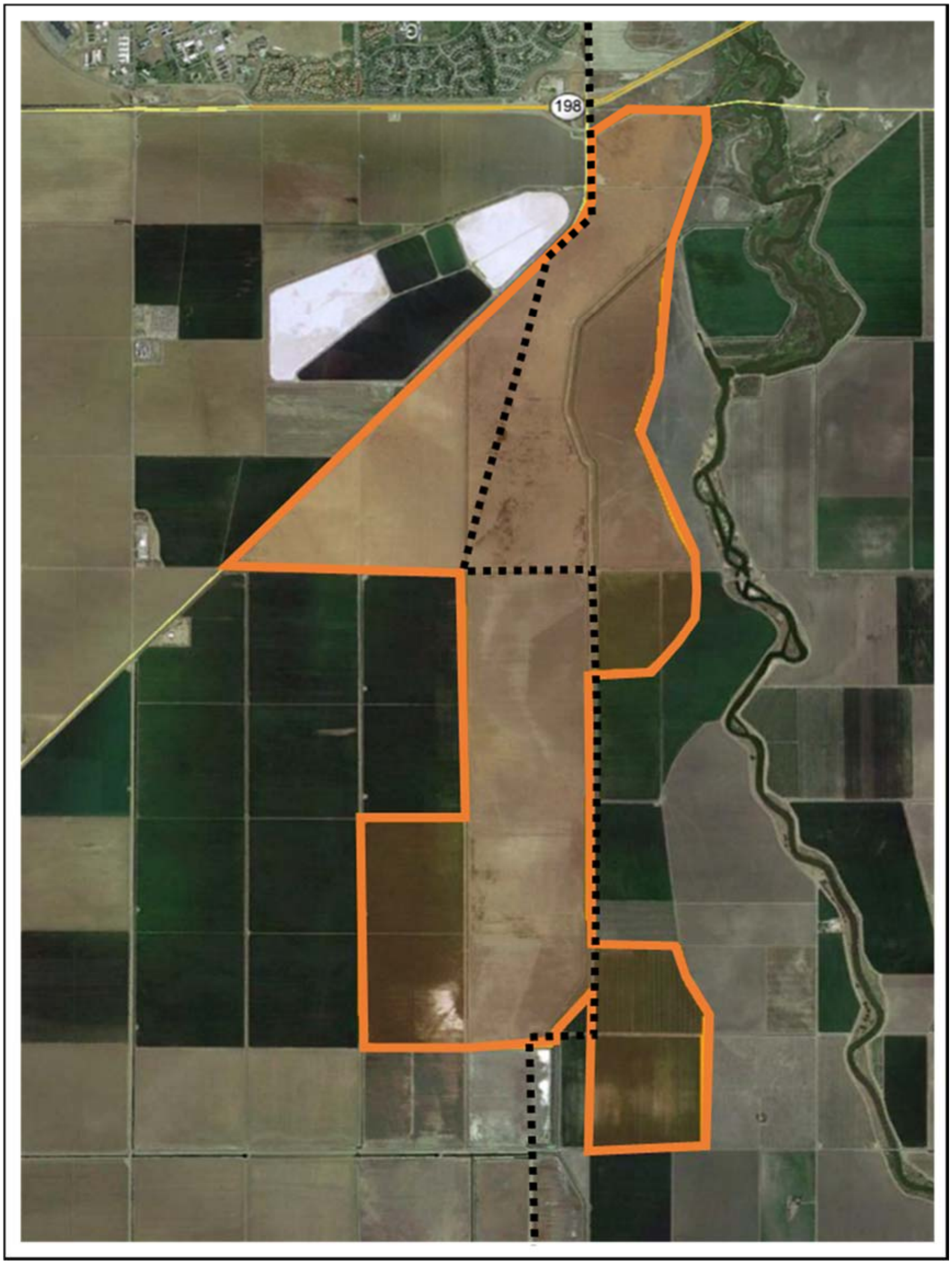

Figure 2-1 **Groundwater subbasin boundary near the proposed RE Slate project area.** The orange outline shows the RE Slate project site. The dashed black line shows the boundary between the Westside (to the left of the figure) and Tulare Lake (to the right of the figure) groundwater subbasins of the San Joaquin groundwater basin, as defined by CA DWR in 2016.

2.1 Westside Subbasin

The western half of the proposed project overlies the Westside subbasin of the larger San Joaquin Valley Groundwater Basin that occupies the entire southern portion of the Central Valley. The subbasin itself (subbasin 5-22.09; CA DWR, 2003) is bounded generally by the Coast Range to the west and the San Joaquin River and Fresno Slough on the east and covers approximately 1,000 square miles (640,000 acres) along the western side of the San Joaquin Valley. The project site is located in the southeastern corner of the subbasin, at the boundary with the Tulare Lake groundwater subbasin[4].

The Westside subbasin contains two primary aquifers, separated by the Corcoran Clay confining unit, a bed of low-permeability old lake deposits approximately 20 to 120 feet thick (CA DWR, 2003). The upper unconfined to semi-confined water-bearing zone extends to a depth of 500 to 850 feet below ground surface. The lower aquifer is a fully confined water-bearing zone, ranging to depths that lie below an elevation of about 400 feet below sea level.

Recharge to the Westside subbasin occurs from infiltration of runoff from Coast Range streams along the western side of the basin as well as through deep percolation of irrigation water (CA DWR, 2003). Inflow to the basin may also occur from adjacent groundwater basins, such as the Tulare Lake subbasin to the southeast and the Kings subbasin to the east. Rates of inflow (or outflow) would be dependent on the amount of pumping within the respective basins and the resulting groundwater gradients established by that pumping.

The Westside subbasin is not an adjudicated groundwater basin, as defined by the California Department of Water Resources (CA DWR). The subbasin has, however, been designated by CA DWR as a “Critically Overdrafted Groundwater Basin” (CA DWR, 2016). WWD oversees groundwater management within its service area through the implementation of a groundwater management plan (WWD, 1996), though WWD itself does not directly regulate or control groundwater extraction. Over the long term it is in the District’s and other users’ best interest for long-term supply to appropriately manage groundwater within the basin to reduce or eliminate overdraft.

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[4] The Tulare Lake subbasin is defined as a separate subbasin by CA DWR, though the subbasins themselves are interconnected. See additional discussion of the Tulare Lake subbasin in Section 2.2 below.

2.1.1 GROUNDWATER LEVELS AND SAFE YIELD

Prior to 1968, agricultural operations within the WWD service area relied solely on groundwater extraction for irrigation. Groundwater withdrawals during that period were on the order of 900,000 acre-feet per year (afy), resulting in water levels within the deep aquifer to be drawn down as low as 150 feet below sea level in elevation (WWD, 1996; **Figure 2-2**). Beginning in 1968, WWD began to receive water deliveries from the Central Valley Project (CVP; see Section 2.2) to offset groundwater pumping (providing in-lieu recharge), and water levels generally recovered over the next twenty years, when groundwater pumping averaged about 225,000 afy (**Figure 2-2**). Beginning with the drought period in the late 1980s and early 1990s, however, CVP allocations have averaged only 54 percent of contracted supply, with full allocation only available in three years since 1990. As a result, groundwater pumping has increased (averaging 290,000 afy) and groundwater levels have stopped rising and have shown marked decreases in years when pumping has increased due to lack of CVP supply.

Analyses in the 1996 Groundwater Management Plan (WWD, 1996) estimated the safe yield of the Westside subbasin to be approximately 200,000 afy[5]. Pumping in excess of this amount will tend to cause water levels to decline over the long term, while water levels in the aquifer will tend to increase when pumping is less than this amount. In general, WWD expects that groundwater withdrawals will exceed the safe yield during dry years, but that groundwater levels will recover in wetter years when pumping is reduced below the safe yield threshold due to offsets from CVP water.

Since 1990, water levels in the aquifer have been drawn down during drought periods (early 1990s, for example), and shown at least some recovery during wetter periods (late-1990s; see **Figure 2-2**). Since 2011, however, the aquifer has experienced drastic increases in pumping in response to severely curtailed CVP deliveries (zero percent in 2014 and 2015, and five percent in 2016; see Section 2.2 and **Table 2-1**). As a result, the aquifer has been drawn down to elevations not seen since the 1960s. Water levels are expected to recover if and when CVP water becomes available again and pumping is reduced. However, the average pumping since the CVP water was first imported is on the order of 250,000 afy, higher than the estimated long-term safe yield of the aquifer. This suggests

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[5] WWD (2013) states that more recent analyses suggest safe yield may be somewhat lower, between 135,000 and 200,000 afy (WWD, 2013). However, the 2015 Deep Groundwater Conditions Report (WWD, 2016) maintains the earlier conclusion of safe yield at 200,000 afy.

that, despite the availability of CVP water and the efforts to improve irrigation efficiency, the subbasin is still in an overdrafted state.

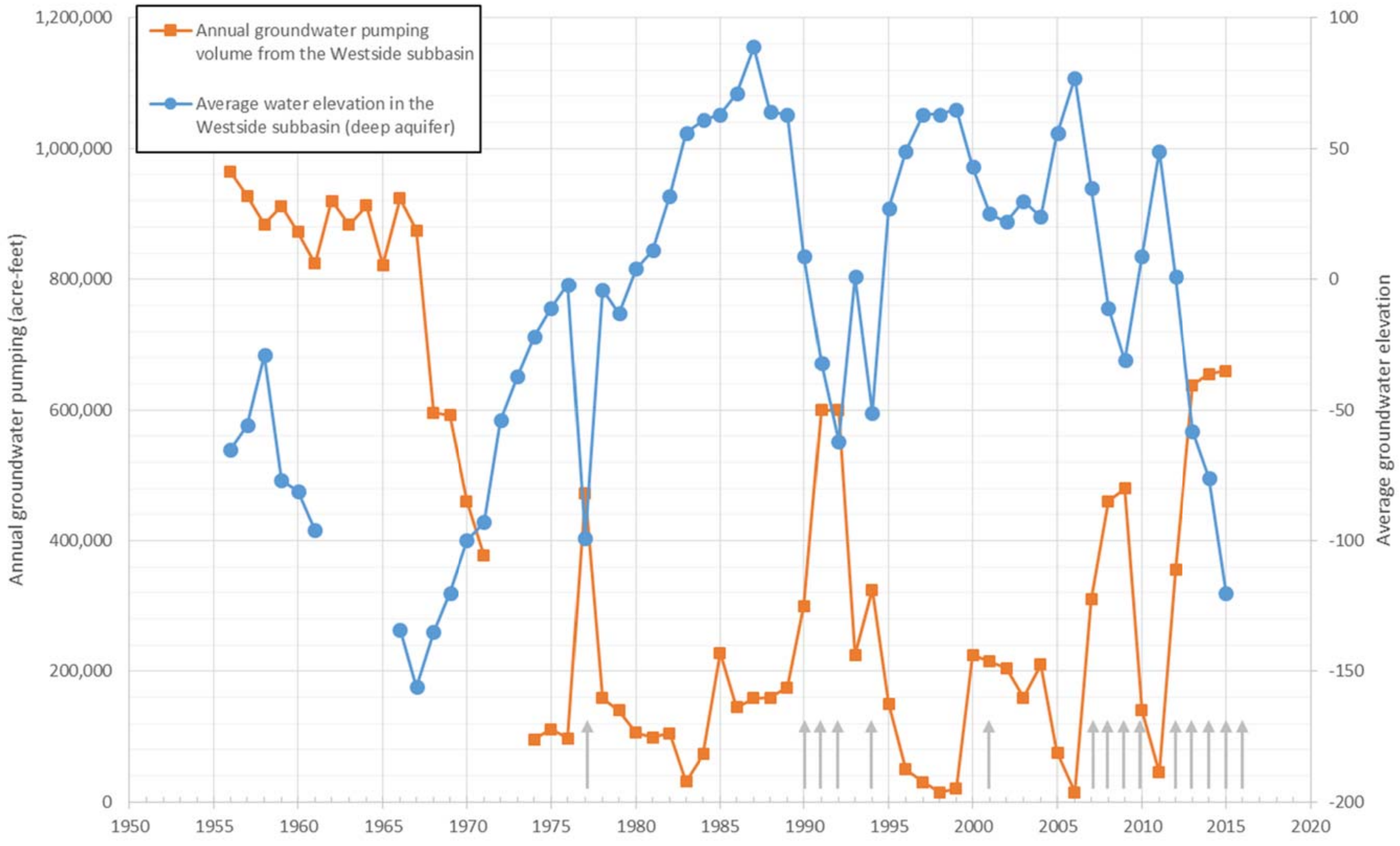

Figure 2-2 **Annual pumping volume and average water level in the Westside groundwater subbasin.**

Significant declines in groundwater level occur during drought periods when groundwater pumping increases due to lack of available CVP water. Gray arrows denote years when CVP water was curtailed by 50 percent or greater. Data from WWD, 2016.

2.1.2 WESTSIDE GROUNDWATER MANAGEMENT PLAN

In 1996, WWD developed a groundwater management plan (WWD, 1996) in response to the California Groundwater Management Act (AB 3030). The plan was enacted to:

- Preserve and enhance the reliability of groundwater resources of the District,
- Ensure the long-term availability of high quality groundwater,
- Maintain local control of groundwater resources within the District, and
- Minimize the cost and impacts of groundwater use.

Secondary goals of the plan included:

- Prohibit unrestricted export of groundwater from the District and use of groundwater to replace surface water removed from the District as a result of a transfer,
- Minimize impacts of groundwater pumping, including subsidence, overdraft, and soil productivity,
- Prevent unnecessary restrictions on the private use of the District's groundwater resources,
- Ensure coordination between District, local, and regional groundwater management activities,
- Optimize use of groundwater storage conjunctively with surface water,
- Ensure efficient use of the District's groundwater resources and minimize deep percolation and its contribution to the shallow groundwater problem through use of an effective water conservation and management program, and
- Ensure that District water users understand the steps they can take to protect and enhance their groundwater supply.

The GMP proposed several programs intended to aid in sustainable management of the District’s groundwater resources. These included continued monitoring and analysis of groundwater conditions, development and importation of new surface-water supplies, and restrictions on the exportation of groundwater. In addition, the District outlined a number of water conservation efforts, including conservation education, providing real-time crop water-use information and other efforts to support efficient irrigation techniques and scheduling. They have also implemented an expanded program to meter groundwater extraction in order to gain additional understanding of groundwater usage within the service area.

2.1.3 CENTRAL VALLEY PROJECT IMPORTED WATER

Beginning in 1963, WWD contracted with the US Bureau of Reclamation (“Bureau”) to obtain imported water supply from the Central Valley Project (“CVP”) in order to reduce the need for groundwater extraction within the District’s service area. The initial contract was for up to 900,000 afy, but an additional agreement was signed in 1965 to bring the total CVP water contract to 1,150,000 afy (WWD, 2013). The District’s CVP allotment is not available to the Project for water supply, but it does affect the amount of water pumped from the underlying aquifer, as discussed below.

WWD received 100 percent of its CVP allocation during the late 1970s (after the 1977 drought) and through the 1980s (WWD, 2013). Since in 1989, however, CVP allocations have generally been reduced due to prolonged drought conditions and regulatory restrictions related to the CVP Improvement Act, the Endangered Species Act, and Bay/Delta water quality (WWD, 1996; **Table 2-1**). During periods of drought or other times when CVP water is less than fully available the reduction in imported water is, at least in part, compensated by an increase in groundwater pumping in the basin (**Figure 2-3**)[6]. As such, groundwater pumping has varied between 15,000 af in 1998 (100% CVP allocation) and 660,000 af in 2015 (0% CVP allocation) within the last 30 years (**Table 2-1**).

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[6] Agricultural operators within WWD do have some other forms of water supply available to them, including user-acquired water and additional District supply, as shown in **Table 2-1**. For the purposes of this analysis, however, the CVP allocation percentage is a reasonable index of total non-groundwater supply and is used to compare groundwater extraction volumes for different year-type scenarios.

Table 2-1 Water supply for the Westlands Water District, 1988 to 2018.

Crop Year[1]	CVP allocation[2] %	Net CVP water supply[3] (acre-ft)	Groundwater pumped[4] (acre-ft)	User-acquired water[5] (acre-ft)	Additional district supply[6] (acre-ft)	Total supply (acre-ft)	Fallowed land (acres)
1988	100%	1,150,000	160,000	7,657	97,712	1,415,369	45,632
1989	100%	1,035,369	175,000	20,530	99,549	1,330,448	64,579
1990	50%	625,196	300,000	18,502	-2,223	941,475	52,544
1991	27%	229,666	600,000	22,943	77,399	930,008	125,082
1992	27%	208,668	600,000	42,623	100,861	952,152	112,718
1993	54%	682,833	225,000	152,520	82,511	1,142,864	90,413
1994	43%	458,281	325,000	56,541	108,083	947,905	75,732
1995	100%	1,021,719	150,000	57,840	121,747	1,351,306	43,528
1996	95%	994,935	50,000	92,953	172,609	1,310,497	26,754
1997	90%	968,408	30,000	94,908	261,085	1,354,401	35,554
1998	100%	945,115	15,000	54,205	162,684	1,177,004	33,481
1999	70%	806,040	60,000	178,632	111,144	1,155,816	37,206
2000	65%	695,693	225,000	198,294	133,314	1,252,301	46,748
2001	49%	611,267	215,000	75,592	135,039	1,036,898	73,802
2002	70%	776,526	205,000	106,043	64,040	1,151,609	94,557
2003	75%	863,150	160,000	107,958	32,518	1,163,626	76,654
2004	70%	800,704	210,000	96,872	44,407	1,151,983	70,367
2005	85%	996,147	75,000	20,776	98,347	1,190,270	66,804
2006	100%	1,076,461	25,000	45,936	38,079	1,185,476	54,944
2007	50%	647,864	310,000	87,554	61,466	1,106,884	96,409
2008	40%	347,222	460,000	85,421	102,862	995,505	99,663
2009	10%	202,991	480,000	68,070	70,149	821,210	156,239
2010	45%	590,059	140,000	71,296	79,242	880,597	131,339
2011	80%	876,910	45,000	60,380	191,686	1,173,976	59,514
2012	40%	405,451	355,000	111,154	123,636	995,241	112,755
2013	20%	188,448	638,000	101,413	143,962	1,071,823	131,848
2014	0%	98,573	655,000	59,714	26,382	839,669	220,053
2015	0%	82,429	660,000	51,134	34,600	828,163	218,112
2016	5%	9,204	612,000	72,154	174,374	867,732	179,784
2017	100%	911,307	54,000	-50,009	174,490	1,089,788	146,275
2018(7)	40%	479,958	370,000	75,000	130,000	1,054,958	160,000
Average	58%	638,277	276,903	72,407	104,895	1,092,482	94,809

Notes:

Table reproduced from WWD water supply summary, available at:

http://wwd.ca.gov/water-management/water-supply/annual-water-use-and-supply/

[1] March 1 to February 28.

[2] Final CVP allocation percentage of contracted water supply for the year.

[3] CVP allocation amount, including carry-over and rescheduled losses.

[4] Total groundwater pumped from the Westside subbasin, deep aquifer.

[5] Private landowner water transfers

[6] Surplus water, supplemental supply and other adjustments.

[7] Numbers estimated for 2018.

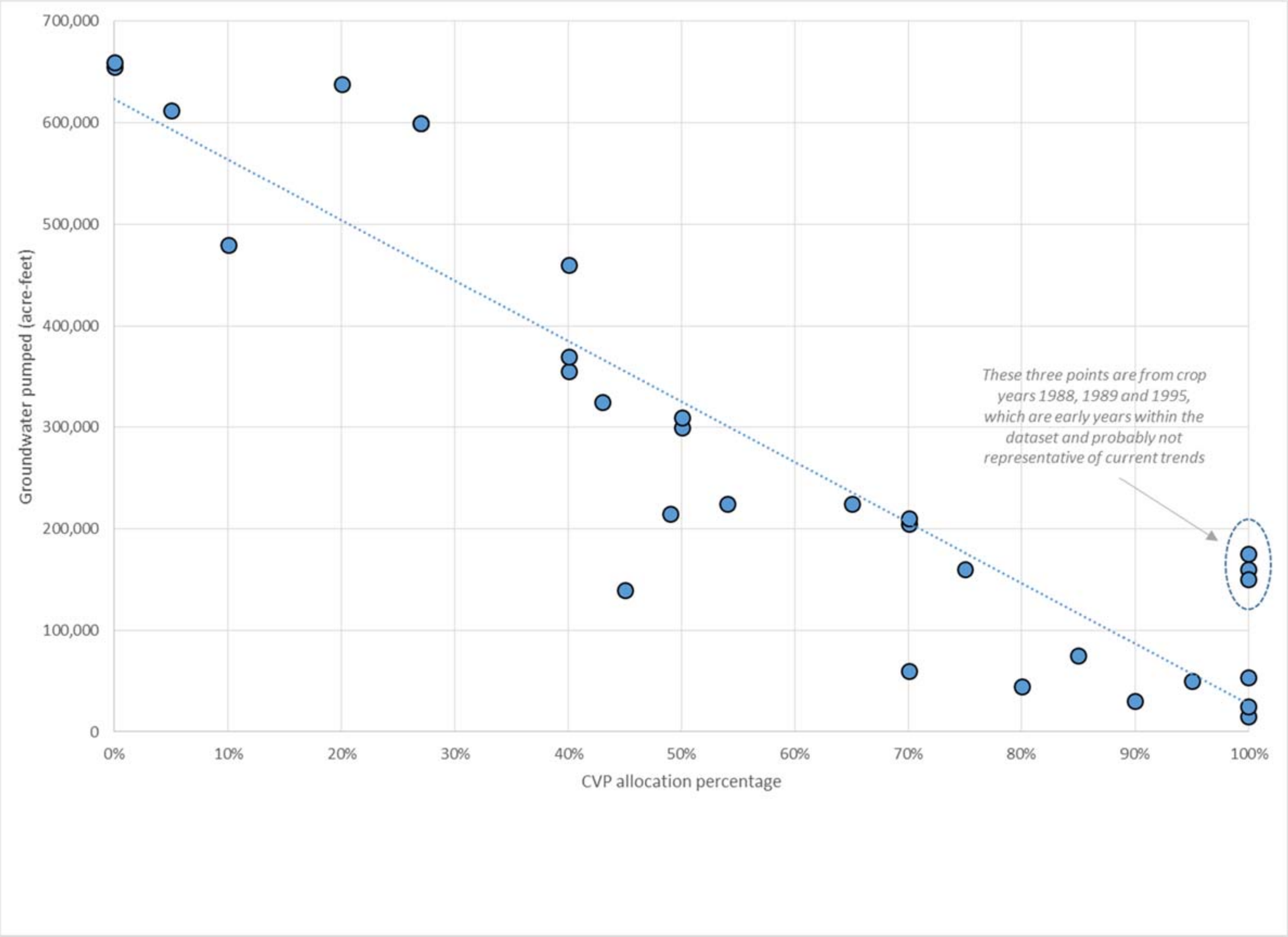

Figure 2-3 **Groundwater pumping in the Westside subbasin as a function of CVP water availability, 1988-2018.** Groundwater is pumped in greater volume when CVP water is less available. See also **Table 2-1**.

2.2 Tulare Lake Subbasin

The eastern portion of the proposed project overlies the Tulare Lake subbasin of the larger San Joaquin Valley Groundwater Basin. The subbasin itself (subbasin 5-22.12; CA DWR, 2003) is bounded generally by the California Aqueduct and the Kettleman Hills of the Coast Range on the west, the Kings/Tulare County line to the east, the Kings River to the north and the Kings/Kern County line to the south. The basin covers approximately 818 square miles (524,000 acres). The project site is located in the northwestern-most corner of the subbasin, at the boundary with the Westside groundwater subbasin.

The subbasin is composed of layers of alluvial and flood basin sediments overlying the Corcoran Clay at a depth of about 300 to 900 feet. The aquifer contains numerous interfingered layers of coarse and fine material and many discontinuous lenticular beds, creating a complicated stratigraphy with highly variable permeability.

Recharge to the Tulare subbasin occurs primarily from stream infiltration and deep percolation of applied irrigation water (CA DWR, 2003). Inflow to the basin also occurs from adjacent groundwater basins, such as the Westside subbasin to the west, the Kings subbasin to the north, the Kaweah and Tule subbasins to the east, and the Kern County subbasin to the south. Rates of inflow (or outflow) would be dependent on the amount of pumping within the respective basins and the resulting groundwater gradients established by that pumping. Groundwater gradient within the subbasin is generally toward the center northwesterly-southeasterly axis of the basin, but can be highly variable locally due to pumping rates.

The Tulare Lake subbasin is not an adjudicated groundwater basin, as defined by the California Department of Water Resources (CA DWR). The subbasin has, however, been designated by CA DWR as a “Critically Overdrafted Groundwater Basin” (CA DWR, 2016). The northern portion of the Tulare Lake subbasin is currently managed by the Kings River Conservation District (KRCD) through the Lower Kings Basin Groundwater Management Plan (WRIME, 2005), though KRCD itself does not directly regulate or control groundwater extraction. Over the long term it is in the District’s and other users’ best interest for long-term supply to appropriately manage groundwater within the basin to reduce or eliminate overdraft[7].

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[7] More directly, the eastern portion of the project area is located within the Empire West Side Irrigation District. However, the EWID does not manage or control groundwater extractions within the area.

2.2.1 GROUNDWATER LEVELS AND SAFE YIELD

KRCD has divided their operational area into several water management areas (WMAs), and considers them separately (though still acknowledging that they are part of a larger groundwater subbasin). The proposed project is located in WMA C1 (**Figure 2-4**). In general, groundwater levels within the KRCD have shown steady decline since at least the 1950s, though the rate of decline appears to have lessened somewhat since the early 1980s (WRIME, 2006). Within WMA C1, however, groundwater levels show a different trend (**Figure 2-5**). Water levels in WMA C1 do decline over short periods of years (1975-1978 and 1988-1992, for example; both of which were notable regional dry periods), but these periods were followed by relatively rapid recovery during subsequent wet years. As a result, the long-term decline seen elsewhere within the KRCD does not appear to be occurring in the WMA C1 portion of the District where the project is located. Admittedly, this is based on a small sample of wells (though the WMA itself is relatively small), but it does show that overdraft in this portion of the subbasin is less of a concern than in other areas. Recent measurements of groundwater at the project location (available through CASGEM[8]), show variable groundwater elevations in the range of about -60 to 60 feet above mean sea level for 2016 and 2017, which are lower than the highest levels observed in the mid-1980s and late 1990s, but still higher than the lows in the early 1960s and late 1980s/early 1990s[9]. This suggests that groundwater conditions in WMA C1 have not significantly worsened since the 2006 GWMP plan was prepared. Water levels were probably significantly drawn down during the 2012-2014 drought (as they were during the late 1970s and late 1980s droughts[10]), but have recovered to within a typical range since the end of the recent drought conditions. Within WMA C, located north and west of WMA C1, groundwater trends are more similar to other areas of the subbasin, showing general declines in average elevation since the 1960s (**Figure 2-6**).

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[8] The ‘California Statewide Groundwater Elevation Monitoring’ program, available at https://gis.water.ca.gov/app/gicima/#bookmark_GroundwaterElevation

[9] Water elevation data in the project area are not available for 2008-2015. 2016 and 2017 data were not plotted in Figure 2-5 because the WMA C1 averages shown in 2-5 are not directly comparable to the water elevation data in CASGEM (because the specific wells used for the C1 averaging are not listed). We reference the CASGEM data simply as a rough comparison of the range of values to show that conditions have not significantly worsened in the area, or have generally recovered since the severe drought of 2012-2014.

[10] Data are not available near the project site for 2012-2014, so the extent to which drawdown occurred during that period is not known.

KRCD has not established a numerical safe yield for its management area[11]. Preliminary estimates of natural and applied recharge as well as agricultural and municipal extractions summarized in CA DWR (2003) suggest a safe yield of around 284,200 afy (0.54 acre-feet per acre per year) for the Tulare Lake subbasin as a whole. This number is within the range of safe yield calculations made for other basins in the area (**Table 2-2**). KRCD has, however, quantified the amount of overdraft for the various WMAs (where overdraft is occurring). They estimate that long-term overdraft for WMA C is within the range of 6,000 to 9,000 afy, depending on whether 1965 or 1950 is used as the calculation baseline[12].

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[11] Safe yield will, however, be a required metric to be calculated under the upcoming Sustainable Groundwater Management Act implementation (see Section 2.3). Currently, however, sustainable yield is not available for the WMA C or WMA C1 portions of the Tulare Lake subbasin.

[12] In general, rate of overdraft decreased after 1965 following the construction of the Pine Flat Dam.

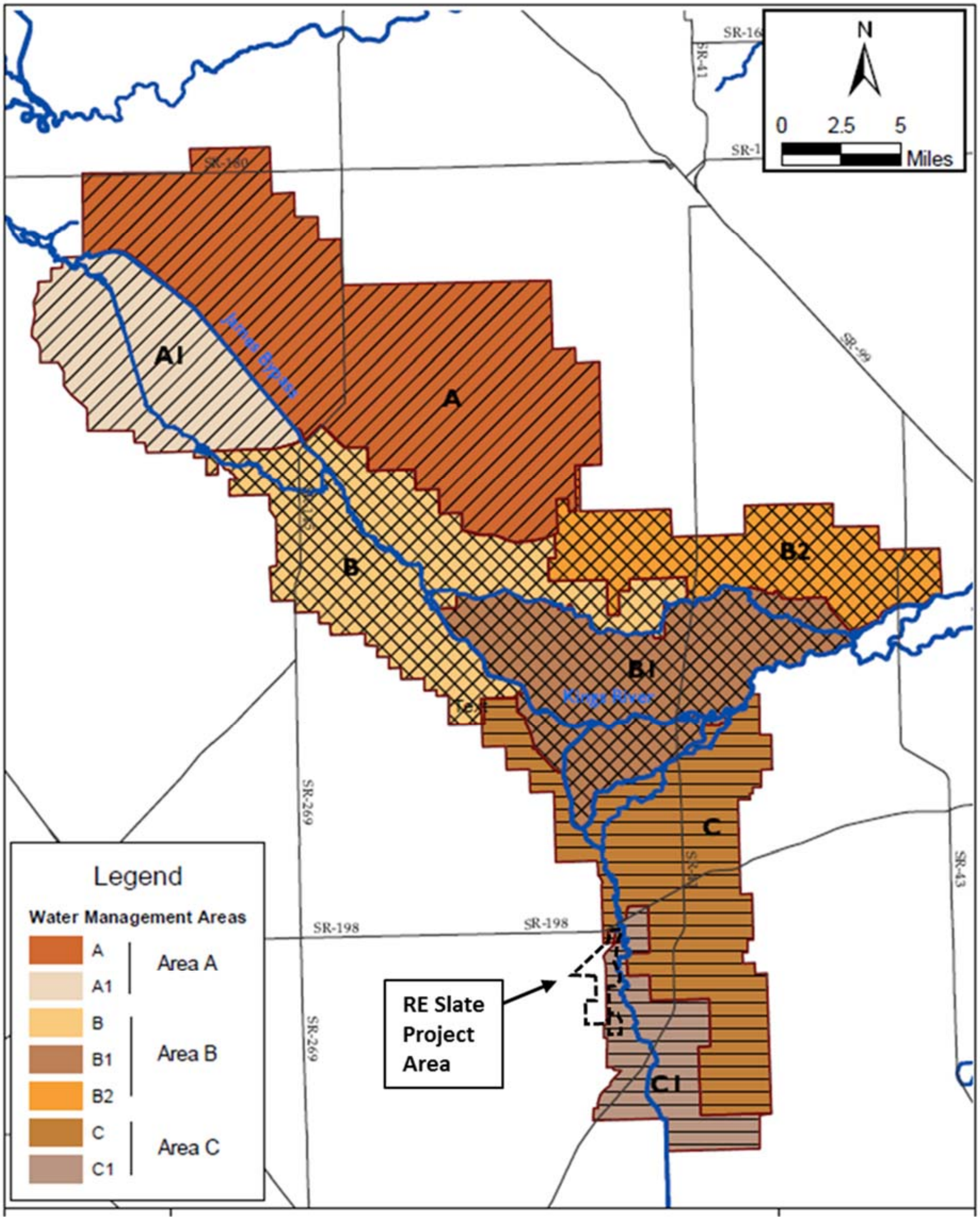

Figure 2-4 **Water Management Areas within the Kings River Conservation District.** The RE Slate project site (dashed black line) is located in the northwestern portion of WMA C1. The City of Lemoore extracts groundwater from WMA C. Basemap reproduced from Figure 1.3 the Lower Kings Basin GWMP (WRIME, 2005).

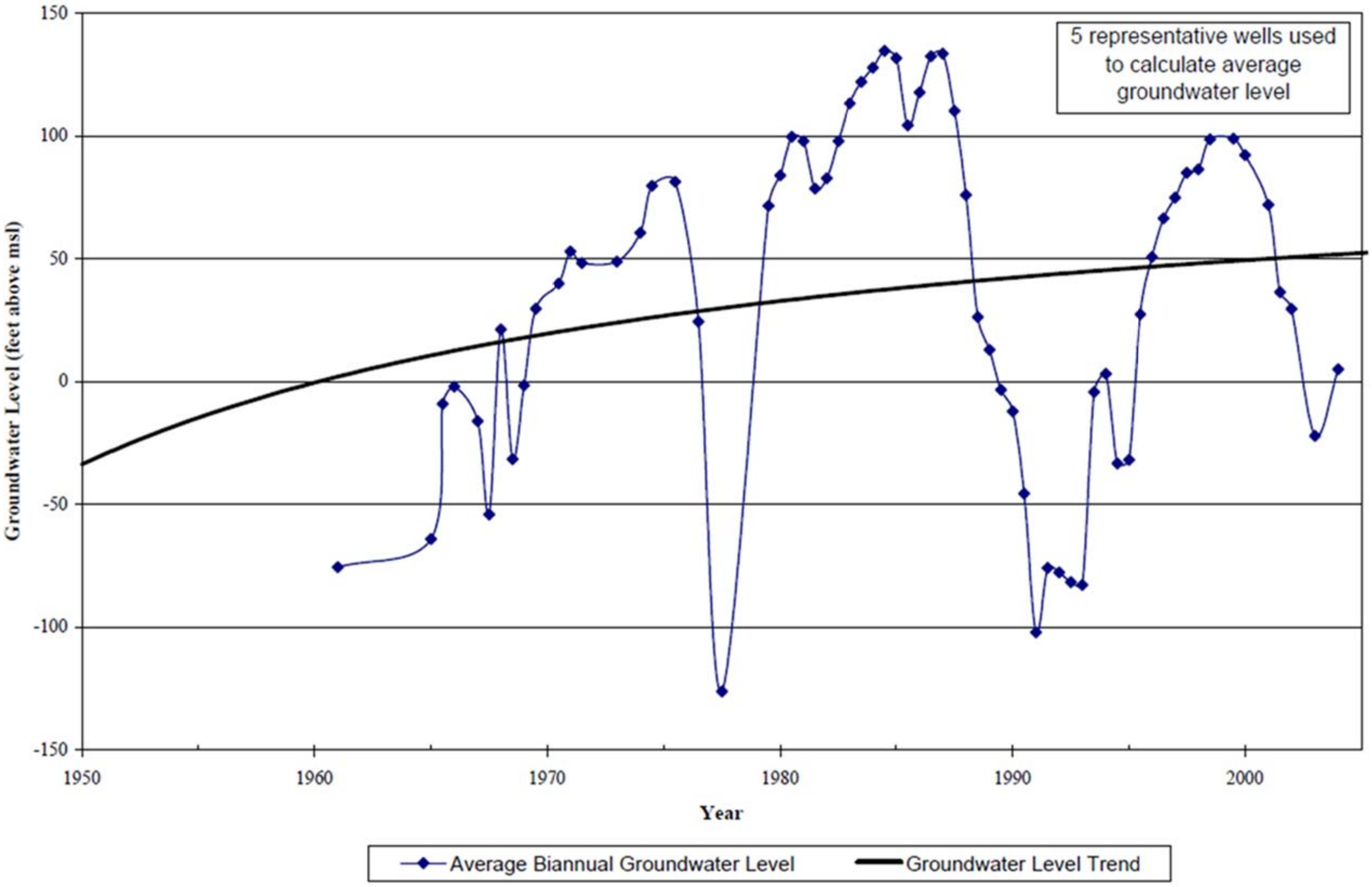

Figure 2-5 **Representative groundwater elevation within WMA C1 of the Kings River Conservation District.** Groundwater elevation drops sharply in response to increase pumping during droughts (1976-1977 and 1987-1992), but shows rapid recovery afterward. The Lower Kings Basin concluded that, as of 2006, WMA C1 was not in an overdrafted condition. The RE Slate project is located in the northwestern portion of WMA C1 (see Figure 6). Reproduced from Figure 2.16 in WRIME, 2005.

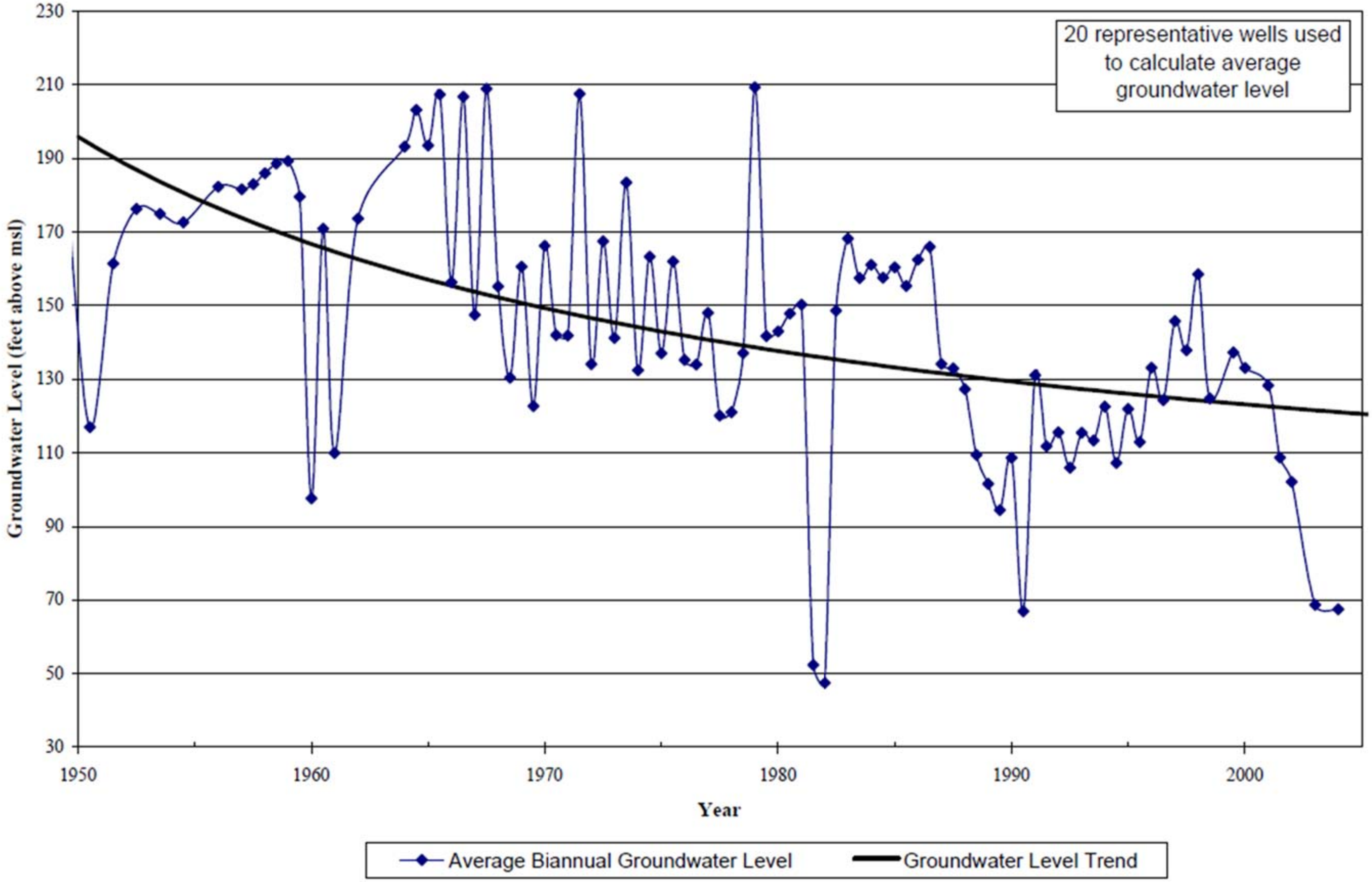

Figure 2-6 **Representative groundwater elevation within WMA C of the Kings River Conservation District.** Groundwater elevation has varied from year to year, but has shown a general decline since the 1950s, and especially since 2000. The Lower Kings Basin concluded that, as of 2006, WMA C was in an overdrafted condition of approximately 6,000 afy. The City of Lemoore is located approximately in the center of WMA C. Reproduced from Figure 2.15 in WRIME, 2005.

Table 2-2 Safe yield for groundwater subbasins within and near the southern San Joaquin groundwater basin.

Basin	**County**	**Safe yield**	**Surface area**	**Apportioned safe yield**	**Safe yield source**
		(afy)	(acres)	(af/ac/yr)	
Westside GWB	Fresno, Kings	200,000	640,000	0.31	WWD, 2013
Tulare Lake GWB	Kings	284,200	524,000	0.54	CA DWR, 2003; preliminary, based on estimated natural and applied recharge
Tule GWB	Tulare	n/a	480,000	0.50	De Groot, 2016; preliminary
Kaweah Delta Water Conservation District	Tulare, Kings	575,000	340,000	1.69	Fugro, 2016
Tehachapi Valley	Kern	5,500	14,800	0.37	CA DWR, 2013
Cummings Valley	Kern	4,090	10,000	0.41	CA DWR, 2013

2.2.2 LOWER KINGS BASIN GROUNDWATER MANAGEMENT PLAN

Despite being part of the Tulare Lake subbasin, geographic and political boundaries have driven the northern part of the Tulare Lake subbasin to be included in the Kings Basin Groundwater Management Plan, managed by the Kings River Conservation District, with the remainder of the Tulare Lake subbasin (well south of the project site) managed under the Tulare Lake Bed Coordinated Groundwater Management Plan.

In 2005, the Kings River Conservation District completed an updated groundwater management plan (WRIME, 2005). The plan was enacted to:

- Develop consensus among various stakeholders regarding water problems current and future demands, and groundwater conditions;
- Document groundwater management goals and objectives;
- Develop specific solutions to groundwater overdraft in several Water Management Areas within the district; and
- Provide an implementation plan.

The GWMP established groundwater thresholds for the various Water Management Areas (WMAs) within the District, and outlined near- and long-term projects to help stabilize and improve groundwater levels and quality in each of the areas. Potential near-term projects were mostly concentrated in areas where local surface water (or imported water) could be used to supplement recharge. Long-term objectives involved establishing groundwater banking and exchange programs that could help optimize use of the groundwater within the basin during wet and dry periods. In general, the options discussed would not directly affect WMA C1, as overdraft was not perceived to be a problem in that area.

2.2.3 CENTRAL VALLEY PROJECT IMPORTED WATER

Though the Empire West Side Irrigation District is not a full Central Valley Project contractor, the District is a 'Non-CVP' subcontractor through the Kings River Conservation District. Through this agreement, EWSID may receive up to 3,000 afy of CVP water when excess supply is available, based on reservoir operations, hydrologic conditions, and other constraints. This supply, however, is unlikely to be available in most years when primary CVP contractors may have priority.

2.2.4 CITY OF LEMOORE GROUNDWATER SUPPLY

As stated in at the beginning of Section 2 of this report, the RE Slate project may obtain some of its supply as a purchase from the City of Lemoore ('Lemoore'). Lemoore obtains all of its water from six active wells within the city limits, all drawing from the underlying Tulare Lake subbasin aquifer. Between 2011 and 2015, Lemoore pumped between 6,371 and 7,915 afy to support residential, commercial, industrial, governmental, and landscape irrigation uses within the city limits (Quad Knopf Inc., 2017). Groundwater usage during that period peaked in 2013, with subsequent declines in 2014 and 2015 as a result of State-mandated water usage restrictions during that period (which have since been lifted).

The Tulare Lake subbasin is not an adjudicated basin, and as such there are no current legal constraints to the amount of water Lemoore can extract from the underlying aquifer. Lemoore estimated that there is over 540,000 af of groundwater stored within the portion of the aquifer underlying the city, that the supply "is available to the City regardless of the climatic conditions related to average, single-dry, and multiple-dry years", and that available supply far exceeds projected demand through 2040 for all year-type scenarios (Quad Knopf, 2017). It is important to note that the UWMP directly compared total groundwater volume (540,000 af) to the annual rate of extraction (~7,000 afy in 2020 to ~14,000 afy in 2040), essentially assuming that the full groundwater volume is available in every year. Given the documented decline in aquifer levels (and correspondingly, aquifer storage), this overstates the amount of 'excess' water available to the city, which is calculated to be approximately 533,000 af. Still, even without accounting for recharge, the city would have enough groundwater supply to meet demand over the 20-year planning period[13].

The UWMP does acknowledge that long-term drought may induce operational constraints to their supply if groundwater drawdown within the subbasin exceeds the depth of the active wells, but suggests that this could be mitigated by deepening of the wells. The UWMP also states that "compliance with SGMA [see Section 2.3 below] may require the City to come up with alternative sources of water in the future based on the result of the Groundwater Sustainability Plan to be developed", but there was no requirement to anticipate the effects of SGMA (and associated regulations related to safe aquifer yield) within the UWMP planning process.

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[13] 540,000 af of supply divided by 20 years is 27,000 afy, well above the projected 2040 annual demand of 13,900 afy.

2.3 Sustainable Groundwater Management Act

In January 2016, the California Department of Water Resources (DWR) released a final list of critically overdrafted groundwater basins in response to the Sustainable Groundwater Management Act (SGMA). The list includes both the Westside and Tulare Lake subbasins. SGMA requires groundwater basins to be managed sustainably through local management plans, but does not define water rights. Under SGMA, the Westside and Tulare Lake subbasins will be required to be managed under a groundwater sustainability plan (or coordinated plans) by 2020. The 1996 version of the Westside groundwater management plan, the 2006 version of the Lower Kings Basin groundwater management plan, and the Tulare Lake Bed Coordinated GMP (Summers Engineering, 2012)[14] will likely serve as the framework for the sustainability plan[15]. Preparation of these Groundwater Sustainability Plans ('GSPs') has begun, but no work products have yet been completed[16].

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[14] The Tulare Lake Bed GMP covers only the portion of the Tulare Lake subbasin that underlies the former Tulare Lake bed itself.

[15] As part of the SGMA process, The South Fork Kings Groundwater Sustainability Agency was formed in 2017. This agency includes the City of Lemoore and the Empire West Side Irrigation District, among others, and was formed for the specific purpose of managing groundwater within the northwest portion of the Tulare Lake subbasin. The agency is currently in the process of preparing a Groundwater Sustainability Plan.

[16] The Westside subbasin GSP is managed by WWD. Updates are available on their website: https://wwd.ca.gov/resource-management/sustainable-groundwater-management-act/. GSP updates for the South Fork Kings Groundwater Sustainability Agency, can be found on their website: http://southforkkings.org/.

3 WATER DEMAND

The following section summarizes the anticipated water demand for the proposed RE Slate solar project, and compares the anticipated demand of the Project to demand assumptions for the Westside subbasin and northern portion of the Tulare Lake subbasin.

3.1 Project Demand

As described in Section 1.4, the proposed project consists of several parcels, totaling about 2,490 acres of existing agricultural land that will be converted to a solar photovoltaic generation facility. During the construction phase of the project, an estimated 260 acre-feet (af) of water would be used, primarily for dust control[17]. Construction is expected to begin in the by the end of 2020, and much of the area (that occupied by the solar arrays) would be completed within about a year.

During the operational phase of the project, up to 15 afy of water would be used for panel washing, sheep watering, restroom facilities, and other non-potable miscellaneous needs[18].

3.2 Subbasin-Wide Demand

3.2.1 WESTSIDE WATER DISTRICT

Total irrigation water (groundwater, CVP water, and other sources) used within the WWD service area has averaged just under 1,200,000 afy since 1978 (**Table 3-1**; WWD, 2013). Irrigable acreage within the service area has remained relatively constant since that time at about 570,000 acres, though between 3 and 27 percent of that area has remained fallow in any given year (especially in dry years with low CVP availability). The average irrigation rate for non-fallowed irrigable land since 1978 was 2.36 acre-feet per acre. Total water usage has declined since the mid-1980s (**Figure 3-1**). Irrigation *rate* (acre-feet per acre of non-fallowed farmland) has remained relatively constant over that period, though since 2009 the irrigation rate has been slightly lower than the highest rates seen during the mid-1980s (**Figure 3-1**). Presumably (at least in part) this is due to more efficient

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[17] Water usage estimates were provided by the project proponent in the draft project description, dated March 12, 2018.

[18] Bottled water service will be provided for drinking water during construction and operation of the facility, which amounts to only a small portion of the total usage. For the purposes of this analysis, all water demand is assumed to be from groundwater pumping.

irrigation and conveyance practices, as outlined in the District's Water Management Plan (WWD, 2013).

Table 3-1 Past water usage and irrigable land area within the WWD service area, 1978-2011.

Crop year[1]	Total irrigable area[2] (acres)	Fallowed area[3] (acres)	Project water[4] (acre-feet)	Transfer water[5] (acre-feet)	Ground- water[6] (acre-feet)	Total irrigation water[7] (acre-feet)	Irrigation rate; non-fallowed land[8] (af/acre)
1978	566,475	36,355	665,895	0	159,000	824,895	1.56
1979	565,917	25,743	1,084,386	0	140,000	1,224,386	2.27
1980	564,719	16,527	1,138,994	0	106,000	1,244,994	2.27
1981	563,301	18,203	1,244,446	0	99,000	1,343,446	2.46
1982	564,039	26,128	1,236,639	0	105,000	1,341,639	2.49
1983	567,184	93,773	1,090,888	0	31,000	1,121,888	2.37
1984	568,197	16,340	1,473,883	0	73,000	1,546,883	2.80
1985	568,554	30,579	1,315,548	0	228,000	1,543,548	2.87
1986	568,986	67,829	1,194,113	0	145,000	1,339,113	2.67
1987	566,844	66,236	1,309,252	0	159,000	1,468,252	2.93
1988	568,083	45,632	1,258,384	11,829	160,000	1,430,213	2.74
1989	567,817	64,579	1,136,714	21,194	175,000	1,332,908	2.65
1990	568,389	52,544	808,978	111,703	300,000	1,220,681	2.37
1991	568,470	125,082	282,957	93,776	600,000	976,733	2.20
1992	570,552	112,718	262,044	113,491	600,000	975,535	2.13
1993	567,390	90,413	444,237	221,664	225,000	890,901	1.87
1994	563,563	75,732	662,672	196,820	325,000	1,184,492	2.43
1995	563,781	43,528	729,238	189,405	150,000	1,068,643	2.05
1996	563,881	26,754	1,136,625	267,340	50,000	1,453,965	2.71
1997	563,900	35,554	1,005,434	326,939	30,000	1,462,373	2.77
1998	564,053	33,481	798,604	211,724	15,000	1,025,328	1.93
1999	564,271	37,206	1,076,148	171,035	23,000	1,270,183	2.41
2000	564,191	46,748	539,460	405,870	192,000	1,137,330	2.20
2001	564,274	73,802	691,127	171,465	234,000	1,096,592	2.24
2002	564,154	94,557	725,703	131,029	299,000	1,155,732	2.46
2003	563,633	76,654	844,950	142,625	221,000	1,208,575	2.48
2004	560,670	70,367	904,464	163,660	265,000	1,333,124	2.72
2005	560,547	66,804	788,926	179,390	118,000	1,086,316	2.20
2006	559,744	54,944	1,049,423	73,163	13,000	1,135,586	2.25
2007	556,547	96,409	891,224	130,273	243,000	1,264,497	2.75
2008	568,627	99,663	358,456	192,279	460,000	1,010,735	2.16
2009	568,652	156,239	225,763	117,519	480,000	823,282	2.00
2010	567,713	131,339	402,832	195,722	189,000	787,554	1.80
2011	568,803	59,514	795,601	144,513	69,000	1,009,114	1.98
Average	*565,468*	*63,764*	*869,824*	*117,189*	*196,500*	*1,186,454*	*2.36*
Std Dev	*3,073*	*34,718*	*332,955*	*103,881*	*150,836*	*203,392*	*0.33*
Max	*570,552*	*156,239*	*1,473,883*	*405,870*	*600,000*	*1,546,883*	*2.93*
Min	*556,547*	*16,340*	*225,763*	*0*	*13,000*	*787,554*	*1.56*

Notes:

Data adapted from WWD, 2013, except where noted;
values reported here may differ from those shown in Table 1 due to compilation from different sources.

[1] March 1 to February 28.

[2] Total acreage of agricultural land within the subbasin.

[3] Area of irrigable land that remained fallow (un-irrigated) in a given year.

[4] CVP water used within the WWD service area.

[5] Private water transfers within the WWD service area.

[6] Groundwater pumped from the Westside subbasin deep aquifer for agricultural irrigation.

[7] Sum of Project water, transfer water, and groundwater.

[8] Total irrigation water volume divided by the acres of non-fallowed irrigable land for a given year.

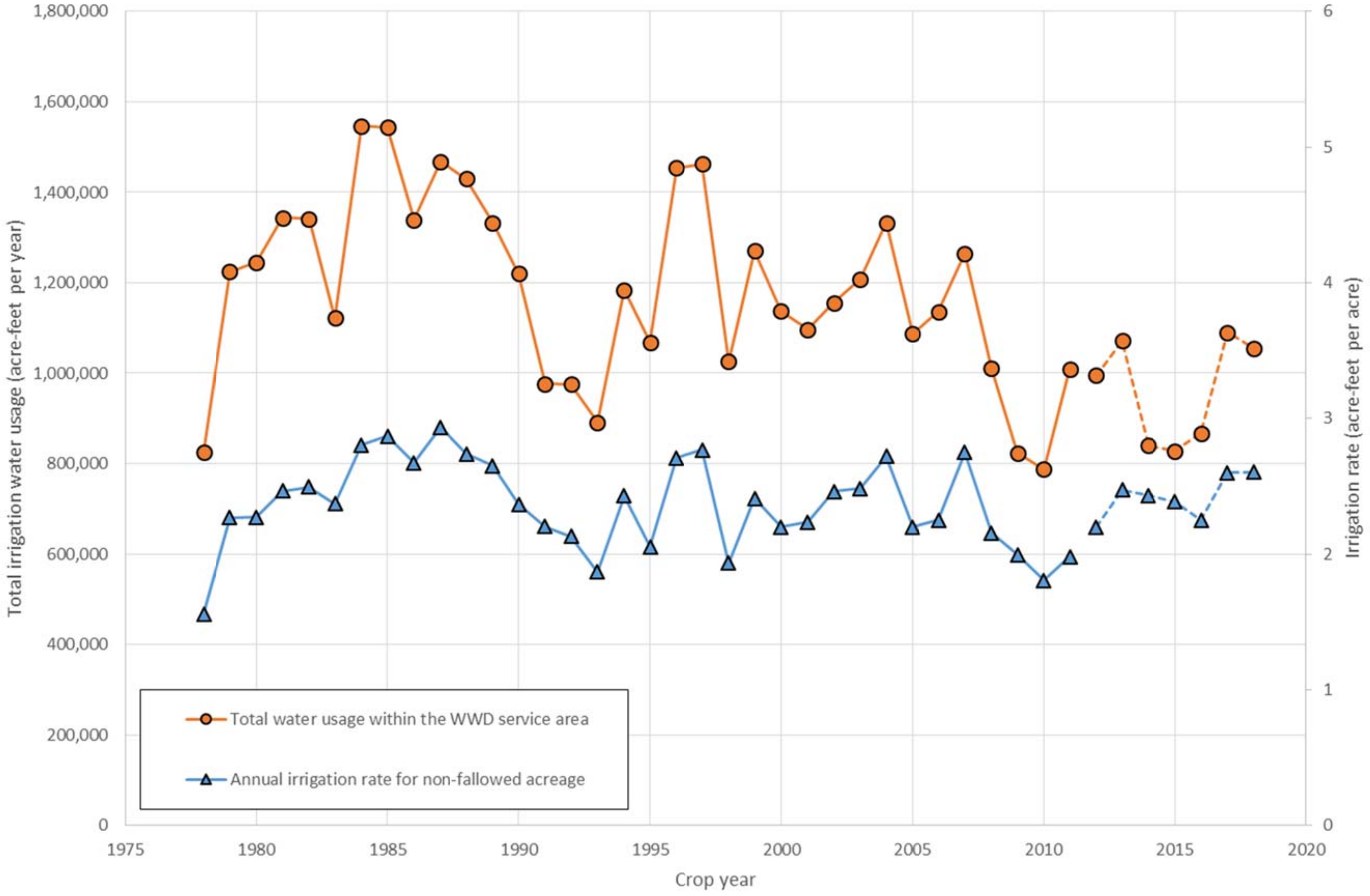

Figure 3-1 **Annual total water usage and non-fallowed land irrigation rate within the WWD service area, 1975-2018.** Total water usage and irrigation rate have both declined since the mid-1980s. Data for 1978-2011 from WWD (2013); Data from 2012-2016 from WWD website (http://wwd.ca.gov/water-management/water-supply/annual-water-use-and-supply/).

3.2.2 KINGS RIVER CONSERVATION DISTRICT

Groundwater demand for WMA C1 of the Kings River Conservation District (the portion of the District in which the project is located) is approximately 50,157 afy, or 2.38 af/acre/yr (WRIME, 2006). Nearly all of that demand is for agricultural purposes. Average demand for the WMA C is 2.58 af/acre/yr and for the District as a whole is 2.80 af/acre/yr. Both numbers are consistent with unit demand shown for the Westside subbasin.

3.2.3 CITY OF LEMOORE

Water demand within the City of Lemoore has varied between about 6,400 afy and 7,900 afy since 2011 (Quad Knopf, 2017). Population within the City steadily increased between 2011 and 2015 (24,493 in 2011 to 25,585 in 2015), but per-capita water usage decreased over the same period (0.23 afy/person in 2011 to 0.14 afy/person in 2015), in part due to mandatory drought restrictions in 2014 and 2015. Unit demand for the City ranged between 1.18 and 1.45 af/acre/year, significantly lower than the primarily agricultural usage for WWD and WMA C1 of the KRCD (described above), as is typical for urban usage in the region.

3.3 Project Comparison to Past Demand

As discussed in Section 1.3, the site has not been irrigated since 2014, but was at least partially irrigated in 2013. Water usage records for the site are not available, but inspection of available aerial photographs shows that the site was partially irrigated in 1994, 2004, 2006, 2007, 2012, and 2013 (see **Figure 1-2** for example aerial photograph)[19]. **Table 3-2** shows the estimated amount of water used for irrigation at the project site from 1994 to 2017. Even when assuming no irrigation in the 11 years for which photographs were not available, the past average annual water usage at the site was approximately 233 afy. As such, the proposed single-year construction-phase water usage (260 af) is similar to past average annual water usage at the site, and operational-phase water usage (15 afy) is well below the amount of water than has been used in the past.

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[19] Aerial photographs were not available for 1995-2002, 2008, 2014, or 2016. There was no evidence of irrigation at the site in 2003, 2005, 2009-2011, 2015, and 2017.

Table 3-2 Irrigation history at the RE Slate project site, 1994 to 2017.

Date of aerial photograph	Estimated irrigated area within project site (sq. miles)[1]	Estimated irrigated area (acres)[2]	Average irrigation rate within WWD (af/ac)[3]	Estimated Irrigation water usage (af)[4]	Allotted CVP percentage[5]
5/1/1994	0.76	486	2.43	1181	43%
1995	*n/a*		2.05	*0*	100%
1996	*n/a*		2.71	*0*	95%
1997	*n/a*		2.77	*0*	90%
1998	*n/a*		1.93	*0*	100%
1999	*n/a*		2.41	*0*	70%
2000	*n/a*		2.20	*0*	65%
2001	*n/a*		2.24	*0*	49%
2002	*n/a*		2.46	*0*	70%
7/1/2003	0	0	2.48	0	75%
9/6/2004	0.44	282	2.72	766	70%
6/11/2005	0	0	2.20	0	85%
4/27/2006	0.67	429	2.25	965	100%
3/29/2007	0.28	177	2.75	486	50%
2008	*n/a*		2.16	*0*	40%
5/24/2009	0	0	2.00	0	10%
4/24/2010	0	0	1.80	0	45%
5/19/2011	0	0	1.98	0	80%
8/27/2012	0.58	371	2.14	793	40%
4/13/2013	1.03	659	2.14	1409	20%
2014	*n/a*		2.14	*0*	0%
5/2/2015	0	0	2.14	0	0%
2016	*n/a*		2.14	*0*	5%
5/1/2017	0	0	2.14	0	100%
Mean			2.26	233	

[1] Irrigated area estimated from aerial photographs; see Figure 1-2 for example; years when photos were not available or where irrigated area could not be delineated denoted by 'n/a'.

[2] No value provided for years when photos were not available or where irrigated area could not be delineated.

[3] Average basin-wide irrigation rate for that year, from Table 3-1; the 2012 rate was used for 2013 to 2017.

[4] Estimated amount of irrigation water applied within the project area for a given year (irrigated acreage times irrigation rate); years when acreage could not be delineated shown as zero (in italics) in order to provide a conservatively low estimate of past water usage at the site.

[5] No CVP water is available at the site; information in this column provided simply as an index of year type.

4 WATER SUFFICIENCY ANALYSIS

This section discusses the water supply sufficiency for the various potential water sources of the project that were outlined in Section 2. Section 4.1 below discusses the supply constraints within the Westside groundwater subbasin, while Section 4.2 discusses projections for options within the Tulare Lake subbasin. For the purposes of this analysis, we assume that all project demand would be supplied solely from a single source over the course of the planning period. However, the project could, in theory, change sources from year-to-year, or even obtain water from multiple sources within a given year.

4.1 Westside Subbasin

As discussed in Section 2, three potential sources of water are being considered for the project that draw from the Westside groundwater subbasin: 1) pumping from an on-site or adjacent site WWD well; 2) groundwater pumped from a well located at the Tranquility Solar Project site; and 3) Purchase of water from a private well located on-site or on an adjacent property[20]. The following section compares the projected basin-wide supply and demand for the Westside subbasin, and the implications for potential water supply for to the project site for both the construction and operational phases of the project.

Table 4-1 presents the estimated long-term sustainable supply of water for the Westside groundwater subbasin for various year-type scenarios. Numbers for this analysis were derived and adapted from the WWD water supply summary table (as summarized in **Table 2-1** of this report). For this analysis, we assume the following:

1. Normal-year sustainable groundwater supply is equal to the safe yield of the Westside subbasin (approximately 200,000 afy). CVP imported supply, as well as other user-acquired and WWD supply, is assumed to be equal to the average amount obtained over the period between 1988 and 2018.
2. For the single-dry-year scenario, we used 2014 (a year when CVP allocation was 0%) as a reference for CVP and other user- and district-acquired supply availability. Because the groundwater basin is known to be in an overdrafted state, using the amount of groundwater pumped in 2014 (655,000 af) as a reference is not sustainable over the long-term. Reducing groundwater pumping within the basin by a factor of 0.7 over the 1988-2018 period brings the average

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[20] The private well may also be located adjacent to the eastern portion of the site, in which case it would come from the Tulare Lake subbasin and is discussed in Section 4.2.2.

annual pumping rate below the safe yield threshold. We adjusted the actual pumping in 2014 by this amount to serve as the reference for dry-year safe aquifer yield.

3. For the multi-dry-year scenario, we used the three-year period between 2014 and 2016, when CVP allocation was 0%, 0%, and 5%, as a reference for CVP and other user- and district-acquired supply availability. Similar to the single-dry-year scenario, groundwater pumping was assumed to be 0.7 times the actual pumping in 2014-2016 to estimate long-term safe-yield supply during multi-year droughts.

4. Under each scenario, we assume that projected water supply remains constant over the 20-year planning period.

Table 4-1 Sustainable water supply projections for the Westside Groundwater Basin, 2020 - 2040.

	Normal year[1] (afy)	Single Dry Year[2] (afy)	Multi-Dry-Year 1[3] (afy)	Multi-Dry-Year 2[3] (afy)	Multi-Dry-Year 3[3] (afy)
Groundwater[4]	200,000	458,500	458,500	462,000	428,400
SVP Water[5]	638,277	98,573	98,573	82,429	9,204
User-aquired water[6]	72,407	59,714	59,714	51,134	72,154
Additional district supply[7]	104,895	26,382	26,382	34,600	174,374
Total water supply	**1,015,579**	**643,169**	**643,169**	**630,163**	**684,132**
Groundwater supply per acre[8]	*0.313*	*0.716*	*0.716*	*0.722*	*0.669*
Total water supply per acre[8]	*1.587*	*1.005*	*1.005*	*0.985*	*1.069*
Anticipated project demand per acre (construction phase)[9]	*0.104*	*0.104*	*0.104*	*0.104*	*0.104*
Anticipated project demand per acre (operational phase)[9]	*0.006*	*0.006*	*0.006*	*0.006*	*0.006*

[1] Average conditions between 1988 and 2018.

[2] Used 2015 as a reference, the first of two years when CVP allottment was set at 0%.

[3] Used 2015-2017 as a reference, a three year period when CVP allotment was set at 0%, 0%, and 5%.

[4] For normal year conditions, used the basin safe yield of 200,000 afy; for dry- and multi-dry-year scenarios, used the groundwater pumped that year (see Table 2-1) scaled by a factor of 0.7, a reduction which results in the long-term average groundwater withdrawal (1988-2018) to something less than the safe basin yield; see text for further discussion.

[5] For normal year conditions, used the average CVP deliveries for the period between 1988 and 2018; for dry- and multi-year scenarios, used the amount of water delivered during the reference year(s) from Table 2-1; WWD received some CVP water in 2015 and 2016 even though CVP allotment was set at 0% in those years.

[6] Private landowner water transfers; used 1988-2018 average for normal-year scenario; used the amount of water delived during the reference year(s) for the dry- and multi-dry-year scenarios.

[7] Surplus water, supplemental supply and other adjustments; used 1988-2018 average for normal-year scenario; used the amount of water delived during the reference year(s) for the dry- and multi-dry-year scenarios.

[8] Groundwater/total supply for each year-type scenario, divided by the total surface area above the Westside sub-basin (640,000 acres).

[9] Project demand (260 afy for construction phase and 15 afy for operational phase) divided by the project area (2,490 acres).

In their 2012 water management plan, WWD (2013) estimated that basin-wide water demand would increase to nearly 1.4 million afy by 2030. This increase is the result of the need to increase crop yield per acre (rather than an increase in agricultural acreage) in order to account for higher production costs and to support the growing state population. This number is used as the basis of the projected demand for the subbasin for the 2020 to 2040 planning period[21].

Table 4-2 and **Table 4-3** compare the projected basin-wide supply demand for normal-, single-dry-, and multi-dry-year scenarios, and show increasing supply shortages within the District, especially when factoring in the need to reduce groundwater pumping over the long-term in order to manage the subbasin sustainably[22].

Table 4-2 Projected supply and demand for the Westside Water District, 2018-2040, normal- and dry-year scenarios.

	1988-2018[1] *(afy)*	2020 *(afy)*	2025 *(afy)*	2030 *(afy)*	2035 *(afy)*	2040 *(afy)*
Basin-wide demand (normal year)[2]	1,092,482	1,190,931	1,289,381	1,387,830	1,387,830	1,387,830
Basin-wide supply (normal year)[3]	1,015,579	1,015,579	1,015,579	1,015,579	1,015,579	1,015,579
Basin-wide supply minus demand	-76,903	-175,352	-273,802	-372,251	-372,251	-372,251
Basin-wide demand (single dry-year)[2]	1,092,482	1,190,931	1,289,381	1,387,830	1,387,830	1,387,830
Basin-wide supply (single dry-year[3])	630,163	630,163	630,163	630,163	630,163	630,163
Basin-wide supply minus demand	-462,319	-560,768	-659,218	-757,667	-757,667	-757,667
Normal-year unit deficit (af/ac/yr)	-0.120	-0.274	-0.428	-0.582	-0.582	-0.582
Single-dry-year unit deficit (af/ac/yr)	-0.722	-0.876	-1.030	-1.184	-1.184	-1.184

[1] Baseline basin-wide demand is the average applied irrigation water for the 1988-2018 period.

[2] Projected maximum demand in 2030 is 1,387,830 afy, per WWD (2012); the increase is attributed to expectations that irrigation systems will eventually be adapted and operated to apply water more frequently in order to increase crop yields and keep ahead of the rising costs of to produce the food and support the state's increasing population; for the purposes of this analysis, demand was proportionally increased to that maximum in 2030, and maintained at a constant level in 2035 and 2040.

[3] From Table 4-1.

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[21] For the purposes of this analysis, the projected demand is expected to increase linearly from current levels to 1.387 million afy in 2030, and remain constant in subsequent years.

[22] Supply deficiencies are greater in Table 4-2 than those outlined in the 2012 Water Management Plan. This is primarily because the Plan included the fully 100% of the contracted CVP in the supply volume calculation, despite the acknowledgement that the supply is not available in all years. In fact, CVP supply has only been available at a level of about 58% since 1988 (see Table 2-1).

Table 4-3 Projected supply and demand for the Westside Water District, 2018-2040, multi-dry-year scenario.

	1988-2018[1]	2020			2025			2030		
		Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3
		(afy)	*(afy)*	*(afy)*	*(afy)*	*(afy)*	*(afy)*	*(afy)*	*(afy)*	*(afy)*
Basin-wide demand (multi- dry-year)[2]	1,092,482	1,190,931	1,190,931	1,190,931	1,289,381	1,289,381	1,289,381	1,387,830	1,387,830	1,387,830
Basin-wide supply (multi- dry-year)[3]	n/a	643,169	630,163	684,132	643,169	630,163	684,132	643,169	630,163	684,132
Basin-wide supply minus demand	n/a	-547,762	-560,768	-506,799	-646,212	-659,218	-605,249	-744,661	-757,667	-703,698
Unit deficit (af/ac/yr)	n/a	*-0.856*	*-0.876*	*-0.792*	*-1.010*	*-1.030*	*-0.946*	*-1.164*	*-1.184*	*-1.100*

		2035			2040		
		Year 1	Year 2	Year 3	Year 1	Year 2	Year 3
		(afy)	*(afy)*	*(afy)*	*(afy)*	*(afy)*	*(afy)*
Basin-wide demand (multi- dry-year)[2]		1,387,830	1,387,830	1,387,830	1,387,830	1,387,830	1,387,830
Basin-wide supply (multi- dry-year)[3]		643,169	630,163	684,132	643,169	630,163	684,132
Basin-wide supply minus demand		-744,661	-757,667	-703,698	-744,661	-757,667	-703,698
Unit deficit (af/ac/yr)	n/a	*-1.164*	*-1.184*	*-1.100*	*-1.164*	*-1.184*	*-1.100*

[1] Baseline basin-wide demand is the average applied irrigation water for the 1988-2018 period

[2] Projected maximum demand in 2030 is 1,387,830 afy, per WWD (2012); the increase is attributed to expectations that irrigation systems will eventually be adapted and operated to apply water more frequently in order to increase crop yields and keep ahead of the rising costs of to produce the food and support the state's increasing population; for the purposes of this analysis, demand was proportionally increased to that maximum in 2030, and maintained at a constant level in 2035 and 2040.

[3] From Table 4-1.

4.1.1 Project Construction Phase

As stated in Section 3.1, the proposed project is expected to use up to 260 acre-feet of water during the construction phase of the project, which is estimated to be completed in approximately one year. It is important to note that this is a one-time use of water, and does not represent a long-term shift in demand. If construction occurs during a wet year when CVP water is available at 70 percent or greater to support subbasin-wide irrigation demand (see **Figure 2-3**), groundwater pumping within the Westside subbasin is typically below the safe yield threshold and the small amount of water required for construction (relative to the safe yield) would be available without impact to the safe yield status of the aquifer.

Water supply from the CVP has generally declined since the late 1980s, to the point that WWD now expects only about 50 percent of their contracted CVP allotment in an average year[23]. As such, project construction would be more likely to occur in a year when CVP availability is less than 70 percent, and when subbasin-wide groundwater pumping is greater than the safe yield of the aquifer. In such normal- to dry-years, groundwater pumping to support project construction would, along with pumping from other users, contribute to withdrawal from the aquifer at amounts greater than the safe yield of the aquifer. WWD expects that groundwater withdrawals will exceed the safe yield during dry years (to make up for reduced CVP supply), but that groundwater levels will recover in wetter years when pumping is reduced below the safe yield threshold due to offsets from CVP water. The project's low water use relative to the total basin withdrawal and relative to what has been used at the site for irrigation in the past would constitute a very small percentage of water demand on the aquifer. More importantly, the one-time use of construction water would not contribute to long-term decline of the aquifer[24], which is of greater concern than exceeding the safe yield of the aquifer in any single given year.

In 2013, the project site was partially irrigated (approximately 30 percent) (see **Figure 1-2**). During that year, CVP water was available at 40 percent, and basin-wide groundwater pumping in the Westside subbasin was 355,000, greater than the safe yield of the aquifer[25]. The fact that groundwater was available at the project site in 2013 for irrigation, despite the high basin-wide pumping, suggests that water would be available in a similarly dry year to support the proposed single-year construction-phase water usage at the site (keeping in mind that the proposed construction usage would be less than 20 percent of the estimated amount of water used to partially irrigate in 2013)[26].

4.1.2 PROJECT OPERATIONAL PHASE

During the operational phase of the project, water usage at the site would be up to 15 afy, primarily for panel washing. As with the construction phase, there would be no impact in years when CVP water is available at greater than 70 percent when

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[23] http://wwd.ca.gov/about-westlands/history/; accessed on 8/17/16.

[24] Construction phase withdrawal of groundwater would temporarily contribute to groundwater decline in that year (albeit at a very small amount due to the small amount of water required relative to other users in the basin), but over the long-term this would be compensated by wet-year recharge.

[25] The project description states that the property was not irrigated in 2014, though no aerial photographs were available to confirm that statement. CVP water was not available in that year and groundwater pumping was 655,000 af.

[26] The fact that the site has not been irrigated since 2014 does not necessarily indicate that water was not available; many factors can affect the decision not to irrigate.

groundwater withdrawals are less than the safe yield of the subbasin. In other years, however, water usage at the site would, along with all other groundwater users in the subbasin, contribute to withdrawal exceeding the safe yield of the Westside subbasin.

20-year supply-demand projections for WWD (**Table 4-2** and **Table 4-3**) show significant basin-wide supply shortages under existing and future conditions. Despite WWD’s efforts to curtail overdraft through implementation of the Westside groundwater management plan, average groundwater withdrawals still exceed the safe aquifer yield. As such, it is in the best interest of the WWD and its members to find ways to better optimize use of the existing water, find additional sources of water, or to increase aquifer recharge (which would increase the safe yield of the aquifer).

On a long-term basis, the proposed project would reduce the amount of water used at the project site relative to what has been used in the past to irrigate the site for agricultural use. Recent prior irrigation averaged at least 233 afy, while the proposed water usage is only 15 afy. In addition, the Project’s long-term water use is less than 0.01 percent of the safe yield of the Westside subbasin, despite the area of the project parcels being about 0.4 percent of the total irrigable land within the WWD service area. Put another way, the project’s low water usage rate of 0.006 af/acre/year, compared to the average rate of 2.36 af/acre/year for the basin as a whole, is an extremely efficient use of groundwater relative to other users.

Compared to past irrigation at the site, the proposed use would contribute to a net *reduction* in pumping of the aquifer over the long term. The net reduction would contribute incrementally toward potential long-term sustainability of the aquifer.

Through SGMA (see Section 2.3), a plan will be formalized by 2020 to provide for long-term sustainability of the Westside subbasin. Because the proposed per-acre water-use rates for the project are low relative to basin-wide average irrigation rates and relative to the aquifer safe yield, ground-water use restrictions for the project are unlikely. In any event, the project has proposed several potential options for water supply, in acknowledgement of the current overdrafted state of the aquifer, as discussed below.

4.2 Tulare Lake Subbasin

Two potential water sources for the RE Slate project are located within the Tulare Lake groundwater subbasin: a) water purchased from the City of Lemoore, and (potentially) b) water purchased from a neighboring private well. The former is located within KRCD WMA C, while the latter is located either in KRCD WMA C1 or the Westside groundwater subbasin (as discussed above). Long term supply and demand for each of these Tulare Lake subbasin sources are discussed below.

4.2.1 CITY OF LEMOORE

As discussed in Section 2.2.4, the City of Lemoore obtains all its water by pumping from the underlying aquifer within the northern portion of the Tulare Lake subbasin. The 2015 UWMP for the City (Quad Knopf, 2017) analyzed the long-term supply and demand, as summarized in **Table 4-4**. The UWMP concluded that available supply greatly exceeds both current and future demand (**Table 4-4a**). Although the RE Slate project is not included in the City's UWMP, the UWMP concluded that surplus water is available to the City, and the project's water demand as summarized above is far less than the surplus water available.

It is important to note that the UWMP analysis quantified the total volume of groundwater located beneath the City, and based availability on the assumption that the total volume would be fully available in every year, which may not accurately reflect the overdraft conditions of the overall subbasin and the declining groundwater levels[27]. The City does acknowledge that the SGMA process may constrain groundwater supply after the 2020 deadline, potentially resulting in the need for the City to come up with alternative sources of water, or otherwise adjust their water supply/demand scenario. Therefore, while the City currently has sufficient supply available to support the RE Slate project through construction and operation (**Table 4-4b**), that availability may change once the SGMA is in effect. Thus, while the water demand for the proposed project is small relative to that of the City as a whole (the project would increase demand by 0.2% or less after 2020), this potential source *may* not be fully reliable over the 20-year planning period, given the currently overdrafted state of the basin as a whole.

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[27] The declining groundwater levels are contributed to by agricultural withdrawals from beyond the City limits and are not solely due to use by the City; however, the associated potential effects on the long-term groundwater availability to the City have been considered in this analysis.

Table 4-4 **Projected supply and demand for the City of Lemoore, 2020-2040.** The City of Lemoore used the same supply and demand numbers for normal-, single-dry, and multi-dry year scenarios.

a. As presented in the UWMP (converted to acre-feet)

	2020	2025	2030	2035	2040
City-wide demand (afy)[1]	7,111	8,400	10,254	11,720	13,862
City-wide supply (af)[2]	545,378	545,378	545,378	545,378	545,378
City-wide supply minus demand[3]	538,266	536,978	535,124	533,658	531,516

b. Lower-bound annual average groundwater availability (in acre-feet per year)

	2020 (afy)	2025 (afy)	2030 (afy)	2035 (afy)	2040 (afy)
City-wide demand[4]	7,111	8,400	10,254	11,720	13,862
Minimum annual city-wide supply[5]	27,269	27,269	27,269	27,269	27,269
City-wide supply minus demand[6]	20,157	18,869	17,015	15,549	13,407

[1] As presented in the Lemoore 2015 UWMP (Quad Knopf, 2016) converted to units of acre-feet per year.

[2] Total volume of groundwater present beneath the Lemoore city limits, as presented in the Lemoore 2015 UWMP (Quad Knopf, 2016) converted to units of acre-feet; the City obtains water solely from the underlying Tulare Lake groundwater subbasin.

[3] As presented in the Lemoore 2015 UWMP (Quad Knopf, 2016); because the UWMP analysis assumes the entire volume of groundwater is available each year (does not factor the existing overdrafted state of the subbasin), the actualy sustainable supply suplus would be less than the value shown.

[4] As presented in the Lemoore 2015 UWMP (Quad Knopf, 2016) converted to units of acre-feet per year.

[5] Total groundwater supply divided by the number of years in the projection, in order to convert to acre-feet per year; because this assumes no recharge or groundwater inflow, this value provides a lower-bound of available supply to the City on a yearly basis.

[6] As presented in the Lemoore 2015 UWMP (Quad Knopf, 2016) converted to units of acre-feet.

4.2.2 KRCD WMA C1

The RE Slate project may choose to purchase water from a private well owner with a well or wells located on adjacent properties, one or more of which may be located within the KRCD WMA C1 of the northern Tulare Lake subbasin[28]. As described in Section 2.2, the Lower Kings Basin 2005 GMP found that this portion of the Tulare Lake subbasin was not in an overdrafted state at that time. Further, that analysis projected that water demand within the WMA would not increase in the future.

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[28] If the water is withdrawn from a well within the Westside subbasin, the supply sufficiency analysis would fall under the analysis provided for that basin, as discussed in Section 4.1 above.

Table 4-5 shows the projected supply and demand for WMA C1, including the potential increase if the RE Slate project were to receive all supply from a neighboring well within this subbasin. The RE Slate project would increase demand by a small amount—0.52 percent for the construction phase and 0.03 percent for the operational phase. The Lower Kings Basin GMP (WRIME, 2005) found that the WMA C1 portion of the Tulare Lake subbasin was not in an overdrafted state, and it is unlikely that the very small percentage increase for the operational phase would shift the WMA C1 to a state where overdraft is a concern.

Table 4-5 Projected supply and demand for WMA C1 of the Kings River Conservation District, within the northern portion of the Tulare Lake groundwater subbasin, 2020-2040. Groundwater levels fluctuate on a year-to-year basis, dropping under dry- and multi-dry-year conditions, but recovering in subsequent wet years. Supply and demand are assumed to be similar under normal-, dry-, and mutli-dry-year scenarios.

	Existing	2020	2025	2030	2035	2040
WMA C1 demand (afy)[1]	50,187	50,447	50,202	50,202	50,202	50,202
WMA C1 supply (afy)[2]	50,187	50,187	50,187	50,187	50,187	50,187
Supply minus demand[3]		-260	-15	-15	-15	-15
Demand as a percent of exisitng[4]:	*100%*	*100.52%*	*100.03%*	*100.03%*	*100.03%*	*100.03%*

[1] Existing demand as presented in WRIME, 2005; projected demand for 2020 - 2040 includes demand for the RE Slate project.

[2] The Lower Kings Basin groundwater management plan concluded that groundwater within WMA C1 did not show signs of overdraft. Therefore, the existing average supply (equal to demand) is assumed to be sustainable within the WMA.

[3] Deficit shown is equivalent to the full demand of the RE Slate project.

[4] Percent increase relative to existing WMA C1 demand as a result of the RE Slate project.

It is important to note that this analysis does not factor in any offset related to reduction in irrigation at the portion of the project site within WMA C1 (see **Figure 2-1**). If any areas of the project site were irrigated with groundwater sourced from the Tulare Lake basin in the past, the net project demand would be less than (or even completely offset by) that shown in **Table 4-5**. See Section 4.1.2 for discussion of proposed project demand relative to past usage at the project site.

As with the other water sources discussed above, the SGMA process introduces some uncertainly as to the long-term availability of water, even though the volume of water proposed for the project is small. WMA C1 was not identified as being in an overdrafted state in the Lower Kings Basin 2005 GMP, but SGMA requirements applied to the Tulare Lake subbasin as a whole may still constrain groundwater pumping within the WMA, if limitations are applied unilaterally across the entire subbasin.

4.3 Potable Bottled Water Service

Potable bottled water service may be used to supply drinking water for construction workers during the establishment phase, and for on-site staff during the operational phase. Bottled water service, if needed, would be purchased from a commercial water retailer and amounts to a very small percentage of the total water needed for the project. There is no reason to believe that commercial bottled water would not be available in the amount to support the small number of on-site staff over the planning period.

5 SUMMARY

The RE Slate Solar Energy project is planned for an area of approximately 2,490 acres of agricultural land within unincorporated Kings County. The project would use up to 260 acre-feet of water during the construction phase (primarily for dust control), and only 15 acre-feet per year (afy) of water for the operational phase of the project (mostly for panel washing).

The project would obtain water for the construction and operational phases from one or more of several sources:

1. Pumping from an on-site or adjacent-site WWD well, both of which draw groundwater from the underlying Westside groundwater subbasin.
2. Groundwater pumped from a well located at the Tranquility Solar Project site, located approximately 50 miles northwest of the project site, but also drawing from the Westside groundwater subbasin.
3. Purchase of water from a private well located on-site or on an adjacent property, which draws water either from the Westside groundwater subbasin or from the northwestern portion of the Tulare Lake subbasin.
4. Imported water from the City of Lemoore, which obtains its supply solely from the underlying northern portion of the Tulare Lake subbasin.
5. Potable bottled water service for construction workers during the establishment phase, and for on-site staff during the operational phase.

The Westside subbasin (over which the western portion of the project site is located) has a safe yield of approximately 200,000 afy, and is classified by CA DWR as a critically overdrafted aquifer. The Tulare Lake subbasin, east of the Westside subbasin is listed as a critically overdrafted aquifer as well, though overdraft does not appear to be a major concern in the specific portion of the subbasin underlying the eastern part of the project site itself. The portion of the Tulare Lake subbasin beneath the City of Lemoore, however, is in an overdrafted state.

5.1 Project Construction Phase

The construction-phase water use at the site would be a temporary, one-time use over the course of approximately one year, and the project is not tied to a specific source of water for this purpose. As discussed in Chapter 4 above, sufficient water supply is available for project construction from any one of the potential sources, as the one-time use would not affect the long-term sustainability of the groundwater within the Westside, Tulare Lake, or neighboring subbasins.

5.2 Project Operational Phase

The operational phase of the project would constitute a very low rate of water use relative to the size of the site and relative to the safe yield of the subbasins. The operational water use is also less than what has been used at the site in the past, even when factoring in that the site had been only periodically irrigated.

The Westside and Tulare Lake subbasins are both classified by CA DWR as a critically overdrafted subbasins, though groundwater levels specifically within the WMA C1 portion of the Tulare Lake subbasin (in which the project is partially located) did not show evidence of such overdraft, according to the Lower Kings Basin GMP (WRIME, 2005).

The long-term supply/demand comparison for the Westside subbasin shows an increasing supply deficit, despite the efforts of WWD to import irrigation water and reduce pumping to maintain a sustainable groundwater supply. The proposed operational demand for the RE Slate project would, along with all other groundwater users in the subbasin, contribute to withdrawal exceeding the safe yield of the Westside subbasin. The upcoming SGMA implementation is directed at solving the overdraft problem, though the exact process through which a solution will be reached is currently unknown.

The City of Lemoore's 2015 UWMP concludes that the City has ample groundwater supply to support existing and projected future municipal demand. Even without considering groundwater recharge, there is enough groundwater volume in storage beneath the City to support municipal demand as well as the additional demand of both the construction and operational phases of the RE Slate project. While the City currently has no legal constraints to use the groundwater, the current analysis does not consider the upcoming requirement under SGMA to operate the subbasin sustainably. The City acknowledges that projected groundwater supply may change after the Groundwater Sustainability Plan is developed, and that the City may need to seek additional supply in the future, which may affect the ability of the RE Slate project to purchase the small amount of water needed from the City.

Review of the Tulare Lake subbasin groundwater conditions in and near the project site (WMA C1) suggests that water would be available to support the relatively small amount of operational demand for the RE Slate project. Groundwater levels east of the site, while fluctuating from year-to-year, do not appear to be in long-term decline. The small amount of water required for operational conditions of the project site would be unlikely to change this trend, and overall demand within this area is not projected to increase over the planning period. Still, SGMA requirements applied at a subbasin-wide scale may curtail water availability for purchase from neighboring parcels, introducing uncertainty as to the long-term supply available in that area.

As discussed above, all assessed potential water sources for this project may be affected by regulatory changes as a result of the upcoming implementation of SGMA regulations. However, there is sufficient water supply available from several different sources to support the project. The following items are key in assessing the long-term availability of water:

1. The project proposes to use very low amounts of water per acre relative to other users in area, relative to what has been used in the past to irrigate the site, and relative to the safe yield of the underlying aquifer.
2. The project has several options for sources of water, including groundwater from both the Westside and Tulare Lake subbasin, increasing flexibility should one potential source become unsustainable in the long-term as the SGMA requirements are defined for each area.
3. The project is not necessarily tied to one particular source through the life of the project, and could potential change year-to-year based on availability and cost.

Based on the information above, groundwater supply (whether sourced on or adjacent to the site, from the Westside subbasin imported from the Tranquility site, from the City of Lemoore, or some combination of those sources) is sufficient to meet the demand of the project.

6 LIMITATIONS

This technical report was prepared in general accordance with the accepted standard-of-practice existing in Northern California at the time the analyses were performed. It is based primarily on information obtained from readily available published reports, papers, plans and project documents. We have not independently verified their validity, accuracy or representativeness to this or other sites. No other warranty is made or implied. Readers are asked to contact us if they have additional relevant information, or wish to propose revisions or modified descriptions of conditions, such that the best data can be applied at the earliest possible date.

7 REFERENCES

California Department of Water Resources (CA DWR), 2003, California's Groundwater. Department of Water Resources Bulletin No.118, 265 p.

California Department of Water Resources (CA DWR), 2013, California's Groundwater Update 2013, Tulare Lake Hydrologic Region, 128 p.

California Department of Water Resources (CA DWR), 2016, Final List of Critically Overdrafted Basins. Available at http://www.water.ca.gov/groundwater/sgm/cod.cfm, 1pg.

De Groot, D., 2016, Tule Subbasin: Sustainable Groundwater Management Act (SGMA). Presentation by 4Creeks, Inc. for the Tule Subbasin Public Outreach Meetings of the Tulare Lake Basin Water Alliance. Downloaded from https://tularelakebasin.com/alliance/index.cfm/sustainable-groundwater-management-act-sgma/tule-sub-basin/ on 5-1-2018.

Kings County Development Agency, 2010, 2035 Kings County General Plan. Multi-paged.

Quad Knopf, Inc., 2017, 2015 Urban Water Management Plan for the City of Lemoore, 143p.

RMC, 2014, Westside San Joaquin Integrated Water Resources Plan. Draft report prepared for the San Luis & Delta-Mendota Water Authority.

Summers Engineering, 2012, Tulare Lake Coordinated Groundwater Management Plan (SB 1938 Compliant), 45p.

Water Resources & Information Management Engineering, Inc. (WRIME), 2005, Lower Kings Basin Groundwater Management Plan Update. Consulting report prepared for the Kings River Conservation District, 225p.

Westlands Water District (WWD), 2016, Deep groundwater conditions report, December 2015. Report dated April 2016, 17p.

Westlands Water District (WWD), 2013, Westlands Water District Water Management Plan 2012. 213p.

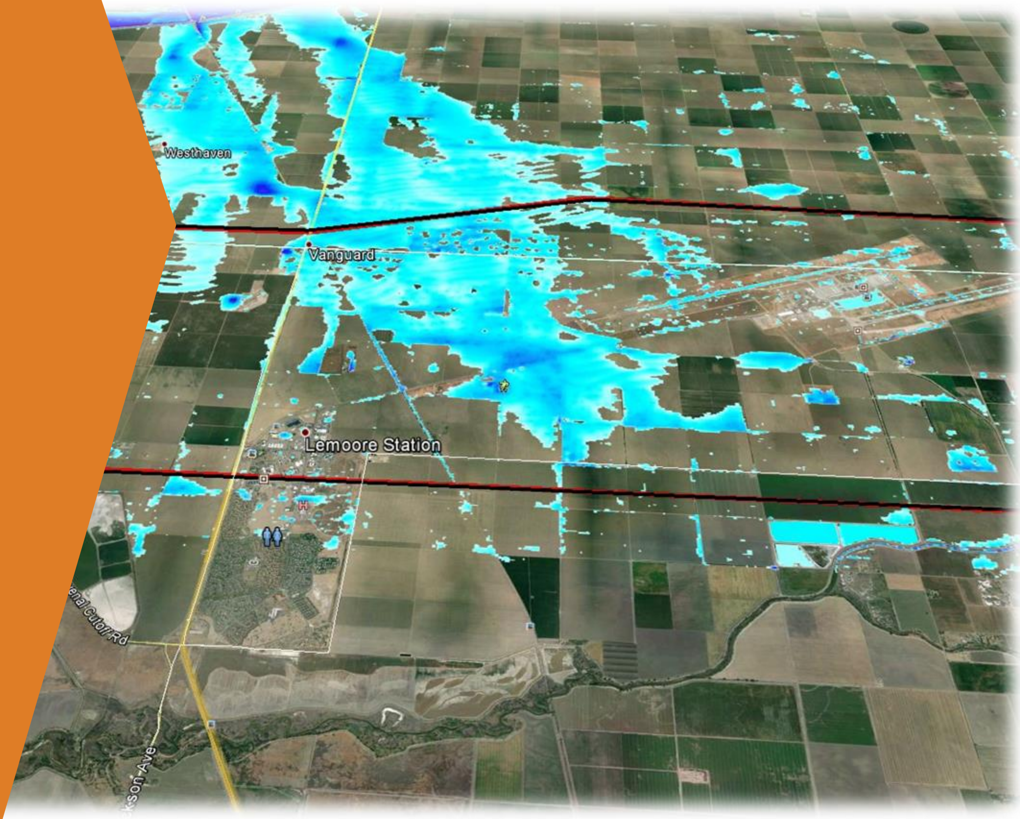
Westlands Water District (WWD), 1996, Westlands Water District Groundwater Management Plan. 32p.

Westwood

PHASE C HYDROLOGY STUDY

RE Slate Solar Project

Kings County, CA
April 2018



Prepared For: RECURRENT ENERGY

Phase C Hydrology Study for

Slate Solar Project

Prepared for:
Recurrent Energy
300 California Street, 8th Floor
San Francisco, CA 94104

Prepared by:
Tom Miller, PE
Westwood Professional Services
1212 Deming Way, Suite 200
Madison, WI 53717

Project Number: 0009406.00
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Exhibit 5: Land Cover Map
Exhibit 6: Curve Number Map
Exhibit 7: 100-Year Max Water Depth Map
Exhibit 8: 100-Year Peak Velocity Map
Exhibit 9: FEMA Boundary Review
Exhibit 10: 100-Year Max Scour Depth Map

Appendices

Appendix A: Atlas-14 Printout
Appendix B: Kings River FEMA Boundary Review Memo

OVERVIEW

The purpose of this hydrology study and FEMA boundary review is to analyze the hydrology of the proposed Slate photovoltaic project (“the project”) and provide design information for use in the engineering design.

This hydrology study covers the updated project area where the Slate Solar Project will be developed. The project area encompasses approximately 2,150 acres in Kings County, CA and the watershed encompasses 45,159 acres of land in Fresno and Kings County, California, near the city of Lemoore (Exhibit 1). The project will consist of solar panels, inverters, interconnection switchgear, and associated access roads. Due to the hydrologic characteristics associated with the flat, largely un-channelized terrain present in the area of interest, FLO-2D hydrologic/hydraulic modeling software was used to determine flow depths and velocities throughout the site.

The proposed project area and surrounding areas are flat agricultural lands. Flood flows at the project arise from precipitation on or adjacent to the area of interest. The California Aqueduct runs perpendicular to the direction of flood flow approximately 10 miles upstream of the project site. Flood waters pond above the diked aqueduct and in the storm water detention basin, markedly reducing downstream flood flow. This effect was accounted for in the Phase B study hydrologic model. It has been further studied and appears that the overtopping of the California Aqueduct levees will have little to no effect on the project area.

USGS SSURGO hydrologic soil group D (high runoff potential) covers the majority of the project boundary. The western edge of the watershed area is mainly classified as hydrologic soil group C (moderately high runoff potential) (Exhibit 5). The existing land cover in the area of interest and its nearby contributing watershed is predominantly cultivated crops and orchards (Exhibit 6).

A FEMA floodplain is not present on the project site. The watershed area is covered by FEMA FIRM panels 06031C0300C, 06019C3300H, and 06031C0325C. The eastern edge of the watershed area is designated as a FEMA Flood Hazard Zone A (1% Annual Chance Flood Hazard). The remainder of the watershed area is designated Zone X (Area of Minimal Flood Hazard) (Exhibit 3).

Overall, the analysis shows low water depth and velocities (Exhibits 7 and 8) across the majority of the site. During a 100 year storm the flood depths across the majority of the project area are 2.25 feet at maximum with velocities less than 1 foot per second (fps). See Exhibits 7 and 8 for areas within the project with higher flood depths and velocities. Based on experience on similar projects, the site is suitable for the planned development by avoiding areas of high flood depths and velocities or elevating equipment in these areas.

DATA SOURCES

The models and methods for this project utilize a combination of public and private data as shown in Table 1.

Table 1: Data Sources

Data Type	Format	Source	Use
Elevation	Digital Terrain Model (DTM)	USGS 10-Meter National Elevation Dataset; 5-Meter Intermap Dataset	Offsite FLO-2D Model Elevations
Elevation (1-Foot Contours)	Triangular Irregular Network (TIN)	Recurrent Energy	Onsite Elevations within Project Boundary
Soils	Shapefile	USGS SSURGO Dataset	Curve Numbers
Precipitation	Text File	NOAA Atlas 14 Website	Design storms
HUC-12 Drainage Boundary	Shapefile	USGS	Define Model Extents
Site Boundary	DWG	Recurrent Energy	Define Model Extents
Aerial Photography	ArcGIS Map Service	USDA FSA	Reference

HYDROLOGIC MODELING

The proposed project site is located in Kings County, California near the City of Lemoore and the watershed extends west into Fresno County, California. The watershed is flat agricultural land. Flood flows in the watershed generally flow from west to east. The California Aqueduct west of the project represents the upper reaches of the watershed. In the Phase B report it was stated that the watershed extended into the Diablo Range west of the California Aqueduct. This mountainous terrain is characterized by sparsely vegetated undulating ridges and valleys. Rainfall forms channels flowing toward the valley floor. Upon reaching the valley floor, flood flows continue toward the east towards the California Aqueduct. Based on further study it appears that a large portion of the flow is held back by the California Aqueduct levee and stormwater detention basin near the City of Huron, approximately ten miles west of the area of interest. It is unknown if flood flow during large storm events overtops the California aqueduct levees in an uncontrolled manner. If the water does cross the aqueduct during a flood event it will overtop north of the proposed project boundary and then the water infiltrates, evaporates or continues east slowly without forming well defined channels. This unknown flood water would most likely not extend to the updated project boundary. Therefore the watershed area for this Phase C report only included the watershed east of the California Aqueduct.

The hydrologic modeling and report are classified as a Recurrent Energy “Phase C” analysis. The area of study has been reduced in order to give proper hydrologic consideration to the parcels that are proposed to have PV solar facilities constructed on them. This detailed report is adequate for the final project design and for submission of the project to government agencies for their review.

FLO-2D

FLO-2D is a physical process model that routes rainfall runoff and flood hydrographs over flow surfaces or in channels using the dynamic wave approximation to the momentum equation. FLO-2D offers advantages over 1-D models and unit hydrograph methods by allowing for breakout flows and visualization of flows across a potential site. This is particularly useful on a flat site that receives offsite flows, such as the project site. The primary inputs are a DTM (elevation data), curve numbers and precipitation.

Precipitation data downloaded from NOAA Atlas 14 (Appendix A) for a 100-year, 24-hour storm is 2.92 inches. Rainfall is distributed in an SCS Type-I distribution pattern. The watershed was small enough where the rainfall amount was similar over the entire watershed so only one value was needed.

Intermap (5M), USGS NED and ground survey data are incorporated into the DTM using the export to xyz file function in Global Mapper. The Intermap elevation data was raised 1’ in order to better match the ground based survey data. These xyz files are read directly into FLO-2D.

USDA-NRCS SSURGO soil data provides nearly full coverage of soil types within the FLO-2D modeled area. Soils in the area are a classified as hydrologic group C in the western portion of the watershed and as hydrologic group D on the eastern portion of the watershed including within the project boundary (Exhibit 5). Land cover was obtained from the USDA 2013 Crop Data Layer. Exhibit 6 displays Land Cover Classes for the entire watershed which is predominantly cultivated crops and orchards. Runoff generated from the solar panels will flow to the edge of the panels and be allowed to drip onto the pervious surface below and allowed to disperse and infiltrate below the panels across the site.

FLO-2D Watershed Model

The potential contributing watershed for the project is approximately 70 square miles. Hydrologic modeling for the project was done with one watershed to accurately model the project’s hydrology. The watershed was modeled using a 50 foot FLO-2D grid cell size. The primary elevation source is the Intermap NEXTMap dataset and onsite topography data within the project boundary. Due to flat terrain and the complex nature of the interconnected irrigation systems and canals in the area, some boundaries of the contributing watershed are poorly defined. The FLO-2D model area is sized to ensure all contributing flows are accounted for.

KINGS RIVER FLOOPLAIN

FEMA mapping for the Kings River indicated that the eastern portions of the updated project boundary could be impacted by FEMA flood zones (Exhibit 3). The portion of the floodplain that could impact the project is a FEMA Zone 'A' last updated in 2009. This floodplain boundary is less precise than a Zone AE boundary and appears to have used older, lower quality elevation datasets. A FEMA Zone A is typically an "approximate" boundary of the floodplain using less rigorous hydraulic modeling and low quality elevation datasets.

It is reasonable to use the FEMA Zone A near the eastern boundary of the project which gives some indication of where the proposed facilities might be impacted. However, these flood extents should not be relied upon for final design. In order to get the correct elevations for the FEMA flood elevations, elevation points were surveyed and taken in the field. These elevation shots were then analyzed to see if the boundary was in the proper location and to determine if the floodwaters would rise high enough to flow onto the project site. Comparing elevations from within the project boundary on the east edge to shots taken on the FEMA floodplain line shows that the project site is at an equal or higher elevation (Exhibit 9), also there are berms in between the project boundary and the FEMA floodplain which are 1'-2' high which further reinforces that the FEMA boundary is correct. If further analysis is needed along this boundary a GEOHEC-RAS model could be created using good quality elevation data along with the field verified elevations. Modeling would help refine the flood extents and depths in this area but is not recommended at this time. A separate memo provides additional information regarding the FEMA floodplain near the project. (Appendix B)

RESULTS AND DESIGN INFORMATION

Overall, the analysis shows relatively low water depths and velocities (Exhibits 7 and 8) across the proposed array. Based on experience on other similar projects, the site is generally suitable for the planned development and most hydrologic concerns can be addressed through detailed engineering design. The following design guidelines have been compiled for the final siting of solar development facilities on this site. If the proposed project footprint changes, the analysis should be revisited to ensure that all assumptions are still valid.

1. Electrical facilities and racking/modules should be elevated 1' above the 100-year peak flood depth as depicted in Exhibit 7.
2. Care should be taken when siting electrical facilities and racking/modules where depths are greater than 2 feet.
3. Recent experience in Kings County shows that retention basins are not required for solar projects but this should be verified during county permitting.
4. The proposed project is not expected to cause more than 1 foot of water surface rise and discharges the 100-year storm in a manner similar to the existing flow pattern. This should be revisited pending final design.

NEXT STEPS

1. This model/report should be updated at final design to ensure that assumptions remain valid.

REFERENCES

National Engineering Handbook, Part 630 Hydrology. Chapter 9 Hydrologic Soil-Cover Complexes. USDA. NRCS. 210-VI-NEH, July 2004

Exhibits