# Technical Memorandum

# Well Site Assessment Palmdale Water District Well Nos. 36 and 37

PWD EST. 1918

**PREPARED FOR:**

## Palmdale Water District

## November 18, 2020

## FINAL

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# Palmdale Water District
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## Palmdale Water District

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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ASTM | American Society for Testing and Materials |
| AVB | Antelope Valley Groundwater Basin |
| bgs | Below Ground Surface |
| DDW | California State Water Resources Control Board Division of Drinking Water |
| DWR | California Department of Water Resources |
| gpm | Gallons per Minute |
| ID | Inside Diameter |
| KGI | KYLE Groundwater, Inc. |
| MCL | Maximum Contaminant Level |
| mg/L | Milligrams per Liter |
| µg/L | Micrograms per Liter |
| msl | Mean Sea Level |
| ND | Below Laboratory Reporting Limits |
| OD | Outside Diameter |
| ppm | Parts per Million |
| PWD | Palmdale Water District |
| TDS | Total Dissolved Solids |
| USEPA | United States Environmental Protection Agency |

# 1.0 INTRODUCTION

## 1.1 BACKGROUND

The Palmdale Water District (PWD) is seeking to develop one or more sources of potable groundwater supply within the vicinity of the planned solar energy farm northeast of the intersection of E. Rancho Vista Road and 10th Street East, in Palmdale, California (see Figure 1). PWD currently owns two (2) parcels of land within the area of the planned solar energy farm, in addition to the parcel of land occupied by existing Well 15 (see Figure 2). An initial hydrogeologic review of the area was conducted in 2008 that resulted in recommendations for a standalone exploratory drilling program (MWH, 2008). However, given the wealth of available knowledge in this area, it has been decided to forgo the exploratory drilling program in favor of proceeding with a two-pass production well drilling program. This report presents a more detailed evaluation of the two proposed well sites shown on Figure 2 to determine suitability and feasibility, and lay the groundwork for construction.

## 1.2 PROJECT LOCATION

The study area is located in Los Angeles County within the southern central part of the Antelope Valley Groundwater Basin (see Figure 1). The potential sites identified by PWD are located on the east side of 10th Street E, approximately 610 feet south of Blackbird Drive, and on the west side of 15th Street E, approximately 1,210 feet south of Blackbird Drive (see Figure 2). For the purposes of this study these sites are designated as Sites 1 and 2, respectively (see Figure 2).

## 1.3 PURPOSE & SCOPE

The purpose of this study was to assess the two (2) proposed well sites at as to suitability for installation of new groundwater production wells, and identify the site that has the greatest probability of success. The scope of work performed to achieve project objectives included:

- Review of existing hydrogeologic data and reports
- Summary of the hydrogeologic setting
- Assessment of water level interference
- Assessment of potential sources of groundwater contamination
- Development of anticipated conditions
- Preparation of a preliminary well design
- Evaluation of construction logistics and constraints
- Evaluation of permitting constraints
- Preparation of engineer's estimates of well construction cost

# 2.0 HYDROGEOLOGY

## 2.1 GEOLOGIC SETTING

The study area is located within the Antelope Valley Groundwater Basin (AVB), an adjudicated basin within the southwestern Mojave Desert, nearly 40 miles north-northeast of Los Angeles, California. The AVB is a wedge-shaped structural depression, covering an area of approximately 1,580 square miles, within Los Angeles and Kern Counties and smaller portions of San Bernardino County (DWR, 2003). The elevation of the valley floor ranges from approximately 2,300 to 3,500 feet above mean sea level (msl). The AVB is bounded to the southwest by the San Andreas fault zone at the base of the San Gabriel Mountains, to the northwest by the Garlock fault zone at the base of the Tehachapi Mountains, and to the north and east by several low-lying bedrock hills and northwest trending fault systems (Duell, 1987). A section of the northern boundary abuts deposits of the Fremont Valley Groundwater Basin and functions as a groundwater divide. To the east, a groundwater divide generally coincident with the San Bernardino County line separates the Antelope Valley area from the El Mirage Valley and Mojave adjudicated areas (Todd, 2020).

Previous studies divided the AVB into twelve subbasins: Finger Buttes, West Antelope, Neenach, Willow Springs, Gloster, Chaffee, Oak Creek, Pearland, Buttes, Lancaster, North Muroc, and Peerless (Bloyd, 1967). The boundaries to these subbasins are based on faults, local groundwater divides, consolidated rocks, and in some instances, arbitrary boundaries (USGS, 1998). These subbasins were redefined in 2010 for purposes of the adjudication and because many of these subbasin boundaries did not demonstrate any impact to groundwater flow (Beeby, et al., 2010). The redefined "Management Subareas" include the Willow Springs, Rogers Lake, West Antelope Valley, Central Antelope Valley, and South East Subareas (Todd, 2020). The proposed well sites are located within the Central Antelope Valley Management Subarea, the largest in area and water use, and the most significant in terms of economy and population (LADPW, 2014).

Natural recharge, by far the largest source of recharge to the AVB, occurs primarily from percolation of perennial runoff from the surrounding mountains and hills. The majority of this recharge originates within the San Gabriel Mountains from Amargosa Creek, Little Rock Creek, and Big Rock Creek, and the Tehachapi Mountains from Oak Creek and Cottonwood Creek (Durbin 1978 and Todd, 2020). Since the AVB is a topographically closed basin, there is little in the way of discharge from the basin through groundwater underflow and/or surface water flow (Siade, et al., 2014).

The sediments that fill the AVB consist of non-marine Quaternary and Tertiary alluvial and lacustrine materials overlying a bedrock complex of pre-Cenozoic igneous rocks and consolidated Tertiary sedimentary rocks (Leighton, et al., 2003). The alluvial deposits consist of Quaternary-age unconsolidated gravel, sand, silt, and clay, becoming increasingly compacted and indurated at depth. The alluvium is coarser near the mountain fronts, becoming increasingly fine-grained toward the central portions of the basin. Alluvial thickness may extend up to 5,000 feet within the central portion of the basin, becoming progressively shallower toward the basin margins. The lacustrine deposits consist of up to 300-foot thick sequences of sand, silt, and clay deposited in low-energy environments (i.e., lakes and marshes), and are primarily composed of blue-green silty clay, known locally as the blue-clay member (Leighton, et al., 2003). Massive beds of the blue-clay member can be up to 100 feet thick in areas and occur at greater depths in the southern reaches of the basin (near Palmdale), becoming progressively shallower towards Rogers Lake.

In the vicinity of the study area the alluvium is known to primarily occur above the blue-clay member (where present), extending to depths of up to approximately 1,100 feet and becoming increasingly less permeable and more indurated with increasing depth (Leighton, et al., 2003 and Siade, 2014). The top of the blue-clay member is estimated to occur at a depth of approximately 800 feet below ground surface (bgs) in the vicinity of the study area, and indeed was encountered at a depth of approximately 920 feet bgs at Well 11A and possibly 900 feet bgs at Well 6A. The thickness of the blue-clay member is estimated to be 80 feet at Well 11A, and it is suspected that the clay member begins to pinch out and become less continuous in the vicinity of the study area, and may not be present at all in areas to the south (Beeby, 2010). Older consolidated sedimentary rocks are known to occur beneath the blue-clay member as reported in Well 11A.

## 2.2 Groundwater

### 2.2.1 Groundwater Occurrence

Prior to development, groundwater within the AVB generally flowed from areas of recharge in the mountain fronts, to areas of discharge at ephemeral lake beds. As such, groundwater would historically flow north from the San Gabriel Mountains, and south and east from the Tehachapi Mountains, toward the natural surface depressions of Rosamond Lake, Buckhorn Lake, and Rogers Lake (Todd, 2020, and Leighton, et al., 2003). Groundwater pumping has altered these natural flow directions and re-directed flow toward local pumping depressions centered in the general vicinity of the Cities of Palmdale and Lancaster (Todd, 2020).

### 2.2.2 Aquifer Systems

Historically, the AVB aquifers were divided into two primary aquifers: the upper aquifer and the lower aquifer. These two aquifers were defined by the occurrence of lacustrine deposits, with the upper aquifer overlying the blue-clay member and being characterized as hydraulically unconfined, and the lower aquifer occurring beneath the blue-clay member and characterized as confined (USGS, 2004). The upper aquifer is the principal aquifer and the primary source of groundwater to wells. This conceptual model was later refined to a three-aquifer system, including an upper aquifer, middle aquifer, and deep aquifer (Leighton, et al., 2003). As with the prior model, the upper aquifer occurs above the lacustrine deposits, is considered to be primarily unconfined in nature, and serves as the primary source of groundwater to wells (LADPW, 2014). The middle and deep aquifers are likely confined by overlying lacustrine deposits and interbedded aquitards (Leighton, et al., 2003).

It is anticipated that a new municipal well within the vicinity of the proposed well sites will target groundwater production from the upper principal aquifer as this aquifer is considered the primary source of groundwater supply within the AVB. However, it is recommended that drilling extend beyond the depth of this aquifer in an effort characterize the deeper aquifers and assess the ability of those aquifers to produce good quality groundwater at acceptable rates.

### 2.2.3 Aquifer Yield

Aquifer transmissivity is defined as the rate of water flow through a vertical section of aquifer one foot in width under a hydraulic gradient of 1 and is typically expressed in units of gallons per day per foot (gpd/foot). This parameter is a measure of the capability of an aquifer to transmit water and can be best estimated from data collected during controlled pumping tests (Cooper and Jacob, 1946). When pumping test data is not available, transmissivity can be estimated from measurements of specific capacity (Ferris, 1963), or the amount of drawdown measured within a well pumping at a known rate. It should be noted that there are many variables affecting transmissivity values as determined from well data, including but not limited to, well depth, aquifers screened, effectiveness of well development, well age, well interference, and the quality of the data collected. However, when taken as a whole, these data do allow for an effective assessment of aquifer production potential.

Specific capacity and pumping test data were compiled for selected production wells within the vicinity of the proposed well sites (see Table 1) and were utilized to provide an indication of the potential yield of the aquifer system. Wherever possible, data collected at the time of well construction were utilized as these data are least affected by fouling of the well screen and are typically most representative of aquifer conditions. Reported specific capacity data for the project area ranges from 3 to 80 gpm per foot (gpm/ft), suggesting aquifer transmissivities ranging from approximately 5,000 to 172,000 gpd/ft, and averaging approximately 91,500 gpd/ft. The very low specific capacity of 3 gpm/ft at Well 6A is an outlier and likely anomalous. Regardless, these specific capacity data suggest transmissivity values that are relatively consistent with published transmissivity data for the upper "principal" aquifer in this area of approximately 67,000 to 105,000 gpd/foot (Durbin, 1978), and generally indicate the presence of productive aquifers within the vicinity of the proposed well site[1].

Instantaneous discharge rates for the aforementioned wells range from approximately 300 to 2,000 gpm with an average of approximately 1,295 gpm (see Table 1). As with transmissivity, the instantaneous pumping rate for Well 6A is anomalously low. Generally, these data indicate the presence of productive aquifers across the study area and the potential for relatively good production potential at either of the proposed well sites.

### 2.2.4 Historical Groundwater Elevations

Groundwater elevations in the AVB have shown relatively large-scale changes over the period of record, primarily related to changes in land use (i.e., agricultural versus urban areas). Groundwater levels began to decline in the 1920s as agricultural pumping began to exceed natural recharge to the

[1] It should be noted that aquifer transmissivity is directly proportional to aquifer thickness, and as such, significant declines in regional groundwater levels, as has occurred in this area, will reduce specific capacity values.

basin (Siade, 2014). In some cases, the magnitude of these declines has been on the order of several hundred feet. Groundwater levels impacted by agricultural pumping then began to stabilize in the late-1970s. However, increased pumping in urban areas such as Palmdale and Lancaster has resulted in continued groundwater level decline in these areas.

Historical groundwater elevations for PWD Well 3A, located approximately one (1) mile southeast of the easternmost proposed well site are shown on Figure 3. Over the period of record from the early 1960s through the late 1970s, water levels measured in this well have declined by approximately 150 feet, at which time water levels began to stabilize, presumably due to the shift from primarily agricultural to urban land use (see Figure 3). Groundwater levels then entered a second period of decline on the order of 100 feet during the period from the mid-1980s through the late-2000s. Since that time, groundwater levels have fluctuated, presumably in response to periods of drought, and have increased by approximately 75 feet since 2015 (see Figure 3). The overall decline in groundwater levels reported for this well has been approximately 200 feet over the entire period of record from 1961 through 2020 (See Figure 3).

### 2.2.5 WELLFIELD INTERFERENCE

Installing groundwater production wells within close proximity to one another will typically result in additional water level drawdown and increased pumping costs. The magnitude of water level interference imparted on existing wells within 1 mile of each proposed well was estimated using the Theis equation for non-steady radial flow to pumping wells (below; Theis, 1935).

$$s(r,t) = \frac{114.6Q}{T} W(u) \qquad \text{and} \qquad u = \frac{1.87r^2S}{Tt}$$

It was assumed that the pumping rate of each new well (Q) would be 2,000 gpm and that the wells would be continuously operational. An estimated aquifer transmissivity (T) of approximately 100,000 gpd/foot was used based on the average capacity data obtained from vicinity wells and excluding Well 6A (Theis, 1963). An estimated well efficiency of 70% and an estimated aquifer storativity (S) of 0.01 was assumed. The distance between wells (r) was measured directly using Google Earth. Water level interference was calculated based on a pumping duration (t) of 10 days.

Utilizing these assumptions, the predicted additional drawdown from water level interference was estimated and is summarized in the following table. Actual water level interference may vary depending upon pumping schedules, actual aquifer parameters, well construction details, and other factors. However, it is considered reasonable to utilize these values as a metric for determining the relative magnitude of water level interference.

**Estimated Water Level Interference**

| | Water Level Interference (feet) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2A | 3A | 6A | 8A | 11A | 14A | 15 | Total |
| **Site 1** | 1 | 1 | 3 | 1 | 3 | 1 | 5 | **15** |
| **Site 2** | 2 | 1 | 2 | 2 | 5 | 3 | 4 | **19** |
| **Both Wells** | 3 | 2 | 5 | 3 | 8 | 4 | 9 | **34** |

The estimated water level interference from a well installed at Site 1 after 10 days of continuous pumping at 2,000 gpm averages approximately two (2) feet with a combined total interference of 15 feet imparted on the existing wellfield. The estimated water level interference from a well installed at Site 2 averages approximately 3 feet with a combined total interference of 19 feet imparted on the existing wellfield. Two new wells operating simultaneously are estimated to impart a combined total of 34 feet of water level interference on the existing wellfield. Of the two proposed well sites, Site 1 is farther from the existing wellfield and offers marginally less interference.

## 2.2.6 GROUNDWATER QUALITY

Potential non-point source constituents of concern within groundwater of the Central Antelope Valley Management Subarea include total dissolved solids (TDS), iron, manganese, arsenic, hexavalent chromium, and nitrate. Additionally, the area is known to be impacted by anthropogenic point-source contaminants from historical military activities, and other industrial activities.

### 2.2.6.1 NON-POINT SOURCE GROUNDWATER QUALITY

#### 2.2.6.1.1 TOTAL DISSOLVED SOLIDS

TDS is a measure of the dissolved mineral content of water and is commonly used as a metric for the general quality of groundwater. Within the Central Antelope Valley Management Subarea, TDS concentrations are generally low and of minimal concern within aquifers utilized for municipal use.

The concentration of TDS for selected production wells within the vicinity of the proposed well sites range from between 105 to 550 milligrams per liter (mg/L) and average approximately 203 mg/L over the period of record from September 1987 to January 2019 (see Figure 4). In all but one case, TDS concentrations are below the California Division of Drinking Water (DDW) recommended secondary maximum contaminant level (MCL) of 500 mg/L. With the exception of Well 11A, the available data demonstrate a slight but generally increasing trend since the late-1990s and early-2000s. Well 11A is exceptional in that it exhibits a more severe increasing trend in TDS, and in one instance exceeds the DDW recommended secondary MCL of 500 mg/L.

Although not shown on Figure 4, inactive Wells 5 and 17 have exhibited elevated TDS concentrations that have been attributed to leaking septic systems (Standish-Lee and PWD, 1999). During the period between September 1987 to January 2001, Well 5 exhibited TDS concentrations ranging from 445 to 961 mg/L, with an average of 650 mg/L. During the period between May 1988 and May 2004, Well 17 exhibited TDS concentrations ranging from 905 to 1,311 mg/L, with an average of 1,130 mg/L in excess of the DDW upper secondary MCL of 1,000 mg/L.

### 2.2.6.1.2 IRON

Iron is regulated under the DDW secondary drinking water MCL of 300 micrograms per liter (µg/L) as it is considered aesthetically displeasing in terms of the color, odor, and taste. Additionally, iron precipitates may stain household fixtures, and clog water supply infrastructure (EPA, 2016).

Iron concentrations for selected production wells within the vicinity of the proposed well sites range from below laboratory reporting limits to 1,130 µg/L and average approximately 29.9 µg/L over the period of record from September 1987 to April 2020 (see Figure 5), periodically exceeding the DDW secondary MCL of 300 µg/L. However, it should be noted that these exceedances are isolated to Wells 6A and 14, do not exhibit any predictable trend, and are not consistently reported. As such, it is considered likely that these elevated values are related to sampling and/or laboratory error (i.e., sediment and/or casing material contained within the sample and digested by the laboratory during sample preparation), and can be considered anomalous. With the exception of Wells 6A and 14, no well within the vicinity of the proposed well sites has reported iron in excess of reporting limits.

### 2.2.6.1.3 MANGANESE

Manganese is regulated under the DDW secondary drinking water MCL of 50 µg/L as it is considered aesthetically displeasing in terms of the color, odor, and taste. Additionally, as with iron, manganese precipitates may stain household fixtures and clog water supply infrastructure (EPA, 2016).

Manganese concentrations for the selected production wells within the vicinity of the proposed well sites range from below laboratory reporting limits to 70 µg/L and average approximately 0.6 µg/L over the period of record from September 1987 to April 2020 (see Figure 6). Reported manganese concentrations at Well 6A have exceeded reporting limits only twice and have exceeded the DDW secondary MCL of 50 µg/L only once (see Figure 6). As with iron, these elevated manganese values are likely related to sampling and/or laboratory error and can be considered anomalous. With the exception of Well 6A, no other well within the vicinity of the proposed well sites have reported manganese in excess of reporting limits.

### 2.2.6.1.4 ARSENIC

Arsenic in drinking water is a naturally-occurring contaminant regulated under the DDW primary MCL of 10 µg/L. Excess levels of arsenic can cause health effects such as high blood pressure and diabetes, and it is classified by the USEPA as a carcinogen (USEPA, 2016).

Arsenic concentrations for the selected production wells within the vicinity of the proposed well sites range from below laboratory reporting limits to 2.8 µg/L and average approximately 0.14 µg/L over the period of record from May 1988 to March 2019 (see Figure 7). Arsenic concentrations within these wells have never exceeded the DDW primary MCL of 10 µg/L during the period of record and the data exhibit observable temporal trend.

#### 2.2.6.1.5 HEXAVALENT CHROMIUM

Chromium in drinking water is a naturally-occurring contaminant regulated under the DDW total MCL of 50 µg/L. A variant of chromium, known as hexavalent chromium, is a known carcinogen and a reproductive toxicant for both males and females (USEPA, 2016). A more stringent MCL of 10 µg/L was established for hexavalent chromium in July 2014 but was later rescinded in May 2017. Hexavalent chromium is currently regulated under the total chromium primary MCL of 50 µg/L.

Hexavalent chromium concentrations for the selected production wells within the vicinity of the proposed well sites range from 3.8 to 11 µg/L and average approximately 6.4 µg/L over the period of record from February 2001 to March 2020 (see Figure 8), below the DDW primary MCL of 50 µg/L for total chromium. However, hexavalent chromium concentrations for several wells, particularly Well 15 (closest well to the proposed well sites), are somewhat elevated and approaching the rescinded MCL of 10 µg/L (see Figure 8). One well, Well 11A, had a single hexavalent chromium value of 11 µg/L, above the rescinded MCL of 10 µg/L (see Figure 8). Chromium concentrations exhibit no observable temporal trend.

#### 2.2.6.1.6 NITRATE

Nitrate is regulated under the DDW primary MCL of 10 mg/L and is a well-known contaminant derived from percolation of nitrogen-based fertilizers applied to crops, high-density animal operations, wastewater treatment, and from leaking septic tanks. Elevated nitrate is known to affect infants under the age of six months as it can interfere with the ability of blood to carry oxygen, and lead to shortness of breath and oxygen deprivation (LADPW, 2014). Elevated nitrate within the AVB is primarily associated with agricultural activity.

Nitrate concentrations for the selected production wells with the vicinity of the proposed well sites range from below laboratory reporting limits to 3.2 mg/L and average approximately 0.6 mg/L over the period of record from September 1987 to March 2020, well below the DDW primary MCL of 10 mg/L (see Figure 9). Since early-2017, nitrate concentrations reported for Well 6A, located less 3,000 feet south-southwest of the proposed well sites, has exhibited slightly more elevated concentrations, likely due to operational changes initiated at that time. Nitrate concentrations in these wells have never exceeded the DDW primary MCL and exhibit no observable temporal trend.

### 2.2.6.2 POINT-SOURCE GROUNDWATER QUALITY IMPAIRMENT

Point sources of contamination are specific sites or locations where contaminants have been released to the subsurface. In areas where there are few or no impermeable layers separating shallow aquifers from deeper aquifers, such as near the mountain fronts, there is the potential threat that these contaminants can readily migrate from the surface to aquifers utilized for water supply. These contaminants can also migrate readily through improperly abandoned wells, and wells screened across multiple aquifer systems.

Figure 10 shows the location of various point sources of contamination in the vicinity of the proposed well sites, including leaking underground storage tank (LUST) sites, permitted underground storage tanks (USTs), military USTs, and Department of Toxic Substances Control (DTSC) sites. The location and status of potential sources of contamination were obtained from the State Water Resources Control Board GeoTracker database (SWRCB, 2020).

There are 17 cases of environmental concern within approximately one-mile of the proposed well site, of which 13 are closed cases, 3 are permitted tanks with no reported leaks (i.e., UST), and one is a DTSC site with no available details or information. These sites are summarized below.

| Site Name | Facility ID | Type | Status | Address |
|---|---|---|---|---|
| A V MALL SHELL #135730 | T10000000154 | LUST | Completed - Case Closed | 1127 Rancho Vista |
| AIR FORCE PLANT 42 - SITE 5 FUEL FARM, UST T5-12, T5-13, T5-14, T5-15, AND T5-16 | T0603700275 | Military UST | Completed - Case Closed | 2501 Avenue P E |
| AIR FORCE PLANT 42 - SITE 7 BLDG 727 | T0603700227 | Military UST | Completed - Case Closed | 1011 Lockheed Way Bldg. 7222 |
| AIR FORCE PLANT 42 - SITE 7 UST T7-15 | T10000002769 | Military UST | Completed - Case Closed | 2001 Avenue P E |
| AIR FORCE PLANT 42 - SITE 7 UST T7-16 | T10000002770 | Military UST | Completed - Case Closed | 2001 Avenue P E |
| CHANDLER LUMBER CO | T0603700263 | LUST | Completed - Case Closed | 39531 15th Street E |
| LOCKHEED AIR TERMINAL | T0603700288 | LUST | Completed - Case Closed | 1011 Lockheed Way |
| LOCKHEED AIR TERMINAL BLDG 617 | T0603700273 | LUST | Completed - Case Closed | 1011 Lockheed Way |
| LOCKHEED AIR TERMINAL CMPLX 10 | T0603700355 | LUST | Completed - Case Closed | 1011 Lockheed Way E |
| LOCKHEED MARTIN AERONAUTICS COMPANY | LACOFA0016375 | Permitted UST | NA | 1011 Lockheed Way |
| LOCKHEED MARTIN SKUNK WORKS | 71004107 | Tiered Permit | Refer: Other Agency | 1011 Lockheed Way |
| LOCKHEED MARTIN SKUNK WORKS | T0603700377 | LUST | Completed - Case Closed | 1011 Lockheed Way |
| LOCKHEED PLANT 10 BLDG 603 | T0603700354 | LUST | Completed - Case Closed | 1011 Lockheed Way E |
| MASSARIAI | T0603700383 | LUST | Completed - Case Closed | 39500 Sierra Hwy |
| PALMDALE SCHOOL DIST | LACOFA0000669 | Permitted UST | NA | 39139 10th Street E |
| PALMDALE SCHOOL DIST | LACOFA0004358 | Permitted UST | NA | 919 E Avenue P-8 #1 |
| PLANT 10, BUILDING 617 | T10000006375 | LUST | Completed - Case Closed | 1011 Lockheed Way |

### 2.2.6.2.1 AIR FORCE PLANT 42

The single major source of potential contamination in the vicinity of the proposed well sites is Air Force Plant 42 and associated facilities (see Figure 10). Air Force Plant 42 began operation in 1940 when Palmdale Airport was activated as a United States Army Air Corps Base. The plant has supported facilities for the production, engineering, final assembly, and flight testing of high-performance aircraft since 1953. Ownership was transferred to the federal government in 1954 and Palmdale Airport officially became Air Force Plant 42 at that time. In 1961, the installation became known by its present name, the Production Flight Test Installation, Air Force Plant 42, Palmdale, California. To support operations at Air Force Plant 42, petroleum, oils, lubricants, solvents, and other chemicals have been utilized (CH2M Hill, 1983 and 2012).

Previous environmental assessments at Air Force Plant 42 have included pre-remedial investigation of soil and soil gas, remedial investigation of shallow and deep soil, soil gas, and groundwater, and interim removal activities (CH2M Hill, 2012). Groundwater investigations were performed at sites where deep soil investigations indicated the presence of soil contaminants that could potentially affect groundwater. Primary constituents of concern include volatile organic compounds (VOCs), particularly trichlorethylene (TCE), which has been detected in groundwater beneath the site.

Data collected during investigation indicate that only relatively low levels of residual chemical constituents exist at the 25 sites identified at Air Force Plant 42. Remedial investigations suggested that 11 of those sites do not pose a significant threat to groundwater. Deep soil investigation results for 11 of the remaining 14 sites suggest no significant threat to groundwater. For the remaining three (3) sites, data were inconclusive with respect to the potential for chemical constituents to affect groundwater, and as such, a supplemental deep soil investigation was performed and groundwater monitoring wells were installed and monitored at those three sites (CH2M Hill, 2012).

Semiannual groundwater monitoring was conducted at three sites as part of the remedial investigation conducted during the period extending from March 2001 through September 2004. Results of this investigation indicated that the primary constituent of concern, TCE, was not detected at a concentration greater than the specified reporting limit of 1 µg/L, with the exception of one detection at a concentration of 1.8 µg/L in September 2002. Confirmation sampling conducted in October 2002 did not detect TCE at concentrations greater than the reporting limit. Results of groundwater monitoring led to the determination that TCE concentrations have stabilized at detection-level concentrations. As such, it was concluded that groundwater underlying the three sites of concern does not appear to be significantly impacted or threatened (CH2M Hill, 2012). Subsequently, regulatory personnel requested in 2004 that the Air Force recommend no further groundwater monitoring for these sites (CH2M Hill, 2012).

# 3.0 ANTICIPATED CONDITIONS

## 3.1 DRILLING

Subsurface materials in this area of the AVB are expected to consist of sand, gravel, silt, and clay in varying proportions. The effective base of the upper principal aquifer is anticipated to occur at a depth of approximately 800 to 1,000 feet bgs in the vicinity of the proposed well sites (see Section 2.1). Based on recent historical water levels measured at nearby Well 15, the depth to groundwater in the vicinity of the proposed well sites is anticipated to range from between approximately 545 to 585 feet bgs within upper principal aquifer (see Figure 3).

## 3.2 PRODUCTION CAPACITY

Instantaneous discharge rates for wells within one mile of the proposed well site range from approximately 300 to 2,000 gpm with an average of approximately 1,295 gpm (see Table 1). These data, combined with published aquifer transmissivity data for the area, suggest aquifers of relatively good yield in the vicinity of the proposed well sites (see Section 2.2.3). As such, it is anticipated that a properly designed and constructed well in this area would be capable of producing approximately 1,000 to 2,000 gpm, depending on local variations in aquifer transmissivity.

## 3.3 GROUNDWATER QUALITY

Groundwater quality data from nearby PWD wells suggest that it is likely possible to design a water supply well at either of the proposed well sites that provides acceptable water quality. The following table summarizes the estimated groundwater quality. However, it should be noted that actual groundwater flow and quality may differ and/or change over time, and as such, it is critical that depth-specific groundwater quality and hydraulic head be well characterized prior to well construction in order to design the best possible water quality blend.

**Estimated Groundwater Quality Blend**

| | TDS [mg/L] | Iron [μg/L] | Manganese [μg/L] | Arsenic [μg/L] | Hex. Chromium [μg/L] | Nitrate [mg/L] |
|---|---|---|---|---|---|---|
| **Regulatory Limit** | **500** | **300** | **50** | **10** | **50*** | **10** |
| Estimated | 220 | ND | ND | ND | 7 | 3 |

*Hexavalent chromium is currently regulated under the primary MLC of 50 μg/L for total chromium. It should be noted that a new, and likely lower, MCL for hexavalent chromium may be promulgated at some point in the future.

Contamination from anthropogenic sources are not expected as there are no significant reported impacts to the deeper aquifers within the area. However, it is recommended that a new well be constructed with a deep annular cement seal in addition to the 50-foot sanitary seal required by DDW, and that isolated aquifer zone testing be performed to verify depth-specific groundwater quality and identify possible contaminants within the various aquifers to be screened.

# 4.0 PRELIMINARY WELL DESIGN CRITERIA

The following sections outline preliminary procedures, protocols, and design elements that are anticipated for installation of a municipal water supply well at either of the proposed well sites. It should be noted the design details presented herein are preliminary and must be refined following drilling and testing of the pilot borehole.

## 4.1 RECOMMENDED WELL DRILLING METHOD

Prior to drilling, it is recommended that a 36-inch outside diameter (OD) conductor casing be installed within a 48-inch diameter borehole to a minimum depth of 50 feet. The conductor casing will be sealed with 10.3-sack sand-cement grout to satisfy Los Angeles County requirements.

A two-pass well drilling method is recommended and will consist of drilling and enlargement of a pilot borehole utilizing the reverse circulation rotary drilling method. This drilling method offers clean and representative lithologic samples and provides for relatively stable large-diameter boreholes. It is recommended that a 17.5-inch diameter pilot borehole be drilled first to an anticipated depth of approximately 1,200 feet bgs, within which, borehole geophysics and isolated aquifer zone testing will be conducted. Information gathered during drilling and testing of the pilot borehole will be utilized to prepare a final well design should it be decided to proceed with well installation. Following the final design phase, the pilot borehole will be reamed (i.e., enlarged) to diameters of 34- and 30-inches to accommodate the well casing and screen, and ancillary tubing.

## 4.2 PRELIMINARY WELL DESIGN

The anticipated design for a municipal water supply well within the study area is shown on Figure 11 and summarized in the following table. It should be noted that this design is conceptual at this time and will require modification and refinement based on the results of drilling and testing.

**Preliminary Well Design Details**

| Depth Interval [feet bgs] | Borehole Diameter [inches] | Casing Diameter [inches] | Casing Wall Thickness [inches] | Slot Size [inches] | Material Description |
|---|---|---|---|---|---|
| +0.5 – 50 | 48 | 36 | 3/8 | - | ASTM A139 Grade B Mild Steel Conductor Casing |
| 0 – 600 | 34 | - | - | - | 10.3-Sack Sand-Cement Grout Seal |
| 600 – 603 | 34 | - | - | - | Fine Transition Sand (#60) |
| 603 – 1,030 | 34 / 30 | - | - | - | Engineered Gravel Envelope (CEMEX Lapis Lustre 6 x 12) |
| +1 – 610 | 34 | 3 | Sch. 40 | - | ASTM A778 304L Stainless Steel Gravel Fill Pipe (x2) |
| +1 – 698* | 34 | 2 | Sch. 40 | - | ASTM A778 304L Stainless Steel Sounding Tube |
| +2 – 620 | 34 | 20 ID | 3/8 | - | ASTM A778 304L Stainless Steel Blank Casing |
| 620 – 700 | 34 | 20 ID | 5/16 | - | ASTM A778 304L Stainless Steel Blank Casing |
| 700 – 1,000 | 30 | 20 ID | 5/16 | 0.080 | ASTM A778 304L Stainless Steel Ful-Flo® Louvered Well Screen |
| 1,000 – 1,010 | 30 | 20 ID | 5/16 | - | ASTM A778 304L Stainless Steel Blank Casing with End Cap |
| 1,010 – 1,030 | 30 | - | - | - | Gravel-Filled Borehole |

* The anticipated depth of the sounding tube entrance box is 696 to 698 feet bgs.

## 4.3 Materials

In an effort to extend the life expectancy of the well and improve the quality of its service life, it is recommended that, at a minimum, all well components, with the exception of the conductor casing, be constructed of ASTM A778 304L stainless steel materials. Under favorable conditions, a well constructed of these materials will have an expected service life of approximately 75 years or greater.

### 4.3.1 Well Casing & Screen

It is recommended that the proposed well casing and screen be a minimum 20-inch inside diameter (ID) throughout its entire length. The recommended wall thickness is 3/8-inch for the upper blank section (+2 to 600 feet bgs) to allow for greater resistance to hydrostatic forces during installation of very deep annular cement seal. The recommended wall thickness for the remaining sections of blank well casing and screen (i.e., 600 to 1,010 feet bgs) is 5/16-inch.

### 4.3.2 Gravel Envelope and Slot Size

A properly engineered gravel envelope design will prevent migration of fine sediments through the well intake structure while allowing for an efficient well with minimum drawdown. Based on previous municipal well installation projects within similar aquifer materials, a CEMEX Lapis Lustre 6 x 12 gravel envelope, or approved equal, with a complimentary 0.080-inch Ful-Flo® louvered slot has proved successful and is recommended in this case. However, the final design of the gravel envelope gradation will ultimately be based on mechanical grading analysis of formation samples collected during drilling of the pilot borehole.

### 4.3.3 Annular Cement Seal

To provide additional protection against migration of surface contaminants, and to protect the upper sections of casing, it is recommended that a deep annular cement seal be installed from ground surface to a depth of approximately 600 feet bgs. The final depth of the annular cement seal will be confirmed based on the results of pilot borehole drilling and geophysical borehole logging.

### 4.3.4 Accessory Tubing

Installation of a deep annular cement seal will necessitate the addition of two (2) 3-inch Schedule (Sch.) 40 304L stainless steel gravel fill pipes to a depth of 610 feet bgs. These gravel fill pipes will allow replenishment of the gravel envelope should it settle during well development and routine operation of the well. It is further recommended that a 2-inch Sch. 40 304L stainless steel sounding tube be installed, entering the casing at depths of 696 to 698 feet bgs through a 3-inch x 3-inch x 2-foot long manufactured transition box. This will allow access for an electric wireline water level meter or pressure transducer such that accurate water level measurements can be taken once the well is permanently equipped and operational.

# 5.0 CONSTRUCTION LOGISTICS

## 5.1 Construction Constraints

Typically, the absolute minimum space required to drill and construct a new municipal supply well using the reverse circulation rotary drilling method is approximately 120 by 60 feet (i.e., 7,200 square feet), but this would require a nearby staging area for storage of equipment and materials, and would present difficulties with the drilling and construction process. An ideal space for drilling and construction is 150 by 150 feet (i.e., 22,500 square feet). The recorded areas of proposed Sites 1 and 2 are 30,542.3 and 43,492.8 square feet, respectively. As such, both sites offer more than adequate space for well drilling and maintenance operations.

The above-ground utilities present at both sites (i.e., telephone and power) must be avoided during construction but do not present any significant hazard or constraints. Additionally, there is an active natural gas pipeline that parallels the western side of 10$^{th}$ Street East, and although not an immediate hazard, it should be considered should heavy equipment be utilized in that area.

The proposed well sites are positioned along the general flight path for Runway 4 at Palmdale Regional Airport. Site 1 is approximately 1.1 miles from the end of the runway and Site 2 is approximately 0.8 miles from the runway. Flight safety should be considered during drilling and the mast of the rig should be equipped with flags and warning lights.

## 5.2 Construction Water Source

The proposed source of construction water at Site 1 is a fire hydrant located approximately 830 feet south of the proposed well site on the east side of 10$^{th}$ Street East (see Figure 12). Use of this hydrant will require the drilling contractor to provide a temporary means of conveyance from the hydrant to the well site, and any associated crossings to maintain access to other facilities. Currently, the closest source of construction water at Site 2 is a fire hydrant located approximately 2,135 feet south and west of the proposed well site that will require a traffic-rated ramp and a traffic control measures to cross E. Rancho Vista Boulevard (see Figure 12). Alternatively, new service could be installed at Site 2 to allow for simpler construction logistics.

## 5.3 Noise Mitigation

The closest sensitive noise receptors to either of the proposed well sites is a single family home located approximately 2,400 feet south of Site 1. As such, it is anticipated that noise mitigation will not be necessary at either of the proposed well sites.

## 5.4 Cuttings and Fluids Disposal

All drill cuttings and fluids used to drill the well (i.e., drilling mud) will be disposed of offsite by the drilling contractor. However, it will be necessary to temporarily store cuttings on site for drying prior to hauling them offsite for disposal.

## 5.5 DISCHARGE CONSIDERATIONS

Waste fluids generated during development and testing of any new well must be legally disposed of at designated discharge points by means of temporary above-ground piping. There are several options that will require further investigation and refinement prior to preparing the technical specifications and contract documents. Those are summarized as follows in no particular order:

- Discharge to ground surface in the vicinity of each of the proposed well sites. This will require permission from adjacent land owners to construct a temporary bermed area to contain and percolate discharges, and will require construction of some length of temporary conveyance pipeline and road crossings to convey the waste water to the designated discharge points. The minimum dimensions of the bermed area are estimated to be 400 by 400 feet assuming a maximum ponded water height of 2.5 feet and a high degree of percolation.

- Discharge to the unlined drainage channel that parallels the western boundary of the solar farm property (along 10th Street East), cutting across the northwestern corner of the property, and ultimately leading to what appears to be a large percolation pond north of the intersection of 15th Street East and Lockheed Way (see Figure 12). Site 1 would require approximately 720 feet of above-ground piping, heading south of the proposed well, to reach the channel (see Figure 12). Site 2 would require approximately 2,800 feet of above-ground piping, heading north and west of the proposed well, to reach the channel (see Figure 12). Erosion control and mitigation measures will be necessary to prevent scouring.

For either option, it will be necessary to investigate any permits and permissions that may be required (e.g., NPDES, encroachment, ROE, etc.) and the requirements thereof. The typical estimated discharge events and associated duration and volumes of waste water anticipated to be discharged for a well of this estimated capacity are summarized in the following table. These values are for planning purposes only and are subject to change based on actual conditions encountered.

**Summary of Anticipated Discharges During Construction**

| Discharge Event | Duration | | Discharge Rate | Discharge Vol. |
|---|---|---|---|---|
| | Work Days | Hours | [gpm] | [gal] |
| **Isolated Aquifer Zone Testing** | | | | |
| Day 1 | 1 | 18 | 200 | 216,000 |
| Day 2 | 2 | 18 | 200 | 216,000 |
| Day 3 | 3 | 18 | 200 | 216,000 |
| Day 4 | 4 | 18 | 200 | 216,000 |
| Day 5 | 5 | 18 | 200 | 216,000 |
| **Initial Development Pumping** | | | | |
| Day 1 | 6 | 24 | 150 | 216,000 |
| Day 2 | 7 | 24 | 150 | 216,000 |
| Day 3 | 8 | 24 | 150 | 216,000 |
| Day 4 | 9 | 24 | 150 | 216,000 |
| Day 5 | 10 | 24 | 150 | 216,000 |

| Discharge Event | Duration | | Discharge Rate | Discharge Vol. |
|---|---|---|---|---|
| | Work Days | Hours | [gpm] | [gal] |
| **Final Development Pumping** | | | | |
| Day 1 | 11 | 10 | 1,800 | 1,080,000 |
| Day 2 | 12 | 10 | 1,800 | 1,080,000 |
| Day 3 | 13 | 10 | 1,800 | 1,080,000 |
| Day 4 | 14 | 10 | 1,800 | 1,080,000 |
| Day 5 | 15 | 10 | 1,800 | 1,080,000 |
| Day 6 | 16 | 10 | 1,800 | 1,080,000 |
| **Step Drawdown Testing** | | | | |
| Day 1 | 17 | 1 | 1,000 | 60,000 |
| | | 2 | 2,000 | 240,000 |
| | | 3 | 3,000 | 540,000 |
| **Constant Rate Test** | | | | |
| Day 1 | 18 | 24 | 2,000 | 2,880,000 |
| **TOTAL:** | **18** | **300** | **-** | **12,366,000** |

## 5.6 PERMITTING CONSIDERATIONS

### 5.6.1 REQUIRED SETBACKS

DDW and the County of Los Angeles Department of Public Health, Environmental Health Division, require that certain minimum distances be maintained between a potable water supply well and specific activities and infrastructure which may present a sanitary hazard. The most common of these minimum setback requirements include the following:

- Sanitary Sewer Line or Lateral: 50 feet
- Sewer Manhole (DDW): 100 feet
- Sewer Manhole (County of Los Angeles): 50 feet
- Storm Drain or Drainage Channel: 50 feet
- Petroleum Transmission Mains: 500 feet
- Dwelling: 25 feet

The proposed well locations currently meet all applicable minimum setback requirements as stipulated by DDW and the County of Los Angeles. However, it may be necessary to revisit these requirements should there be plans to install new sewer systems as part of the solar farm facilities.

### 5.6.2 CONTROL ZONE REQUIREMENT

The area of each proposed well site is sufficient to allow the location of a well within the sites to comply with the California Code of Regulations (CCR) control zone requirement, which states that the area surrounding a new municipal water supply well must be under the control of the well owner to a radius of at least 50 feet. However, it will be necessary to position the wells at an appropriate location from which the requirement will be met.

## 5.7 WELL SITE RECOMMENDATIONS

Both of the proposed well sites are considered feasible locations for installation of new groundwater supply wells. Site 1, located on 10th Street East, is considered most suitable for new well construction as 1) the site is more proximal to an existing construction water source, 2) the site is more proximal to the unlined drainage channel that may be utilized for discharge of waste water, and 3) the site is located farthest from potential water level interference imparted by pumping of the existing PWD wellfield. However, there have been anecdotal reports that the hydrogeology changes from east to west across the study area, becoming less productive to the west. As such, of the two proposed well sites, Site 2 is considered most favorable to PWD.

# 6.0 ENGINEER'S ESTIMATE OF CONSTRUCTION COST

## 6.1 WELL CONSTRUCTION

An engineer's estimate of costs to drill, construct, and develop a well with the conceptual design presented herein is included in Table 2. This estimate was based on recent winning bids in the southern California area for large diameter municipal supply wells, and recent steel prices obtained from Roscoe Moss Company. This estimate should be revised should a significant period of time elapse between the date of this report and bidding of the drilling contract. As shown in Table 2, the estimated cost to install a well per the design included herein is approximately $1.53 million, including a 20% contingency. This estimate does not include design, construction management, or inspection.

## 6.2 WELL EQUIPPING & CONNECTION TO DISTRIBUTION SYSTEM

The estimated cost for equipping of the well and connection to the existing distribution system was based upon recent estimates prepared for similar construction within the Southern California area. The estimated cost for new pipeline installation is based on open-trench construction, a distance of approximately 1,680 feet to the nearest point of connection on E. Rancho Vista Blvd., and 12-inch diameter ductile iron pipe. The total estimated cost for well equipping and connection to the existing distribution system, as shown in Table 3, is approximately $1.25 million, including a general contractor markup of 20% and a contingency of 15%. This estimate does not include design, construction management, or inspection.

# 7.0 REFERENCES

American Water Works Association, 2020. Water Wells. ANSI/AWWA A100-20. July 1, 2020.

Batu, Vedat, 1998. Aquifer Hydraulics – A Comprehensive Guide to Hydrogeologic Data Analysis. A Wiley-Interscience Publication. John Wiley & Sons, Inc., 1998.

Beeby, R., Durbin, T., Leever, W., Leffler, P., Scalmanini, J.C., and Wildermuth, M., (Beeby, et al.), 2010. Summary Expert Report – Phase 3 – Basin Yield and Overdraft – Antelope Valley Area of Adjudication. July 2010.

Bloyd, R.M., 1967. Water Resources of the Antelope Valley-East Kern Water Agency Area, California. USGS Open File Report 67-21. Menlo Park, California. August 28, 1967.

California Department of Water Resources, 2020. Well Completion Report Map Application: https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37. Accessed: May 2020.

California Department of Water Resources, 2003. California's Groundwater. Bulletin No. 118. Update 2004.

California Department of Water Resources, 1991. California Well Standards. Bulletin 74-81 and Supplement 74-90. Sacramento, California. June 1991.

California Department of Conservation, Division of Oil, Gas, and Geothermal Resources, 2019. Online Well Information Database. https://www.conservation.ca.gov/dog/Pages/WellFinder.aspx. Accessed: January 2019.

California State Water Resources Control Board, 2020. GeoTracker Online Database: http://geotracker.waterboards.ca.gov. Accessed: August 2020.

California State Water Resources Control Board, Division of Drinking Water, 2020. Electronic Data Transfer (EDT) Library – Water Quality Analyses Database Files. Accessed: August 2020.

CH2M Hill, 2012. Final Record of Decision for 25 Installation Restoration Program Sites – Air Force Plant 42, Palmdale, California. October 2012.

CH2M Hill, 1983. Installation Restoration Program, Records Search, Phase I / Stage 1 for Plant 42, California.

Cooper, H.H., Jr., and Jacob, C.E., 1946. A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well Field History. Transactions, American Geophysical Union, Vol. 27, No. 4.

Driscoll, Fletcher G., 1986. Groundwater and Wells. Second Edition. Johnson Screens, St. Paul, Minnesota. 1986.

Duell, F.W. Lowell, 1987. Geohydrology of the Antelope Valley Area, California, and Design for a Ground-Water Quality Monitoring Network. USGS Water Resources Investigations Report 84-4081. Sacramento, California. 1987.

Durbin, T.J., 1978. Calibration of a Mathematical Model of the Antelope Valley Ground-Water Basin, California. USGS Water Supply Paper 2046. 1978.

Ferris, J.G., Knowles, R.H., Brown, R.S., and Stallman, R.W., 1963. Theory of Aquifer Tests. U.S. Geological Survey Water Supply Paper 1536-E.

KYLE Groundwater, Inc., 2020. Well Rehabilitation Prioritization Program – 50% Draft Report. Prepared for Palmdale Water District. June 14, 2020.

Leighton, D.A., and Philips, S.P., 2003. Simulation of Ground-Water Flow and Land Subsidence in the Antelope Valley Groundwater Basin, California. USGS Water Resources Investigations Report 03-4016. Sacramento, California. 2003.

Los Angeles County Department of Public Works, 2018. Online Groundwater Well Database: http://dpw.lacounty.gov/general/wells/. Accessed: May 11, 2018.

Los Angeles County Department of Public Works, 2014. Salt and Nutrient Management Plan for the Antelope Valley. May 2014.

MWH, 2016. 2016 Water System Master Plan. Prepared for: Palmdale Water District. December 2016.

MWH, 2008. Hydrogeologic Review for Two Proposed Water Wells. Technical Memorandum prepared for: Palmdale Water District. March 25, 2008.

Pipeline and Hazardous Materials Safety Administration, 2020. National Pipeline Mapping System (NPMS) Public Map Viewer: https://pvnpms.phmsa.dot.gov/publicviewer. Accessed August 2020.

Roscoe Moss Company, 1991. Handbook of Groundwater Development. A Wiley-Interscience Publication. John Wiley & Sons, Inc., 1990.

Siade, A.J., Nishikawa, Tracy, Rewis, D.L., Martin, Peter, and Phillips, S.P., 2014. Groundwater-Flow and Land-Subsidence Model of Antelope Valley, California: USGS Scientific Investigations Report 2014–5166. 136 p.

Standish-Lee Consultants, and Palmdale Water District, 1999. Palmdale Water District Groundwater Assessment and Protection Program. Prepared for: Palmdale Water District. January 1999.

Theis, C.V., Brown, R.H., and Meyer, R.R., 1963. Estimating the Transmissibility of Aquifers from the Specific Capacity of Wells. United States Geological Survey Water Supply Paper 1536-I, pp 331-340. 1963.

Theis, C.V., 1935. The Relation Between the Lowering of the Piezometric surface and the Rate and Duration of Discharge of a Well Using Groundwater Storage. Transactions, American Geophysical Union. Washington D.C., pp 518 524.

Todd Groundwater, 2019. 2018 Annual Report – Antelope Valley Watermaster – Final. Prepared for: Antelope Valley Watermaster. July 29, 2019.

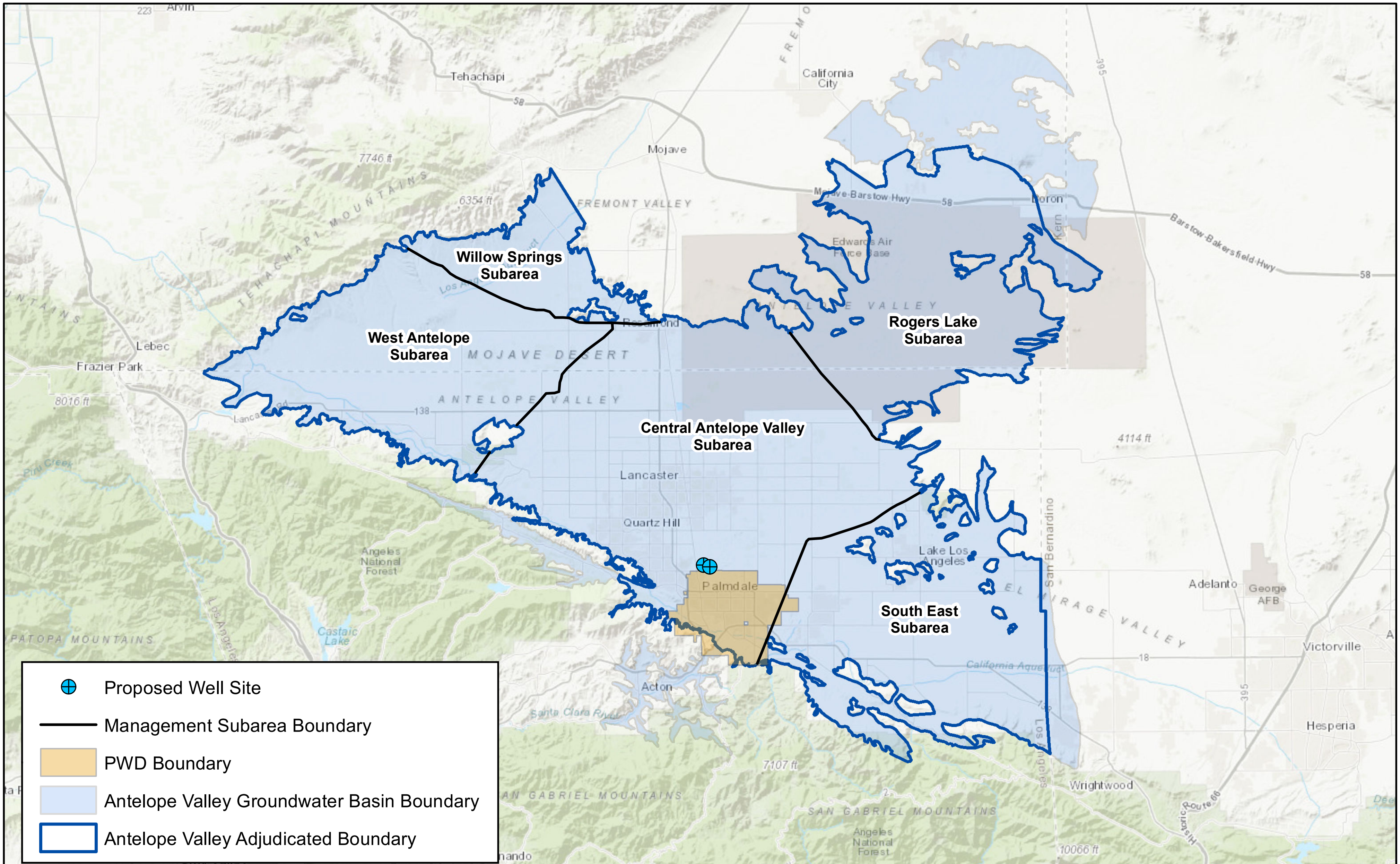
Todd Groundwater, 2020. 2019 Annual Report – Antelope Valley Watermaster – Final. Prepared for: Antelope Valley Watermaster. July 29, 2020.

United States Environmental Protection Agency, 2016. Secondary Drinking Water Standards: Guidance for Nuisance of Chemicals. www.epa.gov. January 2016.

United States Geological Survey, 2013. Groundwater Quality in the Antelope Valley, California. January 2013.

United States Geological Survey, 1978. Antelope Valley East-Kern Water Agency Area, California. Open-File Map 78-937. Compiled by G.G. Blankenbaker. 1978

**FIGURES**




# GENERAL PROJECT LOCATION

WELL SITE ASSESSMENT - WELL NOS. 36 AND 37
PALMDALE WATER DISTRICT
PALMDALE, CALIFORNIA
AUGUST 2020

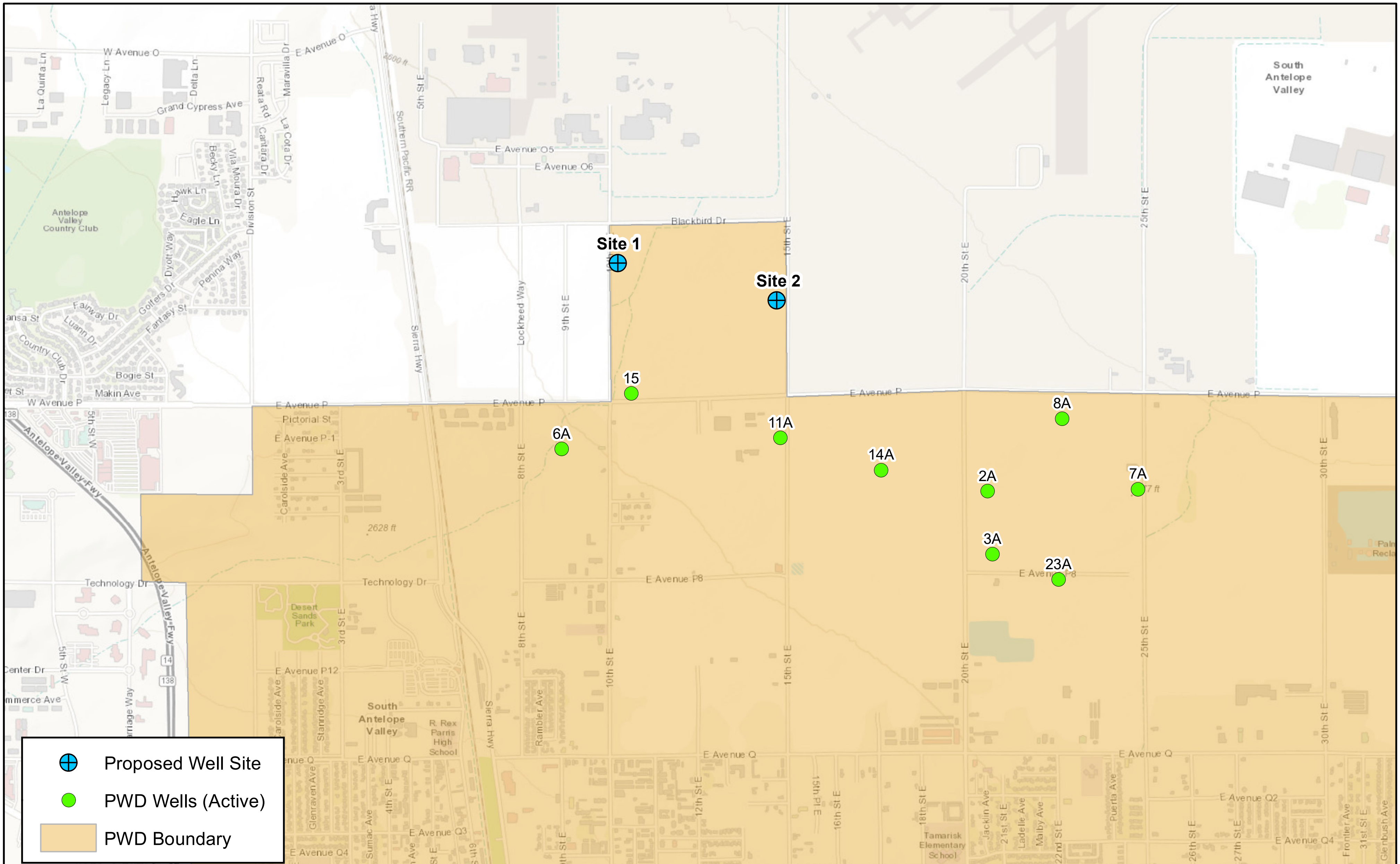
N

0 5 10
Miles

Notes:

KYLE Groundwater

| PROJECT NO. | FIGURE |
|---|---|
| 3020.002 | 1 |




# LOCATION OF PROPOSED WELL SITES

WELL SITE ASSESSMENT - WELL NOS. 36 AND 37
PALMDALE WATER DISTRICT
PALMDALE, CALIFORNIA
AUGUST 2020

N

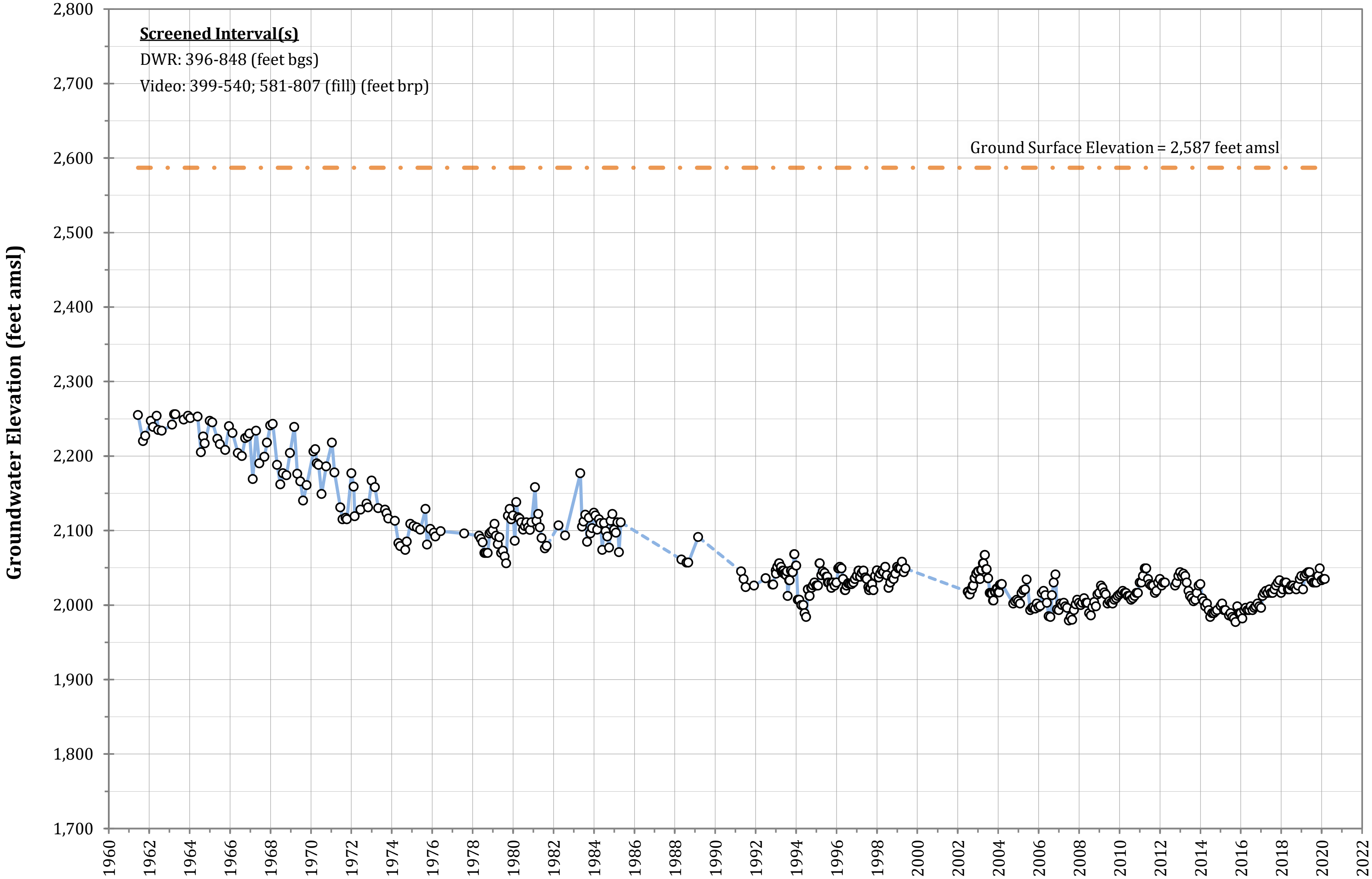
0 1,000 2,000
Feet

Notes:

KYLE Groundwater

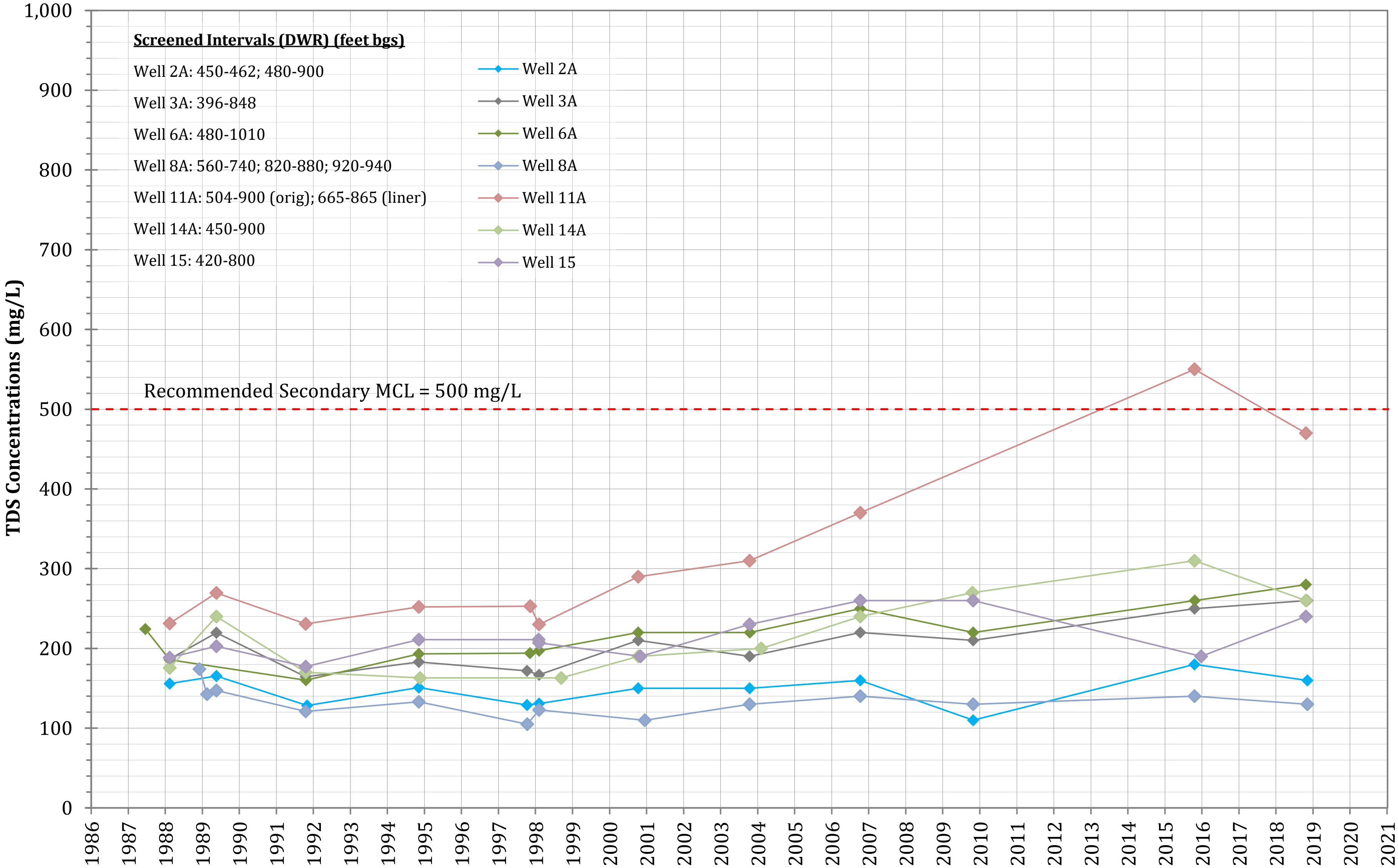
| PROJECT NO. | FIGURE |
| --- | --- |
| 3020.002 | 2 |

## Historical Groundwater Elevations
## Well No. 3A



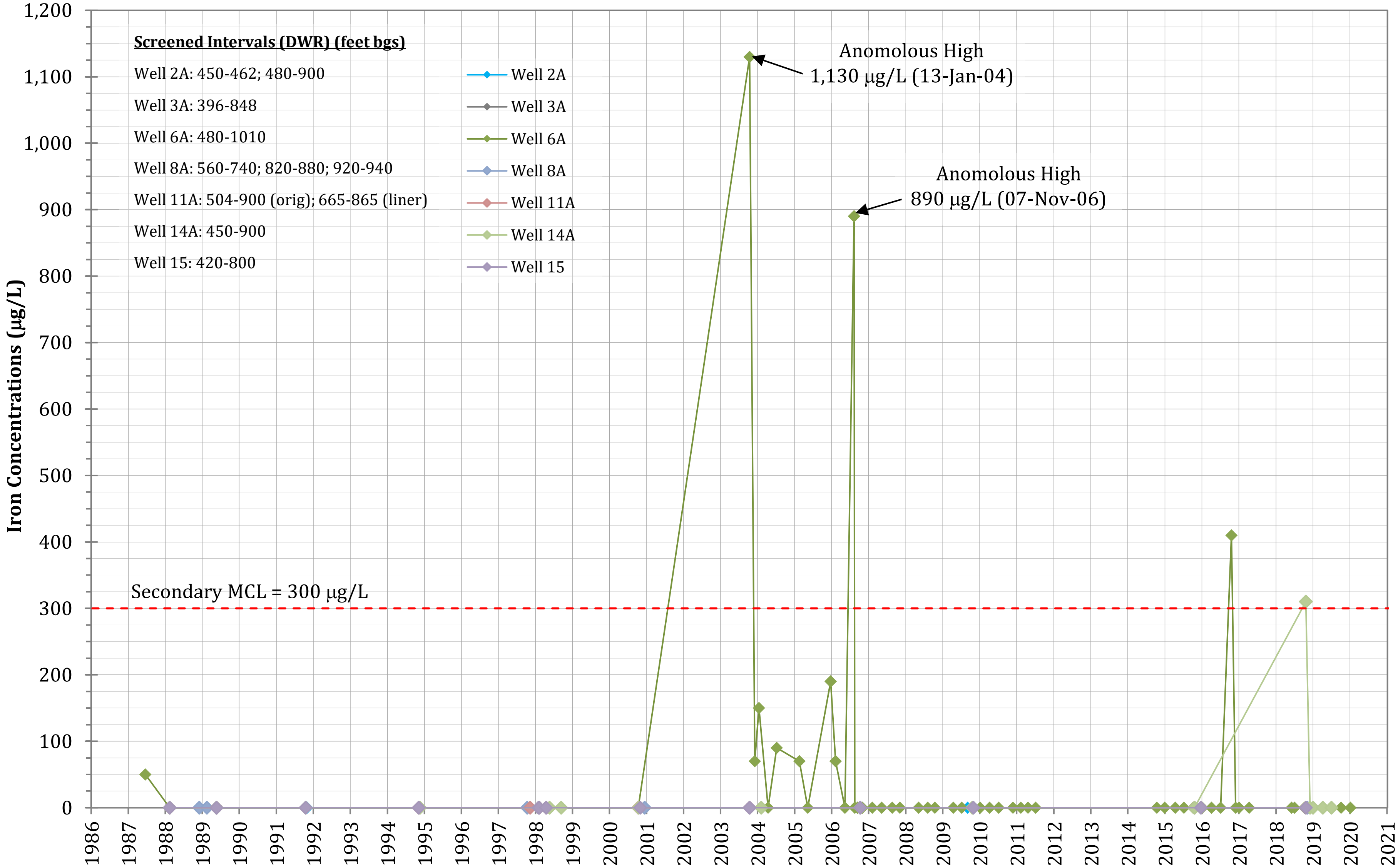

Source: Palmdale Water District (2020) and USGS, 2020.

## Historical TDS Concentrations
## Selected Production Wells




Source: State Water Resources Control Board Division of Drinking Water, 2020.

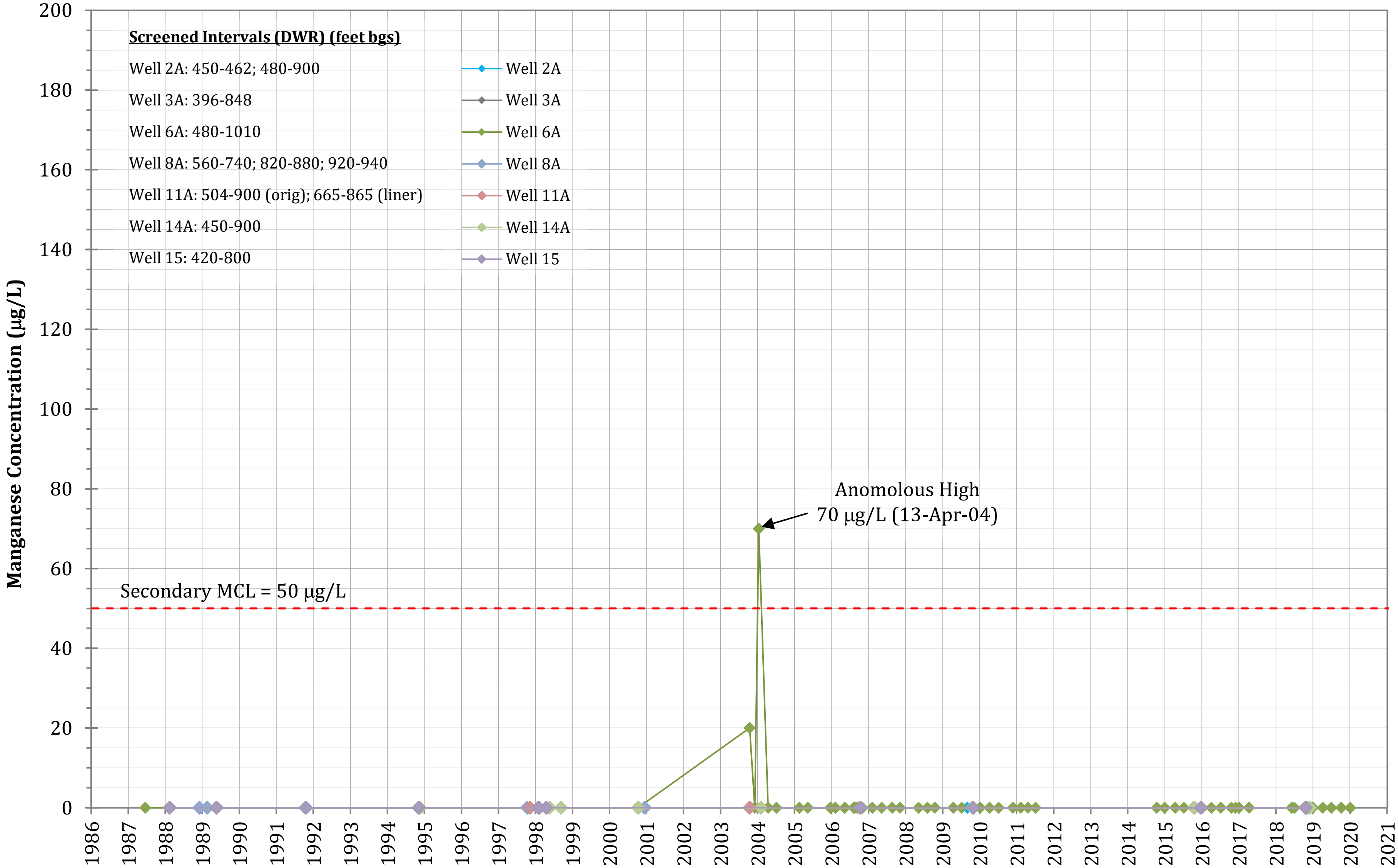
## Historical Iron Concentrations
## Selected Production Wells




Source: State Water Resources Control Board Division of Drinking Water, 2020.

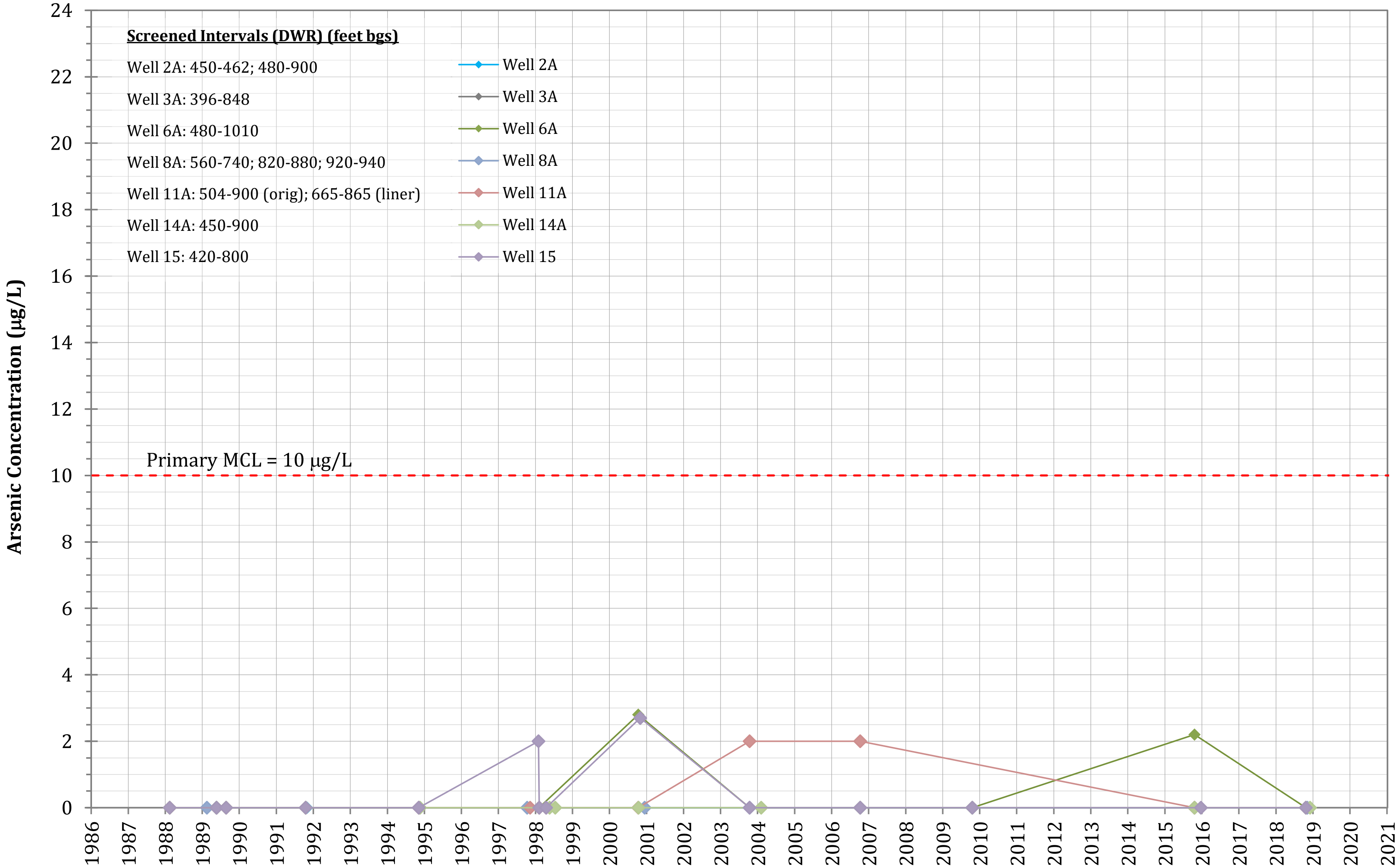
**Figure 6**

## Historical Manganese Concentrations
## Selected Production Wells



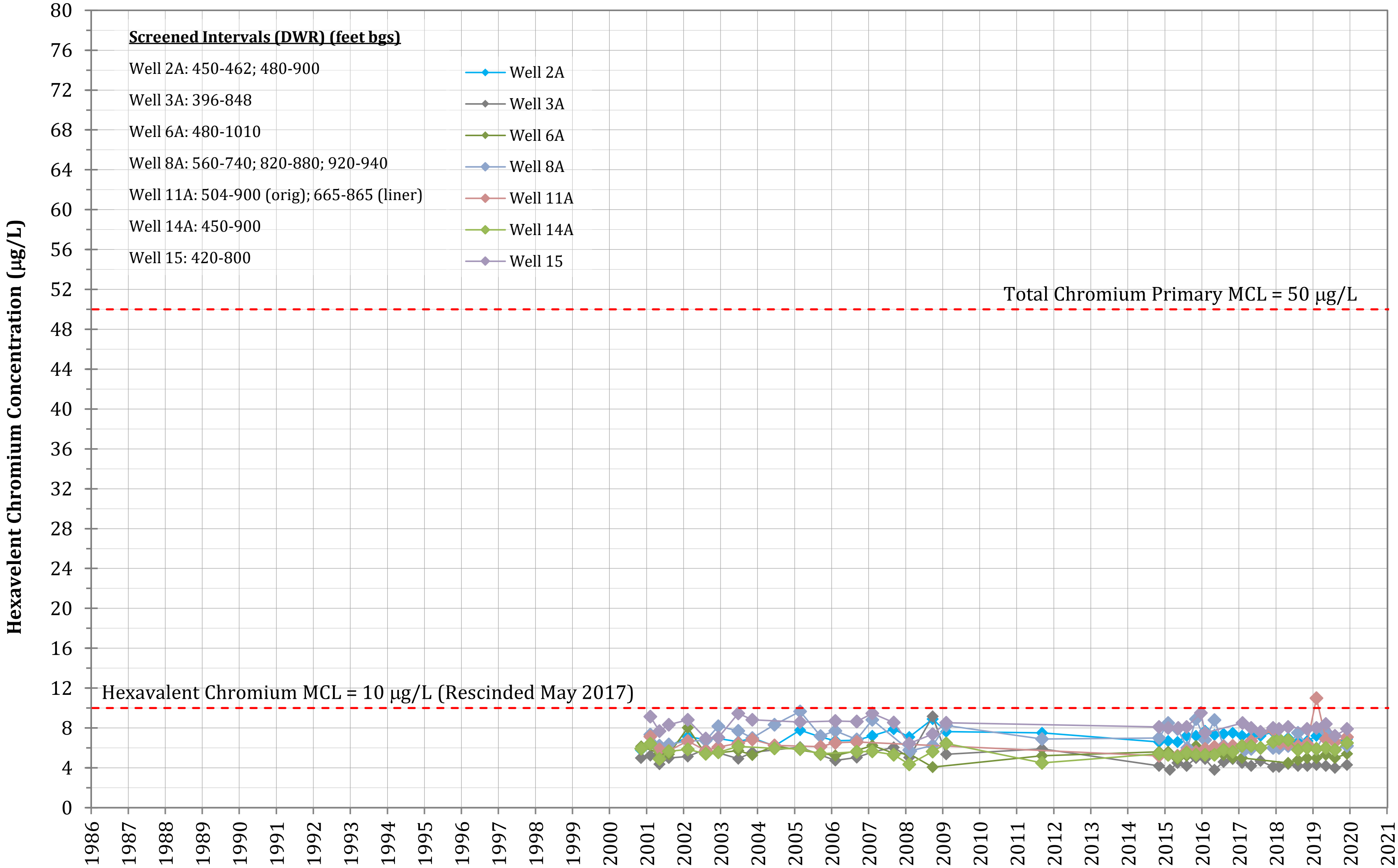

Source: State Water Resources Control Board Division of Drinking Water, 2020.

## Historical Arsenic Concentrations
## Selected Production Wells



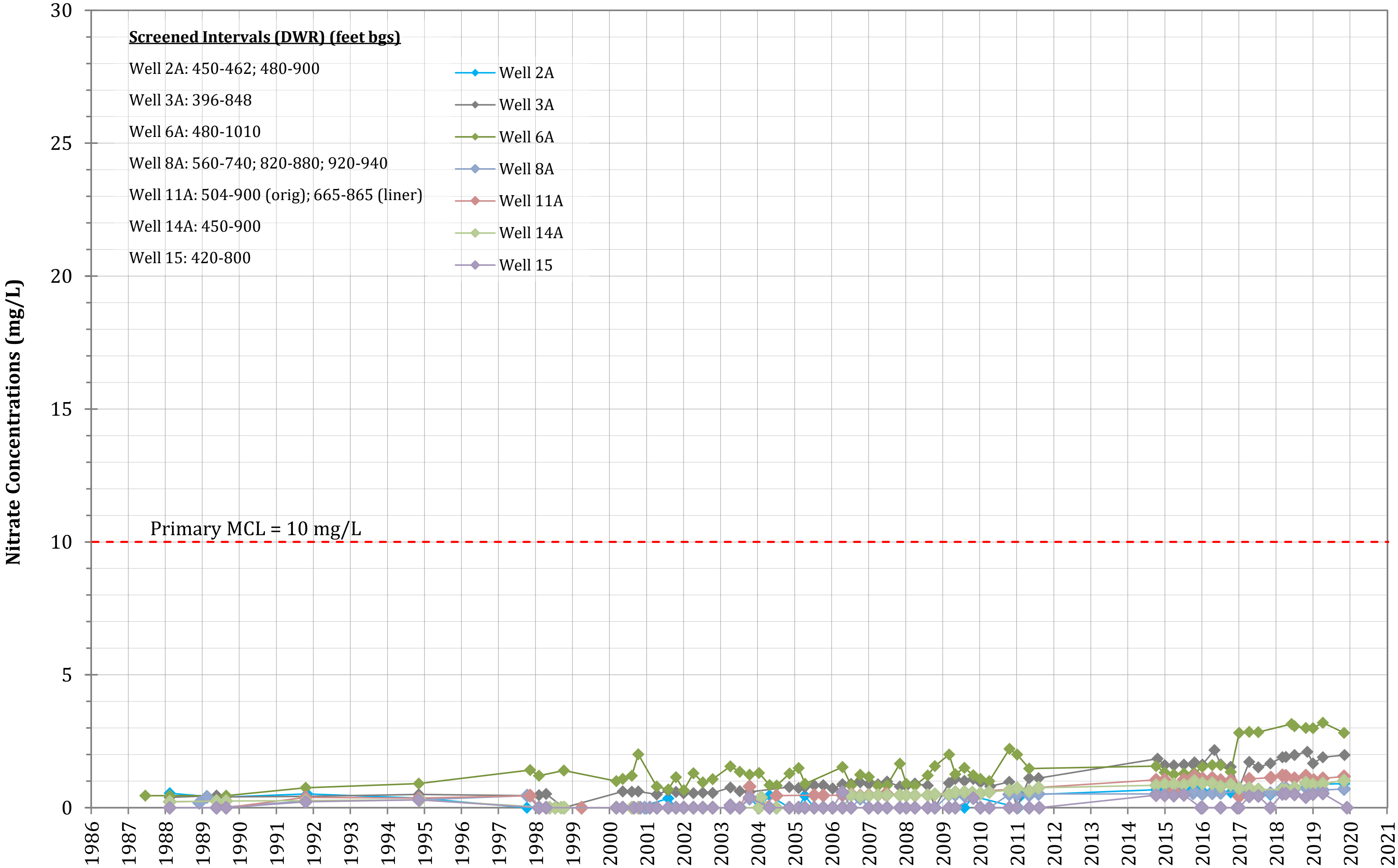

Source: State Water Resources Control Board Division of Drinking Water, 2020.

## Historical Hexavalent Chromium Concentrations
## Selected Production Wells

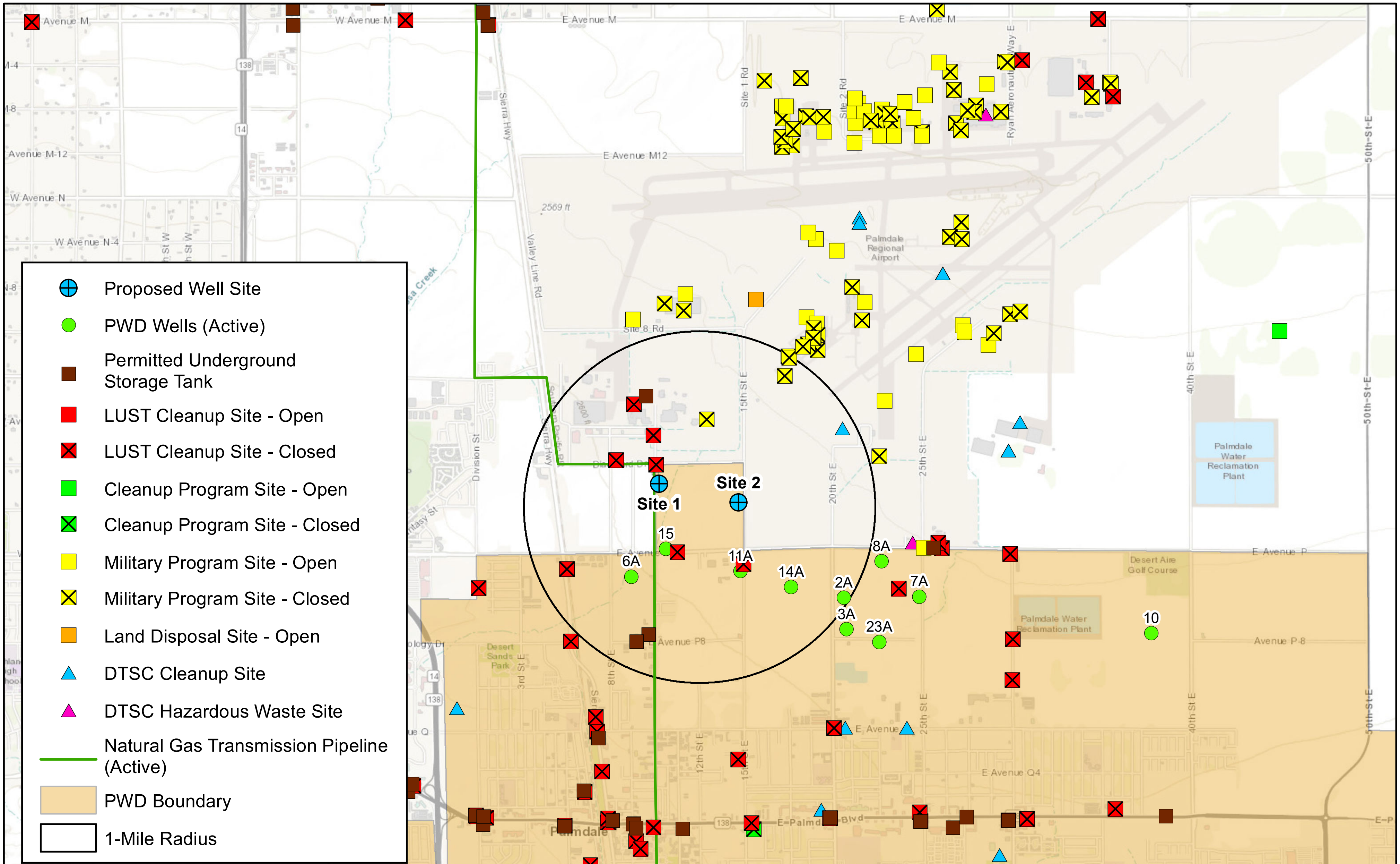



Source: State Water Resources Control Board Division of Drinking Water, 2020.

## Historical Nitrate Concentrations
## Selected Production Wells




Source: State Water Resources Control Board Division of Drinking Water, 2020.




# SITES OF ENVIRONMENTAL CONCERN

WELL SITE ASSESSMENT - WELL NOS. 36 AND 37
PALMDALE WATER DISTRICT
PALMDALE, CALIFORNIA
AUGUST 2020

N

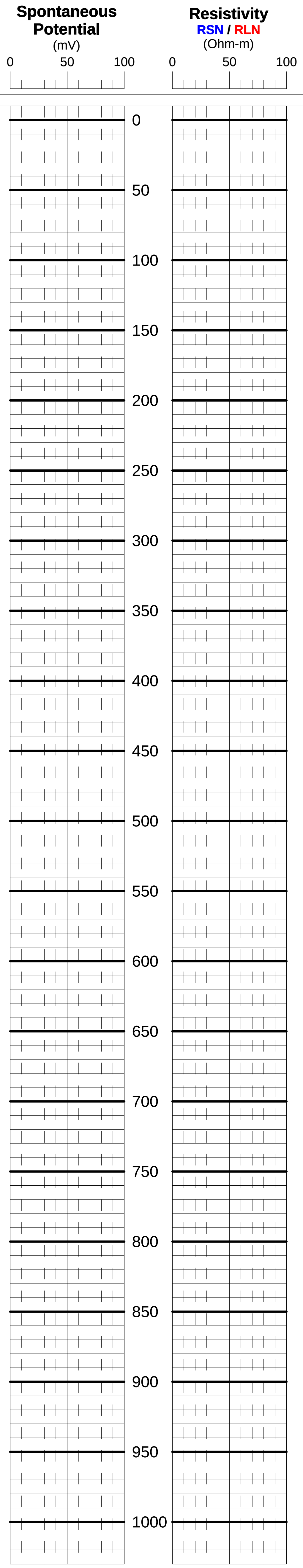
0 2,000 4,000
Feet

Notes:
Geotracker sites as of 8/29/20.

KYLE Groundwater

| PROJECT NO. | FIGURE |
|---|---|
| 3020.002 | 10 |

| Lithology (Well Drillers Report) (Well 15) | Interpreted USCS Field Classification |
|---|---|
| SAND: surface soil | SP |
| GRAVEL: gravel | GP |
| CLAY: clay with gravel | CL |
| SAND: sand, clay streaks | SP |
| SAND W/CLAY: sand, clay and coarse gravel | SP-SC |
| SAND: sand, clay streaks | SP |
| SAND: fine sand | SP |
| SAND: sand, gravel | SP |
| SAND: sand, clay streaks | SP |
| GRAVEL: gravel | GP |
| SAND: hard packed sand | SP |
| SAND: coarse sand | SP |
| SAND: hard packed sand | SP |
| SAND: sand, clay streaks | SP |
| SAND: hard packed sand | SP |
| CLAY: clay and sand | CL |
| SAND: hard packed sand | SP |
| SAND: sand, clay streaks | SP |
| SAND: hard sand | SP |
| SAND: hard fine sand | SP |
| SAND: fine sand and clay | SP |
| SAND: hard sand, cemented | SP |
| Borehole terminated at 880 feet. | N/A |




**Well Design Profile**

Ground Surface

48" Diameter Borehole (0'-50')

Conductor Casing
36" Diameter x 3/8" Wall ASTM A139
Grade B Mild Steel (+0.5'-50')

Sanitary Seal Cement Grout (0'-50')

34" Diameter Borehole
(50'-700')

Well Casing
20" I.D. x 3/8" Wall ASTM A778
304L Stainless Steel Blank
(+2'-620')

Annular Seal
10.3-Sack Sand-Cement Grout
(0'-600')

Static Water Level
Feb-2020
(548' brp)

Fine Transition Sand (#60)
(600'-603')

Gravel Fill Pipes (2x)
3" Nom. Sch. 40 304L Stainless Steel
(+1'-610')

Well Casing
20" I.D. x 5/16" Wall ASTM A778
304L Stainless Steel Blank
(620'-700')

Sounding Tube
2" Nom. Sch. 40 304L Stainless Steel
(+1'-698'; Connection Box 696'-698')

30" Diameter Borehole
(700'-1,030')

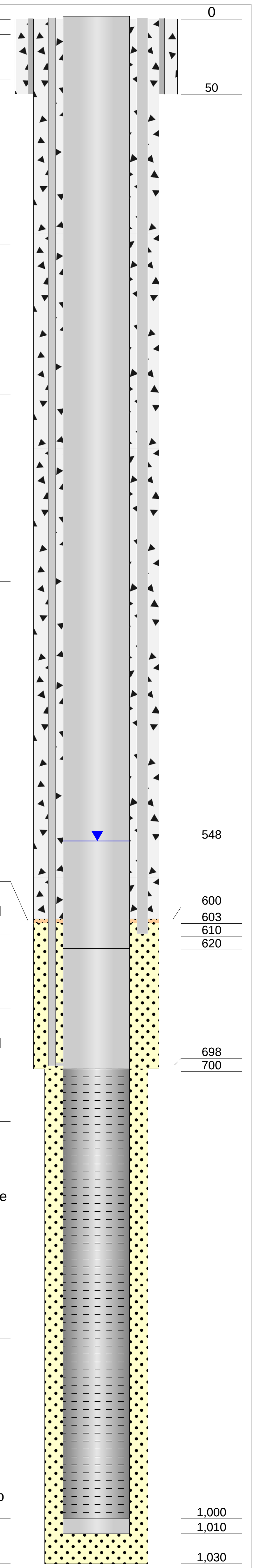
Well Screen
Ful-Flo Louvered
20" I.D. x 5/16" Wall ASTM A778
304L Stainless Steel w/0.080" Slot Size
(700'-1,000')

Gravel Envelope
CEMEX Lapis Lustre 6x12
(603'-1,030')

Well Sump
20" I.D. x 5/16" Wall ASTM A778
304L Stainless Steel Blank w/End Cap
(1,000'-1,010')

Total Well Depth (1,010')

Total Borehole Depth (1,030')




# PRELIMINARY WELL DESIGN PROFILE

WELL SITE ASSESSMENT
WELL NOS. 36 AND 37
PALMDALE WATER DISTRICT
PALMDALE, CALIFORNIA
AUGUST 2020

BOREHOLE DIAMETERS (in): 48; 34; 30
BOREHOLE DEPTHS (ft): 50; 700; 1,030
SCREEN INTERVALS (ft bgs): 700-1,000
CASING INTERVALS (ft bgs): +2-700; 1,000-1,010
STEEL TYPE AND DIAMETER (in): 304L SS, 20 ID

Notes:

DRAWN BY: K.MAKAR
APPROVED BY: R.KYLE

KYLE Groundwater

PROJECT NO. 3020.002

FIGURE 11


# WATER SOURCE AND DISCHARGE CONVEYANCE

WELL SITE ASSESSMENT - WELL NOS. 36 AND 37
PALMDALE WATER DISTRICT
PALMDALE, CALIFORNIA
AUGUST 2020

N

0 750 1,500

Feet

Notes:

KYLE Groundwater

| PROJECT NO. | FIGURE |
| --- | --- |
| 3020.002 | 12 |

# TABLES

KYLE Groundwater

# Summary of Well Construction and Operational Details

| Well Name | State Well Number | Well Status | Street Address | Construction Year | Well Depth | Screen Interval(s) | Pumping Rate | Drawdown | Specific Capacity | Year Measured | Aquifer Transmissivity | Source of Transmissivity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | [feet bgs] | [feet bgs] | [gpm] | [feet] | [gpm/ft] | | [gpd/ft] | |
| 2A | 06N11W19E | Active | 39400 20th Street | 1968 | 900 | 450-462; 480-900 | 1,500 | 25 | 60 | 1,968 | 126,000 | Specific Capacity |
| 3A | 06N11W19E | Active | 2163 E. Avenue P-8 | 1960 | 848 | 396-848 | 1,544 | 32 | 48 | 2,002 | 99,000 | Specific Capacity |
| 4A | 06N11W19F | Inactive Standby (High CrVI) | 2475 E. Avenue P-8 | 1970 | 830 | Ful-Flo: 480-510; 540-630; 690-720; 780-810 Std Flo: 510-540; 630-690; 720-780; 810-830 | 499 | 19 | 26 | 2013 | 51,000 | Specific Capacity |
| 6A | 06N12W23A | Active | 39455 10th Street | 1983 | 1,010 | 480-1,010 | 296 | 87 | 3 | 2,009 | 5,000 | Specific Capacity |
| 7A | 06N11W19F | Active | 39395 25th Street | 1985 | 920 | 570-900 (orig.) 570-832.5 (plugged below) | 2,000 | 54 | 37 | 1,985 | 113,000 | Specific Capacity |
| 8A | 06N11W19C | Active | 2200 E. Avenue P | 1988 | 960 | 560-740; 820-880; 920-940 | 1,977 | 29 | 68 | 1,990 | 145,000 | Specific Capacity |
| 11A | 06N12W24C | Active | 39501 E. 15th Street | 1963 | 900 | 504-900 (orig.) 665-865 (Liner) | 1,161 | 29 | 40 | 1,989 | 81,000 | Specific Capacity |
| 14A | 06N12W24A | Active | 39401 20th Street | 1965 | 900 | 450-900 | 1,479 | 18 | 80 | 1,966 | 172,000 | Specific Capacity |
| 15 | 06N12W13N01 | Active | 1003 East Avenue P | 1960 | 800 | 420-800 (DWR) 320-800 (Actual) | 1,750 | 44 | 40 | 1,960 | 81,000 | Specific Capacity |
| 23A | 06N11W19L | Active | 2202 E. Avenue P-8 | 1991 | 840 | 600-840 | 743 | 33 | 22 | 2,003 | 42,000 | Specific Capacity |

**Sources:**

California Department of Water Resources, 2018.

Palmdale Water District, 2020.

State Water Resources Control Board Division of Drinking Water, 2018.

## ENGINEER'S ESTIMATE OF CONSTRUCTION COST
## Drilling, Construction, Development, and Testing of One New Well

| Item No. | Description | Qty | Units | Unit Price | Total Item Price |
|---|---|---|---|---|---|
| 101 | Mobilization, site preparation, demobilization, site cleanup, and restoration. | 1 | LS | $125,000.00 | $125,000.00 |
| 102 | Comply with Discharge Requirements, Including Discharge Pipeline, Monitoring, and Reporting (assumes discharge to ground) | 1 | LS | $10,000.00 | $10,000.00 |
| 103 | Testing and Disposal of Drill Cuttings | 1 | LS | $5,000.00 | $5,000.00 |
| 104 | Drill 48-inch Borehole, Furnish and Install 36-inch OD x 3/8-inch Wall ASTM A139 Mild Steel Conductor Casing, Cement in Place | 50.5 | FT | $600.00 | $30,300.00 |
| 105 | Drill 17.5-inch Pilot Borehole from 50 to 1,200 feet | 1,150 | FT | $80.00 | $92,000.00 |
| 106 | Provide Geophysical Borehole Logs | 1 | LS | $5,000.00 | $5,000.00 |
| 107 | Install Isolated Aquifer Zone Tool, Seals, and Gravel Envelope, and Provide for Initial Development by Airlifting | 5 | EA | $12,500.00 | $62,500.00 |
| 108 | Pump Isolated Aquifer Zones (estimate 8 hours per zone) | 40 | HR | $400.00 | $16,000.00 |
| 109 | Provide Isolated Aquifer Zone Test Laboratory Analyses | 5 | LS | $3,500.00 | $17,500.00 |
| 110 | Ream Pilot Borehole to 34-inch from 50 to 700 feet | 650 | FT | $80.00 | $52,000.00 |
| 111 | Ream Pilot Borehole to 30-inch from 700 to 1,030 feet | 330 | FT | $70.00 | $23,100.00 |
| 112 | Provide Caliper Survey of Reamed Borehole | 1 | LS | $2,000.00 | $2,000.00 |
| 113 | Furnish and Install 20-inch ID x 3/8-inch Wall ASTM A778 304L Stainless Steel Blank Well Casing (+2 to 620 feet) | 622 | FT | $587.00 | $365,114.00 |
| 114 | Furnish and Install 20-inch ID x 5/16-inch Wall ASTM A778 304L Stainless Steel Blank Well Casing (620 to 700 feet) | 80 | FT | $491.00 | $39,280.00 |
| 115 | Furnish and Install 20-inch ID x 5/16-inch Wall ASTM A778 304L Stainless Steel Ful Flo Louvered Well Screen with 0.080-inch Slots (700 to 1,000 feet) | 300 | FT | $568.00 | $170,400.00 |
| 116 | Furnish and Install 20-inch ID x 5/16-inch Wall ASTM A778 304L Stainless Steel Blank Well Casing and End Cap (1,000 to 1,010 feet) | 10 | FT | $491.00 | $4,910.00 |
| 117 | Furnish and Install 2-inch SCH. 40 304L Stainless Steel Sounding Tube and 2-foot Connection Box (+1 to 698 feet) | 699 | FT | $20.00 | $13,980.00 |
| 118 | Furnish and Install two (2) 3-inch SCH. 40 304L Stainless Steel Gravel Feed Pipes (+1 to 610 feet) | 1,222 | FT | $30.00 | $36,660.00 |
| 119 | Furnish and Install Engineered Gravel Envelope and #60 Fine Transition Sand (600 to 1,030 feet) | 430 | FT | $75.00 | $32,250.00 |
| 120 | Furnish and Install 10.3-sack Sand-Cement Slurry Annular Seal (ground surface to 600 feet) | 600 | FT | $85.00 | $51,000.00 |
| 121 | Provide Initial Development by Swabbing and Airlifting | 120 | HR | $400.00 | $48,000.00 |
| 122 | Provide, Install, and Remove Development Test Pump | 1 | LS | $15,000.00 | $15,000.00 |
| 123 | Provide Final Development by Pumping and Surging | 60 | HR | $400.00 | $24,000.00 |
| 124 | Provide Aquifer Pumping Tests (8-hour step drawdown, 24-hour constant rate drawdown, and 4-hour recovery tests) | 36 | HR | $400.00 | $14,400.00 |

## ENGINEER'S ESTIMATE OF CONSTRUCTION COST
## Drilling, Construction, Development, and Testing of One New Well

| Item No. | Description | Qty | Units | Unit Price | Total Item Price |
|---|---|---|---|---|---|
| 125 | Provide Spinner Flowmeter Survey | 1 | LS | $5,000.00 | $5,000.00 |
| 126 | Provide Title 22 Laboratory Analyses | 1 | LS | $5,000.00 | $5,000.00 |
| 127 | Provide Downhole Video Survey | 1 | LS | $2,000.00 | $2,000.00 |
| 128 | Provide Plumbness and Alignment Surveys | 1 | LS | $3,000.00 | $3,000.00 |
| 129 | Provide Well Disinfection | 1 | LS | $5,000.00 | $5,000.00 |
| 130 | Complete and Cap Well Head and Ancillary Tubing, as Specified | 1 | LS | $2,000.00 | $2,000.00 |

| | |
|---|---|
| **SUBTOTAL:** | **$1,277,394.00** |
| **CONTINGENCY (20%):** | **$255,478.80** |
| **TOTAL:** | **$1,532,872.80** |

## ENGINEER'S ESTIMATE OF CONSTRUCTION COST
## Equipping and Connection of One New Well

| Item No. | Description | Qty | Units | Unit Price | Total Item Price |
|---|---|---|---|---|---|
| 101 | Mobilization (est. 5% of Equipping Cost) | 1 | LS | $25,000.00 | $25,000.00 |
| 102 | Clear and Demo | 1 | LS | $10,000.00 | $10,000.00 |
| 103 | Civil Work | 1 | LS | $10,000.00 | $10,000.00 |
| 104 | Enclosures (Well House and Electrical) | 150 | SF | $250.00 | $37,500.00 |
| 105 | Site Fencing | 829 | LF | $25.00 | $20,725.00 |
| 106 | Pump Station Foundation | 30 | CY | $450.00 | $13,500.00 |
| 107 | Well Pump and Motor | 1 | LS | $150,000.00 | $150,000.00 |
| 108 | Piping, Valves, and Ancillary Equipment | 1 | LS | $12,000.00 | $12,000.00 |
| 109 | Meter/Main, Distribution, Switchboard | 1 | LS | $50,000.00 | $50,000.00 |
| 110 | Yard Piping and Connections | 1 | LS | $10,000.00 | $10,000.00 |
| 111 | MCC | 1 | LS | $60,000.00 | $60,000.00 |
| 112 | Instrumentation | 1 | LS | $25,000.00 | $25,000.00 |
| 113 | SCADA | 1 | LS | $2,000.00 | $2,000.00 |
| 114 | Electrical | 1 | LS | $80,000.00 | $80,000.00 |
| 115 | Pipeline to Distribution System (assumes 12-inch DIP to E. Rancho Vista Blvd.) | 1,680 | LF | $250.00 | $420,000.00 |

| | |
|---|---|
| **SUBTOTAL:** | **$925,725.00** |
| **GENERAL CONTRACTOR MARKUP (20%):** | **$185,145.00** |
| **CONTINGENCY (15%):** | **$138,858.75** |
| **TOTAL:** | **$1,249,728.75** |