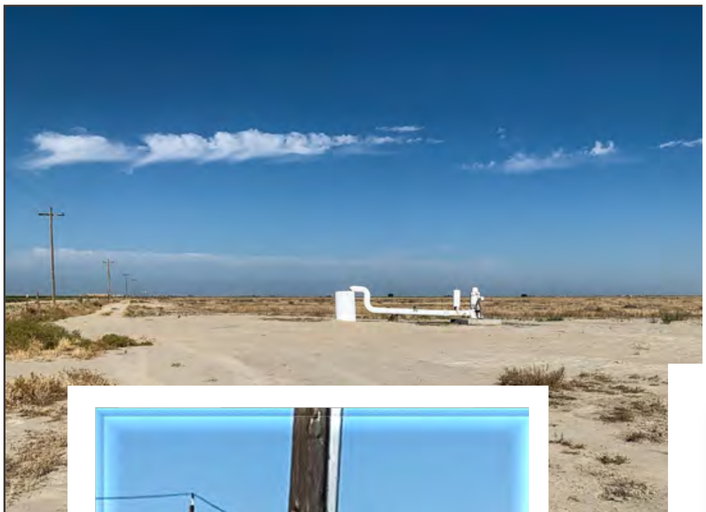
TRI-COUNTY WATER AUTHORITY - TULE SUBBASIN

GROUNDWATER SUSTAINABILITY PLAN AMENDED

JULY 2022



TRI-COUNTY
WATER AUTHORITY

PREPARED BY:

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ACRONYMS & ABBREVIATIONS USED HEREIN

ACOE	ARMY CORPS OF ENGINEERS
AF	ACRE-FEET
AFY	ACRE-FEET PER YEAR
AWD	ANGIOLA WATER DISTRICT
BIA	BUREAU OF INDIAN AFFAIRS
BLM	BUREAU OF LAND MANAGEMENT
BMP	BEST MANAGEMENT PRACTICE
BVDC	BAYOU VISTA DITCH COMPANY
CASGEM	CALIFORNIA STATEWIDE GROUNDWATER ELEVATION MONITORING
CDFW	CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
CIMIS	CALIFORNIA IRRIGATION MANAGEMENT INFORMATION SYSTEM
CFS	CUBIC FEET PER SECOND
CNDDB	CALIFORNIA NATURAL DIVERSITY DATABASE
COC	CONSTITUENTS OF CONCERN
CSD	COMMUNITY SERVICES DISTRICT
CVP	CENTRAL VALLEY PROJECT
DBCP	DIBROMOCHROPROPANE
DLTR	DIVISION OF LAND TITLES AND RECORDS
DMS	DATA MANAGEMENT SYSTEM
DWR	DEPARTMENT OF WATER RESOURCES
iGDE	INDICATORS OF GROUNDWATER DEPENDENT ECOSYSTEMS
GDE	GROUNDWATER DEPENDENT ECOSYSTEMS
GPD	GALLONS PER DAY
GPM	GALLONS PER MINUTE
GSA	GROUNDWATER SUSTAINABILITY AGENCY
GSP	GROUNDWATER SUSTAINABILITY PLAN
HCM	HYDROGEOLOGIC CONCEPTUAL MODEL
ID	IRRIGATION DISTRICT
ILRP	IRRIGATED LANDS REGULATORY PROGRAM
ITRC	IRRIGATION TRAINING AND RESEARCH CENTER
HCM	HYDROGEOLOGIC CONCEPTUAL MODEL
KDSA	KENNETH D. SCHMIDT & ASSOCIATES
KRCD	KINGS RIVER CONSERVATION DISTRICT
LAFCO	LOCAL AGENCY FORMATION COMMISSION
LAR	LAND AREA REPRESENTATION
MCL	MAXIMUM CONTAMINANT LEVEL
MDB&M	MOUNT DIABLO BASE & MERIDIAN
NCCAG	NATURAL COMMUNITIES COMMONLY ASSOCIATED WITH GROUNDWATER
PLAN	GROUNDWATER SUSTAINABILITY PLAN
RWQCB	REGIONAL WATER QUALITY CONTROL BOARD
SGMA	SUSTAINABLE GROUNDWATER MANAGEMENT ACT

SWRCB	STATE WATER RESOURCES CONTROL BOARD
SHP	STATE HISTORIC PARK
SMP	SUBBASIN MONITORING PLAN
SWP	STATE WATER PROJECT
TAC	TECHNICAL ADVISORY COMMITTEE
TCP	TRICHLOROPROPANE
TCWA	TRI-COUNTY WATER AUTHORITY
TDS	TOTAL DISSOLVED SOLIDS
TH&C	THOMAS HARDER & CO.
TNC	THE NATURE CONSERVANCY
TSDMS	TULE SUBBASIN DATA MANAGEMENT SYSTEM
USBR	UNITES STATES BUREAU OF RECLAMATION
WSD	WATER STORAGE DISTRICT

EXECUTIVE SUMMARY §354.4(a)

The Tule Subbasin submitted six GSPs, including one for the Tri-County Water Authority, in January 2020 to the Department of Water Resources (DWR). DWR was required to determine whether the GSPs conformed to the specific requirements of SGMA. DWR issued a single determination letter for the Tule Subbasin commenting on all six GSPs. In a letter dated January 28, 2022, DWR determined that that the GSP is incomplete. DWR stated that the GSP was considered incomplete as “it does not define undesirable results or set sustainable management criteria for groundwater levels, subsidence, and water quality in the manner consistent with SGMA and the GSP regulations.” Upon receiving the incomplete determination, the Subbasin had 180 days to address the identified deficiencies and submit revised GSPs by July 27, 2022.

The TCWA is submitting this 2022 Amended GSP –to address the three deficiencies outlined in the determination letter. The 2022 Amended GSP consists of edited version of the 2020 GS and the attached 2022 GSP Addendum. In addition, a revised Tule Subbasin Coordination Agreement was also submitted. The 2022 GSP Addendum was prepared to specifically address the incomplete determination letter from DWR. Sections of this document have been edited since the original submittal in 2020 and direct the reader to the Addendum for further details.

As noted in the incomplete determination letter, portions of the 2020 GSP differed from the methodology used to determine SMCs from the rest of Subbasin. This amended 2022 GSP was closely coordinated with the Subbasin and the revised Coordination Agreement. In some cases, due to local conditions, the TCWA opted to implement more stringent requirements to be protective of groundwater uses and users.

§ 354.4 General Information

Each Plan shall include the following general information:

a) An executive summary written in plain language that provides an overview of the Plan and description of groundwater conditions in the basin.

b) A list of reference and technical studies relied upon by the Agency in developing the Plan. Each Agency shall provide to the Department electronic copies of reports and other documents and materials cited as references that are not generally available to the public.

ES-1 INTRODUCTION

The lands within the boundaries of the Tri-County Water Authority (”TCWA”) in the Tule Subbasin are the subject of this Groundwater Sustainability Plan (“GSP”). TCWA has divided its lands into two Management Areas based on water supply conditions. These two areas are identified herein as the North Management Area (“North Area”), and the Southeast Management Area (“Southeast Area”). See Figure 1.4.0.

The North Area includes lands that are in the Angiola Water District ("AWD") that have both a surface and groundwater supply. There are also lands supplied by groundwater only, and these amount to about 25% of the lands in the North Area. Therefore about 75% of the lands in the North Area receive surface water. Lands in the North Area have been farmed for many years. Groundwater is pumped from both the upper aquifer (above the Corcoran Clay) and lower aquifer (below the Corcoran Clay) in the North Area (see discussion in Section ES-4, Basin Setting).

The Southeast Area is not in a water district (designated herein as a "white area") and relies entirely on groundwater. Irrigated agriculture was minimal in the Southeast Area until about the turn of the 21st century. Since that time there has been significant development of tree crops, mainly pistachios, in the area. Groundwater is available in the upper and lower aquifer in the easterly two-thirds of this area but is only available in the lower aquifer in the west one-third of the area.

The water supply is not balanced, with a net groundwater inflow from surrounding areas, and with groundwater extracted from the compression of the underlying clay layers. The goal of this GSP is to correct this unbalanced condition by reducing the net inflow from neighboring areas, and by reducing water extracted from the underlying clay layers to a sustainable level. Reduction of groundwater pumping from beneath the underlying clay layers (i.e. the lower aquifer) will reduce land subsidence in the lands within TCWA. Included in this goal is the enhancement of wildlife habitat. Proposed projects, such as the Liberty and Prosperity Farms include design features that incorporate that benefit. These projects incorporate proposed recharge areas that will provide habitat for wildlife and shorebirds.

While a small part of the GSA is within Angiola Water District and benefits from a surface water supply, there are significant areas that are on groundwater with no surface water supply. These un-districted "white" areas have not had the benefit of a water district to institute monitoring programs to serve as a repository of records that are needed to develop a picture of the groundwater conditions and trends. As required by SGMA, these monitoring programs include measurements of groundwater levels, groundwater quality, periodic mapping of the upper and lower groundwater elevations, mapping of water quality, determinations of the historical groundwater inflows and outflows, cropping records, groundwater pumpage, estimates of changes in groundwater storage, mapping of areas of shallow water, mapping of possible groundwater dependent ecosystems, and mapping of ground subsidence. There is a great need to start implementing these programs to obtain information that is needed to more accurately develop management criteria. Hence, this GSP identifies these areas as data gaps whereby TCWA will begin implementing these programs in the first five-year period of the program to eliminate the data gaps and adjust management actions and projects as needed based on the conditions observed.

ES-2 PLAN AREA

TCWA encompasses lands in both the Tule and Tulare Lake Subbasins, see Figure 1.4.1. This GSP covers the lands in the Tule Subbasin portion of the TCWA's area. Although there are substantial lands in the Tulare Lake Subbasin, only about 6,000 acres are irrigated, therefore, TCWA lands in the Tulare Lake Subbasin are covered by the Tulare Lake Subbasin GSP.

Figures 1.4.2 & 1.4.3 show Subbasin boundaries and neighboring Groundwater Sustainability Agencies ("GSA"). Neighboring GSAs in the Tule Subbasin are:

→ Delano-Earlimart GSA

→ Pixley Irrigation District GSA

→ Alpaugh GSA

→ Lower Tule River GSA

Neighboring GSAs in the Tulare Lake Subbasin are:

→ El Rico GSA

→ Southwest Kings GSA

Adjacent to the south boundary of the Southeast Area, in the Kern County Subbasin are:

→ Kern Groundwater Authority GSA

→ Semitropic Water Storage District GSA

TCWA is predominantly irrigated and dryland agriculture. However, there are two small rural disadvantaged communities that depend on groundwater.

→ Allensworth State Park – population of about 600 persons.

→ "West of Earlimart" is a small community of 1 to 2.5 – acre parcels with an estimated population of less than 500 persons.

→ Additionally, there are a number of farmsteads scattered throughout the GSA that are dependent on groundwater.

TCWA lands in Tulare County are designated Valley Agricultural. The description for these lands includes the statement "The County shall seek to protect and enhance surface water and groundwater resources critical to agriculture".

Figure 2.3.1 shows the current cropping pattern. There are about 61,000 acres in the Tule Subbasin portion of the GSA, 29,000 acres of which are irrigated. The North Area encompasses about 12,000 acres, 6,000 acres of which are irrigated. The Southeast Area encompasses about 49,000 acres, 23,000 acres of which are irrigated. The major crops in the North Area are field crops. The Southeast Area contains mostly permanent crops (pistachios).

Figure 1.4.6 shows the distribution of large capacity water wells in the GSA. There are approximately 90 wells in the GSA with Well Completion Reports ("Driller's Logs"); 35 are completed in the upper aquifer and 55 are completed in the lower aquifer - or both the upper and the lower aquifer.

ES-3 OUTREACH EFFORTS

The majority of the water consumed in TCWA is used for irrigation. There are only two public supply wells in the GSA boundary and they are located in Allensworth Community Services District (CSD). There is a small number of domestic wells that serve farmsteads and private homes and dairies, and there is a small rural community west of the town of Earlimart that has 1.5 – 2.5 acre-parcels that are supplied by private wells. All landowners in the GSA have been notified that a GSP is being prepared. The TCWA Board of Directors is comprised of four signatories and five board seats: AWD (general manager and representative), Deer Creek Storm Water District (general manager and representative), Wilbur Reclamation District #825 (one representative), and County of Kings (non-voting representative). The regular Board of Directors meetings are held on the second Thursday of every other month at 1:00 p.m. at the TCWA Boardroom, located at 944 Whitley Avenue in Corcoran. TCWA's website is: http://tcwater.org/events/. Board of Directors meetings are noticed by email to the Board of Directors and the stakeholders / interested party email list, and posted at the District office location. Monthly Technical / Stakeholder Advisory Committee meetings/workshops are held where the findings and the progress of the preparation of the GSP are discussed. The Technical/Stakeholder Advisory Committee meets on the fourth Wednesday of every month at 10:00 am at the TCWA Boardroom. The Technical/Stakeholder and Board meetings often have representatives in attendance from Allensworth, the Bureau of Land Management, Tulare Basin Watershed Partnership, Tulare County LAFCo, the dairy industry, nut growers, farmers, and large agricultural representatives. Board and Technical/Stakeholder Committee meetings are open to all who desire to attend and comment.

The decisions regarding the adoption of sustainable management criteria are made by the TCWA's five-member board of directors. These decisions are made after thoughtful consideration of the results of the studies prepared by the TCWA's consultants, input from the stakeholders, the public, comments by neighboring GSAs, the Department of Water Resources ("DWR"), and in recognition of the existing surface water and groundwater conditions in the GSA.

TCWA will implement management actions and projects, review the results of these planned management actions and projects, fill in data gaps, and develop a better understanding of the groundwater basin over the next five years. TCWA will then determine what further adjustments are needed to achieve sustainability. TCWA will continue its participation and collaboration with the Tule Subbasin Technical Advisory Committee in an effort to achieve sustainability in the Tule Subbasin.

ES-4 BASIN SETTING

Basin Setting - Location

TCWA is located in the San Joaquin Valley. The San Joaquin Valley is a structural trough, whose main axis trends northwest to southeast. The valley is bounded on the east by the crystalline rocks of the Sierra Nevada, and to the west by folded and faulted sedimentary, volcanic, and metamorphic rocks of the Coast

Ranges. Thousands of feet of marine deposits accumulated in the valley, and those are overlain by continental deposits. The marine and continental deposits thicken from the east to west beneath the valley. The continental deposits have been tilted to the west and down-warped. The uplifting of the Sierra Nevada has resulted in the westerly tilting of the overlying sediments.

Lateral Boundaries

The Tule Groundwater Subbasin extends from north of the Tule River on the north, south to near the Kern County line, east to the east edge of the alluvial groundwater basin, and west to near the Kings County-Tulare County line. The county boundaries are considered jurisdictional boundaries, whereas the others are considered hydrologic boundaries.

Vertical Boundaries

Figure 2.1.1 shows the definable bottom of the basin. The deepest bottoms of the basin are in the southeast part of the GSA and near Delano. In contrast, the shallowest bottom of the basin is near the southwest part of the Southeast Management Area, where little groundwater production is possible below a depth of several hundred feet due to a predominance of clay and brackish or salty groundwater. The bottom of the basin ranges from about 1,600 to 2,300 feet deep beneath the north part of the GSA. This corresponds with the base of the fresh groundwater. The bottom of the basin in the southeast part of the GSA ranges from about 900 to 2,000 feet deep. This coincides with the base of the fresh groundwater (less than 3,000 micromhos per centimeter at 25°C).

ES-5 EXISTING GROUNDWATER CONDITIONS

The convention used herein is that which was developed by Croft (USGS Water Supply Paper 1999-H, 1972) in which are identified six “clayey or clay tongues”, designated by letter symbols “A” to “F”, beneath the fringes of parts of the Tulare Lakebed. The most widespread and important of these are the A, C, and E Clays. The E-Clay or “Corcoran Clay” is the most laterally extensive confining bed in the San Joaquin Valley.

Generally, the aquifer within TCWA is considered as “confined” below the Corcoran Clay and un-confined or semi-confined above the Corcoran Clay. For practical purposes, the aquifer is considered a two-tiered system identified as the “upper aquifer” and the “lower aquifer”. In most of the GSA, the base of fresh water is below the Corcoran Clay and above the bottom of the continental deposits, which are deposits from the Sierra Nevada mountains. In the west part of the GSA, these deposits include the Tulare Formation, and as stated, within this formation is the Corcoran Clay.

Aquifer Characteristics

Transmissivities are an indicator of the ability of an aquifer to transmit water. It is the rate of flow (gallons per day) under a unit hydraulic gradient (slope of the water surface or pressure surface), through a unit width of and aquifer (1 foot), of a certain aquifer thickness (feet). Higher values indicate higher flow capability.

North Area

Upper aquifer transmissivities averaged 34,000 gpd per foot for new wells drilled in 2015, relatively low values. Lower aquifer values were higher at 49,000 gpd per foot.

Southeast Area

Transmissivities west of the GSA are indicated to be low averaging about 28,000 gpd/ft, improving easterly to an average of 91,000 gpd/ft near the county lines common to Kings, Tulare and Kern Counties, then decline to an average of 30,000 gpd/ft, (representing wells about 1,100 feet in depth) east of Road 80 – towards Highway 43. Wells that tapped deeper strata in this area (500-1,300 feet in depth) exhibited transmissivities of 59,000 to 76,000 gpd/ft.

Groundwater Quality

Groundwater of suitable chemical quality for irrigation is generally present in the lower aquifer in most of the north part and southeast part of the GSA. However, high sodium adsorption ratios and pH values are common, and those require treatment of the irrigation water and/or the soil. In terms of public supply and domestic use, there are a number of problems in parts of the GSA. These include nitrate, DBCP, and 1,2,3-TCP in shallow groundwater in the east part of the GSA, and arsenic, color, manganese, methane gas, and hydrogen sulfide in deeper groundwater in the Alpaugh-Allensworth area.

Upper Aquifer

Problems with methane gas in the groundwater are common in the Corcoran-AWD area. Water in the upper aquifer in the vicinity often has higher total dissolved solids (TDS) concentrations than present in the lower aquifer.

AWD well samples collected in October 2006 exhibited TDS concentrations ranged from 190 – 470 mg/l. The water was indicated to the of the sodium-bicarbonate type. Nitrates were non-detect, iron and fluoride were below their respective MCL's. Arsenic levels were below the MCL of 10 ppb. Water collected from the Sweetwater Dairy indicated MCL exceedances in manganese and arsenic. Arsenic levels in the Sweetwater Dairy were over 4 times the MCL.

Allensworth wells were sampled during 2011 -2013. TDS ranged from 170 – 510 mg/l. Arsenic levels ranged from 10 – 11 ppb, slightly over the state MCL of 10 ppb. Hexavalent chrome ranged from 9.5 – 10 ppb, compared to the proposed MCL of 10 ppb. Alpha activities were low.

Lower Aquifer

Analyses of water from seven AWD wells sampled in 2004 (one well) and 2006. TDS concentrations ranged from 140 – 206 mg/l. The waters were the sodium bicarbonate type, nitrate concentrations were non-detectable – indicating reduced conditions in the groundwater. pH values were 8.9 to 9.4, fluoride and iron concentrations were below their respective MCLs, and manganese levels, except for one well were acceptable. Arsenic levels exceeded the MCL in five of the eight wells and alpha activities were all below the MCL.

Further discussion of Groundwater quality is presented in Section 4 of the 2022 GSP Addendum.

Groundwater Levels

Hydrographs of selected wells in the upper and lower aquifers are included as Figures 3.3.1 – 3.3.5 and Appendix A of the 2022 GSP Addendum.

Upper Aquifer

Water levels in the upper aquifer have remained relatively stable over the period of record since surface water deliveries began in the 1970s, some indicating a rise in water levels. However, the limited sampling of water levels in both the upper and lower aquifers represents a data gap that will be filled over the next five years of data gathering.

Lower Aquifer

Water levels have been in a steady decline over the period of record. Much of the groundwater pumpage in TCWA is from the lower aquifer. Proposed projects and management actions are directed at arresting this decline. These include projects to bring in supplemental surface water, replacing deep (lower) aquifer pumping with upper aquifer pumping, and removing lands from irrigated agriculture as needed.

Further discussion of Land Subsidence is presented in Section 2 of the 2022 GSP Addendum.

Land Subsidence

Figure 2.2.14 shows historical land subsidence in the GSA from 1949 – 2005. Areas of greatest subsidence (10-15 feet over the period of record) are in the east two-thirds of the North Area and in the south-central part on the Southeast Area near Highway 43. Subsidence of from 5-10 feet is common for the rest of the GSP except for an area exhibiting 0-5 feet subsidence south of Alpaugh in the Southeast Area. Proposed projects and management actions are directed at arresting land subsidence in this area. More recent measurements by satellite imagery indicate subsidence of around one foot per year during the recent drought.

Further discussion of Land Subsidence is presented in Section 3 of the 2022 GSP Addendum.

ES-6 SUSTAINABLE MANAGEMENT CRITERIA

Chapter 3 discusses TCWA's sustainability goals and the criteria by which progress towards the goals will be measured. The Sustainable Management Criteria will be evaluated at least every five years. As the deficiencies noted in the incomplete determination were focused entirely on the SMCs, this chapter was extensively replaced by the Addendum and the revised Coordination Agreement. As discussed in the Introduction, the TCWA closely coordinated with the Subbasin to ensure that similar methodologies were utilized. The TCWA opted to implement Minimum Thresholds (MTs) based on levels that were protective of groundwater uses and users.

CHRONIC LOWERING OF GROUNDWATER LEVELS

Chronic lowering of Groundwater Levels will be measured by annual Spring water level readings at designated wells in the GSA. While both Spring and Fall groundwater level measurements will be taken, the Spring levels, taken at the time of peak recovery, are the indicator of long-term groundwater storage change in the upper aquifer. The Fall water level measurements will demonstrate the seasonal trends in groundwater levels.

Upper Aquifer (B-zone)

MTs for the B-zone were established using the OSCWR database records and reflect a condition to minimize impacts to all uses and users. The MT was calculated to represent conditions where water-levels drop below the bottom elevation of wells in the B-zone. The quantitative definition of the MT elevations is based on a statistical percentile for well completion elevations in the B-zone. TCWA decided that the MTs would be set at the 90th percentile to minimize impacts. This represents a water elevation to protect 90 percent of the wells listed in the database.

TCWA believes that the MT will be protective of beneficial uses in the B-zone and, in conjunction with a mitigation program (described in Attachment 7 of the revised Coordination Agreement), will avoid a significant and unreasonable loss of beneficial uses. The GSAs recognize that mitigation and adaptation to the proposed SMC for groundwater level requires better information on actual well conditions and will require case-by-case assessments of whether beneficial uses have been impacted at a given point in time.

Lower Aquifer (C-zone)

C-zone wells are completed at depths below the Corcoran Clay in a confined aquifer, so the ability to maintain sufficient groundwater supply is not dependent on the completion elevation of the well, but is more related to well performance and whether pumping causes water levels to drop below the top of the confining layer. The MT for groundwater level in the C-zone is defined with respect to the elevation of the E-clay, which is the principal regional confining unit in the Subbasin.

The MT for groundwater level in the C-zone is defined based on the expected drawdown from a C-zone well at a pumping rate of 1,000 gpm, at a specific capacity of 20 gpm/ft. The value of 1,000 gpm was selected based on discussions with stakeholders for their wells completed in the C-zone. Using this methodology, the expected drawdown is 50 feet (1,000 gpm divided by 20 gpm/ft). This expected drawdown is simply added to the elevation of the E-clay to define a groundwater elevation. If groundwater elevations fall below this level, 10% of wells in the C-zone would not be able to pump at 1,000 gpm without drawing water levels below the E-clay. The quantitative definition of significant and unreasonable lowering of groundwater levels in the C-zone is therefore a groundwater elevation of 50 feet above the elevation of the E-clay.

REDUCTION OF GROUNDWATER STORAGE

Reduction of Groundwater Storage will be monitored by upper aquifer water level measurements taken in the Spring of each year. Wells will be measured in both the spring and the fall of each year. This will develop the seasonal fluctuation of groundwater levels in the GSA.

Water Level Hydrographs

The water level hydrographs for the wells shown on Figures 3.3.1–3.3.5 and Appendix A of the 2022 GSP Addendum will be used to monitor this criterion.

Criteria

Annual spring water levels will be measured and compared to the Minimum Thresholds and Measurable Objectives shown on the above-referenced hydrographs. An Undesirable Result would be the exceedance of the Minimum Threshold for two consecutive Spring measurements in 50% of the seven wells monitored (four wells out of seven).

Upper Aquifer

→ Wells used for reduction of Groundwater Storage will be the same wells that have been selected for the upper aquifer for Chronic Lowering of Groundwater Levels. Spring water levels will be used to estimate the annual change in groundwater storage in the upper aquifer. Water levels are therefore a good gage of changes in groundwater storage for the upper aquifer.

Lower Aquifer

→ The lower aquifer is a confined aquifer. Therefore, water levels reflect pressure levels. Pressure levels cannot be used to calculate a volumetric change in storage, because the aquifer stays full, even with large pressure declines. Pumpage for all large-capacity wells installed in the lower aquifer will determine groundwater extractions from the lower aquifer. While storage changes in the lower aquifer cannot be determined by groundwater level measurements, the net inflow and outflow for the aquifer can be determined, and these combined values determine the groundwater balance for the aquifer.

Existing Wells

The number of wells with recent water level measurements is limited, and the seven selected wells may be augmented or replaced with additional wells in the next five years. These wells, and possibly others, will be evaluated for inclusion in the TCWA's monitoring network. For candidate wells in the North Management Area See Figures 4.1.1 and 4.1.2 of Appendix A of the 2022 GSP Addendum. For candidate wells in the Southeast Management Area see Figures 4.1.3 and 4.1.4 of Appendix A of the 2022 GSP Addendum.

DEGRADED GROUNDWATER QUALITY

The TCWA recognizes that municipal and domestic wells with substantially decreased water quality are an undesirable result that needs to be avoided. The Tule Subbasin identified the COCs across the subbasin in Attachment 5 of the revised Coordination Agreement. TCWA then evaluated available data to determine which of those COCs are present in the GSA and selected a subset of the COCs that are appropriate for the TCWA. For the TCWA, the primary COCs will be

- Arsenic
- Nitrate as Nitrogen (N)
- Hexavalent Chrome
- 1,2-dibromo-3-chloropropane (DBCP)
- 1,2,3-trichloropropane (TCP)
- Tetrachloroethene (PCE)
- Chloride
- Sodium
- Total Dissolved Solids (TDS)

To assess groundwater quality conditions considered suitable for agricultural irrigation and domestic use the SMCs were developed based on drinking water primary MCLs and secondary MCLs (SMCL) as provided in the California Code of regulations Title 22 (Title 22) for drinking water and agricultural water quality goals (Ag WQGs). Table 4-1 lists the appropriate values for each of the COCs that used in the development of the SMCs.

LAND SUBSIDENCE

The methodology for calculating the MT for subsidence has been modified from the 2020 GSP. In considering the MT for total subsidence, the TCWA considered the technical evaluation conducted on the critical infrastructure along with discussions of the operators of the infrastructure. The evaluation considered impacts from both local differential subsidence and regional impacts. In addition, the TCWA considered that many of the historic impacts have been mitigated. Based on the results of the evaluation, the TCWA set the MT at values that would be protective of the critical infrastructure. The MT

The MTs for land subsidence were developed based, in part, on land subsidence forecast by the groundwater flow model for the 2020 to 2040 transition period. The model predicted a total subsidence of 6 to 8 feet to occur across the TCWA by 2040. Based on the evaluation conducted by Thomas Harder & Co. (TH&Co), the hydrogeologic consultants for the Tule Subbasin, further impacts to critical infrastructure are limited or that mitigation measures are in place.

Impacts to critical infrastructure will be monitored using the methods described in Sections 3.4 and 3.5. This will serve as an “early warning” to areas that experience impacts and allow the GSA to evaluate if other management actions are required.

INTERCONNECTED SURFACE WATERS WITH GROUNDWATER AND SEAWATER INTRUSION

These two undesirable results do not occur within TCWA. There are no interconnected surface water – groundwater conditions in TCWA nor is there seawater intrusion due to the separation of TCWA from the Pacific Ocean. Therefore, these two indicators cannot create adverse conditions that are significant and unreasonable. While these conditions do not presently apply, TCWA GSA will re-evaluate these conditions’ status every five years as part of the five-year review process.

ES-7 WATER BUDGET

The water year “types” for TCWA were developed from the historical sequence of dry, normal (typical) and wet years produced by Wood for the Tulare Lake Subbasin. The sequence was used to develop, over a fifty-year study period, the percentages of each of these “types” of years in order to apply those percentages to forecast their occurrence over the next 20 to 50 years. In other words, it was assumed that the “type” sequence would repeat itself in the future. This model was used to establish the frequency for availability of surface water for the North Area. The Southeast Area currently has no surface water.

Because surface water deliveries do not necessarily follow the same pattern as the weather conditions that crops on the valley floor are experiencing, it was decided that a better determination of weather conditions for the determination of crop ET year “types” would be precipitation patterns. Annual precipitation records for three weather stations (Stratford, Porterville, and Shafter) were used to develop the weather pattern for determination of water year “types” for the determination of crop ET based on Cal Poly’s ITRC data (see below). The three stations cover the area on the valley floor spanning from the north to the east and south of TCWA and the precipitation patterns were compared and averaged to develop the pattern of Wet, Normal (Typical) and Dry years on the valley floor. This pattern was used to develop the average weather pattern for the determination of crop ET for the study period. The fifty-year precipitation pattern for Porterville was also examined for comparison purposes. A fifty-year tabulation of Wet Typical and Dry years for the Tulare Subbasin done by Wood was used to determine the frequency of surface water availability. The Wood tabulation looked at stream flow in the Kings River among other indicators, and since the Kings is one of the larger suppliers of surface water to AWD, it was decided that this tabulation would be used for that determination.

The current TCWA cropping pattern is much different than it was in the last part of the twentieth century because of the recent planting of permanent crops in the Southeast Area. These new plantings have changed the cropping pattern and placed increased demands on the groundwater resource. The existing cropping pattern was used as the basis to predict demands into the future. The cropping pattern is based on the Tulare County Agricultural Commissioner’s Office GIS mapping of the 2017/2018 crops. Crop ET requirements are based on Cal Poly’s Irrigation Training and Research Center (“ITRC”) ET data for Irrigation District Water Balances for Zone 15 of the Department of Water Resources’ ET Zone delineation for California.

Groundwater plays a huge role in the water supply picture for TCWA, particularly for the Southeast Area. Studies by Thomas Harder and Associates, Inc., verified by Ken Schmidt and Associates, indicate that the current net groundwater supply for TCWA includes 41,000 – 44,000 acre-feet per year (“afy”) of net groundwater inflow and 12,000 afy of water extracted from the compression of aquitards underlying the GSA. The water balance for 2020 includes these amounts. It is estimated that the historical net groundwater flow into the area that is now TCWA was about half of that amount. Therefore, the 2040 water balance includes a reduction in these two sources of about 50% in net groundwater gain and a 100% reduction in water extracted from aquitards due to compaction. Thus, the net groundwater inflow into TCWA for 2040 and beyond, is reduced to 18,300 afy (net groundwater inflow) and zero (water retrieved from the compression of aquitards), respectively.

The current water balance for TCWA follows. It is based on the current water supply sources, cropping pattern, and the predicted water year patterns developed as described above. The effects of climate change are incorporated in the water balance. The water balance develops the groundwater deficit resulting from the above study for the current year (2020), 2040, and 2070. Details are included in Chapter 2 of this GSP. The deficit is to be corrected by projects and management actions.

Tri-County Water Authority
Summary of Groundwater Balance Tabulations
Results of Twenty-Year Study Periods for Years 2020, 2040 and 2070 - No Project Conditions

A	B	C	D	E	F	G	H	I	J
Management Area	**Farmed Acreage[1]**	**Crop Water Requirement (Etc)[2] (af)**	**Surface Water Contribution to Et Requirement[3] (af)**	**Rainfall Contribution to Groundwater[4] (af)**	**Net Subsurface Inflow into the GSA[5] (af)**	**Net Inflow from Compression of Aquitards[6] (af)**	**Estimated Net Municipal and Domestic Water Use[7] (af)**	**Groundwater Extractions Exported from the GSA[8] (af)**	**Net Change in Groundwater Storage in Upper Aquifer[9] (af)**
2.3.8a									
YEAR 2020									
Total for TCWA	29,000	74,300	3,200	900	44,100	12,000	300	9,100	**-23,500**
North Management Area	6,000	13,600	3,200	200	24,700	2,400	100	9,100	**7,700**
SE Management Area	23,000	60,700	0	700	19,400	9,600	200	0	**-31,200**
2.3.8b									
YEAR 2040									
Total for TCWA in Tule Subb	29,000	77,100	3,100	900	18,300	0	600	9,100	**-64,500**
North Management Area	6,000	14,100	3,100	200	12,300	0	200	9,100	**-7,800**
SE Management Area	23,000	63,000	0	700	6,000	0	400	0	**-56,700**
2.3.8c									
YEAR 2070									
Total for TCWA	29,000	79,400	3,000	900	18,300	0	1,000	9,100	**-67,300**
North Management Area	6,000	14,600	3,000	200	12,300	0	400	9,100	**-8,600**
SE Management Area	23,000	64,800	0	700	6,000	0	600	0	**-58,700**

ES-8 MONITORING NETWORK

Chapter 4 develops the monitoring network. The network includes seven wells that are situated throughout the GSA to monitor the upper and lower aquifers. The network includes wells that have been identified as having construction information or for which the information will be attained by video survey.

There is not a great number of wells in the TCWA with both historical and recent (post -2015) groundwater level measurements. A search was made for wells with water level measurements that span a twenty-year period beginning before the recent drought and ending after the drought ended, around 2017. The search resulted in seven active large-capacity wells that have a history of water level measurements, some dating back to before the California Aqueduct began water deliveries.

The network of active wells to be measured in the North Area will be expanded over the next few years, and these wells will be used to develop groundwater contours in order to gain a more complete understanding of groundwater flow. There are a number of wells that do not have complete water level records but that have well completion reports. It is planned to eventually measure about one well per section in the GSA, if possible, in order to prepare suitable water level elevation maps.

TCWA will cooperate with Tule Subbasin GSAs and will utilize the Subbasins' information and share its information with others in the Subbasin. The Tule Subbasin Monitoring Plan (Appendix G) has identified additional wells in and near TCWA and it is planned to incorporate this information in TCWA's monitoring program.

Surface Water Monitoring Plan

Surface water deliveries to AWD will be recorded together with applicable information on surface water deliveries that are included in the Tule Subbasin Monitoring Plan. These sources include the Tule and Kings Rivers, the California Aqueduct, the Central Valley Project, Deer Creek, and occasionally, White River.

Objectives of the Groundwater Monitoring Program

Objective 1: Determine the pumpage from each large capacity well in the GSA.

- The Board of Directors of the TCWA have determined that the pumpage from all large capacity wells in the GSA is to be measured with totalizing flowmeters.

Objective 2: Determine the lateral direction of groundwater flow for each aquifer in the spring of each year.

- There are two main reasons for measuring water levels in the GSA. First, is to prepare water-level elevation maps for both the upper and lower aquifers on at least an annual basis, and possibly on a semi-annual basis. Such a program is in effect south of the Tulare County-Kern County Line, in and near the Semitropic Water Storage District. These maps are essential to determine the lateral direction of groundwater flows in specific areas.

Objective 3: Determine seasonal, annual, and long-term trends in depth to water for each aquifer, and to determine storage changes.

- This portion of the study includes water level hydrographs showing both fall and spring water level measurements, as opposed to those that are used to establish Minimum Thresholds based on spring water level measurements (refer to Figures 3.3.1 -3.3.5 and Appendix A of the 2022 GSP Addendum). The study will include general discussion of historical seasonal and long-term water level trends together with the trends that develop over the next five years. Chapter 4 includes a discussion of historical water level hydrographs that are presented in the Hydrologic Conceptual Model and Groundwater Conditions Report ("HCM") by Kenneth D. Schmidt and Associates ("KDSA") and included in Appendix C. More information will be developed to fill in data gaps in this portion of the study over the next five years.

Objective 4: Determine land subsidence on an annual basis in the GSA.

- Land subsidence is caused by pumping from below the Corcoran Clay, causing a pressure differential that draws water out of the clay, creating voids in the clay that collapse, resulting in compression and thus, settlement of the overlying land surface.
- Two extensometers are planned to be installed, one in the Tulare Lake Subbasin and one in the Tule Subbasin. Extensometers provide valuable information on the depth intervals where compaction of clay layers occurs.
- It is proposed to install a number of elevation benchmarks throughout the GSA to annually measure land elevations and thereby determine the rate of land subsidence.
- TCWA will monitor water levels in the lower aquifer wells and use them as a surrogate for the presence of land subsidence until a network of land – based measuring points can be installed. The Tule Subbasin plans to have this system up and operational by 2025.

- It is proposed to idle a number of wells that are pumping from the lower aquifer and replace them with wells completed in the upper aquifer and thereby reduce the rate of subsidence on the overlying lands. While it is recognized that there are multiple clay layers underlying TCWA, the primary cause of subsidence is pumping from below the Corcoran Clay. The effects of this program will be monitored closely by determination of land elevation changes and determination of water level changes in the upper aquifer. There is a quantity of water that can safely be withdrawn from the upper aquifer without causing undesirable results, and this will be determined by results of the monitoring program. The program is to be instituted in five-year increments, so the safe upper aquifer extraction quantity will be determined over time.

<u>Objective 5:</u> Determine groundwater quality for both aquifers every three years, and long-term trends.

- It is proposed that water samples be collected from selected irrigation and dairy wells in the GSA on the schedule developed by the Tule Subbasin for analyses of irrigation suitability parameters. The water samples will be collected during periods of heavy pumping (normally July or August). The samples will be collected as close to the well head as possible and prior to any addition of chemicals. The wells should have been pumping for at least 24 hours.
- Public water supply wells will not be sampled as part of this program. Public water supply wells are sampled and monitored as required by State regulations. Water quality analyses for public water supply wells in Allensworth will be collected annually and reported as a regular part of the water quality monitoring program. A certain number of private domestic wells will be selected and monitored as well. These will be selected and monitored during the first five years of the program.

<u>Objective 6:</u> Accumulate other information needed to prepare water budgets for the groundwater in each aquifer.

- Water budgets will be prepared annually. These will incorporate all new information gathered in the previous year and will report on the current effectiveness of the TCWA's projects and management actions.

ES-9 PROJECTS AND MANAGEMENT ACTIONS

Chapter 5 or this GSP describes the projects and management actions that are planned for TCWA They are briefly outlined herein.

→ Convert lower aquifer pumping to upper aquifer pumping. This project involves drilling wells into the upper aquifer to replace the capacity of existing wells that are pumping from the lower aquifer. This will reduce land subsidence.

→ White Ranch Project. This project, combined with Phase 1 of the Liberty Project and waters available from Deer Creek, will produce 5,800 afy of surface water that will either be applied directly to crops or will be recharged into the upper aquifer for recovery later.

→ Liberty Project. This project will build up to 60,000 afy of off-stream storage with which to capture excess flows in the tributary rivers and canal projects, and to capture flood flows as well.

- → Reduction in Crop Water Demand. This project involves permanently idling cropped lands to reduce groundwater extractions.
- → Privately-sponsored groundwater recharge project. This project involves construction of a recharge facility to capture and recharge periodic flood flows.
- → Equip all active large capacity irrigation wells with recording water meters.

Tule Subbasin Monitoring Plan

It is the intent of this GSP to incorporate information that is collected for the Tule Subbasin Monitoring Plan into the information that is collected by TCWA. Information collected by TCWA will be shared with neighboring GSAs. Data collection and recordation will be coordinated with other GSAs in the Tule Subbasin.

ES-10 GSP IMPLEMENTATION

Implementation will begin on February 1, 2020. TCWA has taken action to implement certain management strategies immediately and has recognized the ability to develop additional actions and strategies over the 20-year implementation period. Projects and management actions will be reviewed and revised by TCWA's Board of Directors at the five-year interim milestones to ensure sustainability is reached.

TCWA will implement its agriculture production well metering program in 2020. The Board of Directors has required all production wells in its service area to record and report pumping data to the TCWA starting in July of 2020. TCWA will implement the Tule Monitoring Network in the first five-year period with the objective of providing valuable data to the Subbasin and TCWA to better inform future management decisions.

To address overdraft conditions a ten percent demand reduction will be implemented beginning calendar years 2025-2029, and will be increased by an additional ten percent beginning calendar years 2030-2034. The stakeholders and Board of Directors will develop strategies during the first five-year period to accomplish this reduction.

Projects have been submitted to TCWA by independent land owners which will be developed for their benefit and to promote the overall sustainability of TCWA's service area. These projects and implementation periods are found on page 263, Table 5.1 – Projects List. TCWA may choose to implement additional projects and management actions and intends to partner with others, when applicable, to secure grant funding for their development and implementation.

Intra-basin and inter-basin coordination will be an objective for implementation. TCWA is coordinating with the other GSAs in the Tule Subbasin and to intends closely monitor boundary conditions and share data with bordering GSAs.

TCWA will aggregate additional data which will be used to review and revise sustainable management criteria, minimum thresholds, measurable objectives, projects and management actions. TCWA will continually work with stakeholders to develop management actions and projects with the goal of sustainability by 2040 and beyond.

ES-11 FUNDING

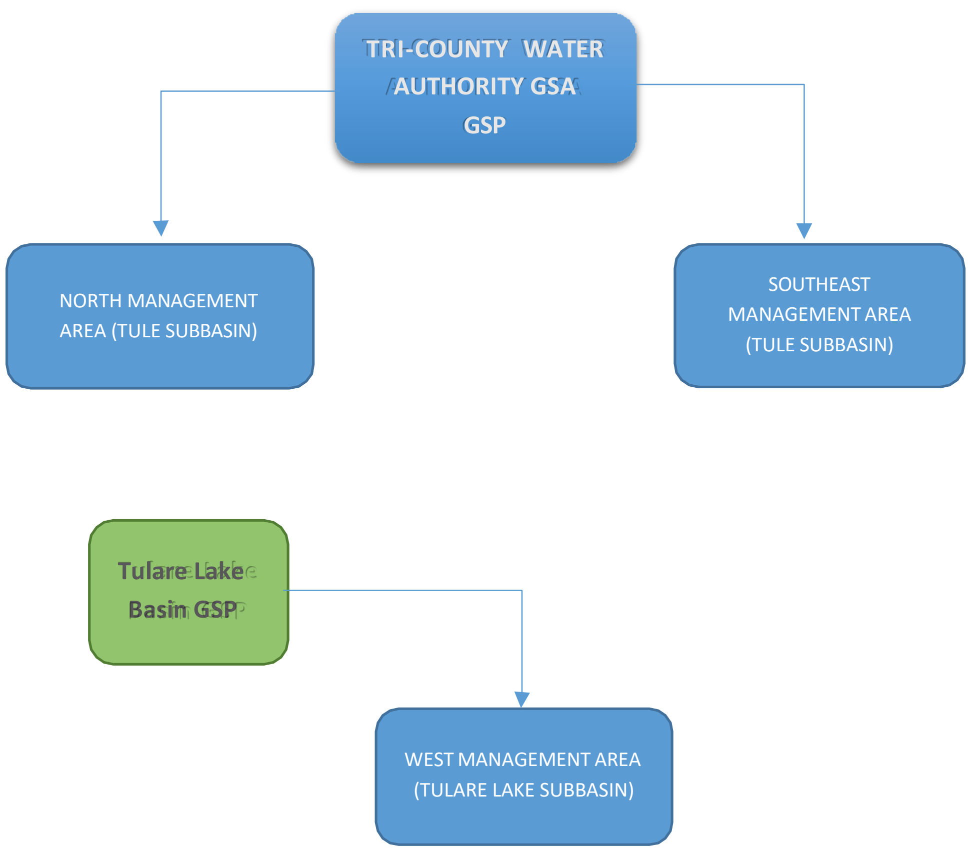
Funding of the GSA is provided by landowner fees administered by TCWA, following successful passage of a Proposition 218 election by the landowners. Projects are planned to be privately funded. TCWA is also planning to conduct a Proposition 218 election to impose groundwater pumping fees starting in 2020.

CHAPTER 1: ADMINISTRATIVE INFORMATION §354.2-354.10

§354.2 Administrative Information
This Subarticle describes information in the Plan relating to administrative and other general information about the Agency that has adopted the Plan and the area covered by the Plan.

1.1 INTRODUCTION

Tri-County Water Authority (TCWA) Groundwater Sustainability Agency (GSA) encompasses lands in the Tule Subbasin and the Tulare Lake Subbasin. This Groundwater Sustainability Plan (GSP) covers lands in the Tule Subbasin. TCWA lands in the Tulare Lake Subbasin are covered by the Tulare Lake Basin GSP. As such, any reference to the TCWA GSA in this GSP refers to the management areas within the Tule Subbasin only.



The TCWA has prepared the attached 2022 GSP Addendum in response to the determination letter received from DWR on January 28, 2022. One comment letter was received for all six 2020 GSPs in the Tule Subbasin and deemed all Tule Subbasin GSPs as "incomplete". The 2022 GSP Addendum has been prepared to specifically address the deficiencies identified in the determination letter from DWR. The 2022 GSP Addendum should be considered a revision to the 2020 GSP and should be read in its entirety. Additional discussion of the 2022 GSP Addendum and why the decision was made to prepare an addendum, is presented in Section 1 and 1.1 of the 2022 GSP Addendum.

1.2 GSP ORGANIZATION

This GSP generally follows the suggested outline recommended by the Department of Water Resources (DWR). The checklist provided below identifies the regulations/GSP contents required to be addressed and where in this GSP those items are evaluated.

Table 1.1: GSP Preparation Checklist

GSP Regulations Section	Water Code Section	Requirement	Description	Complete	Section(s) or Page Number(s) in the GSP
ARTICLE 3. TECHNICAL AND REPORTING STANDARDS					
352.2		Monitoring Protocols	• Monitoring protocols adopted by the GSA for data collection and management	☐	Section 1.4.8
			• Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extractions in the basin	☐	
ARTICLE 5. PLAN CONTENTS, SUBARTICLE 1. ADMINISTRATIVE INFORMATION					
354.4		General Information	• Executive Summary	☐	ES-1 through ES-16
			• List of references and technical studies	☐	Bibliography
354.6		Agency Information	• GSA mailing address • Organization and management structure • Contact information of Plan Manager • Legal authority of GSA • Estimate of implementation costs	☐	Section 1.3
354.8(a)	10727.2(a)(4)	Map(s)	• Area covered by GSP • Adjudicated areas, other agencies within the basin, and areas covered by an Alternative • Jurisdictional boundaries of federal or State land • Existing land use designations • Density of wells per square mile	☐	Section 1.4.1

GSP Regulations Section	Water Code Section	Requirement	Description	Complete	Section(s) or Page Number(s) in the GSP
ARTICLE 5. PLAN CONTENTS, SUBARTICLE 1. ADMINISTRATIVE INFORMATION CONTINUED					
354.8(b)		Description of the Plan Area	• Summary of jurisdictional areas and other features	☐	Section 1.4.2
354.8(c) 354.8(d) 354.8(e)	10727.2(g)	Water Resource Monitoring and Management Programs	• Description of water resources monitoring and management programs	☐	Section 1.4.3
			• Description of how the monitoring networks of those plans will be incorporated into the GSP	☐	Section 1.4.3
			• Description of how those plans may limit operational flexibility in the basin	☐	Section 1.4.4
			• Description of conjunctive use programs	☐	Section 1.4.5
354.8(f)	10727.2(g)	Land Use Elements or Topic Categories of Applicable General Plans	• Summary of general plans and other land use plans	☐	Section 1.4.6 -1
			• Description of how implementation of the GSP may change water demands or affect achievement of sustainability and how the GSP addresses those effects	☐	Section 1.4.6-2
			• Description of how implementation of the GSP may affect the water supply assumptions of relevant land use plans	☐	Section 1.4.6-3
			• Summary of the process for permitting new or replacement wells in the basin	☐	Section 1.4.6-4
			• Information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management	☐	Section 1.4.6-5
354.8(g)	10727.4		• A description of any of the additional Plan elements included in Water Code Section 10727.4 that the Agency determines to be appropriate.	☐	Section 1.4.7

GSP Regulations Section	Water Code Section	Requirement	Description	Complete	Section(s) or Page Number(s) in the GSP
ARTICLE 5. PLAN CONTENTS, SUBARTICLE 1. ADMINISTRATIVE INFORMATION CONTINUED					
354.10		Notice and Communication	• Description of beneficial uses and users	☐	Section 1.5.1
			• List of public meetings	☐	Section 1.5.2
			• GSP comments and responses	☐	Section 1.5.3
			• Decision-making process	☐	Section 1.5.4-1
			• Public engagement	☐	Section 1.5.4-2
			• Encouraging active involvement	☐	
			• Informing the public on GSP implementation progress	☐	
ARTICLE 5. PLAN CONTENTS, SUBARTICLE 2. BASIN SETTING					
354.14(a) 354.14(b) 354.14(c)		Hydrogeologic Conceptual Model	• Description of the Hydrogeologic Conceptual Model	☐	Section 2.1 2 Section 2.1.3 Section 2.1.4 Section 2.1.5
			• Two scaled cross-sections	☐	Section 2.1.6
			• Map(s) of physical characteristics: topographic information, surficial geology, soil characteristics, surface water bodies, source and point of delivery for imported water supplies	☐	Section 2.1.6

GSP Regulations Section	Water Code Section	Requirement	Description	Complete	Section(s) or Page Number(s) in the GSP
ARTICLE 5. PLAN CONTENTS, SUBARTICLE 2. BASIN SETTING CONTINUED					
354.14(d)(5)	10727.2(a)(5)	Map of Recharge Areas	• Map delineating existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas	☐	Section 2.1.7
	10727.2(d)(4)	Recharge Areas	• Description of how recharge areas identified in the plan substantially contribute to the replenishment of the basin	☐	Section 2.1.7
354.16	107272.2(a)(1) 10727.2(a)(2)	Current and Historical Groundwater Conditions	• Groundwater elevation data	☐	Section 2.2.1
			• Estimate of groundwater storage	☐	Section 2.2.2
			• Seawater intrusion conditions	☐	Section 2.2.3
			• Groundwater quality issues	☐	Section 2.2.4
			• Land subsidence conditions	☐	Section 2.2.5
			• Identification of interconnected surface water systems	☐	Section 2.2.6
			• Identification of groundwater-dependent ecosystems	☐	Section 2.2.7
354.18	10727.2(a)(3)	Water Budget Information	• Description of inflows, outflows, and change in storage	☐	Section 2.3.2 Section 2.3.3
			• Quantification of overdraft	☐	Section 2.3.5
			• Estimate of sustainable yield	☐	Section 2.3.7
			• Quantification of current, historical, and projected water budgets	☐	Section 2.3.8

GSP Regulations Section	Water Code Section	Requirement	Description	Complete	Section(s) or Page Number(s) in the GSP
ARTICLE 5. PLAN CONTENTS, SUBARTICLE 2. BASIN SETTING CONTINUED					
	10727.2(d)(5)	Surface Water Supply	• Description of surface water supply used or available for use for groundwater recharge or in-lieu use	☐	Section 2.3.2
354.20		Management Areas	• Reason for creation of each management area	☐	Section 2.4.2
			• Minimum thresholds and measurable objectives for each management area	☐	Section 2.4.3
			• Level of monitoring and analysis	☐	Section 2.4.3
			• Explanation of how management of management areas will not cause undesirable results outside the management area	☐	Section 2.4.3
			• Description of management areas	☐	Section 2.4.2
ARTICLE 5. PLAN CONTENTS, SUBARTICLE 3. SUSTAINABLE MANAGEMENT CRITERIA					
354.24		Sustainability Goal	• Description of the sustainability goal	☐	Section 3.2.1
354.26		Undesirable Results	• Description of undesirable results	☐	Section 3.2.2
			• Cause of groundwater conditions that would lead to undesirable results	☐	Section 3.2.2
			• Criteria used to define undesirable results for each sustainability indicator	☐	Section 3.2.2 Section 3.3.1
			• Potential effects of undesirable results on beneficial uses and users of groundwater	☐	Section 3.3.2

GSP Regulations Section	Water Code Section	Requirement	Description	Complete	Section(s) or Page Number(s) in the GSP
ARTICLE 5. PLAN CONTENTS, SUBARTICLE 3. SUSTAINABLE MANAGEMENT CRITERIA CONTINUED					
354.28	10727.2(d)(1) 10727.2(d)(2)	Minimum Thresholds	• Description of each minimum threshold and how they were established for each sustainability indicator	☐	Section 3.4.1
			• Relationship for each sustainability indicator	☐	Section 3.3.3
			• Description of how selection of the minimum threshold may affect beneficial uses and users of groundwater	☐	Section 1.4.7-12, 3.3, 3.4.1
			• Standards related to sustainability indicators	☐	Section 3.2.2
			• How each minimum threshold will be quantitatively measured	☐	Section 3.3.3
354.30	10727.2(b)(1) 10727.2(b)(2) 10727.2(d)(1) 10727.2(d)(2)	Measurable Objectives	• Description of establishment of the measurable objectives for each indicator	☐	Section 3.5.1
			• Description of how a reasonable margin of safety was established for each measurable objective	☐	Section 3.5.2
			• Description of a reasonable path to achieve and maintain the sustainability goal, including a description of interim milestones	☐	Section 3.5.3

GSP Regulations Section	Water Code Section	Requirement	Description	Complete	Section(s) or Page Number(s) in the GSP
ARTICLE 5. PLAN CONTENTS, SUBARTICLE 4. MONITORING NETWORKS					
354.34	10727.2(d)(1) 10727.2(d)(2) 10727.2(e) 10727.2(f)	Monitoring Networks	• Description of monitoring network	☐	Section 4.2
			• Description of monitoring network objectives	☐	Section 4.2
			• Description of how the monitoring network is designed to: → Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features; → Estimate the change in annual groundwater in storage; → Monitor seawater intrusion; → Determine groundwater quality trends; → Identify the rate and extent of land subsidence; and → Calculate depletions of surface water caused by groundwater extractions	☐	Section 4.3
			• Description of how the monitoring network provides adequate coverage of Sustainability Indicators	☐	Section 4.3
			• Density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends	☐	Sections 4.4 – 4.7 Figure 2-9 & Appendix A of 2022 GSP Addendum
			• Scientific rational (or reason) for site selection	☐	Figure 2-9 & Appendix A of 2022 GSP Addendum

GSP Regulations Section	Water Code Section	Requirement	Description	Complete	Section(s) or Page Number(s) in the GSP
			• Consistency with data and reporting standards	☐	Sections 4.5 – 4.7
ARTICLE 5. PLAN CONTENTS, SUBARTICLE 4. MONITORING NETWORKS CONTINUED					
354.34	10727.2(d)(1) 10727.2(d)(2) 10727.2(e) 10727.2(f)	Monitoring Networks	• Corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone	☐	Section 3.3.3 Section 4.4.
			• Location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used	☐	Section 4.2 Figure 2-9 & Appendix A of 2022 GSP Addendum
			• Description of technical standards, data collection methods, and other procedures or protocols to ensure comparable data and methodologies	☐	Section 4.4
354.36		Representative Monitoring	• Description of representative sites	☐	Section 4.5
			• Demonstration of adequacy of using groundwater elevations as proxy for other sustainability indicators	☐	Section 4.5
			• Adequate evidence demonstrating site reflects general conditions in the area	☐	Section 4.5
354.38		Assessment and Improvement of	• Review and evaluation of the monitoring network	☐	Section 4.6 Section 4.6.3
			• Identification and description of data gaps	☐	Section 4.6.1

GSP Regulations Section	Water Code Section	Requirement	Description	Complete	Section(s) or Page Number(s) in the GSP
ARTICLE 5. PLAN CONTENT, SUBARTICLE 5. PROJECTS AND MANAGEMENT ACTIONS					
3354.44		Projects and Management Actions	• Description of projects and management actions that will help achieve the basin's sustainability goal	☐	Section 5.2
			• Measurable objectives that is expected to benefit from each project and management action	☐	Section 5.2
			• Circumstances for implementation	☐	Section 5.2
			• Public noticing	☐	Section 5.2
			• Permitting and regulatory process	☐	Section 5.2
			• Timetable for initiation and completion, and the accrual of expected benefits	☐	Section 5.2
			• Expected benefits and how they will be evaluated	☐	Section 5.2
			• How the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.	☐	Section 5.2
			• Legal authority required	☐	Section 5.2
			• Estimated costs and plans to meet those costs	☐	Section 5.2
			• Management of groundwater extractions and recharge	☐	Section 5.2
354.44(b)(2)	10727.2(d)(3)		• Overdraft mitigation projects and management actions	☐	Section 5.2

GSP Regulations Section	Water Code Section	Requirement	Description	Complete	Section(s) or Page Number(s) in the GSP
ARTICLE 8. INTERAGENCY AGREEMENTS					
357.4	10727.6	Coordination Agreements – Shall be submitted to the Department together with the GSPs for the basin and, if approved, shall become part of the GSP for each participating agency.	**Coordination Agreements shall describe the following:** • A point of contact	☐	Appendix G
			• Responsibilities of each Agency	☐	
			• Procedures for the timely exchange of information between Agencies	☐	
			• Procedures for resolving conflicts between Agencies	☐	
			• How the Agencies have used the same data and methodologies to coordinate GSPs	☐	
			• How the GSPs implemented together satisfy the requirements of SGMA	☐	
			• Process for submitting all Plans, Plan amendments, supporting information, all monitoring data and other pertinent information, along with annual reports and periodic evaluations	☐	
			• A coordinated data management system for the basin	☐	
			• Coordination agreements shall identify adjudicated areas within the basin, and any local agencies that have adopted an Alternative that has been adopted by the Department	☐	

§ 354.6 Agency Information

When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:

a) The name and mailing address of the Agency.

b) The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan.

c) The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.

d) The legal authority of the Agency, with specific reference to citations setting forth the duties, powers, and responsibilities of the Agency, demonstrating that the Agency has the legal authority to implement the Plan.

e) (e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.

1.3 AGENCY INFORMATION [§354.6]

The following information is provided in compliance with Section 354.6 of Article 1, Subchapter 2, Chapter 1.5, Division 2, of Title 23 of the California Code of Regulations.

(A) NAME AND MAILING ADDRESS OF THE AGENCY

Tri-County Water Authority
944 Whitley Avenue, Suite E
Corcoran, CA 93212
www.tcwater.org

(B) MANAGEMENT STRUCTURE

The TCWA is a Joint Powers Authority created among local agencies cooperatively working towards groundwater sustainability. TCWA is a Groundwater Sustainability Agency (GSA) and has developed a Groundwater Sustainability Plan (GSP) to manage groundwater in the Tulare Lake Hydrologic Region to accomplish measurable goals and prevent unreasonable harm to the basins in its service boundaries. The TCWA is governed by a five-person board of directors. Day to day management of the TCWA is the responsibility of the Authority’s Executive Director, Ms. Deanna Jackson.

(C) Contact Information of the Plan Manager

The Groundwater Sustainability Plan Manager is Ms. Deanna Jackson, Executive Director, TCWA.

Phone Number: (559) 762-7240

Address: Tri-County Water Authority
944 Whitley Avenue, Suite E
Corcoran, CA 93212

E-Mail Address: djackson@tcwater.org

(D) Legal Authority of the Agency

The TCWA is a joint powers authority created under the Joint Exercise of Powers Act (SB 1350, of the Senate Local Government Committee, 2000: Government Code §6500, et seq) of the State of California. The Act sets forth the duties, powers, and responsibilities of Joint Powers Agencies. TCWA is governed by its Amended and Restated Joint Exercise of Powers Agreement.

(E) Cost of Implementation of the Plan

The estimated cost of implementation of the GSP (hereinafter referred to as Plan or GSP) is approximately $515,000, not including start- up costs and the cost of the Proposition 218 election (estimated to be $188,000), ongoing management (estimated to be $140,000 to $160,000 annually), and the cost of special projects that may be necessary to achieve the objectives of the Plan. Additionally, the annual cost of maintaining the Plan, archiving the pertinent data, measuring water levels, performing crop surveys, calculating crop water use, measuring subsidence, establishing groundwater levels, developing the annual reports, along with other Sustainable Groundwater Management Act (SGMA) related administrative duties is estimated to be $112,000 per year. Therefore, the total cost of SGMA for the TCWA from 2018 through 2022 is estimated to be about $1.8 million. The TCWA will meet the costs of implementing the Plan by collecting revenues from landowners either by direct assessments or extraction fees.

§354.8 Description of Plan Area

Each Plan shall include a description of the geographic areas covered, including the following information:

(a) One or more maps of the basin that depict the following, as applicable:

1) The area covered by the Plan, delineating areas managed by the Agency as an exclusive Agency and any areas for which the Agency is not an exclusive Agency, and the name and location of any adjacent basins.
2) Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.
3) Jurisdictional boundaries of federal or state land (including the identity of the agency with jurisdiction over that land), tribal land, cities, counties, agencies with water management responsibilities, and areas covered by relevant general plans.
4) Existing land use designations and the identification of water use sector and water source type.
5) The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the Department, as specified in Section 353.2, or the best available information.

1.4 DESCRIPTION OF PLAN AREA [§354.8]

Figure 1.4.0 depicts the Management Areas (North Management Area and Southeast Management Area), which comprise the focus area of this GSP.

1.4.1 DEPICTION OF THE PLAN AREA {§354.8(a)]

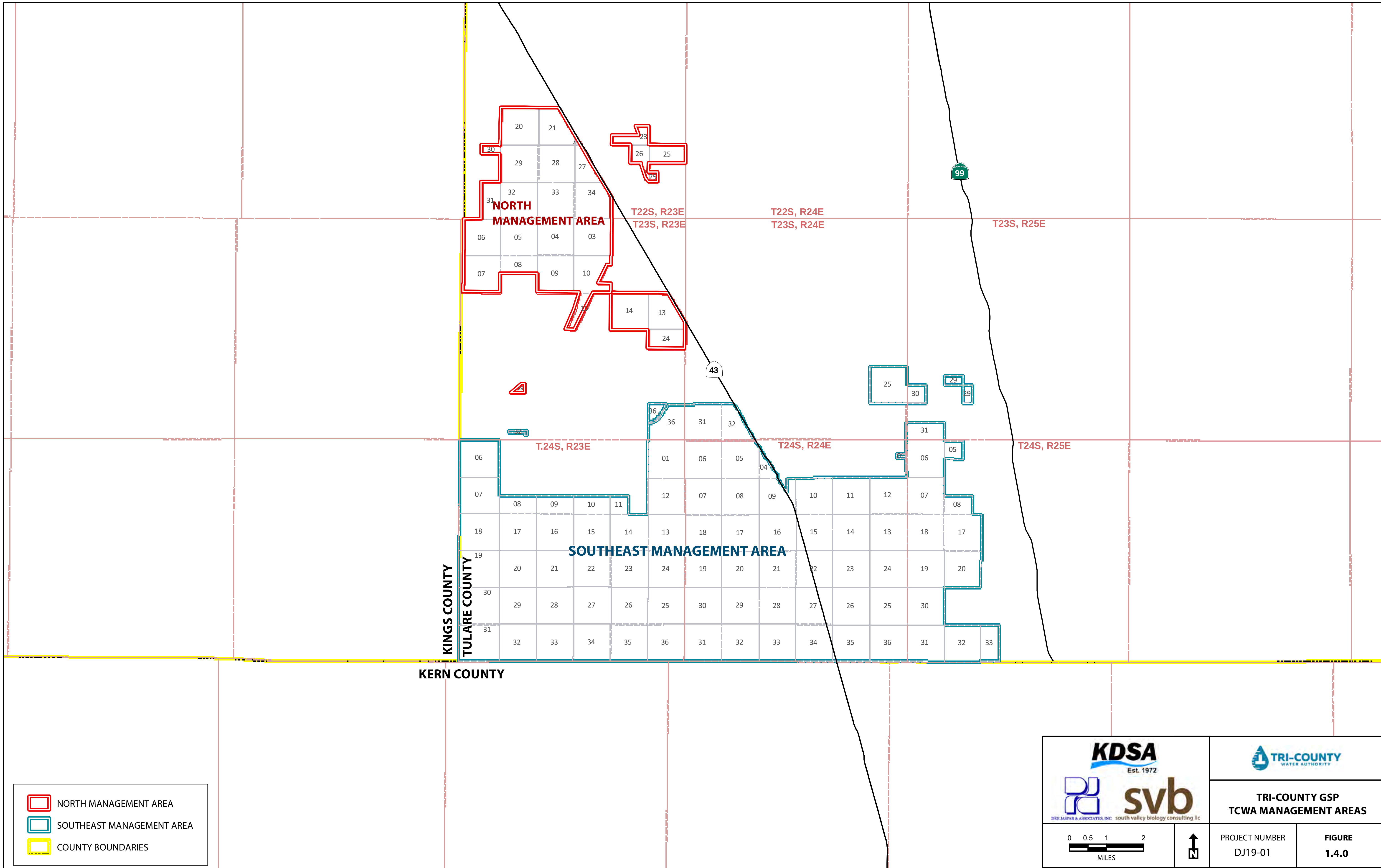
1.4.1-1 Area Covered by the Plan [§354.8 (a)(1)]

Figure 1.4.1 depicts the area managed by TCWA. Areas included within this GSP, but for which TCWA is not the exclusive agency overlying the land, include:

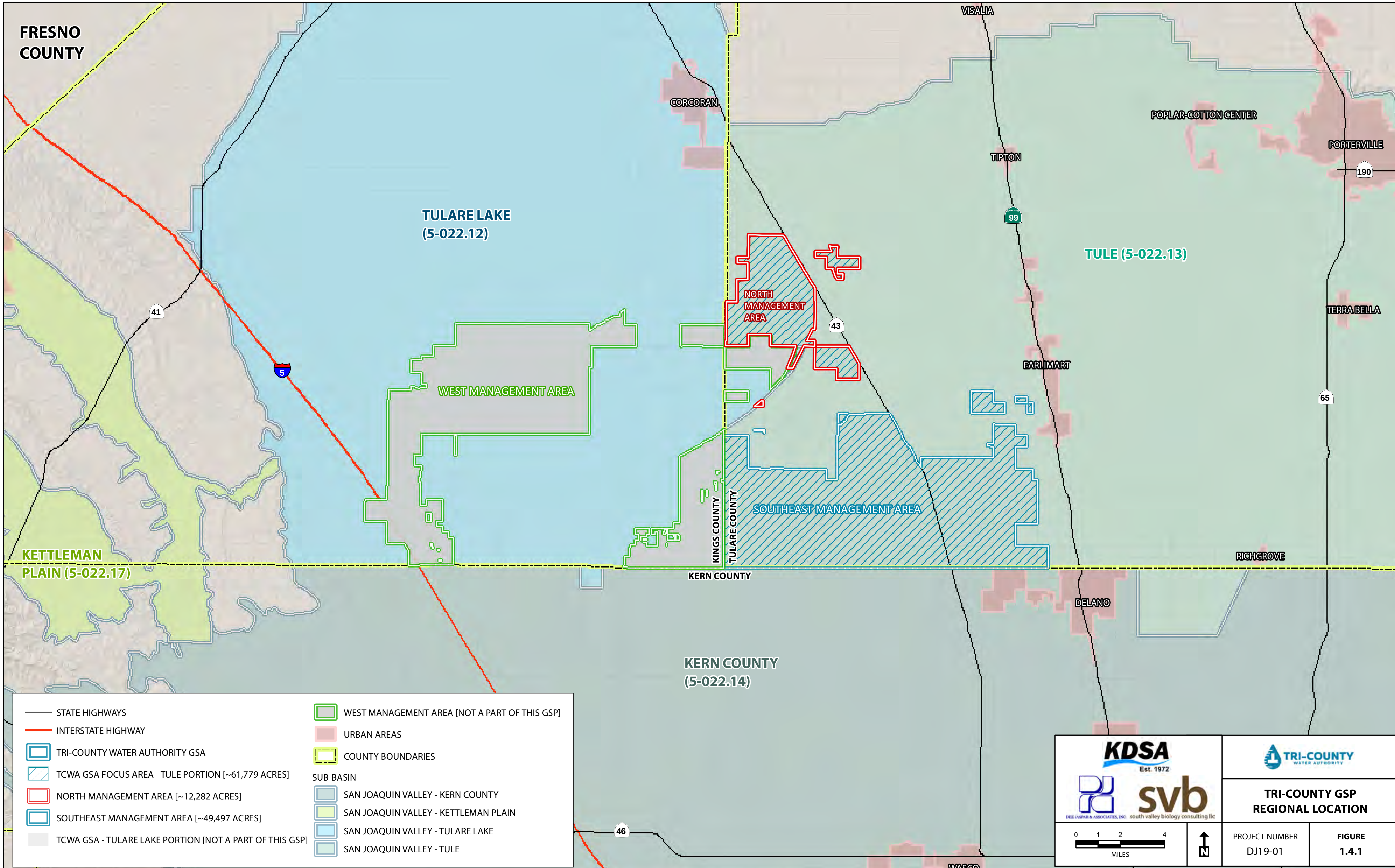
1. Angiola Water District
2. Deer Creek Storm Water District
3. Allensworth Community Services District
4. W.H. Wilbur Reclamation District
5. Atwell Island Water District
6. The County of Tulare
7. The County of Kings

Also shown on Figure 1.4.1 are the Subbasins:

1. Kern County Groundwater Subbasin No. 5.022-14.
2. Tule Subbasin (No. 5-22.13) and the Tulare Lake Subbasin (No. 5.022-12).



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/U.S. CENSUS BUREAU



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/U.S. CENSUS BUREAU

Groundwater Basins - Areas Managed by TCWA

Figure 1.4.1 above depicts the regional setting of TCWA. TCWA manages groundwater in both Kings and Tulare Counties. TCWA's south border is the Kings/Kern and Tulare/Kern County lines. TCWA is divided east-west by the Kings/Tulare County line. There are no major cities in the GSA. Kern County's second-largest city of Delano is just east of the east boundary of TCWA. The largest community in TCWA is Allensworth, located in the Colonel Allensworth State Park, with a population of less than 500. Allensworth Community Services District serves domestic water to the community via two municipal wells.

Figure 1.4.2 depicts neighboring GSAs.
In the Tule Subbasin these are:

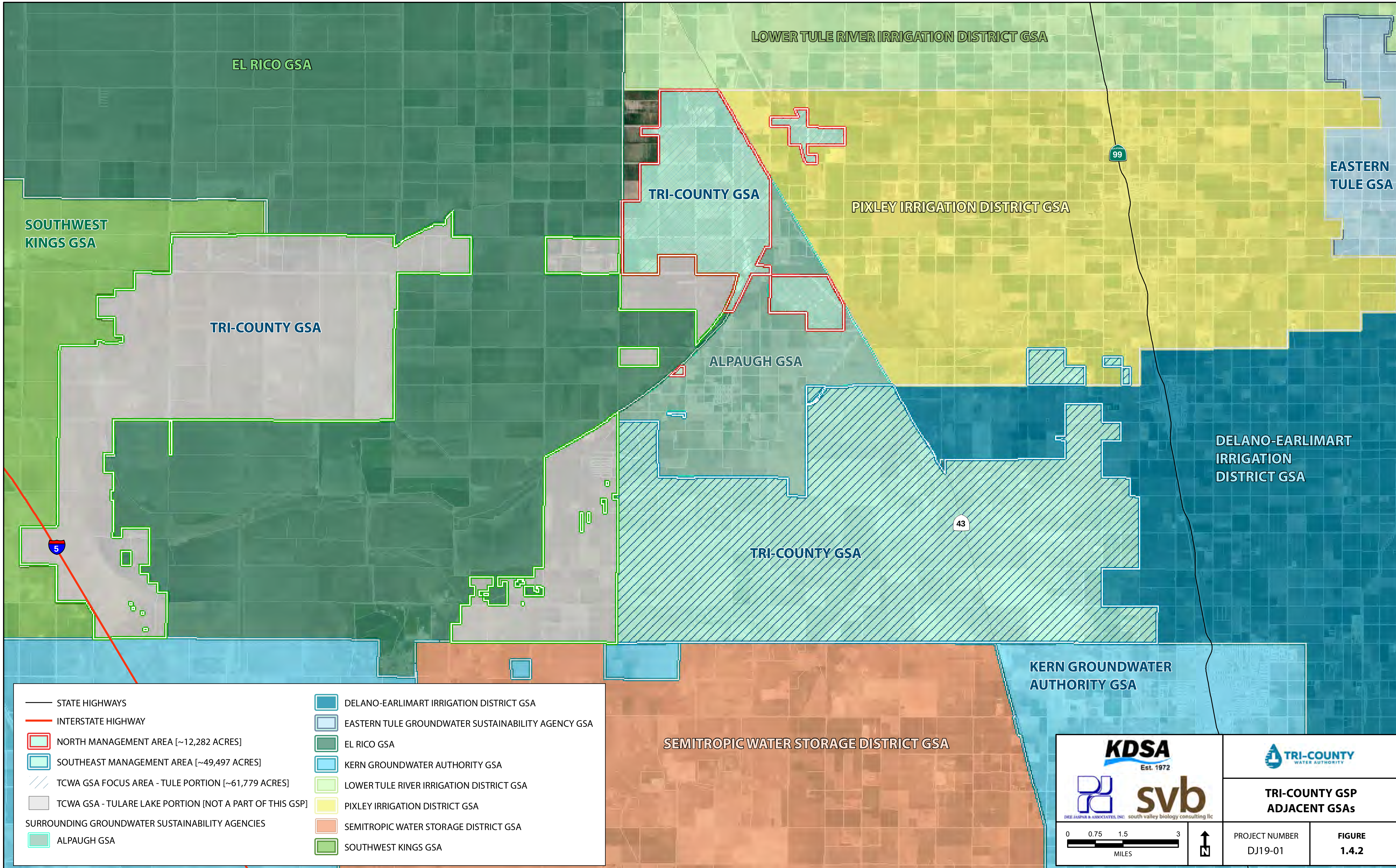
1. Delano-Earlimart Irrigation District GSA
2. Pixley ID GSA
3. Alpaugh GSA
4. Lower Tule River ID GSA

In the Tulare Lake Subbasin these are:

1. El Rico GSA
2. Southwest Kings GSA

In the Kern County Subbasin these are:

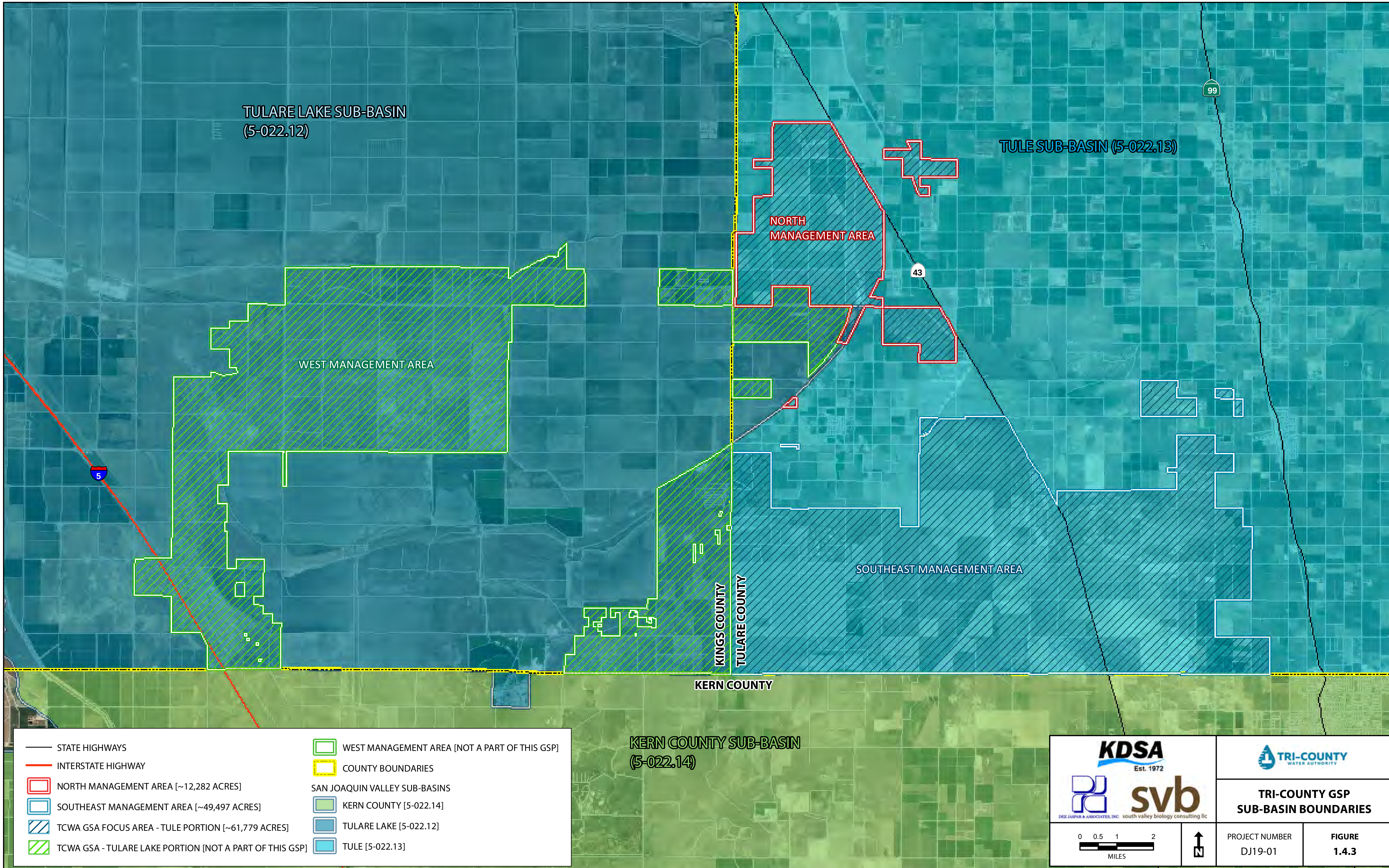
1. The Kern Groundwater Authority GSA
2. Semitropic Water Storage District (WSD) GSA



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/U.S. GEOLOGICAL SURVEY

Figure 1.4.2 shows the Subbasin boundaries and neighboring GSAs. TCWA's lands in the Tulare Lake Subbasin (lands that are a part of TCWA's West Area), are separated from lands in the Tule Subbasin by El Rico GSA (dark green in Figure 1.4.2). The west boundary of the West Area adjoins the Southwest Kings GSA. The easterly portion of the West Area is bounded on the east by the Kings/Tulare County line. GSA's surrounding TCWA's lands in Tulare County, which are in the Tule Subbasin, are Lower Tule River Irrigation District GSA (light green), Pixley Irrigation District GSA (yellow), and Delano-Earlimart Irrigation District GSA (dark blue). El Rico GSA extends slightly into Tulare County - following the boundary of Tulare Lake Subbasin. Alpaugh GSA is located between the North and Southeast Areas of TCWA's lands. The southern boundary of TCWA adjoins lands in the Kern County Subbasin that are managed by Kern Groundwater Authority GSA and Semitropic Water Storage District GSA.

The Department of Water Resources' Bulletin 118 identifies the groundwater basins in California. TCWA is located in two of those basins and is adjacent to another. Figure 1.4.3 shows the Tule Subbasin (Subbasin 5-22.13) in light blue and the Tulare Lake Subbasin (Subbasin 5-22.12) in dark blue. TCWA's area in the Tulare Lake Subbasin is shown in dark green and is outlined in blue in the Tule Subbasin. The Kern County Subbasin is shown in light green and forms the south boundary of lands in TCWA.



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/U.S. GEOLOGICAL SURVEY

1.4.1-2 ADJUDICATED AREAS [354.8(a)(2)]

There are no areas within the TCWA that are a part of a groundwater adjudication.

1.4.1-3 JURISDICTIONAL BOUNDARIES [354.8(a)(3)]

Figure 1.4.4-A depicts the areas under the jurisdiction of the Bureau of Land Management (BLM) (Bureau of Reclamation Surface Estates), the Allensworth State Park, and the Allensworth Community Services District, which serves domestic water for the community of Allensworth which is located within the State Historic Park, and certain lands that are a part of the Pixley National Wildlife Refuge.

Figure 1.4.4-B depicts the external extent of Federal Indian reservations in the vicinity of TCWA's Management Areas. No tribal lands are located within the TCWA. The Land Area Representation (LAR) illustrates land areas for Federally-recognized tribes and is the Bureau of Indian Affairs' (BIA) official geospatial representation of Federal Indian land areas. The BIA maintains the LAR dataset as part of the Division of Land Titles and Records (DLTR). As provided by the BIA "A Federally-recognized tribe is an American Indian or Alaska Native entity that is recognized as having a government-to-government relationship with the United States. Federally-recognized tribes are recognized as possessing certain inherent rights of self-government (i.e., tribal sovereignty) and they are eligible to receive certain Federal benefits, services, and protections because of their special relationship with the United States. " (BIA 2018).

1.4.1-4 LAND USE DESIGNATIONS [354.8(a) (4)]

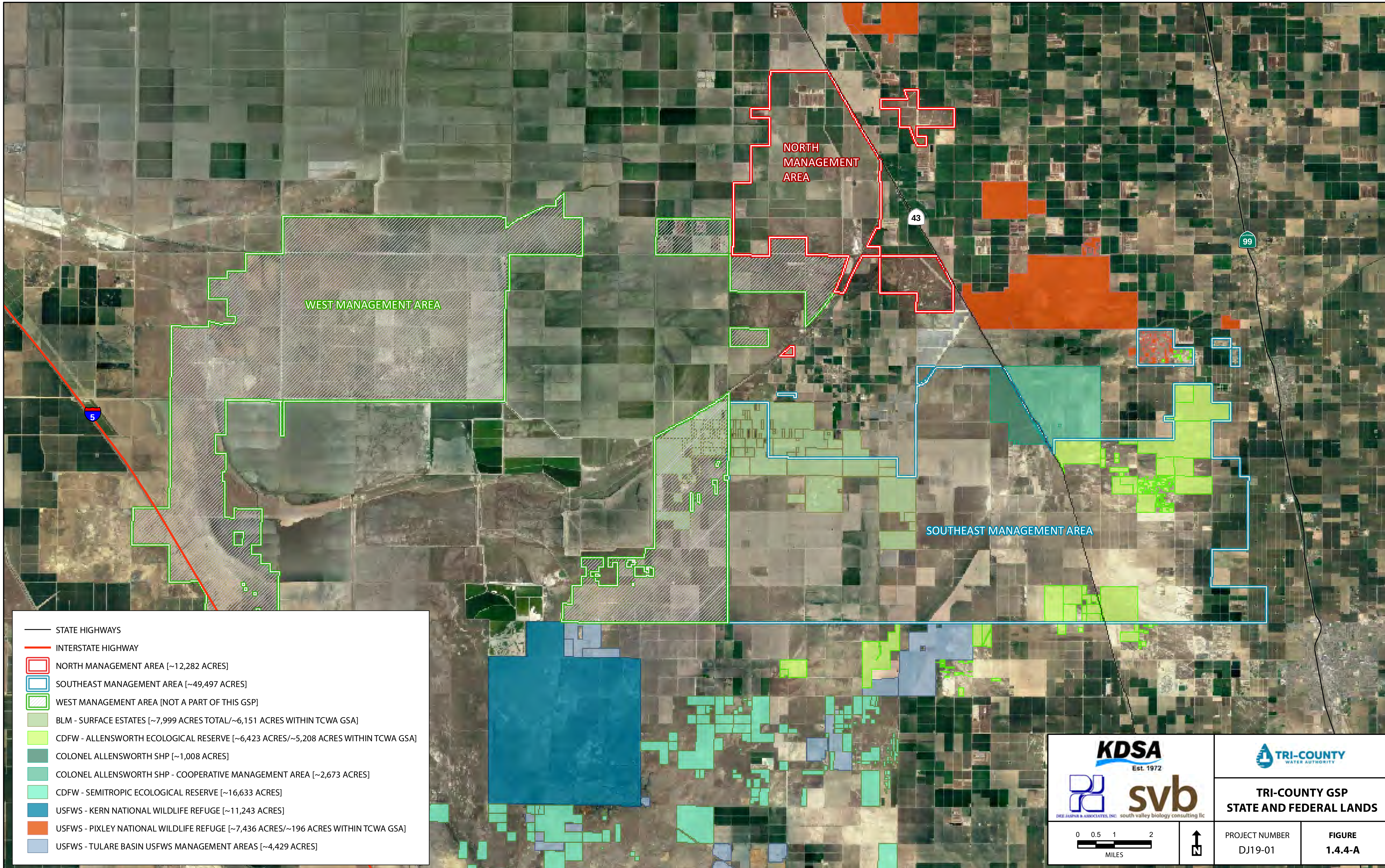
Figure 1.4.5 shows the existing land use designations, the water use sectors and the water source type for the lands within the TCWA. Lands in the Tule Subbasin, which are in Tulare County, are designated Valley Agricultural while lands in Kings County are designated General Agricultural. Both designations allow for the current land use. The community of Allensworth in Tulare County is designated Hamlet Development and is within the Allensworth State Park. The water use sector is primarily Agricultural with the only Urban water use being located in Allensworth.

1.4.1-5 WELLS AND WELL DENSITY [354.8(a) (5)]

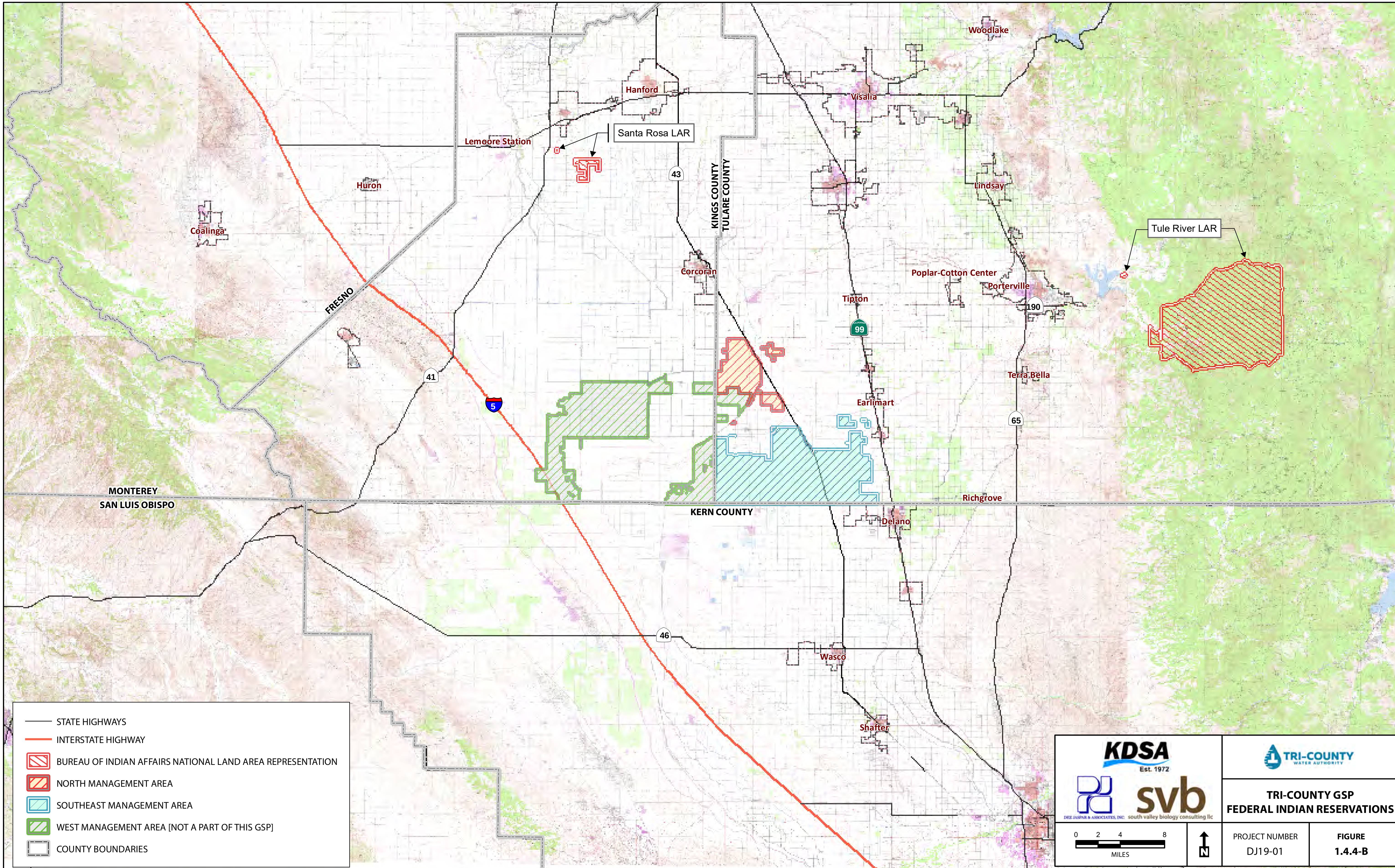
Figure 1.4.6 shows the density of wells per square mile and the general distribution of agricultural, industrial and public water supply wells. The community of Allensworth is the sole community dependent on groundwater in the TCWA. Groundwater use is minimal in Allensworth, averaging about 100 acre-feet annually.

Figure 1.4.6 shows the irrigation wells in the GSA. The GSA has been divided into three Management Areas, two of which are the focus of this GSA. These are shown in Figures 1.4.6-A - the North Area; and 1.4.6-B - the Southeast Area. Areas 1.4.6-A and 1.4.6-B are in the Tule Subbasin. The locations of irrigation wells are shown on the figures, together with the public water supply wells for Allensworth. Figure 1.4.6-C is a dasymetric map depicting the density of supply wells in the GSA.

The Management Areas are separated because of differences in location, water supplies and groundwater conditions. These Areas are discussed in greater detail in Chapter 2 of this report.



SOURCE(S): BUREAU OF LAND MANAGEMENT/CA DEPT. OF FISH AND WILDLIFE/CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/CA STATE PARKS/U.S. CENSUS BUREAU/U.S. FISH AND WILDLIFE SERVICE/U.S. GEOLOGICAL SURVEY



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/U.S. CENSUS BUREAU/U.S. DEPT. OF THE INTERIOR - INDIAN AFFAIRS

Figure 1.4.4-A depicts state and federal lands within and adjacent to TCWA. The majority of the jurisdictional areas are depicted in light green. These are lands defined as "Surface Estates" of the Bureau of Land Management. Surface Estates are lands on which the surface rights and mineral rights are split, also known as "Split Estates". The lands identified by the light green color are lands upon which the BLM has acquired the surface rights and the previous landowner has retained the mineral rights. Allensworth State Park and the Community of Allensworth are depicted in the dark green color. Other jurisdictional lands within TCWA are lands of the USFWS Pixley National Wildlife Refuge (Red) and the CDFW Allensworth Ecological Reserve. Together these lands occupy about 12,500 acres within TCWA, or approximately 20% of the land.

Figure 1.4.4-B depicts the external extent of Federal Indian reservations in the vicinity of TCWA's Management Areas. No tribal lands are located within TCWA.

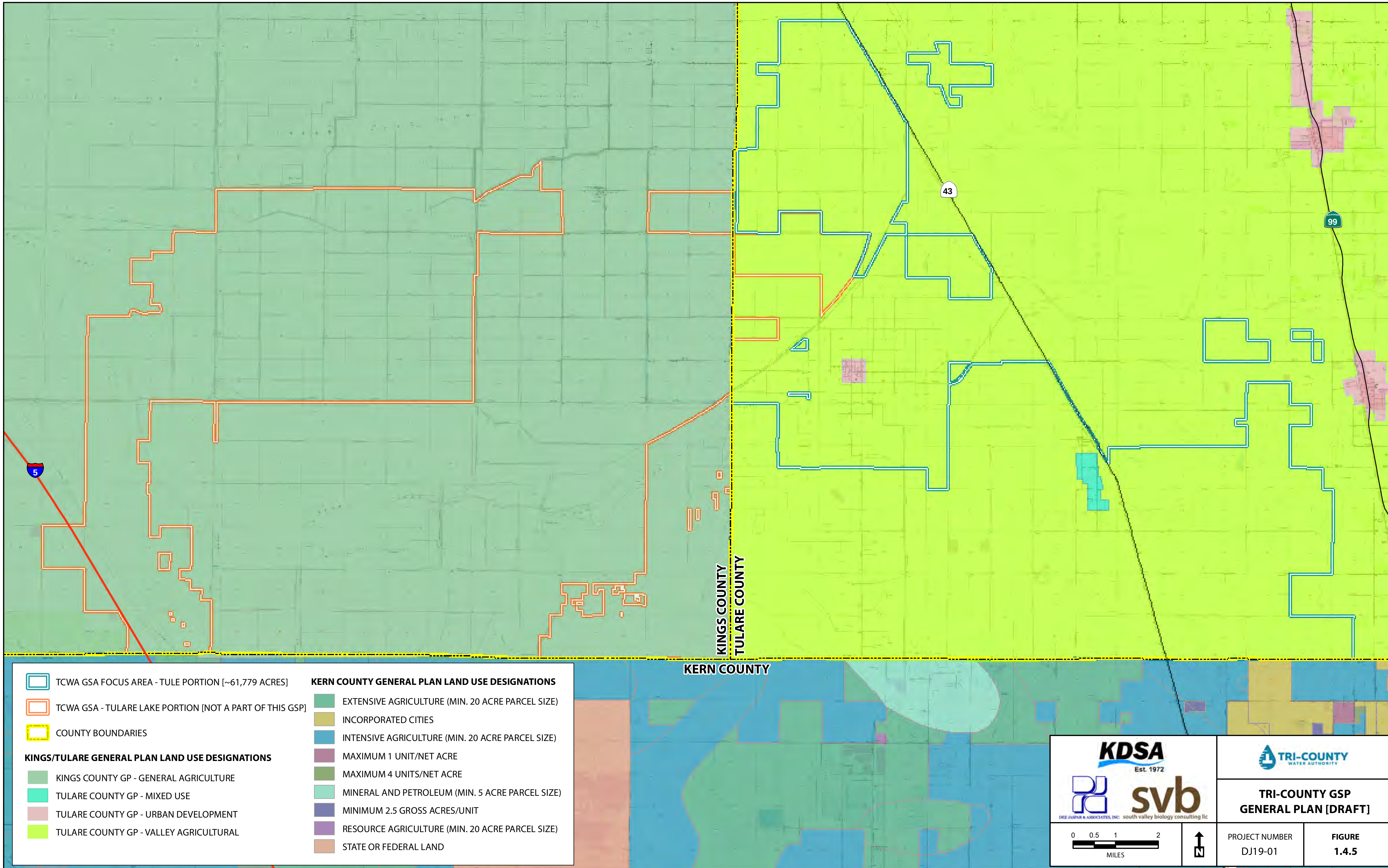
Figure 1.4.5 shows County General Plan Designations. The majority of the lands in both Kings and Tulare Counties are designated for agricultural use. Lands in Kings County are designated General Agriculture and lands in Tulare County are designated Valley Agricultural. The only lands designated for municipal use are those of Allensworth, which are designated Hamlet Development by Tulare County.

Figure 1.4.6 is the well index map for TCWA. All known large capacity supply wells (not small domestic wells - such as at farmsteads) are plotted on Figures 1.4.6-A and 1.4.6-B. TCWA has been divided into three management areas based on groundwater conditions of which the North and Southeast Management Areas comprise the focus area of this GSP. These areas are shown on this map bounded by red borders.

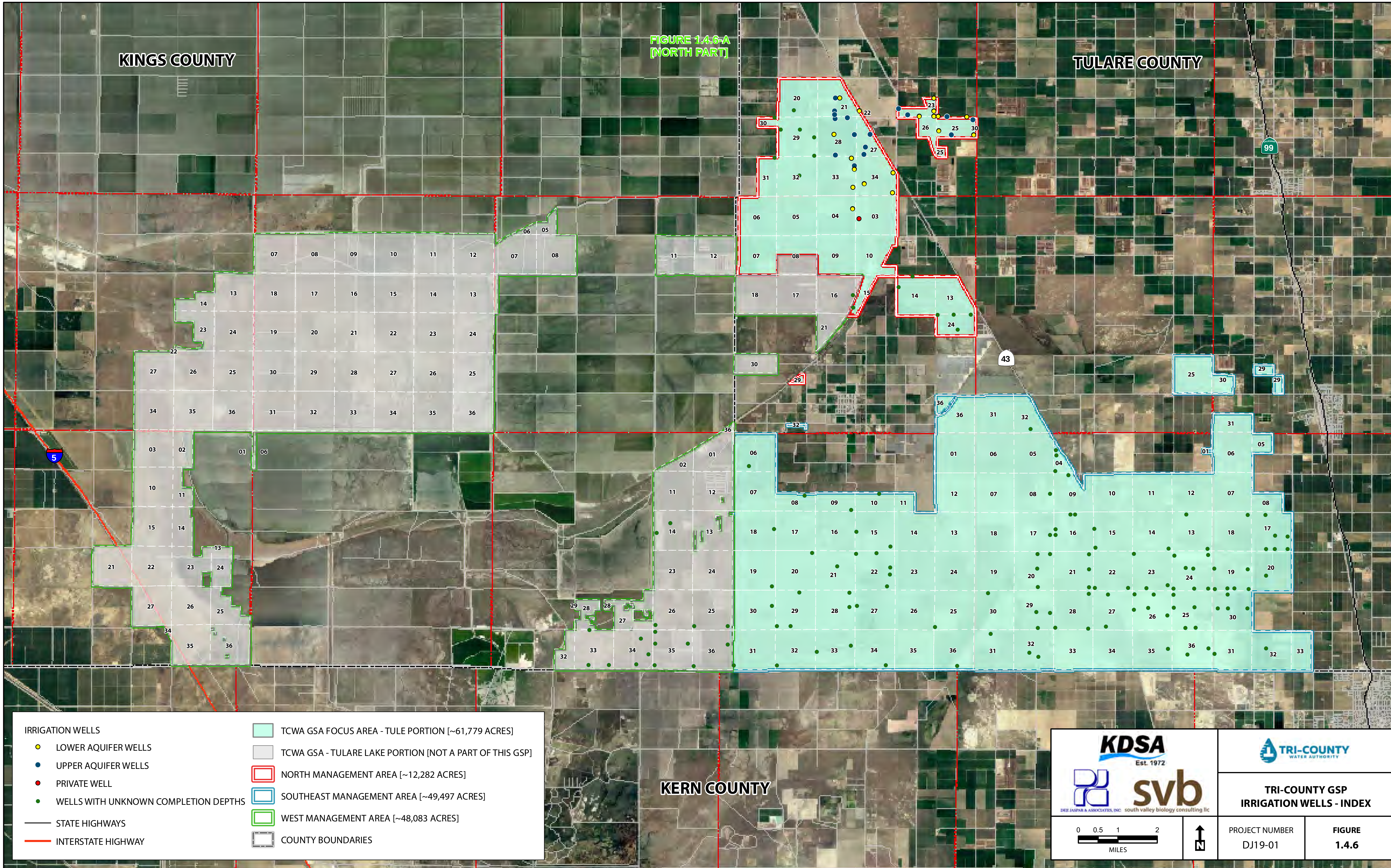
Figure 1.4.6-A is the well map for the North Area of TCWA. Note that AWD's West and East Well Fields are designated on this map. Well depths are designated by the color of the symbols on this map. A number of deep wells have been replaced by shallow wells in an effort to reduce subsidence.

Figure 1.4.6-B is the well index map for the Southeast Area of TCWA. It is proposed to eventually replace a number of wells that are currently completed in the Lower Aquifer with wells drilled into the Upper Aquifer in an effort to reduce land subsidence. This is not considered possible in all of the Southeast Area, but only for the east two-thirds of the Area.

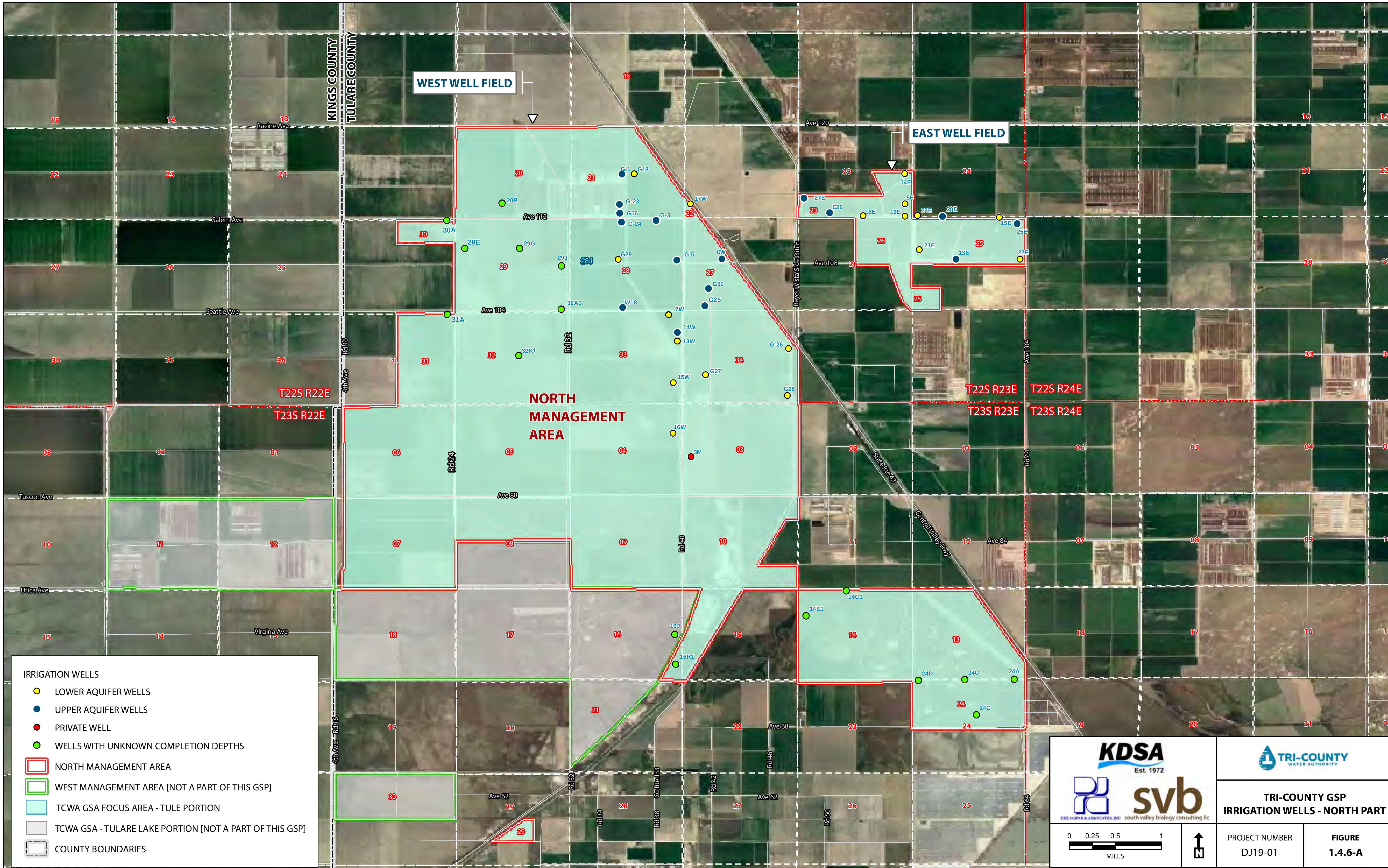
Figure 1.4.6-C shows the relative density of the placement of wells in TCWA. There are a few sections with no wells, but the majority of sections have well densities of 1-4 wells per section.



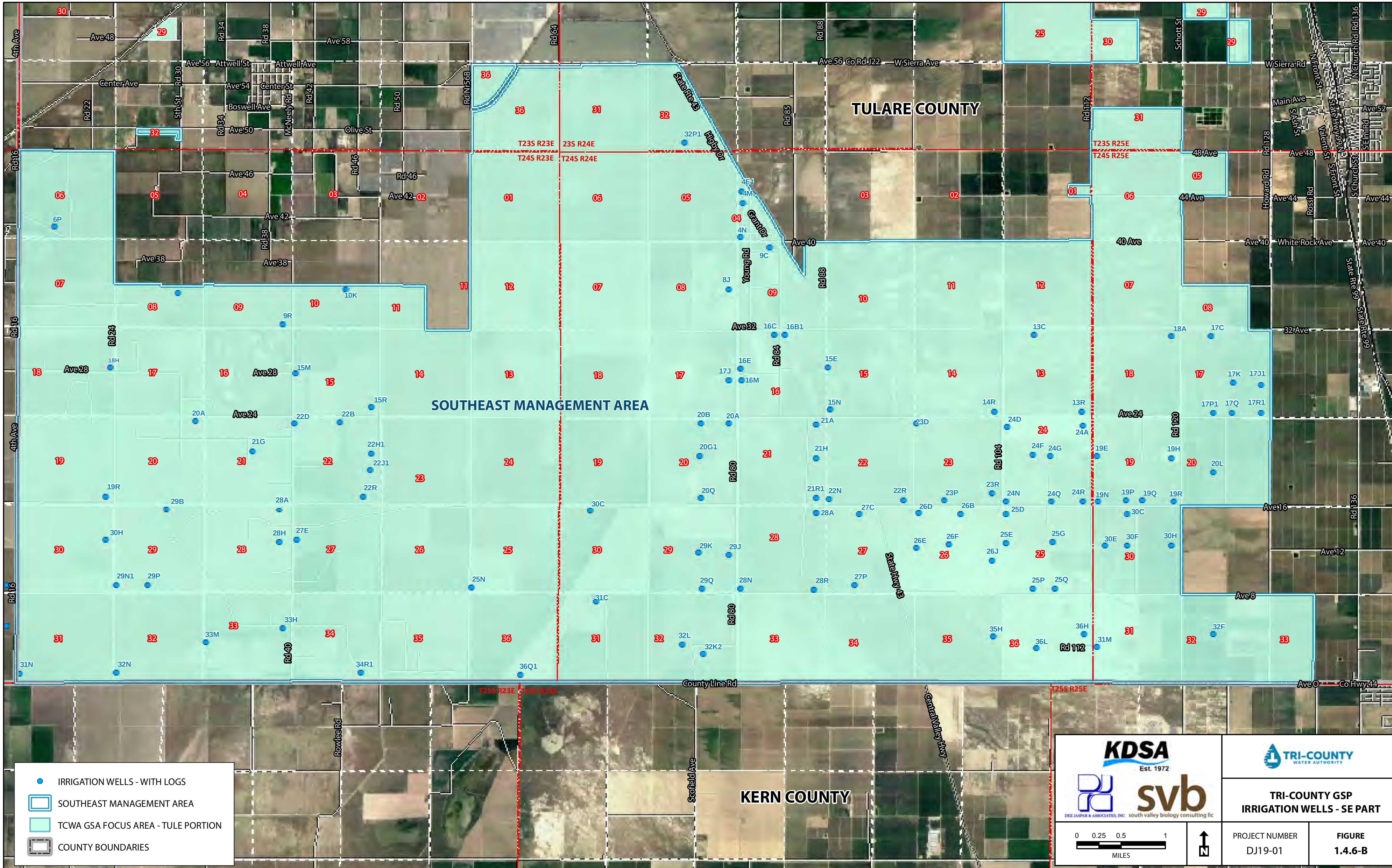
SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/COUNTY OF TULARE/COUNTY OF KERN



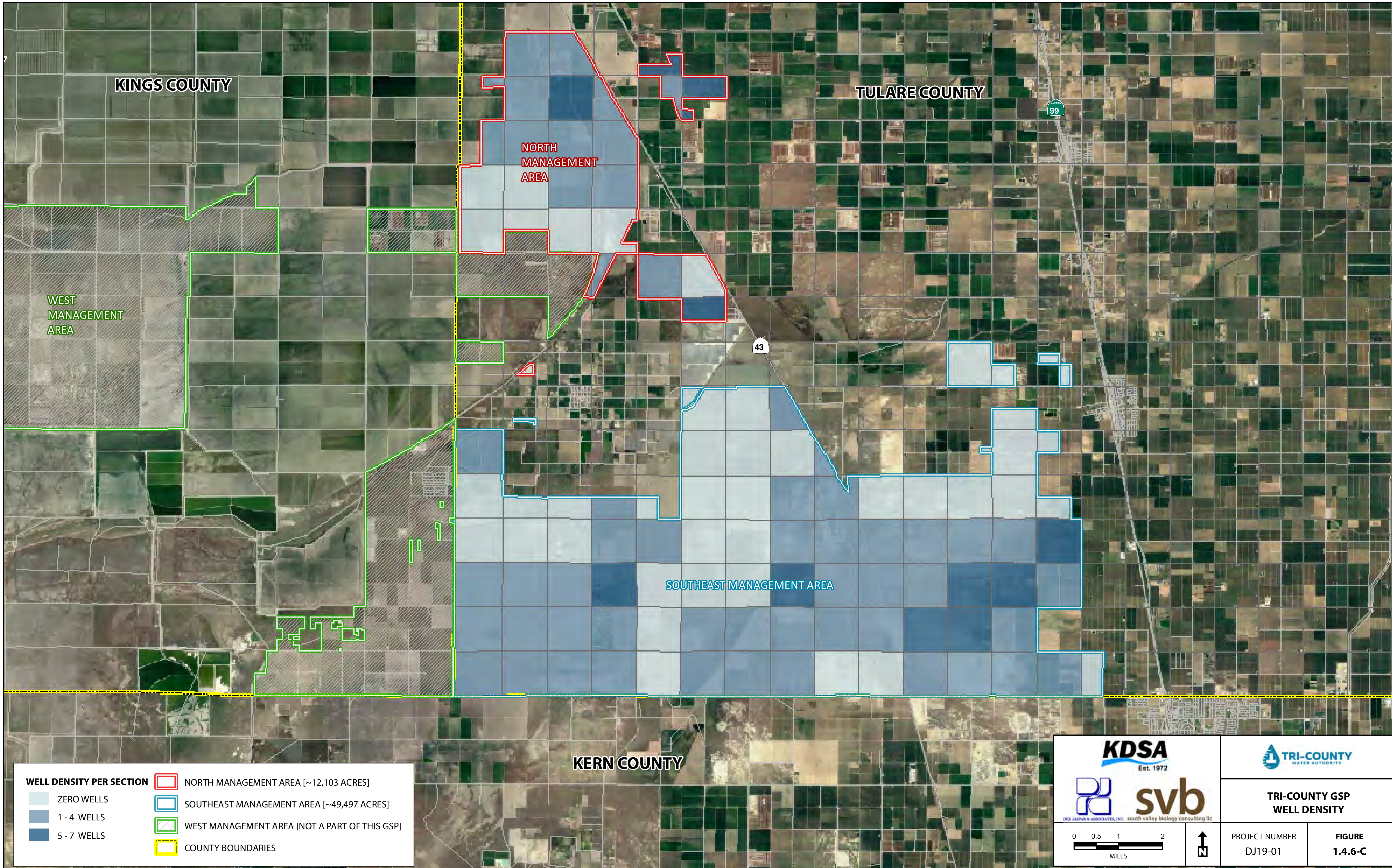
SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/KENNETH D. SCHMIDT AND ASSOCIATES/U.S. CENSUS BUREAU



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/KENNETH D. SCHMIDT AND ASSOCIATES/U.S. CENSUS BUREAU



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/KENNETH D. SCHMIDT AND ASSOCIATES/U.S. CENSUS BUREAU



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/KENNETH D. SCHMIDT AND ASSOCIATES/U.S. CENSUS BUREAU

§354.8 Description of Plan Area

b) A written description of the Plan area, including a summary of the jurisdictional areas and other features depicted on the map.

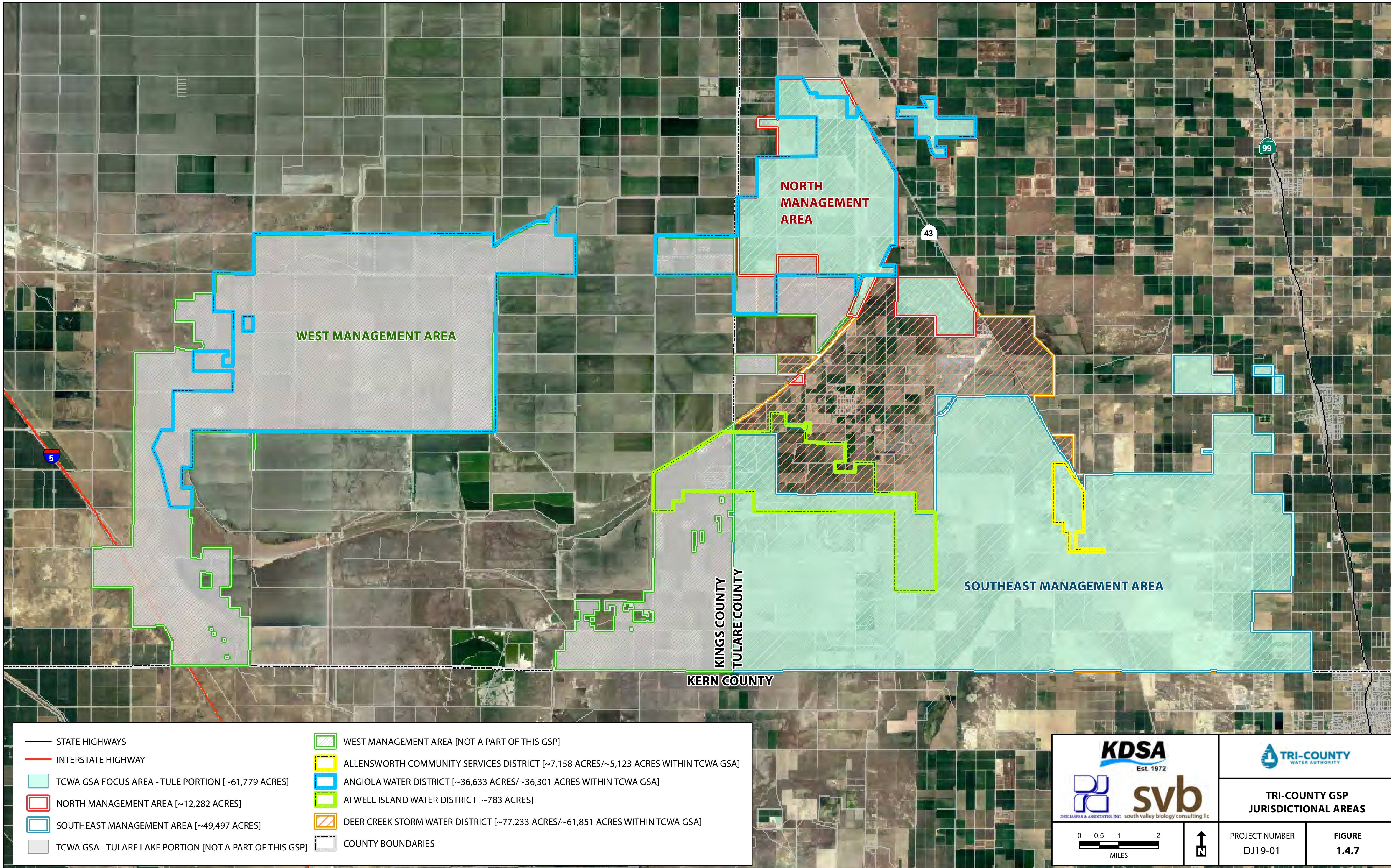
1.4.2 DESCRIPTION OF PLAN AREA [§354.8(b)]

TCWA is located in Tulare and Kings Counties, north of the Kern County Line, which forms its southern boundary. The eastern part of the GSA is in the Tule Subbasin (5-22.13) and the western part is in the Tulare Lake Subbasin (5-22.12). North of Avenue 48, TCWA is located west of Highway 43, except for lands east of Angiola, comprising Angiola Water District's East Well Field. South of Avenue 48, there are additional lands in the GSA that area east of Highway 43 and extend east to about a mile west of Earlimart and Delano. The subject of this GSP are the lands of the TCWA that are in the Tule Subbasin which are located in Tulare County. The lands within the Tulare Lake Subbasin that are located in Kings County are addressed in the Tulare Lake Subbasin GSP.

Jurisdictional areas within TCWA include:

- → Angiola Water District (AWD)
- → Deer Creek Storm Water District
- → Allensworth Community Services District
- → W.H. Wilbur Reclamation District
- → Atwell Island Water District
- → The County of Tulare
- → The County of Kings

Figure 1.4.7 below shows the public districts within TCWA and if TCWA shares jurisdiction with another public entity upon these lands.



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/KENNETH D. SCHMIDT AND ASSOCIATES/U.S. CENSUS BUREAU

Water supply for lands within TCWA is primarily groundwater (see Table 1.4.2). Lands in the North Management Area receive a surface water supply from Angiola Water District. Lands in the Southeast Management Area do not have a surface water supply.

Table 1.4.2
Water Supply and Water Use for TCWA

Water Use Sector	Water Source	Supply Percentage	Approximate Annual Use (af)
Urban / Municipal	Groundwater	100%	Less than 200
Agriculture	Groundwater	91%	49,500
Agriculture	Surface Water	9%	4,500

§354.8 Description of Plan Area

c) Identification of existing water resource monitoring and management programs, and description of any such programs the Agency plans to incorporate in its monitoring network or in development of its Plan. The Agency may coordinate with existing water resource monitoring and management programs to incorporate and adopt that program as part of the Plan.

1.4.3 EXISTING WATER RESOURCE MANAGEMENT PROGRAMS [§354.8(c)]

Surface Water Management

AWD receives surface water from many sources. These are: Kings and Tule Rivers, Deer Creek, White River, Article 21 water from the State Water Project ("SWP"), Central Valley Project ("CVP") via the Fresno Slough Water District and Mercy Springs Water District Transfers, and flood waters in years when available. AWD holds stock in the Bayou Vista Ditch Company ("BVDC"). BVDC is a member of the Downstream Kaweah and Tule River Association and thereby receives Tule River Water.

Groundwater Management

Angiola operates two well fields. The East Well Field is located in Sections 23, 24, 25, and 26 of T.22S., R.23E., M.D.B.&M., generally south of Avenue 120 and east of Highway 43. There are 10 active wells in the East Well Field. The West Well Field is located in Sections 21, 27, 28, 33, and 34 of T.22S., R.23E. M.D.B.&M., and Section 4 of T. 23S., R.23E., M.B.D.&M. There are 18 active wells in the West Well Field. These wells are operated by AWD. Figure 1.4.6-A shows the location of the above-mentioned district wells.

Management Areas

For purposes of this GSP, the Tule Subbasin portion of TCWA has been divided into two Management Areas. The North Area and the Southeast Areas are located in Tulare County (Tule Subbasin 5-22.13).

North Area

The North Area is located north of Avenue 60 and includes the AWD East and West Well Fields and the east part of AWD. Geologically it is located in a transition area between the Tulare Lakebed to the west and the alluvial fans of the Tule River and other streams to the east. The North Area receives surface water from AWD.

Southeast Area

The Southeast Area is bounded on the south by the Kern County line and extends from 8-1/2 Avenue on the west to Road 132 on the east. It includes the township of Allensworth – which is a State Park. Earlimart and Delano are just east of TCWA. Deer Creek passes through the area north of the Southeast Area and White River passes through this area. The Southeast Area is underlain by the alluvial fans of Deer Creek, White River, and possibly Poso Creek. See Chapter 2 for a description of the geologic setting.

Angiola Water District Surface Water Supplies

Angiola Water District was formed in 1957 for the purpose of delivering agricultural water. AWD is located in both the Tule and Tulare Lake Subbasins (Refer to Figure 1.4.7). It is a landowner voting district governed by a five-member board of directors. The total acreage in the district is approximately 36,600 acres.

Allocation of water within the AWD is governed by the *Angiola Water District Second Restated Water Distribution Agreement (*Agreement*).* The Agreement covers all the various water supply sources of the district. All water is distributed on a pro-rata acreage basis to all land with a water entitlement based on assessed acreage. If a landowner chooses to take less than its pro-rata share, then the excess water from that landowner is made available to all other landowners in the district. If there is a water supply shortage, available water is distributed on an acreage basis based on assessed acreage.

AWD records indicate that average water deliveries increased significantly after the construction of the State Water Project in 1969. During the pre-SWP years of 1959-1966, AWD delivered an average of 29,000 acre-feet per year (“afy”). After the inception of the SWP average deliveries increased to about 39,000 afy, from 1974 through 2006. In 2004 AWD sold its SWP Table A water and this put a greater reliance on other surface water sources and groundwater. From 2005 through 2018 average AWD deliveries were also about 39,000 afy, however, there was, and continues to be, a greater reliance on groundwater because of the loss of the Table A supply.

§354.8 Description of Plan Area

d) A description of how existing water resource monitoring or management programs may limit operational flexibility in the basin, and how the Plan has been developed to adapt to those limits.

1.4.4 LIMITATIONS ON OPERATIONAL FLEXIBILITY [§354.8(d)]

Water Supply Limitations

Historically groundwater has been pumped from the Angiola Well Fields. About 75% has been transported out of TCWA, 25% has been delivered within TCWA to lands in AWD. The AWD has a Prescriptive Groundwater Right to pump and export approximately 24,000 afy of groundwater from the Subbasin. Historically a range of 0 to 30,000 afy of groundwater has been exported from the Subbasin, depending on water year type. Historical water deliveries for AWD are listed in Table 2.3.2 in Section 2.3.2 (repeated below). The table reflects a 45-year history of the water deliveries to AWD.

Table 2.3.2

Angiola Water District

Historical Water Deliveries (Acre-Feet)

Angiola Water District 2004-2018 Water Supplies[1]													
Year	**State Water Project**			**Tule River**	**Kings River[2]**	**Other**	**Flood**	**Local**	**Deer Ck.**	**Total Surface Sources**	**AWD District Pumpage**	**Total Supply**
.	Total	Table A	Article 21	Total	Total	Total	Total	Total	Total	Total	Total	Total
2004	1,787	1,293	494	559	0	5,293	0	4,657	0	12,296	26805	39,101
2005	13,047	564	12,483	1,680	10,632	1,235	5,890	15,954	0	48,438	662	49,100
2006	11,289	614	10,675	795	14,253	0	7,973	6,134	0	40,444	141	40,585
2007	5,124	243	4,881	0	18,083	63	0	0	0	23,270	32,894	56,164
2008	762	761	1	828	4,756	0	0	0	0	6,346	32,502	38,848
2009	35	34	1	0	0	0	0	0	0	35	37,798	37,833
2010	13	12	1	1,676	10,587	282	0	0	0	12,558	22,568	35,126
2011	1,835	1,835	0	1,170	14,383	434	10,011	0	1,516	29,349	3,615	32,964
2012	1,413	1,413	0	271	4,326	1,760	0	0	0	7,770	33,097	40,867
2013	1,080	1,080	0	0	0	4,912	0	0	0	5,992	30,603	36,595
2014	0	0	0	0	0	3,174	0	0	0	3,174	27,783	30,957
2015	0	0	0	0	0	2,439	0	0	0	2,439	30,220	32,659
2016	0	0	0	252	0	1,710	0	0	0	1,962	29,036	30,998
2017	3,849	3,849	0	6,908	13,182	0	23,457	0	0	47,396	2,750	50,146
2018	1,300	1,300	0	714	6,596	6,921	0	0	0	15,531	18,193	33,724
Total	41,534	12,998	28,536	14,853	96,798	28,223	47,331	26,745	1,516	257,000	328,667	585,667
Average	2,769	867	1,902	990	6,453	1,882	3,155	1,783	101	17,133	21,911	39,044

1. Source: Angiola Water District Records.
2. AWD's holdings as a Kings River Water Member Unit are used in the Tulare Lake Subbasin in lieu of pumping in the Tule Subbasin.

AWD's contract for acre-feet of surface water from the State Water Project (SWP) was reduced in 2003-2004. The Table A supply remaining from the SWP is about 100 afy. However, AWD qualifies for Article 21 water in years of abundant runoff. From 2005 through 2018, AWD has received about 2,800 afy from the combination of Table A and Article 21 water from the SWP.

Limitations on Operational Flexibility consist of restrictions on pumping groundwater and the uncertainty of the surface water supply. TCWA, as a part of its groundwater sustainability program, is implementing improvements to existing conjunctive use and in-lieu surface water programs to reduce groundwater extractions when surface water for these programs is available. These programs are necessary in order to minimize fallowing of croplands. There are transportation facilities in TCWA to facilitate implementation of these programs, however, scheduling of capacity in the Federal and State Projects may become an issue as competition increases for available capacity due to the effects of SGMA.

TCWA is implementing a program to reduce groundwater extractions from AWD wells in the lower aquifer by replacing wells that are currently pumping from the lower aquifer with wells pumping from the upper aquifer. TCWA believes that the upper aquifer is currently balanced and can provide an adequate quantity of replacement water to reduce subsidence.

1.4.5 CONJUNCTIVE USE PROGRAMS [§354.8(e)]

Conjunctive use programs consist of replacing groundwater with surface water in years when Article 21 Turnback Water supply is available from the SWP contractors, the Kings and Tule Rivers, and captured flood waters that are used for irrigation.

Sources of surface water to TCWA are tabulated in Table 2.3.2. According to AWD, on average, 25% of surface water supplies provided to the AWD has been retained for use in the district, on lands in the North Area. 75% of water supplies have been exported out of the AWD.

§354.8 Description of Plan Area

e) A description of conjunctive use programs in the basin.

The surface water supplies of AWD that replace groundwater pumping are considered in-lieu conjunctive use programs. These include:

- Replacing groundwater with surface water when available. 25% of average deliveries for 2004-2018, are listed below.
  - → SWP Water: 690 afy
  - → Tule River Water: 250 afy
  - → Kings River Water: 1,610 afy
  - → Other Water: 470 afy

→ Flood Water: 790 afy
→ Local Water: 450 afy
→ Deer Creek Water: 20 afy

Total Average Annual Surface Water Deliveries: 4,300 afy

- White Ranch Project (proposed): 5,800 afy
- TCWA Southeast Area Recharge Scenario (proposed): 1,500 afy
- Liberty Project (proposed): Varies – see Section 5.2

Refer to Section 5.2 for an outline of these projects.

Total Conjunctive Use Programs (existing and proposed): 11,600 afy + Liberty Project

§354.8 Description of Plan Area

f) A plain language description of the land use elements or topic categories of applicable general plans that includes the following:

1. A summary of general plans and other land use plans governing the basin.
2. A general description of how implementation of existing land use plans may change water demands within the basin or affect the ability of the Agency to achieve sustainable groundwater management over the planning and implementation horizon, and how the Plan addresses those potential effects.
3. A general description of how implementation of the Plan may affect the water supply assumptions of relevant land use plans over the planning and implementation horizon.
4. A summary of the process for permitting new or replacement wells in the basin, including adopted standards in local well ordinances, zoning codes, and policies contained in adopted land use plans.
5. To the extent known, the Agency may include information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management.

1.4.6 GENERAL PLAN LAND USE ELEMENTS [§354.8(f)]

1.4.6-1 GENERAL PLANS SUMMARY [§354.8(f)(1)]

The general plan designation for the majority of the lands within TCWA is Agriculture. The only urban lands in TCWA are those of the Colonel Allensworth SHP - which houses about 500 residents. The State Park is served by wells that are operated by the Allensworth Community Services District.

Lands designated as potential Groundwater Dependent Ecosystems (GDE) are identified on Figure 1.4.9.

There are about 61,400 acres in the Tule Subbasin portion of TCWA. Of these 61,400 acres about 29,000 are developed to irrigated agriculture. Allensworth SHP encompasses about 3,675 acres of which approximately 1,002 acres occur within TCWA.

Natural Gas Production

The Trico Gas Field extends through TCWA in a southeasterly direction from Section 6, T23S, R23E, MDB&M, through Section 35, T24S, R23E, MBD&M. The deepest well is 13,480 feet deep (Section 36, T24S, R23E). About 25 sections of land are encompassed by the gas field. It is still active, although there is only one well that is currently active. See Figure 1.4.8A.

The Trico Northwest Gas Field is located in Section 29, T23S, R22E, MDB&M and Section 25, T23S, R21E. The gas field is shown on Figure 1.4.8A. This gas field is now abandoned. It was operated from 1944 through 1992. The field consists of two pools; the MYA Pool, shut in since 1988, produced about 2,700,000

Mcf of gas and the Atwell Island Pool produced about 6,400,000 Mcf of gas, shut in since 1985. The deepest well was drilled to a depth of 15,240 feet (Section 25). All wells were scheduled to be abandoned by the end of 1992.

1.4.6-2 IMPLEMENTATION OF LAND USE PLANS & WATER DEMAND IMPACTS [§354.8(f)(2)]

Existing land use plans designate the lands within TCWA as Valley Agricultural (Tulare County). Pertinent to this GSP is Goal AG-1.17 "Agricultural Water Resources: 'The County shall seek to protect and enhance surface water and groundwater resources critical to agriculture'. Implementation of the GSP has the potential to reduce the amount of irrigated acreage within TCWA, but will not require a re-designation of the lands in the County General Plans. Leaving the designations as they currently exist will give agriculture the flexibility to decide how to implement SGMA. The Plan leaves the decision making to the individual farm operators in that landowners/farm operators must decide how they will implement the Plan on each farm operation, but the result must be sustainable. Flexibility and local decision-making about land use is paramount to the success of the SGMA program and is the basis upon which the program was developed.

1.4.6-3 PLAN IMPLEMENTATION & LAND USE IMPACTS [§354.8(f)(3)]

Groundwater sustainability is the goal of SGMA. It is anticipated that there will be a reduction in irrigated acreage due to reduction in groundwater use. Associated with this will be the development of programs that will augment the groundwater supply with surface water where possible, together with the development of recharge and in-lieu facilities to take advantage of excess streamflow and available surface water in years of above-average precipitation.

Reduction of groundwater extractions will depend on the effectiveness of the planned management programs and the assessment of the impacts on groundwater conditions. TCWA will not target landowners and require that certain properties be subject to a cropping reduction. Rather, when reduced extractions are implemented, the decision of how to accomplish the reduction will be left to the landowner. The goal is to reduce groundwater extractions, not to manage private property. Groundwater extractions will be monitored to verify compliance with groundwater extraction requirements.

1.4.6-4 NEW/REPLACEMENT WELLS PERMITTING PROCESS [§354.8(f)(4)]

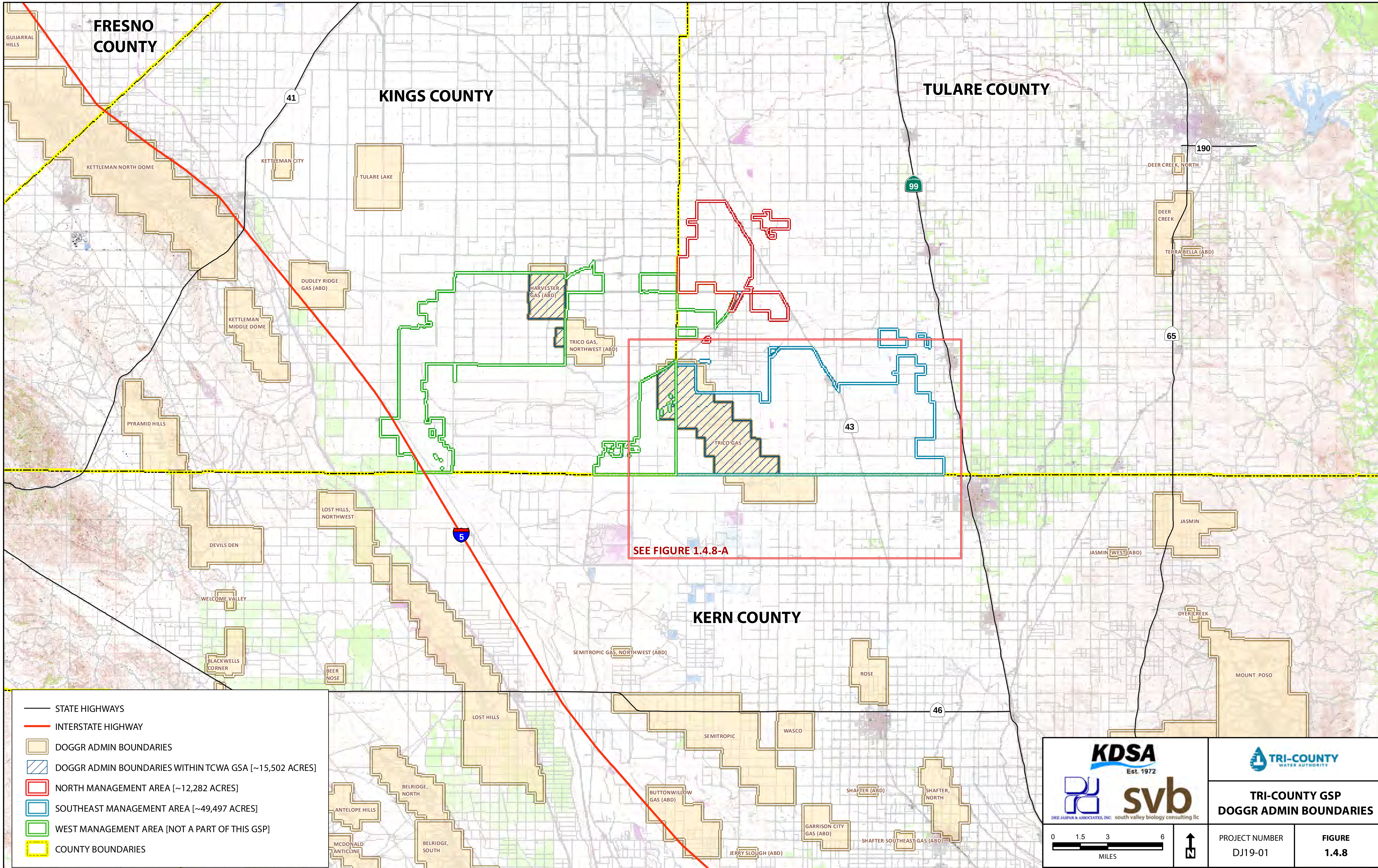
The well permitting process is regulated by the County of Tulare. Tulare County Environmental Health Services Division requires applicants for a new well to fill out a questionnaire that includes information on the proposed capacity and annual production, and an estimate of the seasonal fluctuations in the water depth. An estimate of the proposed recharge rate is requested to the extent that it is reasonably known. The cumulative extraction of the new well before January 1, 2020 is to be estimated. Information on existing wells that may be on the property is also requested. This information is not required if the well is a replacement well but information regarding the destruction of the old well must be summited to the county.

The county requires that all wells that are being replaced must be destroyed prior to or concurrently with construction of the new well. Details of the well construction are requested. Included are the location, the Subbasin, the type of work and the drilling method, and the type of well (e.g. domestic, community, agricultural, etc.)

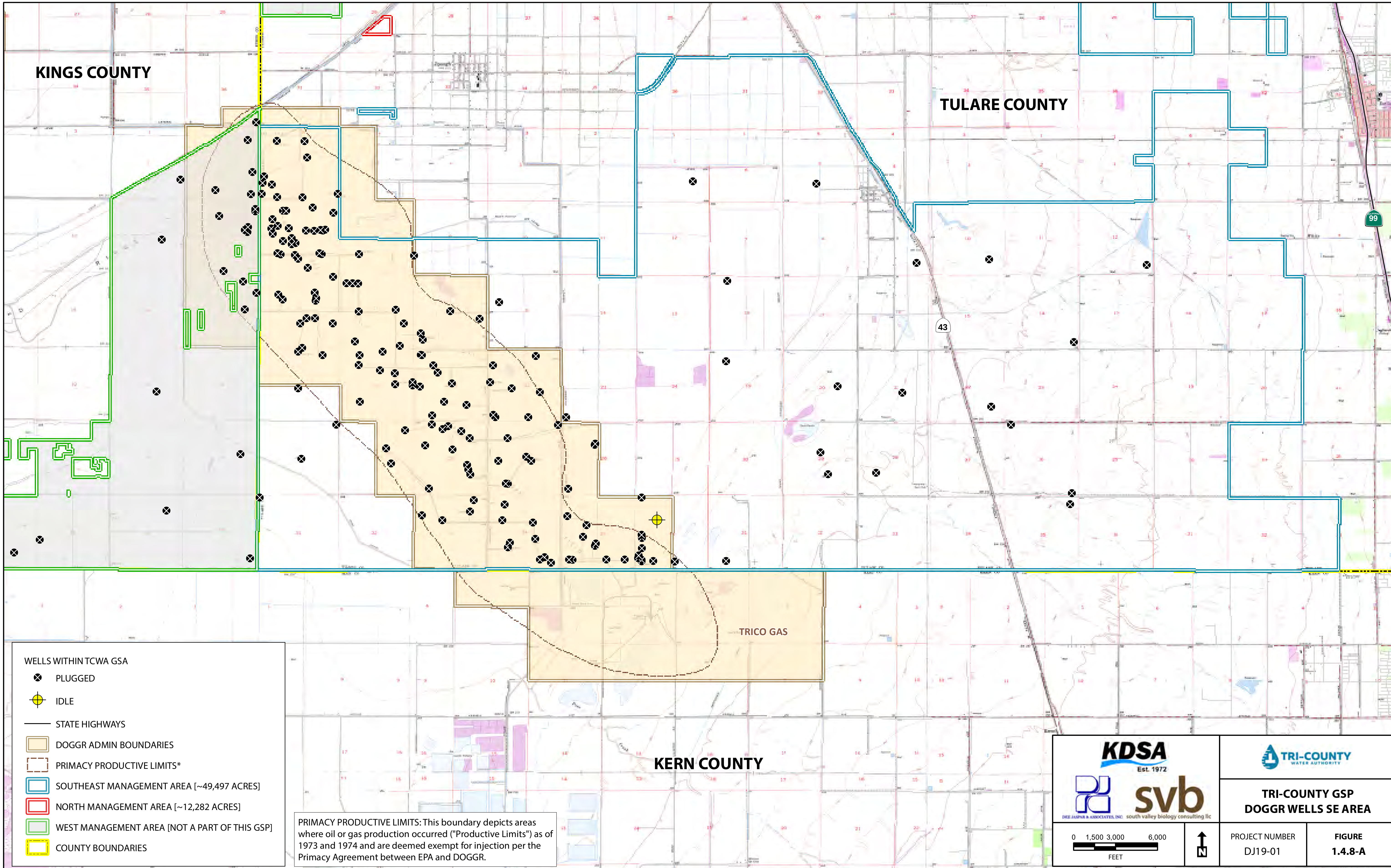
The Tulare County Well Permit Application and Ordinance is appended.

1.4.6-5 IMPACTS OF NEIGHBORING LAND USE PLANS [§354.8(f)(5)

Land use plans for the neighboring GSA's are primarily agricultural. As the TCWA GSP is implemented, groundwater levels are forecasted to stabilize over the 20-year implementation period of the GSP. Initially, for TCWA, reductions in irrigated acreage will not be required. During the five-year period from 2020 to 2025 groundwater conditions will be monitored and data gaps filled. Groundwater monitoring programs will be implemented. A portion of groundwater extractions from the lower aquifer will be replaced by extractions from the upper aquifer, resulting in reductions in subsidence. The Liberty Project is planned to begin in 2020. See Chapter 5 for the project details. The Liberty Project involves development of up to twenty sections of land in what was formerly the Liberty Ranch into a surface water storage basin. In wet years this facility will store available excess stream flows and flood waters and transport it to lands in the Tule Subbasin portion of TCWA. This project is projected to initially deliver about 5,000 acre-feet of water into the North Area of the GSA, resulting in reduction of groundwater extractions from the East Well Field. The project will be developed in phases. The effects of these two initial programs will be monitored. Net subsurface inflow will be reduced. Therefore, the impacts on the neighboring land use plans will be positive, and as future phases of the Liberty Project are implemented, together with additional projects (see Chapter 5) and water management programs continue through 2040, groundwater conditions will stabilize. The goal of the TCWA GSP is to reduce net subsurface inflow and subsidence, and to minimize the loss of farmland in the TCWA's jurisdictional area, and to minimize the loss of managed habitat, and to increase habitat areas in conjunction with recharge projects and storage facilities.



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/CA DEPT. OF CONSERVATION - DIVISION OF OIL, GAS AND GEOTHERMAL RESOURCES



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/CA DEPT. OF CONSERVATION - DIVISION OF OIL, GAS AND GEOTHERMAL RESOURCES

§354.8 Description of Plan Area

g) A description of any of the additional Plan elements included in Water Code Section 10727.4 that the Agency determines to be appropriate.

1.4.7 WATER CODE SECTION 10727.4 PLAN ELEMENTS [§354.8(g)]

See Chapter 5 for details on planned groundwater programs. Below is a brief discussion of these programs.

1.4.7-1 GROUNDWATER REPLENISHMENT PROGRAMS

The TCWA has put forth several programs that are of an in-lieu and a recharge nature. Recharge opportunities are available in both the Southeast and North Areas of the GSA. The eastern portion of the Southeast area is the most promising for direct recharge. TCWA is proposing a recharge program that will initially recharge or replace about 5,800 acre-feet of groundwater extractions in this area. Additionally, TCWA is implementing a program to reduce extractions from the lower aquifer and replace them with water from the upper aquifer. Direct recharge of the lower aquifer by well injection is also being considered to reduce subsidence.

Water can be conveyed through a series of canals and ditches throughout AWD. Some of these conveyance facilities include: Wilbur Ditch, Blakeley Canal, Laterals A and B, Gates-Jones Canal, and Liberty Farms South and East Canals.

1.4.7-2 CONJUNCTIVE USE OPPORTUNITIES

Conjunctive use opportunities are available in the Deer Creek area. Soils in the area are conducive to recharge. Water can be conveyed to this area via the Liberty Project and AWD's Blakely Canal and an improved Lateral A. Lateral A is a bi-directional canal.

1.4.7-3 IN-LIEU SURFACE WATER PROGRAMS

In-lieu surface water programs have been utilized by AWD for many years and are anticipated to increase in volume of surface water delivered. See Section 1.4.5 for a review of the existing surface water supplies.

1.4.7-4 WATER CONSERVATION PROGRAMS & POLICIES

Permanent crops in the Southeast Area of the GSA are irrigated by drip irrigation. Efficiencies are very high in these applications. In the eastern two-thirds of the Southeast Area, water that escapes the root zone recharges the upper aquifer. Less permeable deposits in the western one-third of the Southeast Area limit the movement of deep percolation to the upper aquifer. The forage crops that are grown in the North Area are irrigated by row and sprinkler irrigation. On-farm ditches and on-farm return-flow facilities maximize the water use on these crops. Water that travels below the root zone contributes to the upper aquifer groundwater storage in the North Area of the GSA. The result is that very little water is lost by infiltration of applied water in the basin.

1.4.7-5 RECYCLING

Recycling of irrigation water in the GSA is accomplished by on-farm return-flow installations on lands that are irrigated by row and sprinkler applications.

1.4.7-6 CONVEYANCE PROJECTS

AWD has implemented several conveyance projects to improve the capability of its canals and ditches to receive surface water when it is available. Improvements to the canals and ditches of AWD include reduction of use of water by phreatophytes. These programs are conducted annually by the AWD. Lining of canals can reduce the loss of surface water to the groundwater basin, but infiltration from unlined canals and ditches is utilized through groundwater extractions. Lining of conveyance canals and ditches must be considered in light of the impacts that lining has on the reduction of groundwater replenishment and/or groundwater quality (increased salinity).

1.4.7-7 WATER EFFICIENCY PROGRAMS FOR DELIVERY SYSTEMS

AWD canals and ditches are earth lined. These canals are maintained during the winter to reduce canal head loss. As discussed above, lining of canals reduces water loss from the canals while also reducing groundwater replenishment. AWD is lining canals in areas where shallow ("perched") groundwater exists in an effort to improve efficiency and reduce the inflow to shallow water.

1.4.7-8 DEVELOPMENT OF RELATIONSHIPS WITH STATE AND FEDERAL AGENCIES

AWD is the only surface water purveyor in the GSA. AWD has contracts with the State of California for State Water Project water and has developed programs to import surface water from the Federal Central Valley Project, the Tule River, together with local supplies, when available.

1.4.7-9 DIVERSION OF SURFACE WATER TO GROUNDWATER STORAGE

See Section 1.4.7-1, above.

1.4.7-10 WELL CONSTRUCTION POLICIES

TCWA is developing well construction regulations for the GSA. The regulation will restrict drilling new wells into the Lower Aquifer in parts of the area and encourage development of water from the Upper Aquifer, which is currently in balance. This will reduce inflow into the lower aquifer from neighboring GSA's and reduce subsidence caused by compression of aquitards.

1.4.7-11 COORDINATION WITH LAND USE PLANNING AGENCIES

TCWA is in contact with Tulare County Local Agency Formation Commission (LAFCo), the BLM on the Bureau's Surface Estates properties, and the Tulare Basin Watershed Partnership in efforts to assure that any retired croplands are appropriately utilized for opportunities to enhance wildlife habitat.

1.4.7-12 IMPACTS OF WATER SUPPLY AND MANAGEMENT PRACTICES ON GROUNDWATER DEPENDENT ECOSYSTEMS

DWR's GSP regulations define GDEs as 'ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface.' To identify potential GDEs present within the groundwater basin, the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset, developed by DWR, CDFW, and The Nature Conservancy (TNC), was evaluated. This dataset includes two habitat classes: 1) wetland features commonly associated with the surface expression of groundwater under natural, unmodified conditions; and 2) vegetation types commonly associated with the sub-surface presence of groundwater. Further, as the dataset represents indicators of GDEs (iGDE) as opposed to a GDE; the iGDEs were compared against agricultural areas within the GSA by overlapping the layers in ArcMap. Based on that review, no modifications were made to the dataset at this time and the results are presented in Figure 1.4.9-A. Preliminary mapping identifies about 3,516 acres of potential GDEs in the TCWA (the North and Southeast Management Areas). Hence, this map displays areas that may support ecosystems that are solely or in part dependent on groundwater.

To adequately determine if these parcels represent true GDEs that rely only on the presence of shallow groundwater or if the mapped ecosystems rely on a surface water supply, additional data is needed. Potential GDE parcels that are located on lands with a depth to groundwater greater than 30 feet, or areas located adjacent to farmed/irrigated lands would be removed from the list of identified GDEs as currently displayed on Figure 1.4.9-A. Comparing the 2017/2018 cropping pattern (refer to Figure 2.3.1), numerous parcels are located immediately adjacent to irrigated/farmed lands. Some of the ecosystems may benefit from being located next to land subject to regular irrigation water and may not be relying on groundwater. Several of the GDE parcels are also located immediately adjacent to or within 50 to 100 feet of a stream channel (Deer Creek and White River Channel), and some parcels are located along Homeland Canal. Some of these parcels may be dependent on these surface water sources and would therefore not be classified as GDEs.

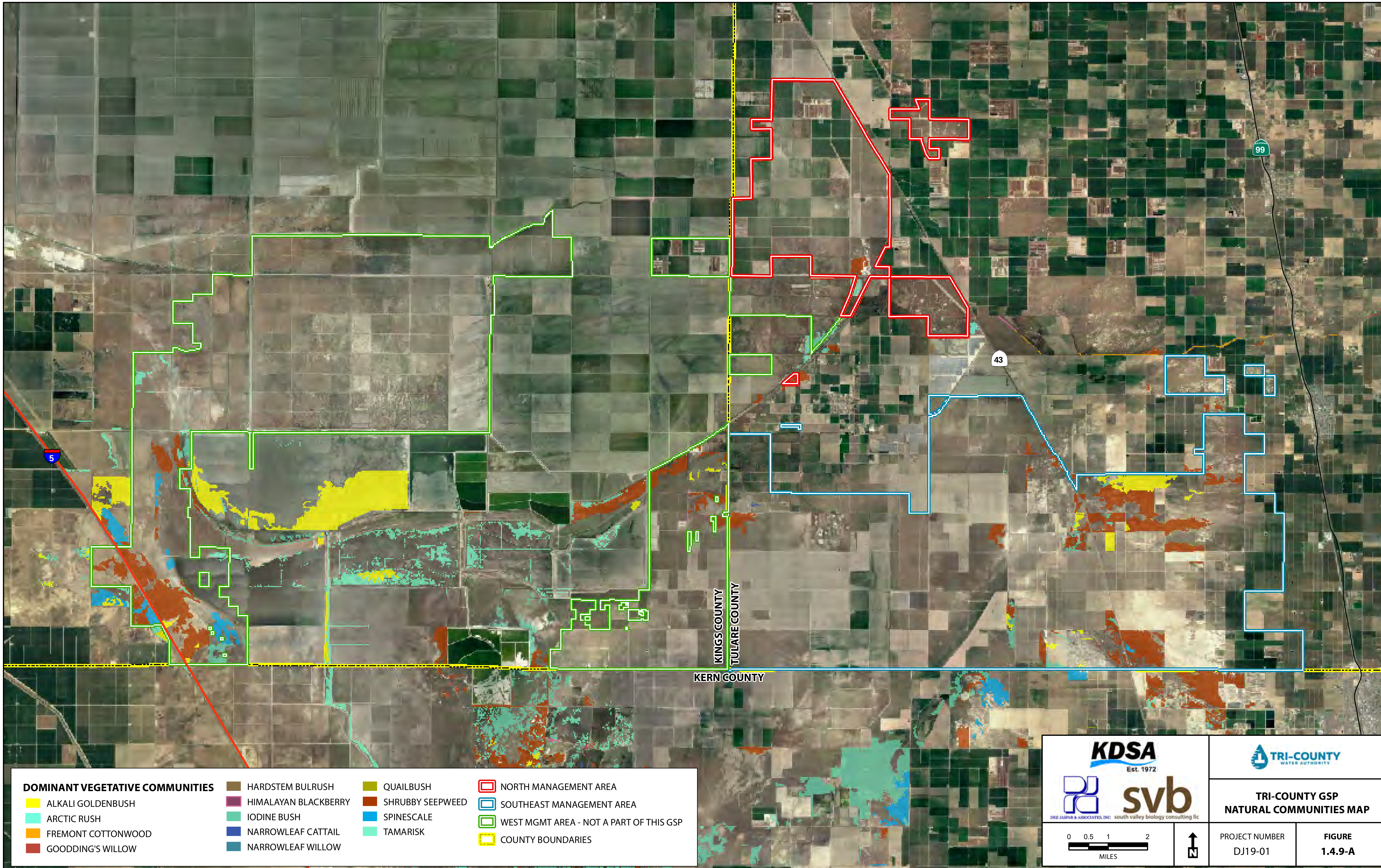
At present there is not sufficient data available to accurately determine areas of shallow groundwater within the North and Southeast Management Areas, hence this is identified as a data gap. Also, additional evaluation is needed to determine connectivity between surface water and groundwater. If data (obtained from the proposed monitoring network) shows that lands within the TCWA are underlain by shallow groundwater and it is likely that these areas could support GDEs, TCWA will consider installing an appropriate number of shallow monitor wells as funding becomes available. Data obtained from these monitor wells will determine if the water is shallow enough (less than 30 feet below ground surface) to support the ecosystems identified on Figure 1.4.9-A. Current available data indicates that shallow groundwater is more likely to occur in the area of the old Tulare Lake Bed - west of Highway 43 (refer to Appendix F).

Figure 1.4.9-B identifies wetlands associated with groundwater. The NCCAG dataset was used to generate this map. Wetlands are defined as "…*lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year*." (Cowardin et al. 1979). As seen on Figure 1.4.9-B, three major systems are displayed including Lacustrine, Palustrine, and Riverine. The Lacustrine system includes wetlands and deepwater habitats with the following characteristics: it's a system that occurs in a topographic depression or a dammed river channel; it lacks trees, shrubs, persistent emergents, emergent mosses or lichens with 30 percent or greater areal coverage; and has a total area of at least 20 acres. The Palustrine system includes all nontidal wetlands dominated by trees, shrubs, persistent emergent, emergent mosses or lichens, and wetlands in tidal areas where the salinity from ocean-derived salts is below 0.5 ppt. The Riverine system primarily refers to all wetlands and deepwater habitats contained within a channel (FGDC 2013). Some of the mapped wetlands occur adjacent to or nearby channels (including the White River Channel and Homeland Canal). Further evaluation is needed to determine the extent and accuracy of these potential wetlands.

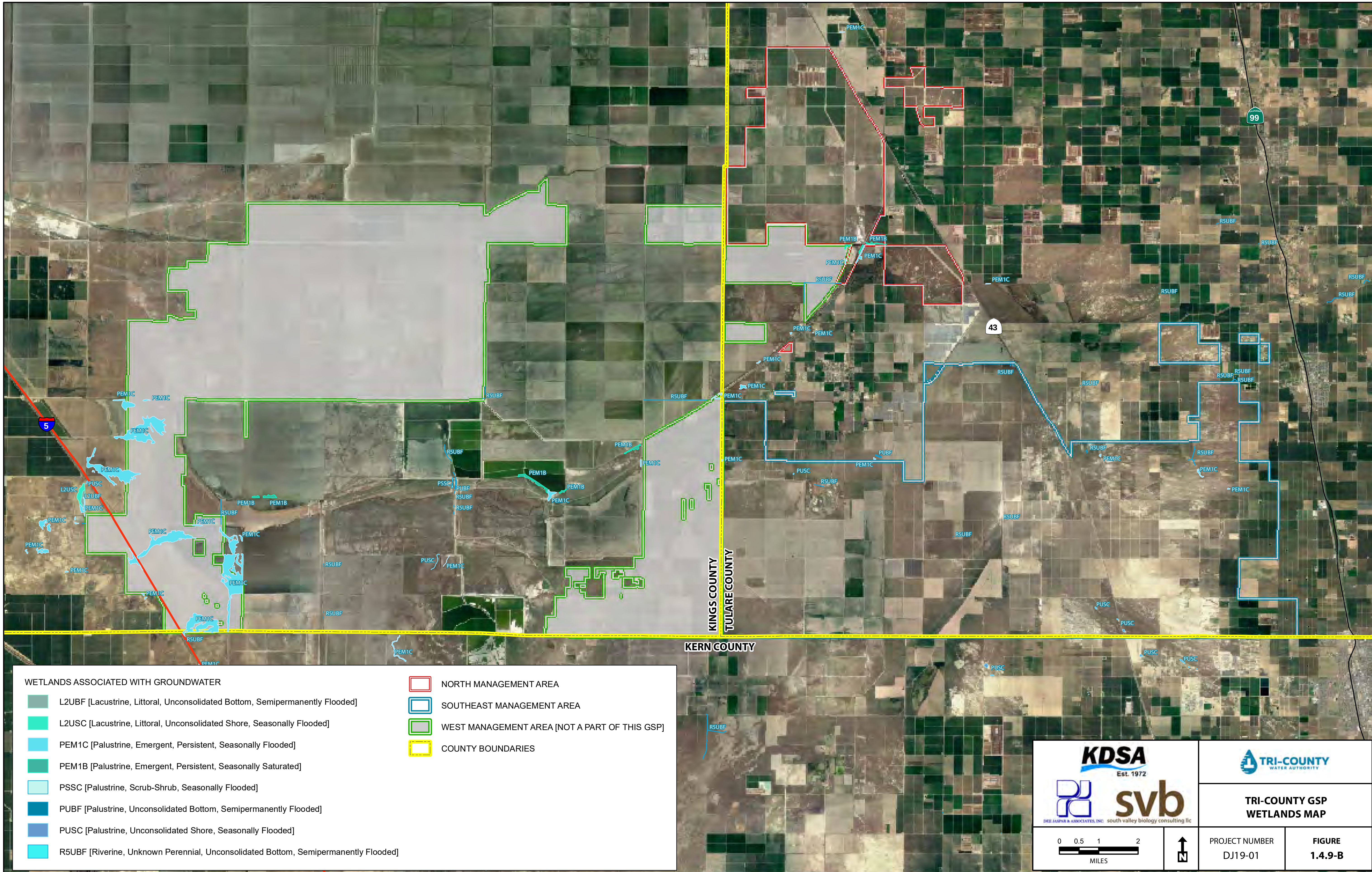
Approximately 1,722 acres of potential GDEs are located within the Allensworth ER, hence these ecosystems are afforded some protections as these lands are owned by CDFW. There are four wells located within the Allensworth ER; however, the ownership and groundwater rights to these wells were retained by the previous owner.

This GSP identifies GDEs as beneficial user/uses of groundwater. Therefore, potential impacts to GDEs and the wildlife species that may depend on these habitat areas will be considered. Preliminary review of the California Natural Diversity Database (CNDDB) identifies plant/vegetation communities that overlap GDE parcels. Specifically, Figure 1.4.9-C identifies Valley Saltbush Scrub, Valley Sink Scrub and Coulter's goldfield (*Lasthenia glabrata ssp. Coulteri*) communities that partially overlap GDE parcels of bush seepweed (*Suaeda nigra*) (formerly shrubby seepweed (*Suaeda moquinii*)) and alkali goldenbush (*Isocoma acradenia*).

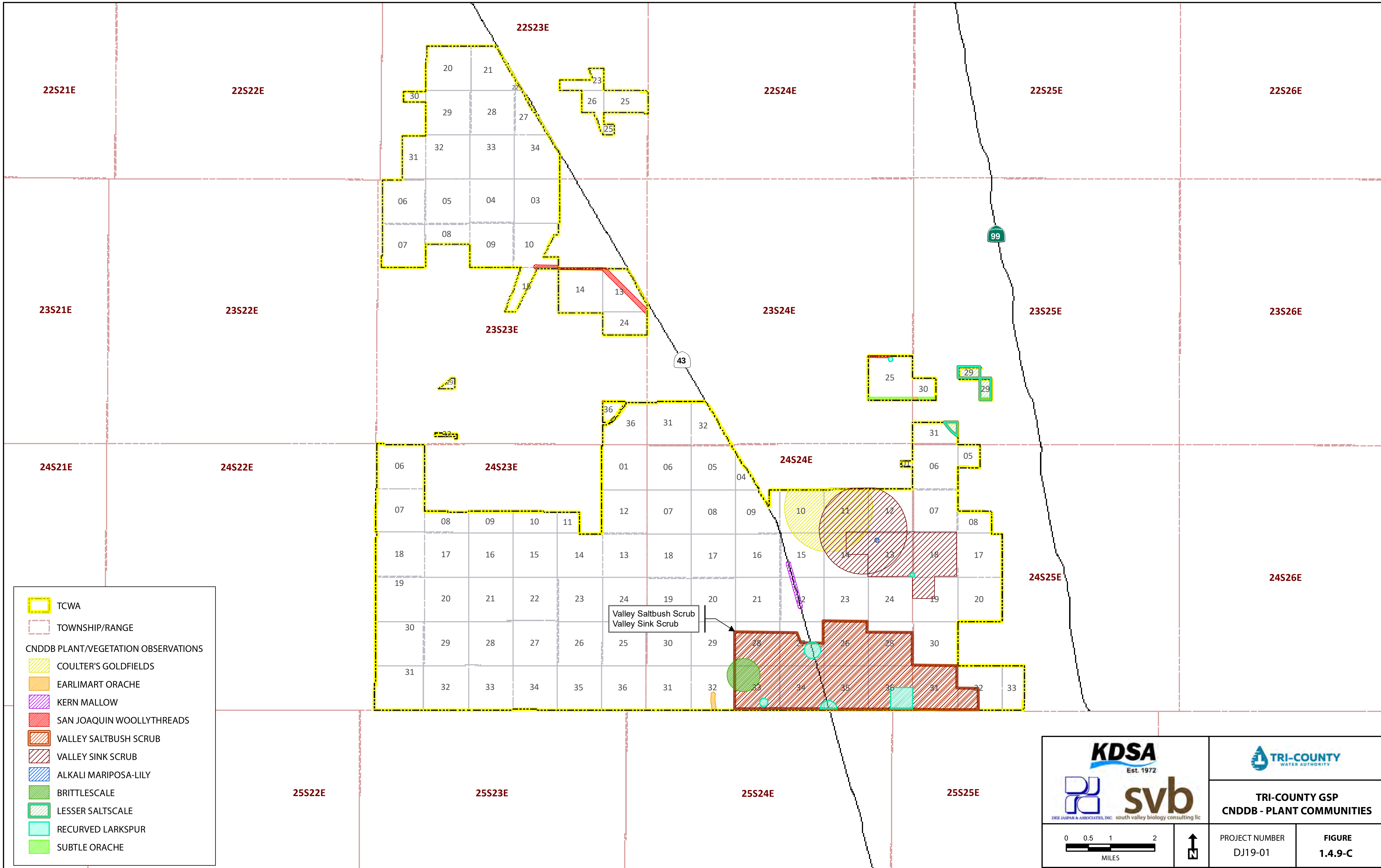
CNDDB data also identify occurrence of sensitive species observations within or near areas currently classified as potential GDEs. Specifically, potential GDEs overlap areas with observations of sensitive/protected species including the blunt-nosed leopard lizard (*Gambelia sila*), Tipton kangaroo rat (*Dipodomys nitratoides nitradoides*), San Joaquin kit fox (*Vulpes macrotis mutica*), and burrowing owl (*Athene cunicularia*) (see Figure 1.4.9-D). However, as additional data is needed in order to confirm parcels currently identified as potential GDEs, any impact evaluation of species that may depend on these areas for nesting/breeding or utilize these areas as foraging habitat is premature. TCWA will consider impacts to these potential plant and habitat communities pending acquisition of depth to groundwater data. Regardless, and as previously noted, planned projects, including Liberty and Prosperity Farms, incorporate design features to improve wildlife habitat. Specifically, these two projects include proposed recharge areas that will provide habitat for wildlife and shorebirds.



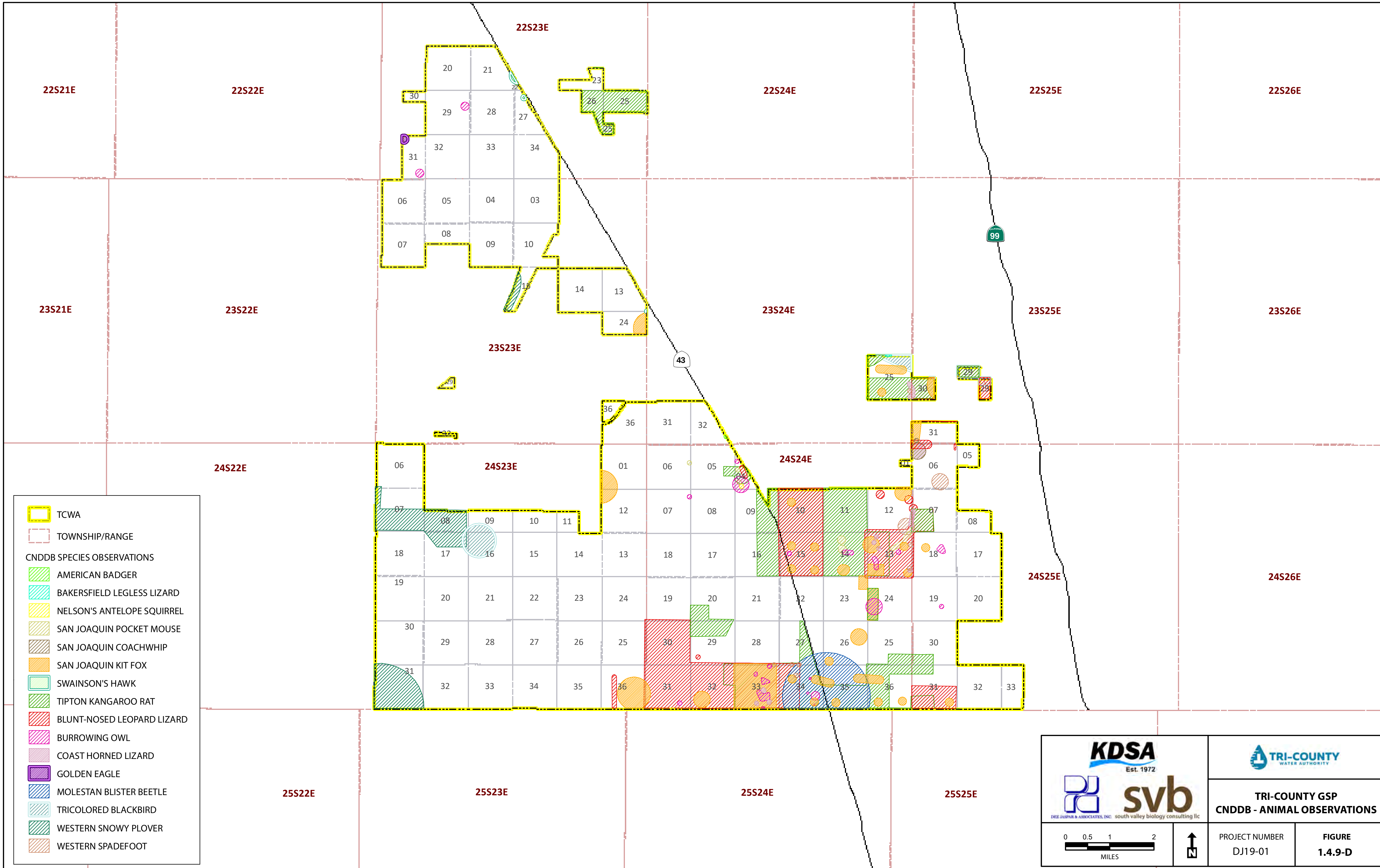
SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/CA DEPT. OF FISH AND WILDLIFE, THE NATURE CONSERVANCY



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/CA DEPT. OF FISH AND WILDLIFE, THE NATURE CONSERVANCY



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF FISH AND WILDLIFE - CNDDB



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF FISH AND WILDLIFE - CNDDB

1.4.7-13 WELLHEAD PROTECTION AREAS AND RECHARGE AREAS

Municipal wells in the GSA are subject to Wellhead Protection regulations of the Drinking Water Division of State Waterboards. The agricultural supply wells are not subject to wellhead protection measures. The Allensworth Community's wells have been subjected to the Wellhead Protection Surveys and are compliant with current regulations.

1.4.7-14 MIGRATION OF CONTAMINATED WATERS

A review of state records indicates that there are no significant contamination plumes in TCWA.

1.4.7-15 WELLHEAD ABANDONMENT AND DESTRUCTION PROGRAMS

The County of Tulare's Wellhead abandonment and destruction regulations are appended. Article 7 "Defective, Inactive, and Well Destruction Standards" of the County of Tulare Ordinance Code, "Part IV. Health, Safety and Sanitation, Chapter 13. Construction of Wells", appended, regulates the destruction of water wells in Tulare County.

1.4.7-16 DISADVANTAGED RURAL COMMUNITIES

County area located about ½ mile west of the town of Earlimart and designated herein "West of Earlimart". A brief discussion of each of these communities follows. Allensworth was founded at the beginning of the last century (1908). Earlimart was established in 1880 by the San Joaquin Valley Railroad and was originally named "ALILA" but became "Earlimart" in 1910. Subdivision of "West of Earlimart" into 1.25-acre parcels began in 1939.

Allensworth

Allensworth is a small community in southwestern Tulare County in Sections 4, 9, 15, and 16, T24S, R24E, M.D.B.&M (see Figures 1.4.10 and 1.4.10-A). It was founded in 1908 by Colonel Allen Allensworth, Professor William Payne, Dr. William H. Peck. J.W. Palmer – a Nevada miner, and Harry Mitchell – a Los Angeles realtor. Allensworth was first named Solito in 1908, but re-named Allensworth in honor of Colonel Allensworth that same year. Allensworth marks the eastern high-water shoreline of Tulare Lake, once the largest U.S. lake outside the Great Lakes, which supported one of the largest Indian populations on the continent, herds of elk, millions of waterfowl, as well as a commercial fishery and ferry service.

In 1912, Allensworth had a population of 300 persons. Today Allensworth has an estimated population of nearly 600 persons and an estimated 140 housing units (Tulare County – adopted Allensworth Hamlet Plan). According to Disadvantaged Communities (DAC) GIS data, the 2016 median income for Allensworth Census Designated Place (CDP) is $29,091. The projected 2030 population for Allensworth is 683 persons and 160 housing units (Allensworth Hamlet Plan) In the 1960's the state of California discovered high levels of arsenic in the drinking water, which caused most of the residents to leave, with only 34 remaining. In 1976 the California State Parks and Recreation Commission approved plans to develop the Colonel Allensworth State Park. Today the Allensworth Community Services District provides water to the community. The district's service area is approximately 800 acres and comprises 146 households, one school, and the State Park. The district was formed in 1981 with assistance from Self Help Enterprises.

The district operates two water supply wells located about 3 miles east of the community in Section 13, T24S, R24E, M.D.B.&M. Water is piped to the community from this site via a 6-inch pipeline to a 42,000-gallon storage tank with a booster pumping plant to pressurize the community's water system. Well Number 1 was constructed in 1984, has a depth of 245 feet, with a perforated interval of 185-240 feet, sealed from 170 feet in depth to the surface, producing 140 gpm. The well has an arsenic concentration of 11 – 14 ppb, and as such, is just above the newly-adopted arsenic mcl of 10 ppb. Well Number 2 was constructed in 1998-1999 to a depth of 315 feet, perforated from 100-150 feet, 170-240 feet, and 270-305 feet in depth. It is sealed from 90 feet in depth to the surface, produces 130 gpm, with an arsenic concentration of 7-14 ppb. However, with a bottom cement seal installed in 2015, from 260 feet to the bottom, arsenic concentrations have remained below 10 ppb. A future project includes construction of a new well to replace Well Number 1 and addition of a 500,000-gallon storage tank in the community. (See Appendix C, page 121, Section 2.2.4, Groundwater Quality.)

Wells Number 1 (T24S/R24E-13C) and Number 2 (T24S/R24E-13D) are candidates for addition to the monitoring network. These wells are shown on Figure 4.1.3.

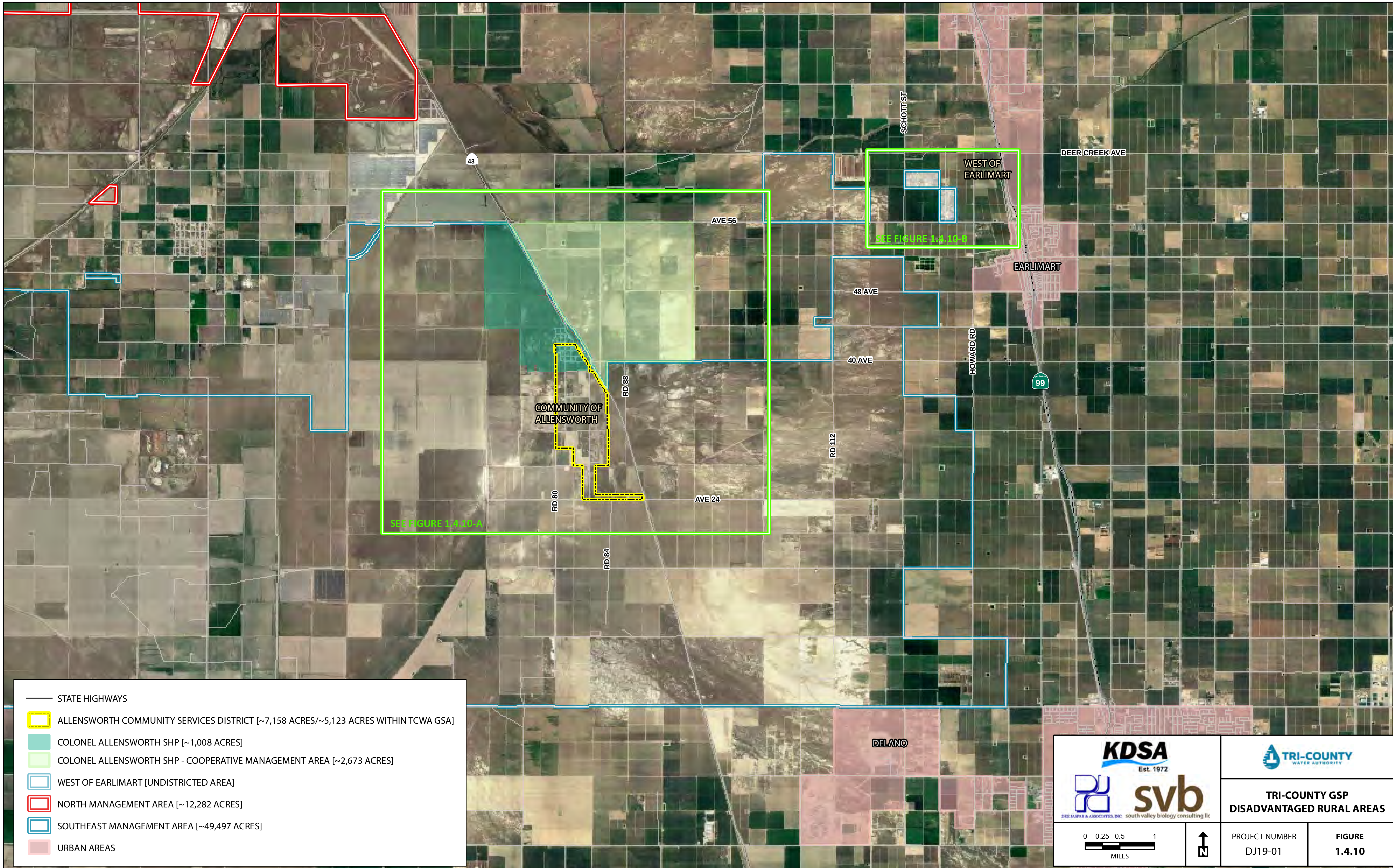
West of Earlimart

Well logs for the wells in the community indicate that occupation of the lots occurred at a much later date – nearer to the end of the 20^{th} Century. Housing in this community consists of modular homes on the 1.25-2.00 – acre lots.

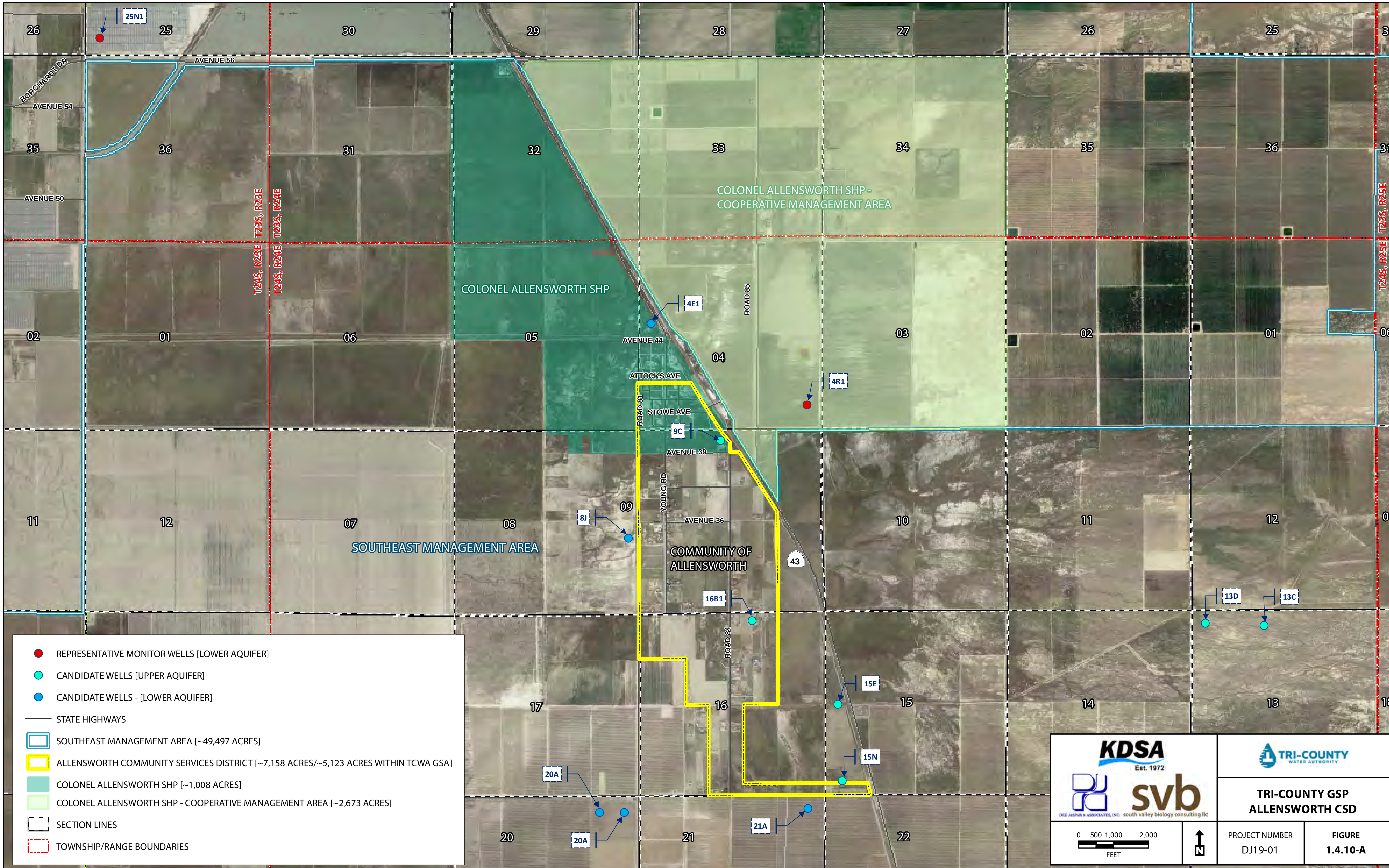
There is a small rural community in TCWA, located about ½ mile west of the community of Earlimart in Section 29, T23S, R25E, M.D.B.&M (See Figures 1.4.10 and 1.4.10-A). This area is an island within the Pixley GSA, bordered on the south by the Delano-Earlimart GSA. It consists of two-eighty-acre parcels that together contain 77 parcels. These parcels are on shallow private wells on parcels that range from about 1 acre to about 25 acres, with the average size about 2 acres. No monitoring of water quality has been conducted by the County of Tulare because these are small private wells and there is no requirement for water quality testing. There were only two wells for which some water quality information was available, the owners of which had taken advantage of the County's offer to run water quality tests for new wells at no charge. Most of the wells in the community are around 200 feet in depth, which puts them above the Corcoran clay (refer to Figure 2.1.2 "Depth to the Top of the Corcoran Clay" – KDSA HCM). From a site visit in early August 2019, this rural community appears to be a severely disadvantaged community and would benefit from a study to determine the current water quality conditions and a feasibility study to determine if the community would benefit from a community water system. Discussions with Self Help Enterprises of Visalia and the Tulare County Environmental Health Department indicated that such a study would be given consideration for grant funding. This will be explored during the first five years of the implementation period.

Four wells were selected for a brief discussion of well construction and water quality. Well 09-0554 (APN 314-150-002) was drilled in 2009. It is on a 1.25-acre lot. The well is 220 feet in depth, cased with PVC to 200 feet, perforated from 100 – 120 feet and 140-200 feet in depth, with a bentonite clay seal from 24 feet in depth to the surface. Water depth was 68 feet in August 2009. Water quality tests revealed no coliform bacteria, nitrate at 50.1 mg/l (vs MCL = 45 ug/l), and DBCP at 0.08 ug/l (vs MCL = 0.20 ug/l). Therefore, this well was in violation of the nitrate MCL when it was drilled. No other testing was reported. Well 09-0628 (APN 314-161-022) was drilled in 2009. It is on a 2.50-acre lot. The well is 208 feet in depth, cased with PVC to 200 feet, perforated from 120-200 feet in depth, sealed with bentonite clay from 27 feet in depth to the surface. Water depth was 77 feet in late September 2009. Water quality tests revealed no coliform bacteria, nitrate at 28.5 mg/l (vs MCL 45 mg/l), DBCP less than 0.01 ug/l (vs MCL = 0.20 ug/l). No other testing was reported.

Well 1800734 (APN 314-162-011) was drilled in 2018. It is on a 2.50-acre lot. The well is 320 feet in depth, cased with PVC to 300 feet, perforated from 140-300 feet in depth, with a cement seal from 50 feet in depth to the surface. Water depth was 125 feet in late July 2018. No water quality testing was reported for this well. This well was completed in sandy clay and is completed very near the top of the Corcoran Clay. It would be a good candidate for water depth measurements and water quality testing. Well 1600872 (APN 314-162-027) was drilled in 2016. It is on a 2.49-acre lot. The well is 420 feet in depth, cased with PVC to a depth of 390 feet, perforated from 200-390 feet in depth, with a bentonite clay seal from 20 feet in depth to the surface. Water depth was 130 feet in early October 2016. No water quality testing was reported. This well was completed in coarse sand and is indicated to be completed just above the Corcoran Clay. It would also be a good candidate for water depth measurements and water quality testing.



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/KENNETH D. SCHMIDT AND ASSOCIATES/U.S. CENSUS BUREAU



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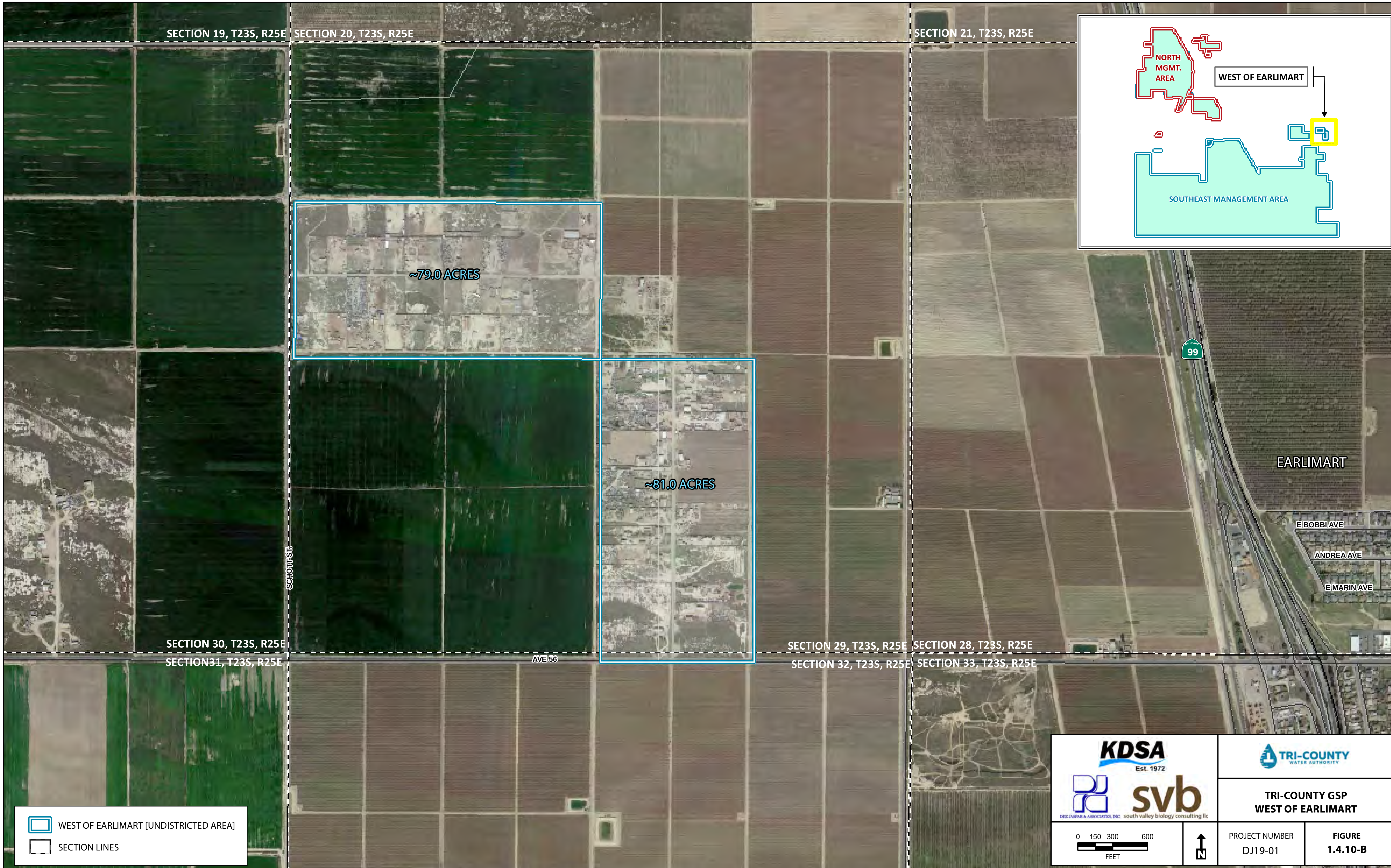


SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/COUNTY OF TULARE/TRI-COUNTY WATER AUTHORITY

1.4.8 REPORTING STANDARDS [§352.2, §352.4, §352.6]

Monitoring Protocols Water Code §352.2

Chapter 4 of this GSP develops the monitoring network and its objectives. The monitoring protocols shall comply with §352.2 of the Water Code which includes the following:

- Monitoring protocols shall be developed in accordance with best management practices.
- Monitoring protocols shall comply and may include Best Management Practices (BMPs) developed by the Department of Water Resources.
- Monitoring protocols shall be reviewed every five years as a part of the periodic evaluation of the GSP.

Data and Reporting Standards Water Code §352.4

(a) The following standards shall apply to all categories of information included in this GSP.

1. Water volumes reported in acre-feet.
2. Surface water flow reported in cubic feet per second (cfs) and groundwater flow in acre-feet per year.
3. Field measurements of elevations of groundwater, surface water, and land surface shall be measured and reported in feet to an accuracy of at least 0.1 feet relative to NAVD88, and the method of measurement shall be described.
4. Reference point elevations shall be measured and reported in feet to an accuracy of at least 0.5 feet, or the best available information, relative to NAVD88.
5. Geographic locations shall be reported in GPS coordinates by latitude and longitude in decimal degree to five places, to a minimum accuracy of 30 feet, relative to NAD 83.

(b) Monitoring sites shall include the following information:

1. A unique site identification number and narrative description of the site location.
2. A description of the type of monitoring, type of measurement taken, and monitoring frequency.
3. Location, elevation of the ground surface, and identification and description of the reference point.
4. A description of the standards used to install the monitoring site. Sites that do not conform to best management practices shall be identified and the nature of the divergence from best management practices described.

(c) Wells

1. Wells used to monitor groundwater conditions shall be constructed according to applicable construction standards, and shall provide the following information in both tabular and geodatabase-compatible shapefile form:
    A. A California Statewide Groundwater Elevation Monitoring (CASGEM) well identification number or appropriate well information shall be entered on forms made available by the Department, as described in §353.2.
    B. Well location, elevation of the ground surface and reference point, including a description of the reference point.
    C. A description of the well use, such as public supply, irrigation, domestic, monitoring, or other type of well, whether the well is active or inactive, and whether the well is a single, clustered, nested, or other type of well.
    D. Casing perforations, borehole depth, and total well depth.
    E. Well completion reports, if available, from which the names of private owners have been redacted.
    F. Geophysical logs, well construction diagrams, or other relevant information, if available.
    G. Identification of principle aquifers monitored.
    H. Other relevant well construction information, such as well capacity, casing diameter, or casing modifications, as available.
2. If wells lacking casing perforations, borehole depth, or total well depth information, are used to monitor groundwater conditions as a part of the GSP, the Agency shall describe a schedule for acquiring monitoring wells with the necessary information, or demonstrate that such information is not necessary to understand and manage groundwater in the basin.
3. Well information used to develop the basin setting shall be maintained in the Agency's data management system.

(d) Maps submitted to the Department shall meet the following requirements:

1. Data layers, shapefiles, geodatabases, and other information provided with each map, shall be submitted electronically to the Department in accordance with the procedures described in Article 4.8.
2. Maps shall be clearly labeled and contain a level of detail to ensure that the map is informative and useful.
3. The datum shall be clearly identified on the maps or in an associated legend.

(e) Hydrographs submitted to the Department shall meet the following requirements:

1. Hydrographs shall be submitted to the Department in accordance with the procedures described in Article 4.
2. Hydrographs shall include a unique site identification number and the ground surface elevation for each site.
3. Hydrographs shall use the same datum and scaling to the greatest extent practical.

(f) Groundwater and surface water models used for a GSP shall meet the following standards:

1. The model shall include publicly available supporting documentation.
2. The model shall be based on field or laboratory measurements, or equivalent methods that justify the selected values, and calibrated against site-specific field data.
3. Groundwater and surface water models developed in support of a GSP after the date of these regulations shall consist of public domain open-source software.

(g) The Department may request data input and output files used by the TCWA, as necessary. The Department may independently evaluate the appropriateness of model results relied upon by TCWA and use that evaluation in the Department's assessment of the GSP.

Data Management System Water Code §352.6

Each Agency shall develop and maintain a data management system that is capable of storing and reporting information relevant to the development or implementation of the GSP and monitoring of the basin.

§354.10 Notice and Communication

a) A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interest, and the nature of consultation with those parties.

1.5 NOTICE AND COMMUNICATION [§354.10]

The majority of the water consumed in TCWA is used for agriculture irrigation. The two public supply wells for Allensworth Community Services District (CSD) are the only such wells in the GSA. There is a small number of domestic wells that serve farmsteads and private homes and dairies. All landowners in the GSA have been notified that a GSP is being prepared for the GSA. The TCWA Board of Directors is comprised of four signatories and five board seats: AWD (general manager and representative), Deer Creek Storm Water District (general manager and representative), Wilbur Reclamation District #825 (one representative), and County of Kings (non-voting representative). The regular Board of Directors meetings are held on the second Thursday of every other month at 1:00 p.m. at the TCWA Boardroom, located at

944 Whitley Avenue in Corcoran, unless otherwise noted on the GSA's website: http://tcwater.org/events/. Board of Directors meetings are noticed by email to the Board of Directors and the stakeholders / interested party email list, and posted at the District office location. Monthly Technical / Stakeholder Advisory Committee meetings are held where the findings and the progress of the preparation of the GSP are discussed. The Technical/Stakeholder Advisory Committee meets on the fourth Wednesday of every month at 10:00 am at the TCWA Boardroom. The Technical/Stakeholder and Board meetings often have representatives in attendance from Allensworth, the Bureau of Land Management, Tulare County Wildlife Partners, Tulare County LAFCo, the dairy industry, nut growers, farmers, and large agricultural representatives. Board and Technical/Stakeholder Committee meetings are open to all who desire to attend and comment. Additional discussion of Engagement with Interested Parties is presented in Sections 1.2, 1.3 and 1.4 of the 2022 GSP Addendum.

Allensworth representatives participate in monthly meetings and had a member on the Board from July 2015 to December 2018. This representative was recently replaced by a new representative of Deer Creek Storm Water District. A community meeting was held in Allensworth to discuss the status of the GSP and to receive input from the community.

In addition to TCWA meetings, the Tule Subbasin holds regular Tule Subbasin Stakeholder meetings and maintains an Interested Parties email list.

1.5.1 BENEFICIAL USE OF GROUNDWATER [§354.10(a)]

The California Constitution prohibits the waste of water and requires reasonable and beneficial use, and method of diversion, for all surface and groundwater rights. The doctrine of reasonable and beneficial use is the basic principle defining California water rights: that no one can have a perpetual interest in the unreasonable use of water, and that holders of water rights must use water reasonably and beneficially. The major use (over 99%) of the groundwater used in TCWA is for agricultural irrigation, a beneficial use of groundwater. TCWA's water users depend on a reliable water supply to support their farming operations.

§354.10 Notice and Communication

b) A list of public meetings at which the plan was discussed or considered by the Agency.

1.5.2 PUBLIC MEETINGS [§354.10(b)]

A list of public outreach meetings where the GSP was considered is provided below. Meetings are noticed and conducted in accordance with Section §54954.2 of the State of California Government Code. All meetings are open to the public, and public meetings specific to Allensworth, the only community in the GSA, have been held. Representatives of irrigation and water districts, landowners, the BLM, Tulare County, Alpaugh, Kings County, the Tulare Basin Watershed Partnership, the Community of Allensworth, among others, attend the meetings.

Table 1.5.2
Public Outreach Meetings

Meeting/Event	Date
TCWA Stakeholder Advisory Committee Meeting	March 7, 2018 @ 1:00 PM
TCWA Special Board Meeting	March 13, 2018 @ 1:00 PM
TCWA Technical Advisory Committee Meeting	March 26, 2018 @ 10:00 AM
TCWA Stakeholder Advisory committee Meeting	March 29, 2018 @ 1:00 PM
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	April 25, 2018 @ 10:00 AM
TCWA Board Meeting	June 26, 2018 @ 1:00 PM
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	June 27, 2018 @ 10:00 AM
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	July 25, 2018 @ 10:00 AM
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	August 22, 2018 @ 10:00 AM
TCWA Board Meeting	September 6, 2018 @ 1:00 PM
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	October 1, 2018 @ 10:00 AM
TCWA Special Board Meeting	October 11, 2018 @ 1:00 PM
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	October 24, 2018 @ 10:00 AM
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	December 19, 2018 @ 9:00 AM
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	January 23, 2019 @ 10:00 AM
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	February 27, 2019 @ 10:00 AM
TCWA Board Meeting	March 5, 2019 @ 1:00 PM
TCWA Board Meeting	April 2, 2019 @ 1:00 PM
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	April 24, 2019 @ 10:00 AM
TCWA Board Meeting	May 2, 2019 @ 1:00 PM
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	May 22, 2019 @ 10:00 AM
TCWA Board Meeting	June 4, 2019 @ 1:00 PM
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	June 26, 2019 @ 10:00 AM
TCWA Board Meeting	July 9, 2019 @ 1:00 PM
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	July 24, 2019 @ 10:00 AM
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	August 1, 2019 @ 10:00 AM
TCWA Board Meeting	August 1, 2019 @ 1:00 PM
TCWA Board Meeting – Public Review of GSP Presentation	September 16, 2019 @ 1:00 PM
TCWA & SGMA – Public Outreach Meeting, Allensworth	November 12, 2019 @ 2:00 PM

TCWA Board Meeting	December 18, 2019 @ 1:00 PM
TCWA Board Meeting – Adoption of GSP	January 16, 2020 @ 1:00 PM

§354.10 Notice and Communication

c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.

1.5.3 PUBLIC REVIEW COMMENTS & RESPONSES [§354.10(c)]

All public review comments/comment letters and responses are included in Appendix H.

§354.10 Notice and Communication

d) A communication section of the Plan that includes the following:

1) An explanation of the Agency's decision-making process.

1.5.4 COMMUNICATION & PUBLIC INVOLVEMENT [§354.10(d)]

1.5.4-1 DECISION MAKING PROCESS [§354.10(d)(1)]

The decisions regarding the adoption of sustainable management criteria are made by the TCWA's board of directors. These decisions are made after thoughtful consideration of the results of the studies prepared by the TCWA's consultants, input from the stakeholders, the public, comments by neighboring GSAs, the Department of Water Resources ("DWR"), and recognition of the existing and surface water supplies and groundwater conditions within the GSA.

TCWA will implement initial management actions and projects, review the results of these planned management actions and projects, fill in data gaps, and develop a better understanding of the groundwater basin over the next five years. TCWA will then determine what further adjustments are needed to achieve sustainability. TCWA will continue its participation and collaboration with the Tule Subbasin Technical Advisory Committee in an effort to achieve sustainability in the Tule Subbasin.

§354.10 Notice and Communication

d) A communication section of the Plan that includes the following:

2) Identification of opportunities for public engagement and a discussion of how public input and response will be used.

3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.

4) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

1.5.4-2 PUBLIC OUTREACH [§354.10(d)(2)(3)(4)]

1) Public outreach will continue throughout the 20-year implementation period, focusing on the first five years of the implementation period. Results will be published on an annual basis and annual meetings held to discuss the program's achievements and areas needing modification. Public and stakeholder input will be requested and discussed, and program modifications implemented in order to achieve sustainability in 20 years.

2) The GSA is dominated by agricultural interests, but TCWA recognizes the importance of reaching out to not only stakeholders but to the Community of Allensworth, and to stakeholders of interest in wildlife habitat and organizations interested in the ecosystems in the GSA. The effects of the program on upper aquifer water quality for domestic use on farmsteads and farm offices will be considered, with the goal of assuring that domestic water supplies will be sustainable.

3) Public notices will be posted on TCWA's website. Board meetings and special meetings will be noticed, and public participation is encouraged.

CHAPTER 2: BASIN SETTING §354.12-354.20

Additional discussion of the GSA and Basin Summary is presented in Section 1.5 of the 2022 GSP Addendum.

2.1 HYDROGEOLOGIC CONCEPTUAL MODEL [§354.14]

§354.14 Hydrogeologic Conceptual Model

a) Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.

2.1.1 INTRODUCTION

The hydrogeologic conceptual model (HCM) covers the following topics:

- → Regional Geologic & Structural Setting
- → Basin Boundaries
- → Principal Aquifers and Aquitards
- → Data Gaps
- → Cross Sections
- → Depiction of Physical Characteristics of the Basin

Other topics are subsequently discussed under Groundwater Conditions, which includes:

- → Groundwater Elevation
- → Groundwater Storage
- → Sea Water Intrusion
- → Groundwater Quality
- → Land Subsidence
- → Interconnected Surface Water System
- → Groundwater Dependent Ecosystems

Kenneth D. Schmidt & Associates has prepared a report that is appended to this plan (Appendix C). It covers almost all of the hydrogeologic conceptual model and groundwater condition topics. It is organized to provide a smooth transition from one topic to another, and to integrate the hydrogeologic issues into one document.

§354.14 Hydrogeologic Conceptual Model

b) The hydrogeologic conceptual model shall be summarized in a written description that includes the following:

1) The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.
2) Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.
3) The definable bottom of the basin.
4) Principal aquifers and aquitards, including the following information:

   A) Formation names, if defined.

   B) Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity, and storativity, which may be based on existing technical studies or other best available information.

   C) Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features.

   D) General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.

   E) Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.
5) Identification of data gaps and uncertainty within the hydrogeologic conceptual model.

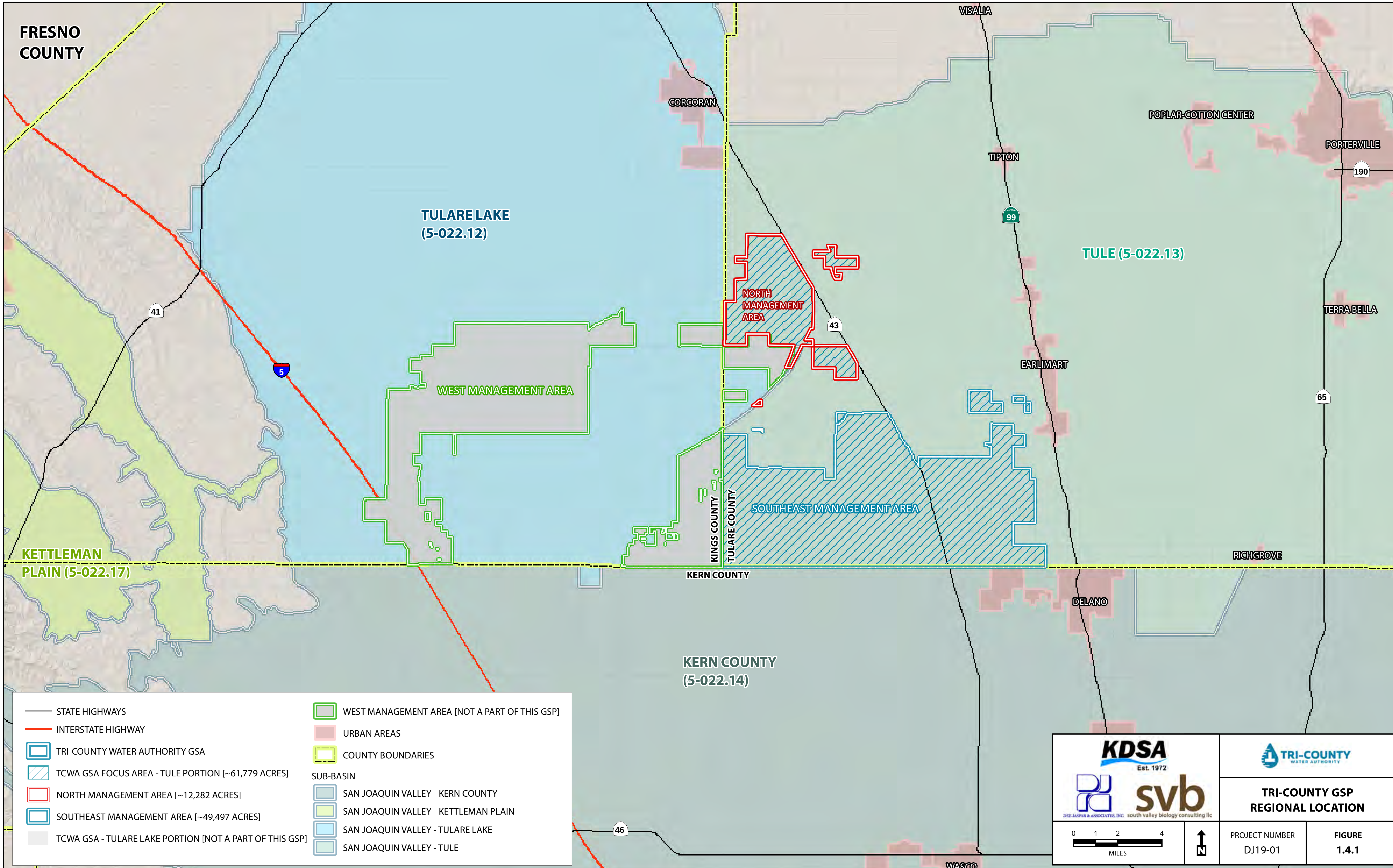
2.1.2 REGIONAL GEOLOGIC & STRUCTURAL SETTING [§354.14(b)(1)]

Lofgren and Klausing (1969) described groundwater conditions in the Tulare-Wasco area, which includes the Tulare County part of the GSA and the east edge of the Kings County part of the GSA. The San Joaquin Valley is a structural through, whose main axis trends northwest to southeast. The valley is bounded on the east by the crystalline rocks of the Sierra Nevada, and to the west by folded and faulted sedimentary, volcanic, and metamorphic rocks of the Coast Ranges. Thousands of feet of marine deposits accumulated in the valley, and those are overlain by continental deposits. The marine and continental deposits thicken from the east to west beneath the valley. The continental deposits have been tilted to the west and down-warped. The uplifting of the Sierra Nevada has resulted in the westerly tilting of the overlying sediments.

2.1.3 BASIN BOUNDARIES [§354.14(b)(2)(3)]

Lateral Boundaries

The Tule Groundwater Sub-basin extends from north of the Tule River on the north, south to near the Kern County line, east to the east edge of the alluvial groundwater basin, and west to near the Kings County-Tulare County line. The county boundaries are considered jurisdictional boundaries, whereas the others are considered hydrologic boundaries. These boundaries are shown on Figure 1.4.1, Section 1.4, repeated below.



TRI-COUNTY GSP
REGIONAL LOCATION

PROJECT NUMBER DJ19-01

FIGURE 1.4.1

SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/U.S. CENSUS BUREAU

Definable Bottom of the Basin

Figure 2.1.1 shows the definable bottom of the basin, which was determined by reviewing and interpreting drillers logs and electric logs for test holes and wells in and near the GSA. Resistivities of less than about 5 ohm-meters are usually indicative of clay and/or salty groundwater. In general, the deepest bottoms of the basin are in the north part of the GSA and near Delano. In contrast, the shallowest bottom of the basin is near the southwest part of the Southeast Management Area, where little groundwater production is possible below a depth of several hundred feet due to a predominance of clay and brackish or salty groundwater.

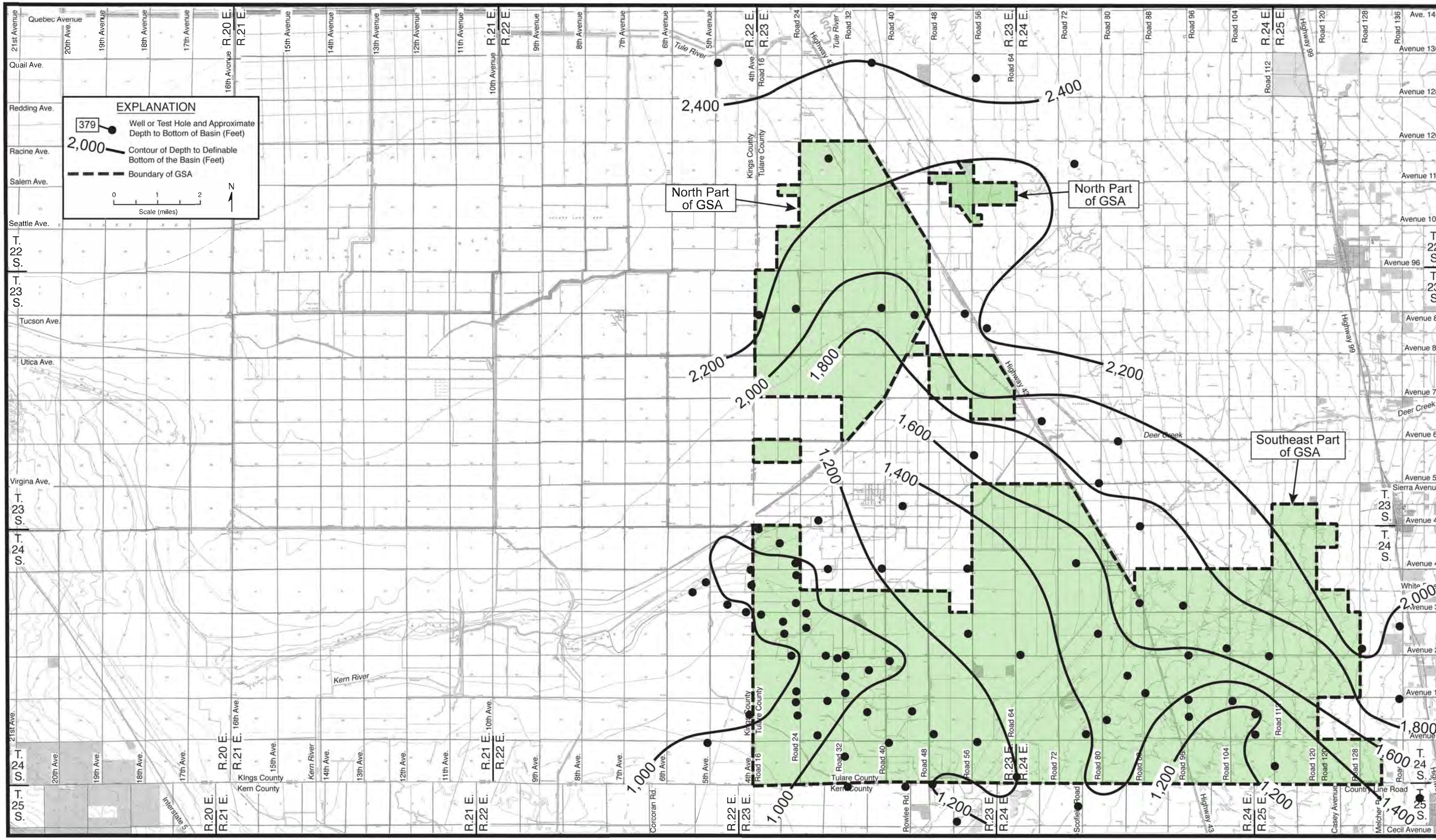


FIGURE 2.1.1 - DEFINABLE BOTTOM OF THE BASIN

The bottom of the basin ranges from about 1,600 to 2,300 feet deep beneath the north part of the GSA. This corresponds with the base of the fresh groundwater. The overall trend in this part of the GSA is a deeper bottom as one proceeds to the north. The bottom of the basin in the southeast part of the GSA ranges from about 900 to 2,000 feet deep. The depth to the bottom in this part of the GSA generally increases to the northeast. The shallowest bottom of the basin in this part of the GSA is south-southwest of Alpaugh and the deepest is near Delano. The bottom of the basin in the southeast part of the GSA also coincides with the base of the fresh groundwater (less than 3,000 micromhos per centimeter at 25°C).

2.1.4 PRINCIPAL AQUIFERS AND AQUITARDS [§354.14(b)(4)]

Principal Aquifers

Groundwater above the A-clay generally is not used for water supply in the GSA due to its high salinity. An exception may be several stock wells, and GDEs. The Corcoran Clay is used to separate the overlying upper aquifer from the underlying lower aquifer. Both of these aquifers are tapped in the north and southeast parts of the GSA.

Aquitards

Croft (1972) of the USGS prepared several generalized subsurface geologic cross sections extending through the Tulare Lakebed. Croft's sections were based entirely on electric logs or geologic logs for core holes. He identified six "clayey or silty clay tongues", designated by letter symbols A to F, beneath the fringes of part of the lakebed. The most widespread and important of these are the A, C, and E Clays. The E-Clay or Corcoran Clay is the most laterally extensive confining bed in the San Joaquin Valley.

Figure 2.1.2 shows the depth to the top of the Corcoran Clay in the GSA. In the north part of the GSA, the depth to the top of the Corcoran Clay ranges from about 400 to 600 feet. The greatest depth to the top of the clay in this part of the GSA is east of Alpaugh, and the shallowest depth is east of the AWD's east well field. In the southeast part of the GSA, the depth to the top of the Corcoran Clay ranges from about 250 to 550 feet. The depth in this part of the GSA generally increases to the south and southwest.

FIGURE 2.1.2 - DEPTH TO THE TOP OF THE CORCORAN CLAY

2.1.4-1 FORMATION NAMES

Lofgren and Klausing (1969) grouped the subsurface deposits in the Tulare-Wasco area into the following main categories:

1. Continental deposits from the Sierra Nevada
2. Upper Pliocene and Pleistocene Marine Strata
3. Santa Margarita Formation
4. Others

Only the first category is relevant in terms of groundwater production in the GSA. In the west part of the GSA, these deposits include the Tulare Formation. Within this formation is the Corcoran Clay member, also termed the E-clay. The bottom of the usable groundwater is the base of the fresh groundwater (less than 3,000 micromhos per centimeter at 25°C). In most of the GSA, this base is below the Corcoran Clay and above the bottom of the continental deposits.

2.1.4-2 PHYSICAL PROPERTIES

Physical properties of the principal aquifers are discussed under aquifer characteristics.

AQUIFER CHARACTERISTICS

PUMP TESTS

AWD Wells

Table 2.1.4.1 summarizes pump test data for AWD upper aquifer wells. Pumping rates ranged from 720 to 3,000 gallons per minute (gpm) and specific capacities ranged from 7.6 to 18.7 gpm per foot. Most pumping rates ranged from 800 to 2,010 gpm, and most specific capacities range from 8 to 16 gpm per foot. Actual pumping rates for most of these wells are less than 1,500 gpm. Table 2.1.4.2 shows pump test results for AWD lower aquifer wells. For lower aquifer wells, pumping rates ranged from 750 to 2,600 gpm and specific capacities from 8.3 to 56.5 gpm per foot. Pumping rates for most of the wells ranged from about 1,150 to 2,300 gpm. Most specific capacities ranged from about 15 to 50 gpm per foot.

AQUIFER TESTS

North Part of GSA

Ten-hour constant discharge tests were conducted on five new AWD upper aquifer wells in late 2015. Drawdown measurements for the tests on three of the wells (E-26, E-27, and W-18) were suitable for determining aquifer transmissivity. Transmissivities ranged from 30,000 gallons per day (gpd) per foot to 37,000 gpd per foot and averaged 34,000 gpd per foot.

A storage coefficient for the upper aquifer of 0.02 is considered applicable to estimate drawdowns beyond about a mile from the centroid of pumping in the AWD's West Well Field. Drawdown calculations indicate that the groundwater in the upper aquifer would no longer be confined at closer distances to the centroid of pumping in the West Well Field. Thus, a larger storage coefficient (0.10) could be used to calculate drawdowns in the upper aquifer within one mile of the pumping centroid in the West Well field. A storage coefficient of 0.02 can be used to estimate drawdowns due to pumping in the AWD's East Well Field, because drawdown calculations indicate that the groundwater would still be partially confined.

Table 2.1.4.1

PUMP TEST DATA FOR AWD UPPER AQUIFER WELLS

Local No.	Date	Pumping Rate (gpm)	Static Water Level (feet)	Pumping Water Level (feet)	Drawdown (feet)	Specific Capacity (gpm/ft)
E-25	11/15	1,790	191.8	388.9	197.1	9.1
E-26	11/15	1,995	169.2	275.9	106.7	18.7
E-27	10/15	2,005	184.0	328.3	144.3	13.9
G-1	1/07	870	109	246	137	6.4
G-3	1/07	950	127	223	96	9.9
G-5	1/07	800	119	210	91	8.8
G-30	11/15	2,060	177.3	331.0	153.7	13.4
W-6	4/02	720	190	285	95	7.6
W-14	8/07	3,000	180	396	216	13.9
W-18	11/15	2,035	188.3	312.2	123.7	16.4

Pump tests for older wells by Kimball Pump Co., results provided by Angiola Water District. 2015 pump tests for new wells from Layne Christiansen Co.

Table 2.1.4.2

RESULTS OF PUMP TESTS FOR AWD LOWER AQUIFER WELLS

Local No.	Date	Pumping Rate (gpm)	Static Water Level (feet)	Pumping Water Level (feet)	Drawdown (feet)	Specific Capacity (gpm/ft)
1E	1/07	1,390	-	-	-	-
5E	1/07	750	159	210	51	14.7
10E	1/07	1,150	172	239	67	17.2
13E	1/07	1,300	166	206	40	32.5
14E	1/07	1,300	162	196	34	38.2
15E	6/02	1,915	332	374	42	45.6
16E	1/07	2,300	190	259	69	33.3
18E	1/07	2,250	212	284	72	31.3
19E	1/07	1,800	186	275	89	20.2
7W	1/07	1,150	154	199	45	25.6
13W	4/02	1,390	269	315	46	30.2
G-11	1/07	1,990	184		40	49.8
G-13	1/07	2,250	-	-	-	-
G-18	1/07	1,900	164	303	139	13.7
G-19	1/07	2,050	150	274	124	16.5
G-20	1/07	1,830	151	317	166	11.0
G-21	1/07	1,425	182	354	172	8.3
G-25	7/07	2,200	196	272	76	28.9
G-26	7/07	2,600	312	358	46	56.5

Pump tests by Kimball Pump Co., provided from Angiola Water District.

For the lower aquifer, a transmissivity of 49,000 gpd per foot is applicable for the AWD well fields, based on aquifer tests on two new wells (15E and 17E) in July 1991. A storage coefficient of 0.001 is applicable for drawdown calculations, because this value provided drawdown estimates consistent with historical water-level data.

For the area south of Alpaugh, the results of pump tests for private wells in that vicinity were considered. Based on evaluation of these tests, a transmissivity of 57,000 gpd per foot was developed for the lower aquifer in that area.

Southeast Part of GSA

Aquifer test results are available for about two dozen wells tapping the lower aquifer in or near the southeast part of the GSA (Table 2.1.4.3). Most of these values are from 12 to 24-hour pump tests, and recovery values were used for most of the tests. All of these tests were done on newly constructed wells, following the end of pump and surge development. Specific capacities ranged from 8.6 to 64.8 gpm per foot. Most values ranged from about 14 to 45 gpm per foot. Transmissivities ranged from 15,000 to 135,000 gpd per foot. Most values ranged from about 25,000 to 85,000 gpd per foot. The transmissivities can be grouped into several geographic areas.

Table 2.1.4.3

SUMMARY OF AQUIFER TRANSMISSIVITIES IN SOUTHEAST PART OF GSA

Well	Date	Perforated Interval (feet)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)
T24S/R23E-29B	3/13	560-880	26.0	37,000
-30B	6/17	450-980	51.8	89,000
T24S/R24E-14R	3/17	580-1,395	29.5	36,000
-22M	8/17	650-1,320	27.2	59,000
-23D	3/14	530-1,270	10.3	25,000
-23R	2/18	550-1,390	19.7	28,000
-24Q	8/13	380-1,100	8.6	31,000
-27P	6/17	440-1,250	22.7	37,000
-28R	5/17	440-1,260	38.2	76,000
-36E	7/12	360-1,310	16.9	34,000
T24S/R25E-19R	6/11	720-1,100	14.0	15,000
-20B	7/13	500-1,240	19.3	67,000
-30H	5/10	420-1,170	18.5	29,000
T25S/R21E-3H	11/16	600-1,020	8.9	20,000
-3R	8/16	520-840	15.0	36,000
-10H	12/16	760-930	13.8	29,000
T25S/R22E-1B	1/13	420-890	64.8	104,000
-2A	2/13	410-850	58.4	135,000
T25S/R25E-5B	9/90	955-1,370	22.5	25,000
-7C	5/03	800-1,380	36.5	84,000
-7F	4/03	780-1,370	44.6	85,000
-17G	11/14	350-790	21.3	30,000

R21E. Aquifer test results are available for three wells in R21E in Kern County within about two miles of the County line. These wells are generally between the west part and the southeast part of the TCWA. These wells tap the lower aquifer below a depth of 540 feet and above a depth of about 1,000 feet. Transmissivities ranged from 20,000 to 36,000 gpd per foot and averaged about 28,000 gpd per foot. These relatively low values appear to be representative of alluvial deposits west of the influence of the ancestral Kern River. Limited data indicate lower transmissivities (13,000 gpd per foot or less) can be expected farther west, near the south boundary of the west part of the GSA.

Near Kings County-Tulare County-Kern County Lines. Aquifer test results are available for four wells between 6th Avenue and Road 32, and within two miles of the Kern County line. These wells tap the lower aquifer below a depth of about 400 feet and above an average depth of about 900 feet. Transmissivities ranged from 37,000 to 135,000 gpd per foot and averaged about 91,000 gpd per foot. These higher values are considered representative of deposits influenced by the ancestral Kern River, which is indicated to have passed through this area.

East of Road 80. Aquifer test results are available for 15 wells in the area between Road 80 and Road 128 and within about three miles of the Kern County line. The top of the Corcoran Clay is generally less than about 350 feet in most of this area. Aquifer transmissivities ranged from 15,000 to 85,000 gpd per foot. The highest values (84,000 to 85,000 gpd per foot) were for two wells in Kern County, several miles west of Delano at Cal State Prison II. These wells tapped strata between about 800 and 1,400 feet in depth.

Wells ranged from 15,000 to 37,000 gpd per foot and averaged about 30,000 gpd per foot. These lower values were thus similar to those for wells farther west in R21E. They appear to be representative of strata above about 1,100 feet in depth in this part of the GSA. These wells tap highly permeable deposits below a depth of about 1,100 feet, similar to a number of deep wells farther east in the City of Delano. Transmissivities for three other wells ranged from 59,000 to 76,000 gpd per foot. These wells tapped strata between about 500 to 1,300 feet in depth, and they tapped part of the deeper permeable deposits. Excluding these five wells, transmissivities for the remaining ten wells ranged from 15,000 to 37,000 gpd per foot and averaged about 30,000 gpd per foot. These lower values were thus similar to those for wells farther west in R21E. They appear to be representative of strata above about 1,100 feet in depth in this part of the GSA.

2.1.4-3 STRUCTURAL PROPERTIES

Structural features of the principal aquifers and aquitards are demonstrated by Figure 2.1.2 (Depth to the top of the Corcoran Clay) and by a number of detailed subsurface cross sections, presented in a later section.

2.1.4-4 GENERAL GROUNDWATER QUALITY

Groundwater of suitable chemical quality for irrigation is generally present in the lower aquifer in most of the north part and southeast part of the GSA. However, high sodium adsorption ratios and pH values are common, and those require treatment of the irrigation water and/or the soil. In terms of public supply and domestic use, there are a number of problems in parts of the GSA. These include nitrate, DBCP, and 1,2,3-TCP in shallow groundwater in the east part of the GSA, and arsenic, color, manganese, methane gas, and hydrogen sulfide in deeper groundwater in the Alpaugh-Allensworth area. More information on groundwater quality is provided in a subsequent part of this report.

2.1.4-5 AQUIFER PRIMARY USES

There are two aquifers in the GSA, the upper and lower aquifers, and both are primarily used for irrigation. Groundwater in the upper aquifer is also used for public supply for Allensworth and also for private domestic use and dairies. Groundwater in the lower aquifer is used primarily for irrigation and for dairies. Managed habitat areas are also current and future users of groundwater from the shallow, upper and lower aquifers.

2.1.5 DATA GAPS [§354.14(b)(5)]

In terms of the HCM, there are significant data gaps in the GSA. Data gaps are discussed under the specific areas herein that they pertain to. The monitoring program discussed herein will develop a significant amount of information that will begin to fill the gaps in data in the GSA in the first five years.

§354.14 Hydrogeologic Conceptual Model

c) The hydrogeologic conceptual model shall be represented graphically by at least two scaled cross-sections that display the information required by this section and are sufficient to depict major stratigraphic and structural features in the basin.

2.1.6 CROSS SECTIONS [§354.14(c)]

As part of this evaluation, seven subsurface geologic cross sections were prepared (KDSA, 2019). These are considered necessary to portray all of the GSA in the Tule Sub-basin. Locations of these are shown in Figure 2.1.3. Cross Sections A-A', B-B', and C-C' extend through the north part of the GSA. These sections were modified from ones previously prepared for the AWD (Kenneth D. Schmidt and Associates, 2011, Appendix D). Cross Sections D-D' and E-E' extend through the west part of the southeast part of the GSA. Cross Sections F-F' and G-G' extend through the east part of the southeast part of the GSA. These latter two sections are more distant than the other cross sections from the Tulare Lakebed.

The deepest water supply wells in the GSA have been in the AWD well fields, and the next deepest have been in the east part of the southeast area, in the Delano-McFarland area. The subsurface geologic cross sections generally extend to near the deepest water supply wells in the different parts of the GSA.

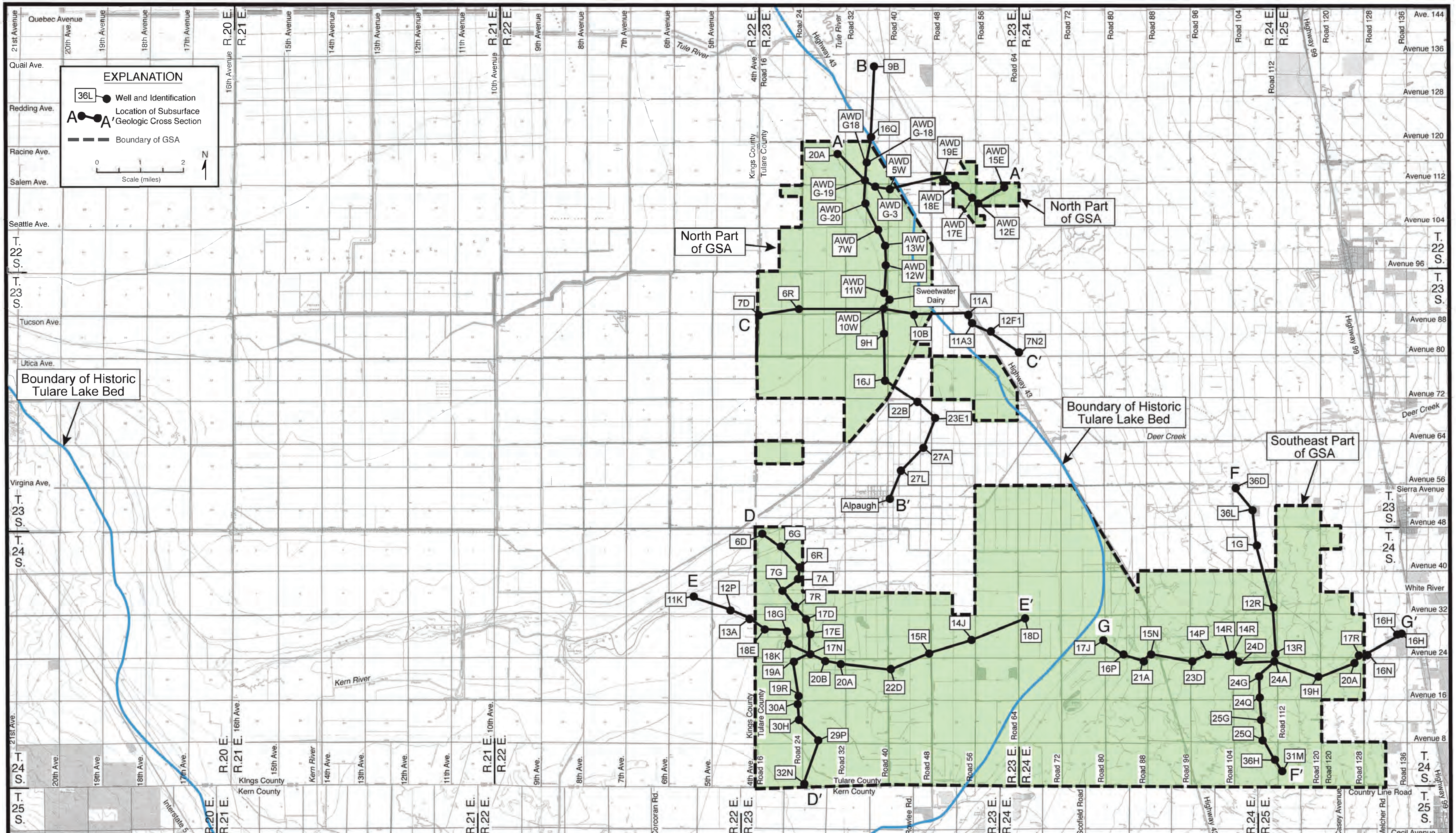


FIGURE 2.1.3 - TOPOGRAPHIC MAP OF GSA AND LOCATION OF SUBSURFACE GEOLOGIC CROSS SECTIONS

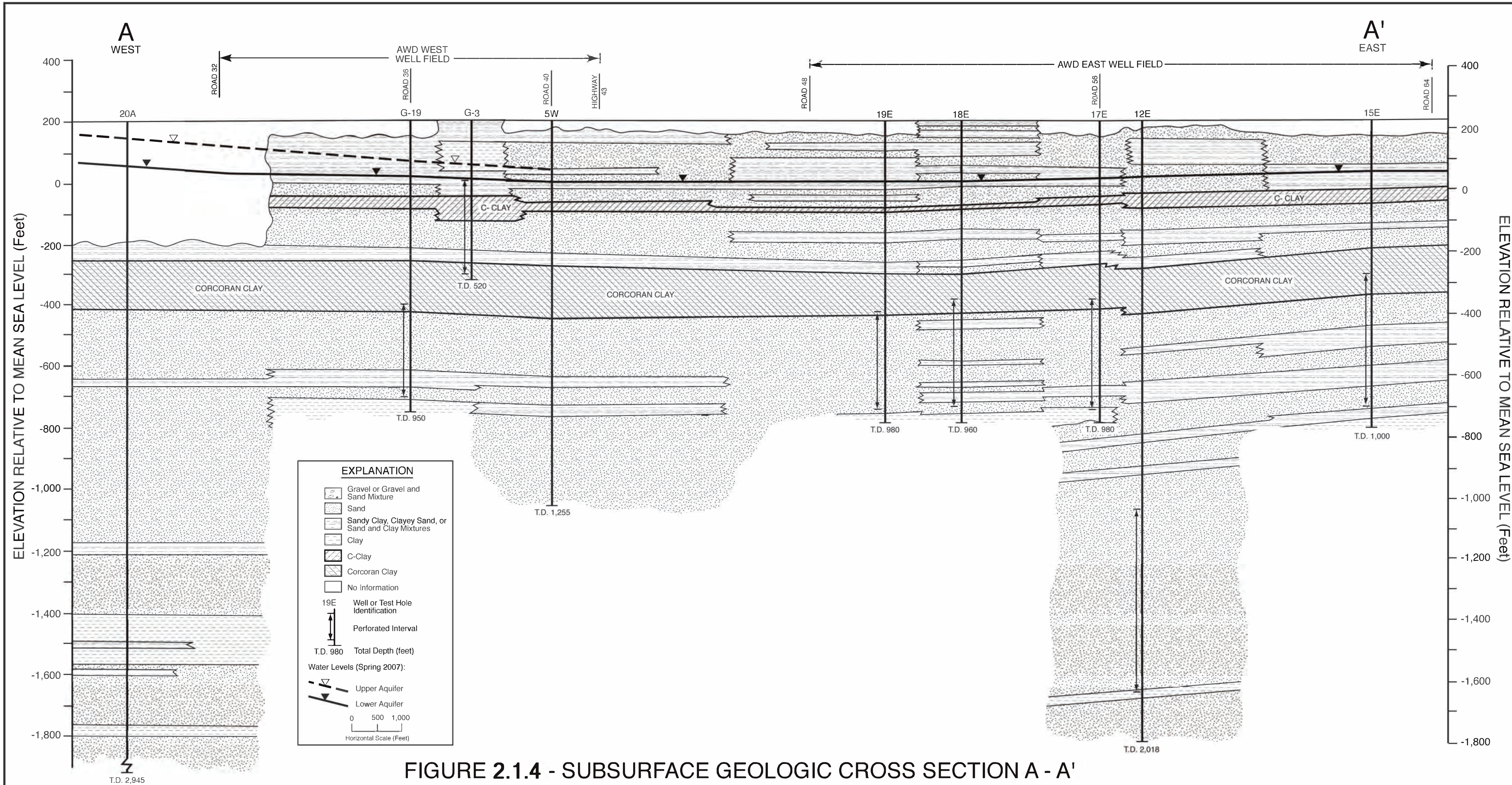


FIGURE 2.1.4 - SUBSURFACE GEOLOGIC CROSS SECTION A - A'

Cross Section A-A' (Figure 2.1.4) extends from south of Avenue 120 and west of Road 32 on the west to the east, through the north part of the AWD's West Well Field, thence through the East Well Field, to near Avenue 112 and Road 64. The top of the Corcoran Clay ranges from about 300 to 500 feet deep along the section, and the clay ranges from about 20 to 180 feet thick along the section. The thickness of this clay increases to the west along the section toward the interior of the Tulare Lakebed. Relatively thick sand strata are present both above and below the Corcoran Clay along most of the western and central parts of this cross section. A sand layer below the Corcoran Clay and above a depth of about 1,000 feet is tapped by a number of intermediate depth (900 to 1,100 feet deep) AWD wells. Sand is predominant below the Corcoran Clay and above a depth of about 2,000 feet along this section, where logs for deep holes or wells are available. The base of the fresh groundwater has been defined as where the total dissolved solids (TDS) concentrations are about 2,000 mg/l. The base of the fresh groundwater is indicated to be below the bottom of this section. The C-clay is also shown along this section. The top of this clay is normally about 250 feet deep in the AWD vicinity. This clay is indicated to pinch out just east of the AWD's East Well Field. Where present, this clay usually ranges from about 10 to 40 feet in thickness. Most irrigation wells in the vicinity (including AWD wells) that tap the upper aquifer are perforated primarily opposite strata below the C-clay and above the Corcoran Clay. Deposits between these two clay layers along this section are predominantly sand. Both the Corcoran and C-clays function as confining beds, which hinder the vertical flow of groundwater. Relatively shallow groundwater is found above the C-clay in the part of the area southwest of Highway 43.

Cross Section B-B' (Appendix C)

Cross Section B-B' (Figure 2.1.5) extends from near Avenue 120 on the north, through the AWD's West Well Field, to Alpaugh on the south. The top of the Corcoran Clay ranges from about 420 feet deep near the south end of the section to 500 feet near Avenue 120. The Corcoran Clay ranges from about 200 to 400 feet thick along the section. The C-Clay is present along this section, where information is available. The top of this clay is about 250 feet deep and this clay ranges from about 15 to more than 50 feet thick along this section. A thick, laterally continuous sand is also present above the Corcoran Clay along this section between Avenues 80 and 120 and is the major water-producing layer tapped by shallow (about 500 feet deep) AWD wells in the West Well Field. Interbedded fine-grained layers generally thicken to the south along this section. Deposits below a depth of about 1,400 feet along the south part of the section are indicated to primarily be clay. A third regional clay layer (A-Clay) that is shallower than the C-Clay is shown along the south part of the section. The base of the fresh groundwater is shown along part of this section. This base ranges from about 1,300 feet deep near Alpaugh to more than 1,800 feet deep along most of the section north of Avenue 88.

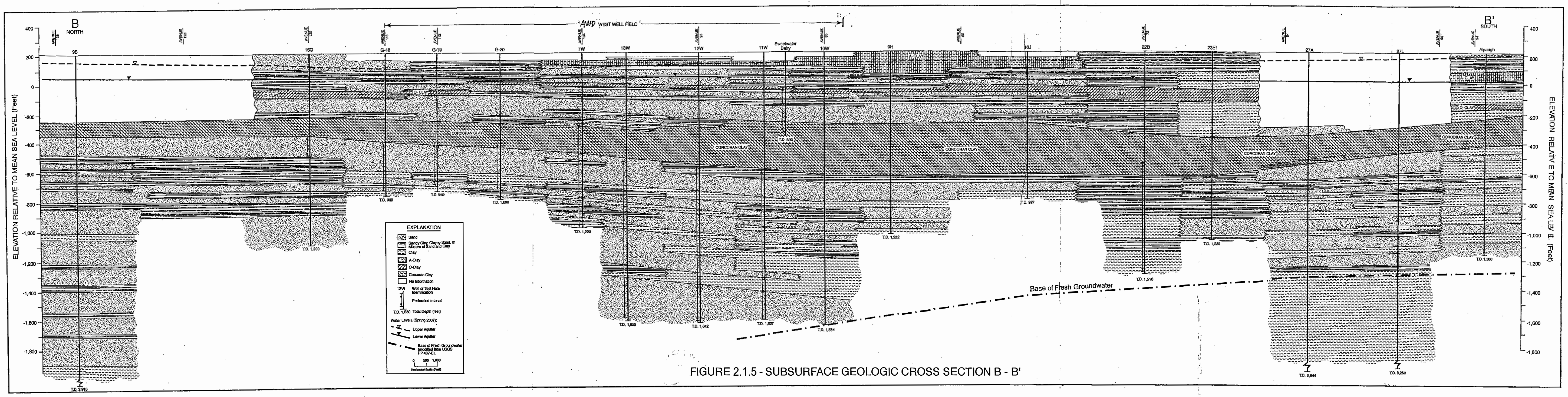


FIGURE 2.1.5 - SUBSURFACE GEOLOGIC CROSS SECTION B - B'

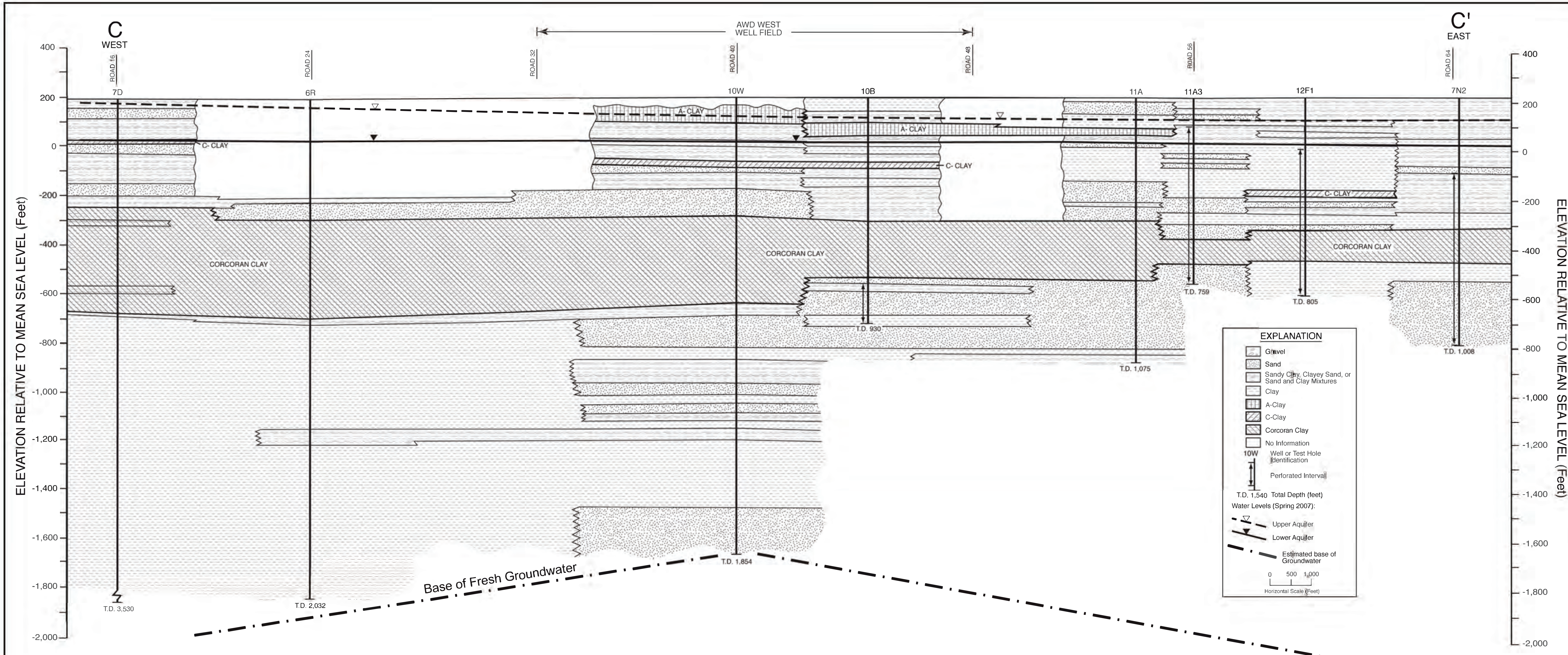


FIGURE **2.1.6** - SUBSURFACE GEOLOGIC CROSS SECTION C - C'

Cross Section C-C' (Figure 2.1.6) extends from near Avenue 88 and Road 16 on the west to the east through the south edge of the AWD's West Well Field, thence farther to the east and southeast, to near Avenue 80 and Road 64. Clay is increasingly predominant to the west along this section, toward the interior of the Tulare Lakebed. The productive sands of the upper aquifer extend farther west than those of the lower aquifer along this section. This section shows that sands of the lower aquifer become progressively thinner to the west and are generally not present in the area west of Road 32. Logs for oil or gas exploration holes in the area farther west indicate that clay is predominant and high salinity groundwater is also common. There are few known active large capacity water supply wells in the area west of Road 24 in the AWD area. The base of the fresh groundwater is indicated to be present beneath most of this section, and ranges from about 1,850 to more than 2,000 feet deep. The base of the fresh groundwater is below the bottom of the cross section near the west and east ends. The top of the Corcoran Clay ranges from about 450 to 550 feet deep along the section. This clay thickens considerably to the west along the section, ranging from about 100 to 150 feet thick to the east to 450 feet thick to the west. The C-clay also pinches out to the east along this section and is not indicated to be present east of Road 48 along this section. The top of the C-clay ranges from about 180 to 270 feet deep along this section, and this clay ranges from about 15 to 30 feet in thickness. The A-clay is also shown along the central part of the section, where it is about 30 to 50 feet thick.

Subsurface Geologic Cross Section D-D’ (Figure 2.1.7) extends from the north near Avenue 48 and Road 16 to the south near the Kern County line. Because most of the electric logs used for the northern two-thirds of this section are oil or gas exploration holes, little information on deposits above the Corcoran Clay was available along that part of the section. This is because of the conductors that were normally installed in such wells, don’t allow electric logging of the shallow deposits opposite the conductors. The Corcoran Clay dips to the north along this section. The Corcoran Clay ranges from about 400 feet deep near the north end of the section to 270 feet near the south end. The Corcoran Clay generally thins to the south along the section, from about 100 feet to 50 feet. Neither the A-clay nor the C-clay could be differentiated along this section. A fairly thick sand layer is present above the Corcoran Clay beneath most of the southern third of this section. Sands are predominant below the Corcoran Clay and above a depth of about 1,000 feet south of Avenue 32 along this section. Farther north, clay is predominant between the Corcoran Clay and the bottom of this section, typical of the lakebed area.

Cross Section E-E’

Subsurface Geologic Cross Section E-E’ (Figure 2.1.8) extends from near Avenue 36 and Avenue 5-1/2 on the west to near Avenue 32 and Road 64 on the east. The top of the Corcoran Clay ranges from about 270 feet deep near Road 30 to 450 feet deep near the west edge of the section. The thickness of the clay ranges from about 70 feet near the east edge to 95 feet near the west edge. The A-clay was identified at one Well (13A) along the west part of the section, within the uppermost 100 feet. The thickest sands below the Corcoran Clay are present beneath the central part of the section, whereas the thickest clays are in the area west of Road 16 near the Tulare lakebed. Most irrigation wells in this area are less than 1,200 feet deep.

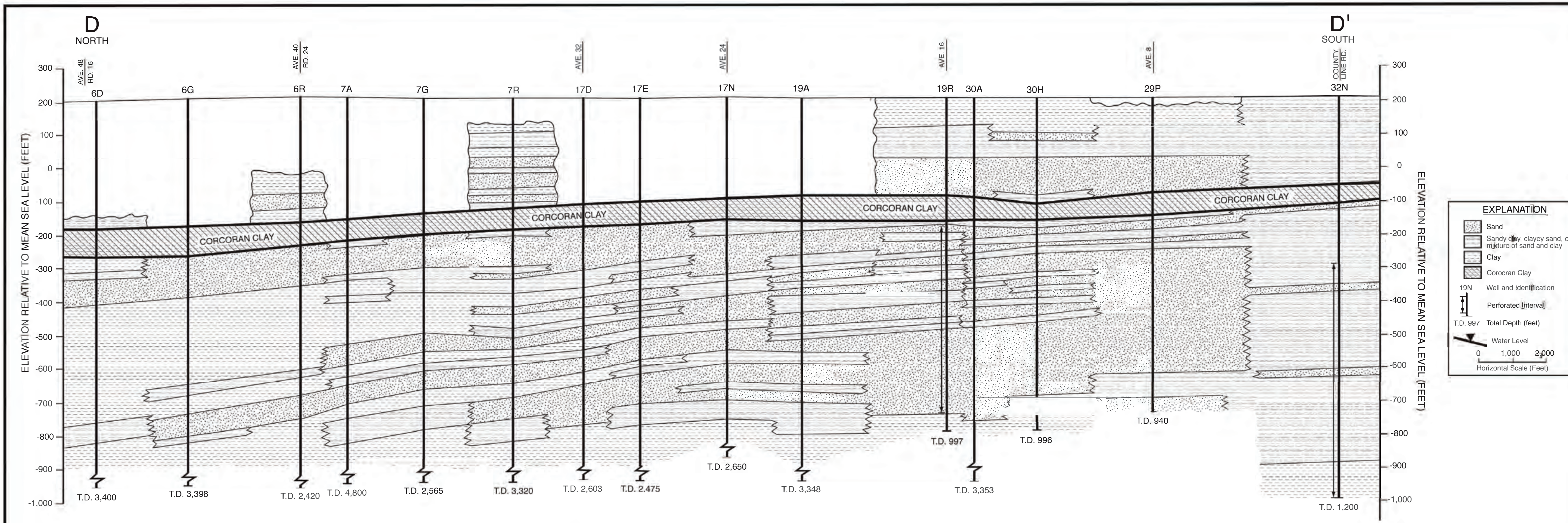


FIGURE 2.1.7 SUBSURFACE GEOLOGIC CROSS SECTION D-D'

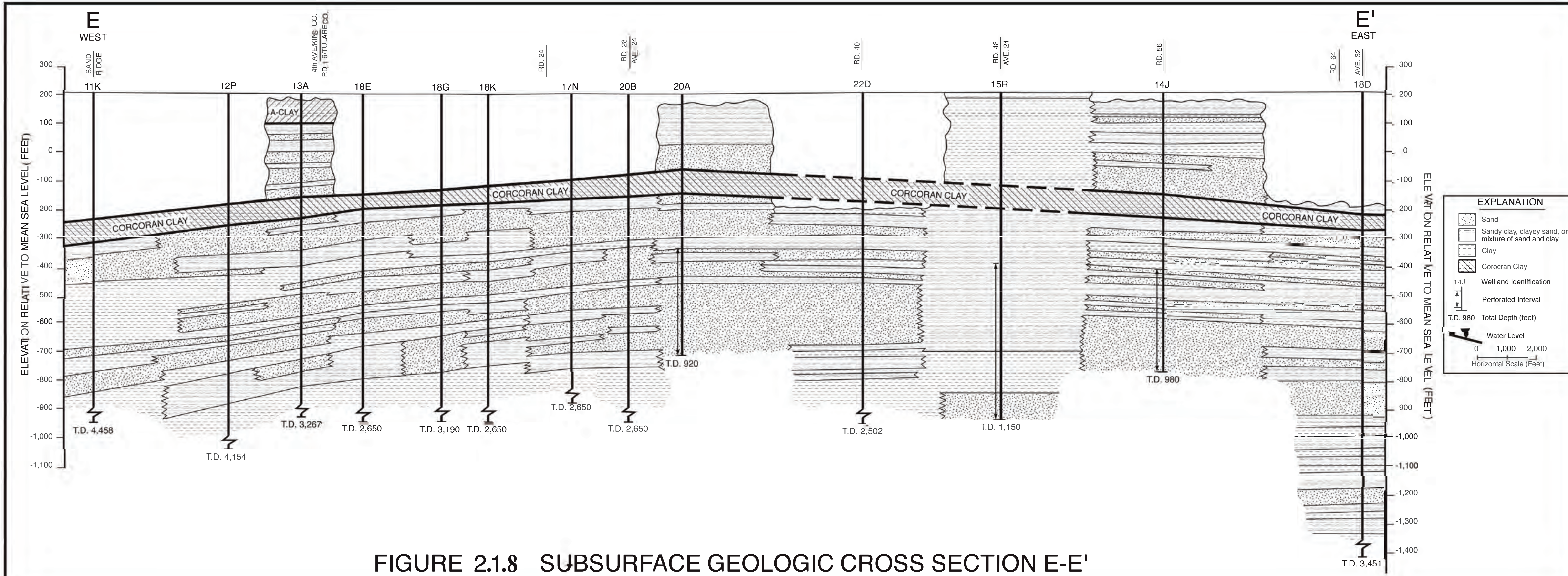


FIGURE 2.1.8 SUBSURFACE GEOLOGIC CROSS SECTION E-E'

Cross Section F-F'

Cross Section F-F' (Figure 2.1.9) extends from near Avenue 56 and Road 104 on the north to near Avenue 4 and Road 112 on the south. The north end of the section is about three miles west of Earlimart and the south end is about three miles west of Delano. The top of the Corcoran Clay ranges from about 320 feet deep to about 360 feet along this section. The Corcoran Clay thins to the south along this section, from about 50 feet near the north edge to 25 feet near the south edge. Logs for the deepest wells along the section indicate significant sands below a depth of about 1,200 feet, and this is consistent with information from deep wells in McFarland and Delano. Fine-grained or intermediate textured deposits are predominant below the Corcoran Clay and above a depth about 1,200 feet along much of the section.

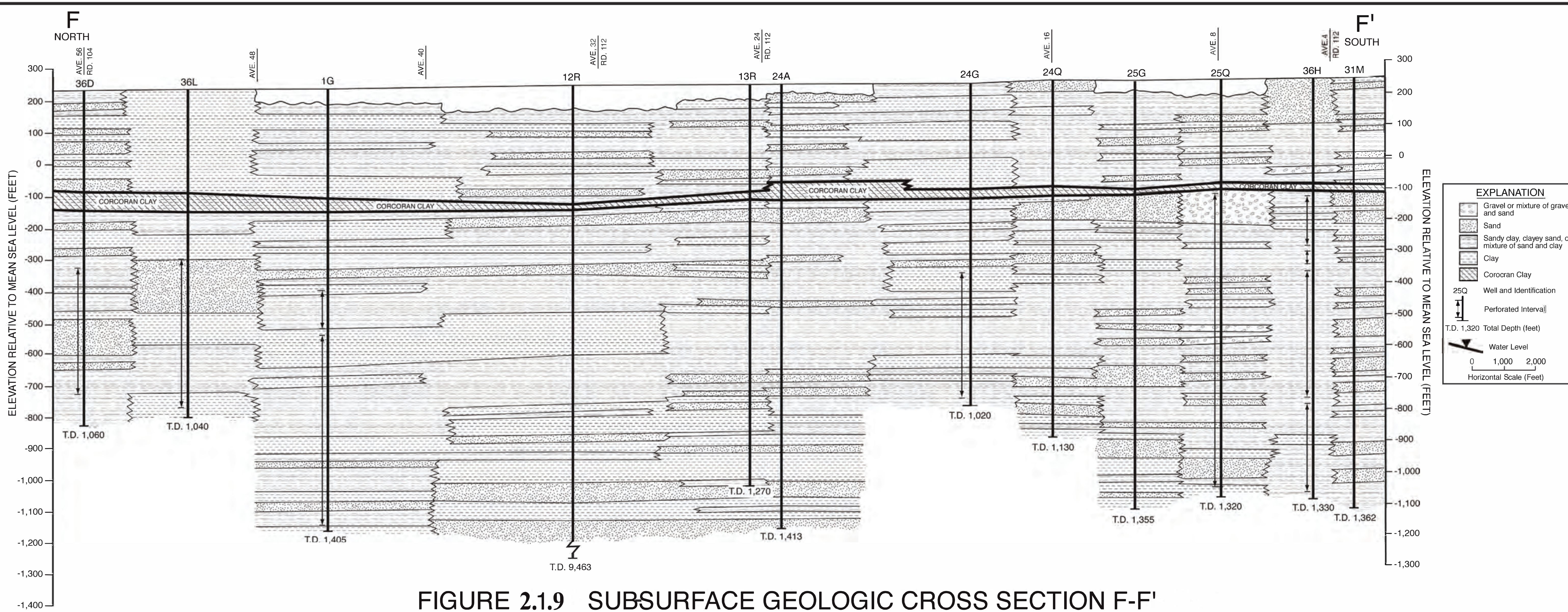


FIGURE 2.1.9 SUBSURFACE GEOLOGIC CROSS SECTION F-F'

Cross section G-G'

Cross section G-G' (Figure 2.1.10) extends from near Avenue 28 and Road 80 on the west to west of Highway 99 and Avenue 28 on the east. The Corcoran Clay dips to the west along this section. The top of the clay ranges from about 420 feet deep near the west edge to about 270 feet deep near the east edge. Fine-grained or intermediate textured deposits are predominant in the upper aquifer along most of the section west of road 120. East of this road, sand strata are predominant below the Corcoran Clay, and sand strata are predominant below a depth of about 1,100 feet along most of this section. There are numerous sand strata less than about 50 feet thick in the lower aquifer along most of the section.

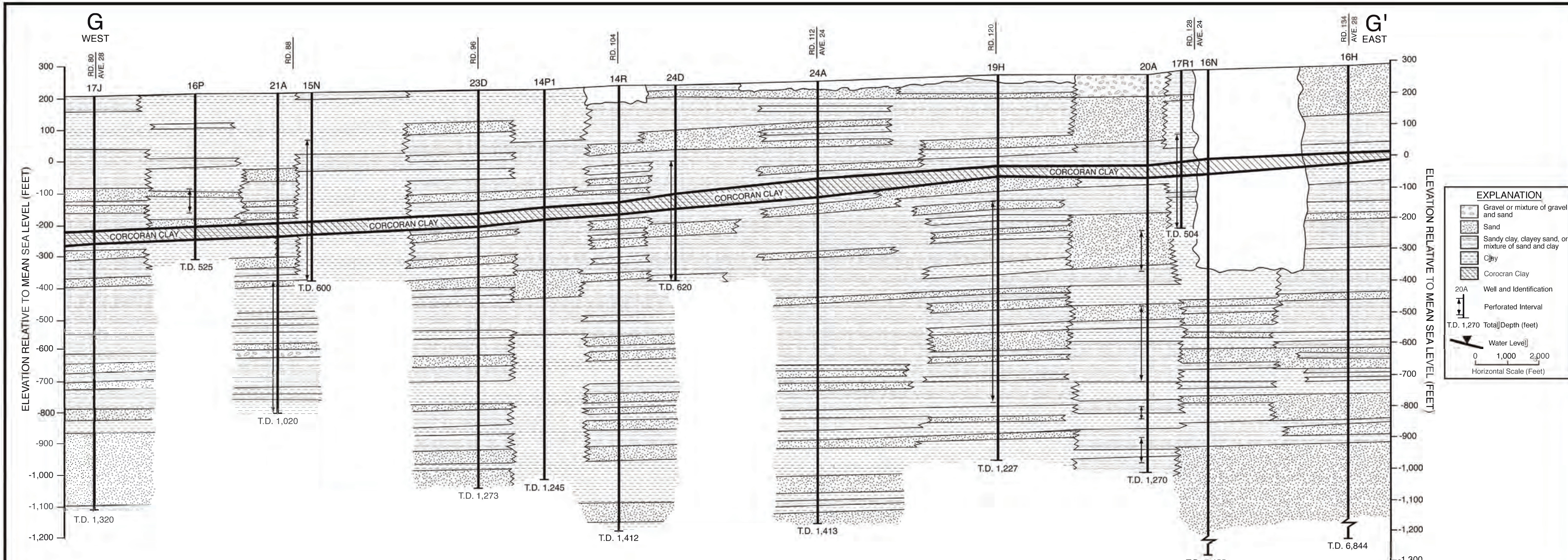


FIGURE 2.1.10 - SUBSURFACE GEOLOGIC CROSS SECTION G-G'

§354.14 Hydrogeologic Conceptual Model

d) Physical characteristics of the basin shall be represented on one or more maps that depict the following:

1) Topographic information derived from the U.S. Geological Survey or another reliable source.
2) Surficial geology derived from a qualified map including the locations of cross sections required by this Section.
3) Soil characteristics as described by the appropriate Natural Resources Conservation
4) Service soil survey or other applicable studies.
5) Delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.
6) Surface water bodies that are significant to the management of the basin.
7) The source and point of delivery for imported water supplies.

2.1.7 DEPICTION OF PHYSICAL CHARACTERISTICS OF THE BASIN [§354.14(d)]

Topography

Figure 2.1.3 (repeated below) shows the topography in and near the GSA. In general, the Tulare Lakebed is the lowest area (the lowest part of the lake is about 175 feet above mean sea level). The historic boundary of the lakebed is shown in blue. The highest area is west of Delano, where the land surface elevation is about 285 feet above mean sea level. The main streams in the vicinity, the Tule River, Deer Creek, and the White River, drain from the east to the west, following the slope of the topography.

Surface water bodies are shown on Figure 2.1.15. Refer to the discussion on page 93.

Imported water supplies and points of delivery are:

Tule River: Taylor Canal
SWP, Kings and Kaweah Rivers: Lateral A and Lateral B
Kings River: Wilbur Ditch
Flood Water: Deer Creek and White River

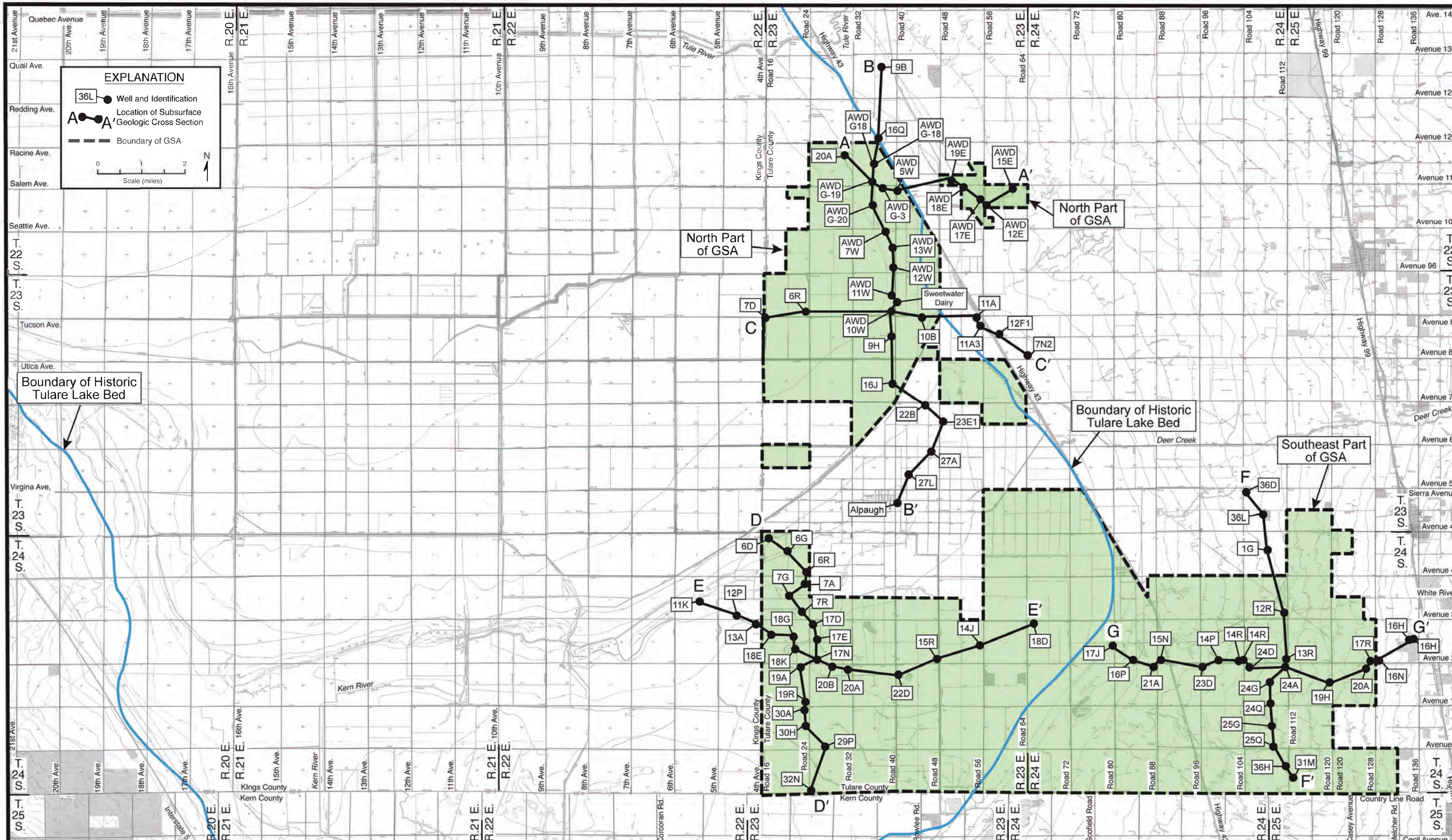


FIGURE 2.1.3 - TOPOGRAPHIC MAP OF GSA AND LOCATION OF SUBSURFACE GEOLOGIC CROSS SECTIONS

Figure 2.1.11 is a surficial geologic map of the GSA, modified from Smith (1964). The predominant surficial deposits in the GSA are lake deposits. Basin deposits are present in relatively small areas of the GSA in the southwest part of the west part, in the east part of the AWD east well field, and between 4th and 7th Avenues near the Kern County line. A larger area of basin deposits is in the east part of the east part of the GSA. There is a small area of dune deposits located near the west edge of the west part of the GSA.

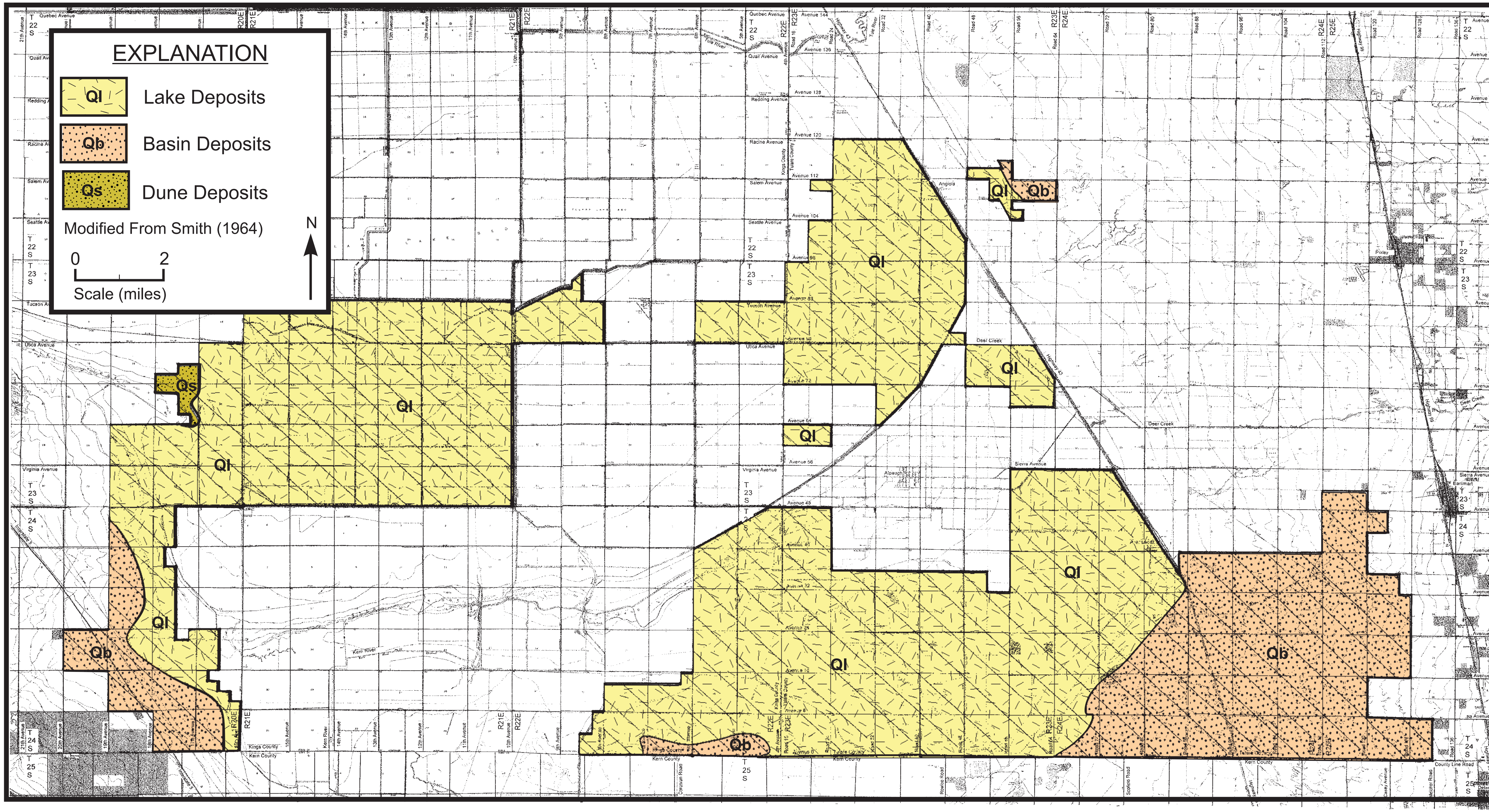


FIGURE 2.1.11 - SURFICIAL GEOLOGIC MAP

Figure 2.1.12 shows the major soil types in the GSA. The map is modified for Arroues and Anderson (1956) for the Kings County part and Wasner and Arroues (2003) for the Tulare County part. In most of the north part of the GSA, topsoils are saline-alkali soils that have a perched (shallow) water table. These topsoils are essentially within the historic Tulare Lakebed. Topsoils are saline-alkali soils on the lower alluvial fans and basin rims. In the east part of the GSA, topsoils are deep and very deep well drained and moderately drained soils that formed on alluvium. These was a very small area near the southeast corner of the GSA that is covered by very well drained soils formed in alluvium.

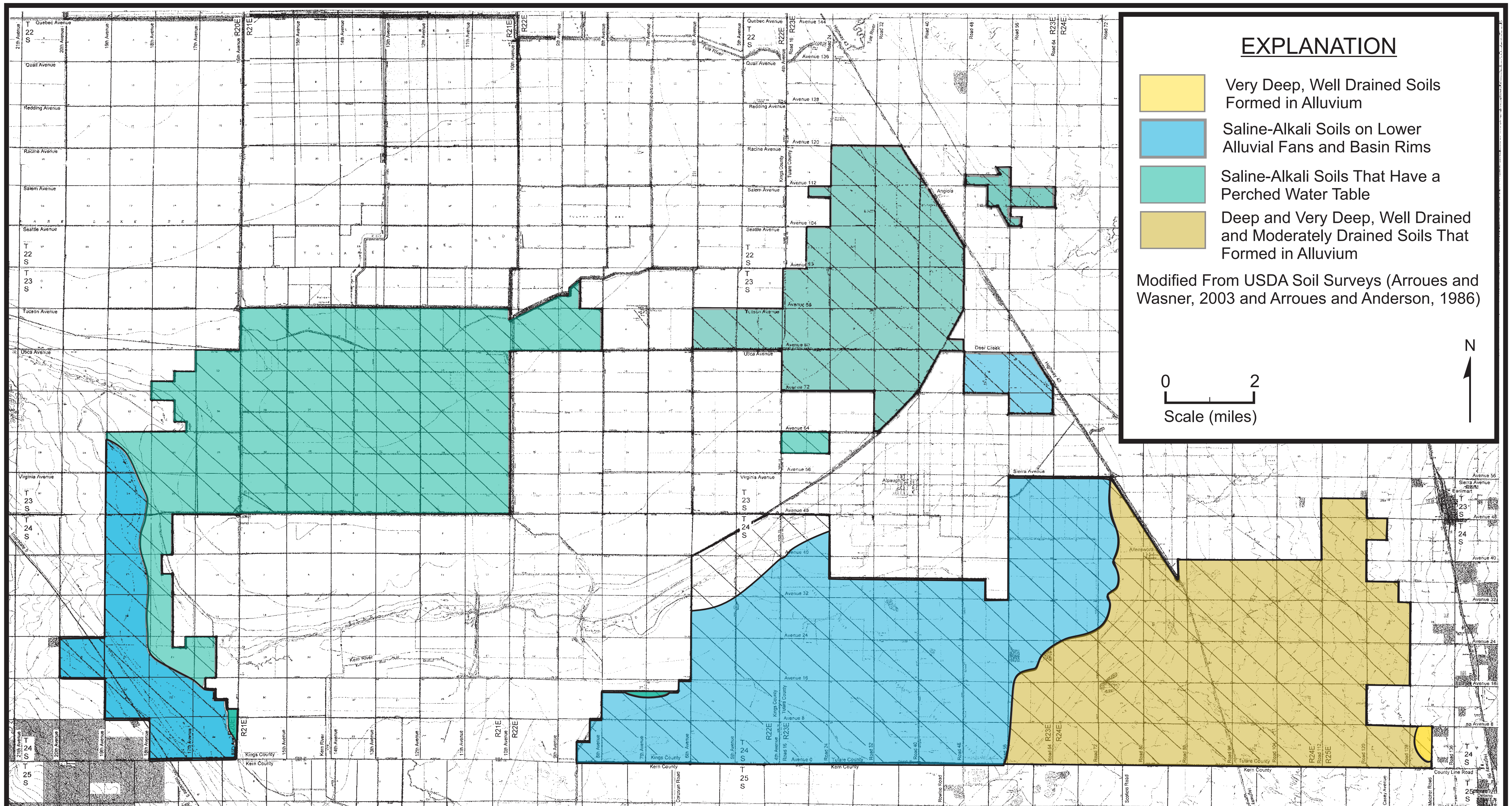


FIGURE 2.1.12 - TOPSOILS

SOURCES OF RECHARGE

Tule River

The Tule River is the largest stream in the Tule Sub-basin. It passes through the area north of the north part of the TCWA GSA. Water-level elevation contours for the upper aquifer indicate that the Tule River is a losing stream and contributes significant recharge to the groundwater.

Deer Creek

Deer Creek passes through the area north of the southeast part of the GSA. Farther west, the realigned creek flows through the south part of the north part of the GSA. Deer Creek is also indicated to be an important source of recharge to the groundwater.

White River

The White River passes beneath Highway 99 south of Earlimart and flows to the west near the north boundary of the southern part of the GSA in the area east of Highway 43. It no longer normally flows in the area west of Highway 43.

Poso Creek

Poso Creek crosses Highway 99 at Famoso and eventually flows into Tulare County west of Highway 43. It is an important source of recharge to the groundwater in the north part of the Semitropic WSD, upgradient of the southeast part of the GSA.

Canal Seepage

The Homeland Canal is a major canal that passes through the north and southwest parts of the GSA. Seepage form the canal is a source of recharge to the upper aquifer, primarily in areas northeast of the Tulare Lakebed.

Deep Percolation

The primary areas where deep percolation is an important source of recharge are lands within AWD and outside of the Tulare Lakebed that are served with canal water. Water applied in excess of crop consumptive use is a termed deep percolation and is considered a source of recharge. This is primarily on lands in the east part of AWD.

Groundwater Inflow

There is groundwater inflow into the upper aquifer in the north part of the GSA from the northwest and southwest. There is groundwater inflow into the upper aquifer in the southeast part of the GSA from the southeast and south. There is groundwater inflow in the lower aquifer in the north and southeast parts of the GSA from the northeast.

Favorable Recharge Areas

Figure 2.1.2, repeated here, shows the location of potential groundwater recharge areas. These include streamflow seepage, groundwater inflow, and deep percolation from irrigation return flow. Streamflow from the Tule River, Deer Creek, and White River were discussed by Thomas Harder & Co. (2017).

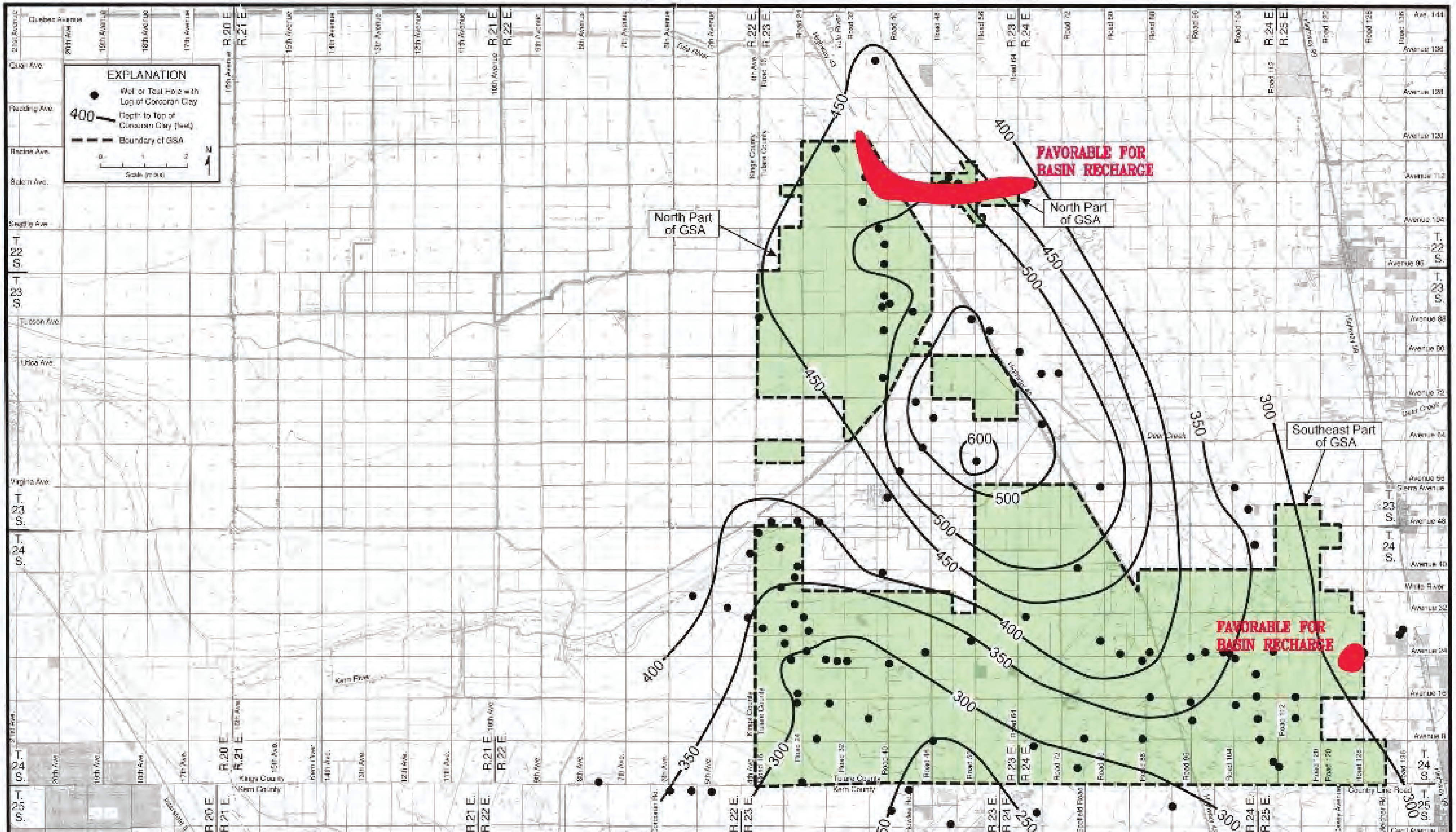


FIGURE 2.1.2 - DEPTH TO THE TOP OF THE CORCORAN CLAY

Figure 2.1.3 of this report shows the easterly extent of the historic Tulare Lakebed, northwest of Allensworth, this east edge is generally close to Highway 43. From near Allensworth, the southwest edge trends to the southwest, and at the Kern County line is near Road 56.

Sites within this historic lakebed area west of this line aren't considered favorable for basin recharge due to the presence of the A-Clay and/or other shallow fine-grained deposits. Figure 2.1.3 also shows the locations of seven subsurface geologic cross sections that were prepared by KDSA (2019). These sections were reviewed to examine the texture of the shallow deposits. Only two areas were indicated to be favorable for future basin recharge. The first was in the AWD East Well Field, extending to the west between the East and West Well Fields, to part of the West Well Field, north of Avenue 108 and near Highway 43.

The only other area that was indicated to be suitable was in an area northwest of Delano, near Avenue 24 and Road 128 and near Avenue 28 and Road 136. There are parts of the Southeast Area that are east of the historic lakebed where detailed subsurface cross sections are not available. One part is between Avenue 20 and the Kern County line and west of Road 104. Another is north of Avenue 24 and east of Road 112. The last is east of Road 112, between County Line Road and Avenue 16. Drillers logs and electric logs for wells and test holes in this area could be examined to look for additional sites that may be favorable for basin recharge.

Groundwater Discharge Areas

Figure 2.1.14 shows the areas of groundwater discharge. Groundwater discharge is accomplished via the water supply wells in the GSA.

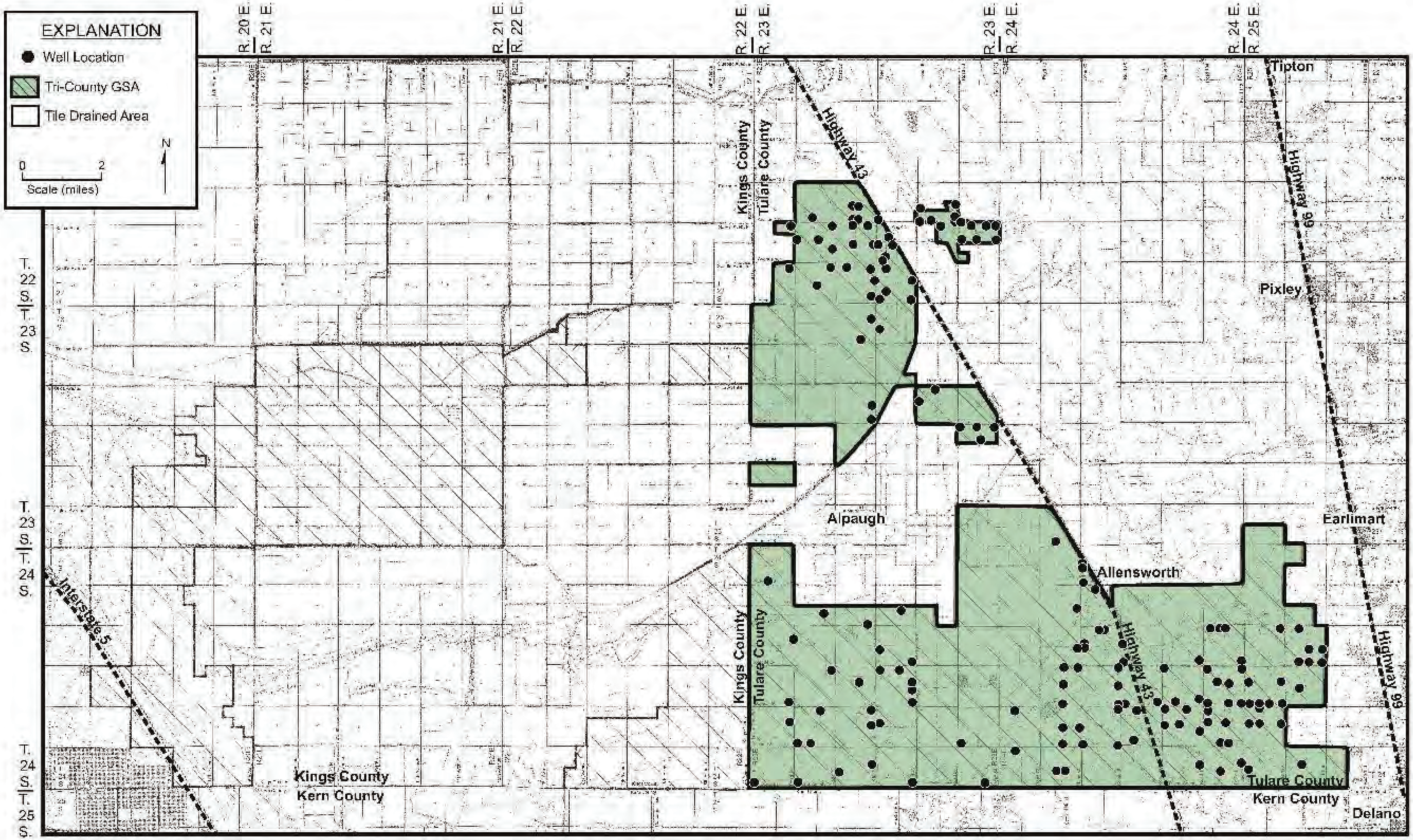


FIGURE 2.1.14 - POTENTIAL GROUNDWATER DISCHARGE AREAS

Sources of groundwater discharge include pumpage and groundwater outflow. Figure 2.1.14 shows active large capacity wells in the GSA.

Pumpage

Pace Engineering (2009) discussed pumpage in the AWD. Thomas Harder & Co. (2017) discussed pumpage in the Tule Subbasin.

Private Wells

Pumpage from private wells in the GSA is not measured. If possible, power consumption records and pump tests can be used to estimate pumpage. Otherwise, the best approach is to estimate the applied water for irrigation by calculating the consumptive use of water by crops and dividing this by acceptable values for irrigation efficiencies. Then the amount of surface water used for irrigation is deducted from the applied irrigation water to calculate the groundwater pumpage.

Groundwater Inflow

There is groundwater inflow into the upper aquifer in the north part of the GSA from the northwest and southwest. There is groundwater inflow into the upper aquifer in the southeast part of the GSA from the southeast and south. There is groundwater inflow in the lower aquifer in the north and southeast parts of the GSA from the northeast.

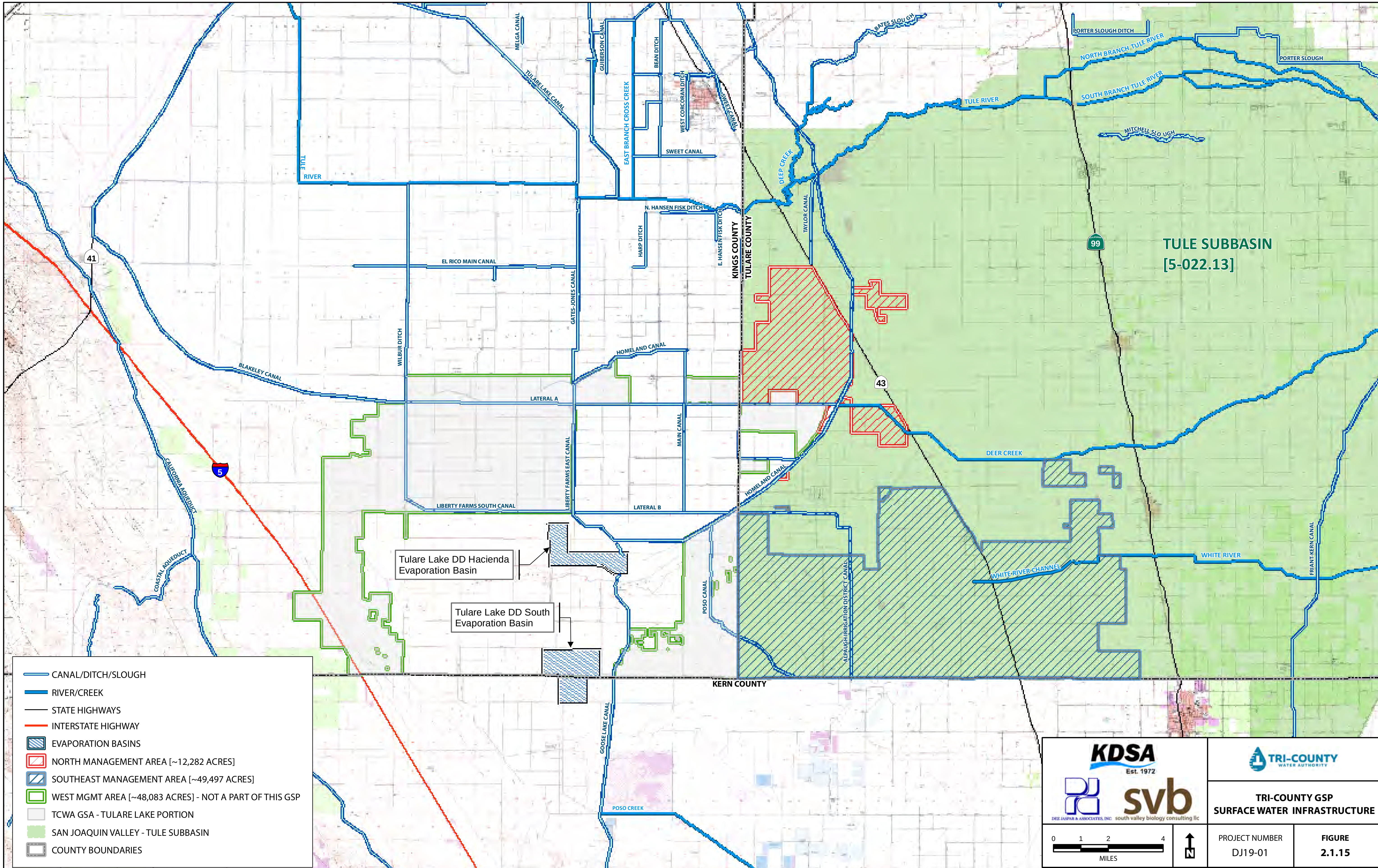
Groundwater Outflow

Groundwater in the upper aquifer flows out of the north part of the GSA to the east to the Pixley I.D. Groundwater in the lower aquifer flows out of the north part of the GSA to the southeast and into groundwater below the Tulare Lakebed. Groundwater in the upper aquifer in the southeast part of the GSA flows to the north toward the Pixley I.D. Groundwater in the lower aquifer flows to the northwest to groundwater underneath the Tulare Lakebed.

Amounts of groundwater inflow and outflow are discussed in the Water Budget section of this GSP.

Surface Water Bodies

Figure 2.1.15 (below) shows surface water bodies in and near the GSA. The Tulare Lakebed is now largely a dry lakebed, except during periods of flooding. The original area of the lake was about 570 square miles. The Tule River passes through the area about two miles west of the north part of the GSA. The Tule River flows from Lake Success into the San Joaquin Valley and eventually to the Tulare Lakebed; The Deer Creek channel extends westerly past Highway 99, where it is about two to three miles north of the east part of the GSA (east of Highway 43). Downstream, the diverted Deer Creek channel then passes through the north part of the GSA and reaches the Tulare lakebed. The White River crosses Highway 99 south of Earlimart and extends into the southeast part of the GSA. The White River **no** longer naturally flows into the Tulare Lakebed. Watersheds for these streams are shown in Figure 2 of Thomas Harder Co. (2017). There are also a number of canals in the GSA. The Homeland Canal is one of the largest, extending from near AWD to the south and southwest.



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/U.S. GEOLOGICAL SURVEY/CA DEPT. OF FISH AND WILDLIFE SERVICE

2.2 GROUNDWATER CONDITIONS [§354.16]

§354.16 Groundwater Conditions

a) Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:

1) Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.

2) Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.

2.2.1 GROUNDWATER ELEVATION [§354.16(a)(1)(2)]

Water-Level Elevations and Direction of Groundwater Flow

KDSA (2011, Appendix D) provided a series of water-level elevation and direction of groundwater flow maps for both the upper and lower aquifers for the area bounded by Avenue 192 on the north, Avenue 48 on the south, 7th Avenue on the west, and Road 144 on the east. Upper aquifer maps were prepared for November 1921, February 1959, and Spring 2007. Lower aquifer maps were prepared for February 1959 and Spring 2007. These maps essentially cover the north part of the GSA and lands to the east.

North Part of the GSA

Figure 2.2.1 shows water-level elevations and the direction of groundwater flow in the upper aquifer, in and east of the north part of the GSA in Spring 2007. There was a well developed cone of depression in the area east of Road 32 and between Avenue 72 and 144. Groundwater was flowing into a depression beneath the Pixley ID from the north, west, and southwest. Seepage from the Tule River was indicated to be an important source of recharge to groundwater in the area. Figure 2.2.2 shows water-level elevations and the direction of groundwater flow in the lower aquifer in Spring 2007 in and east of the north part of the GSA. Two localized cones of depression were indicated, one coincident with the AWD well fields and a second west of Highway 43 near Deer Creek. Overall, groundwater was flowing from the northeast (in the forebay area) to the southwest toward a pumping depression west and south of the AWD well fields.

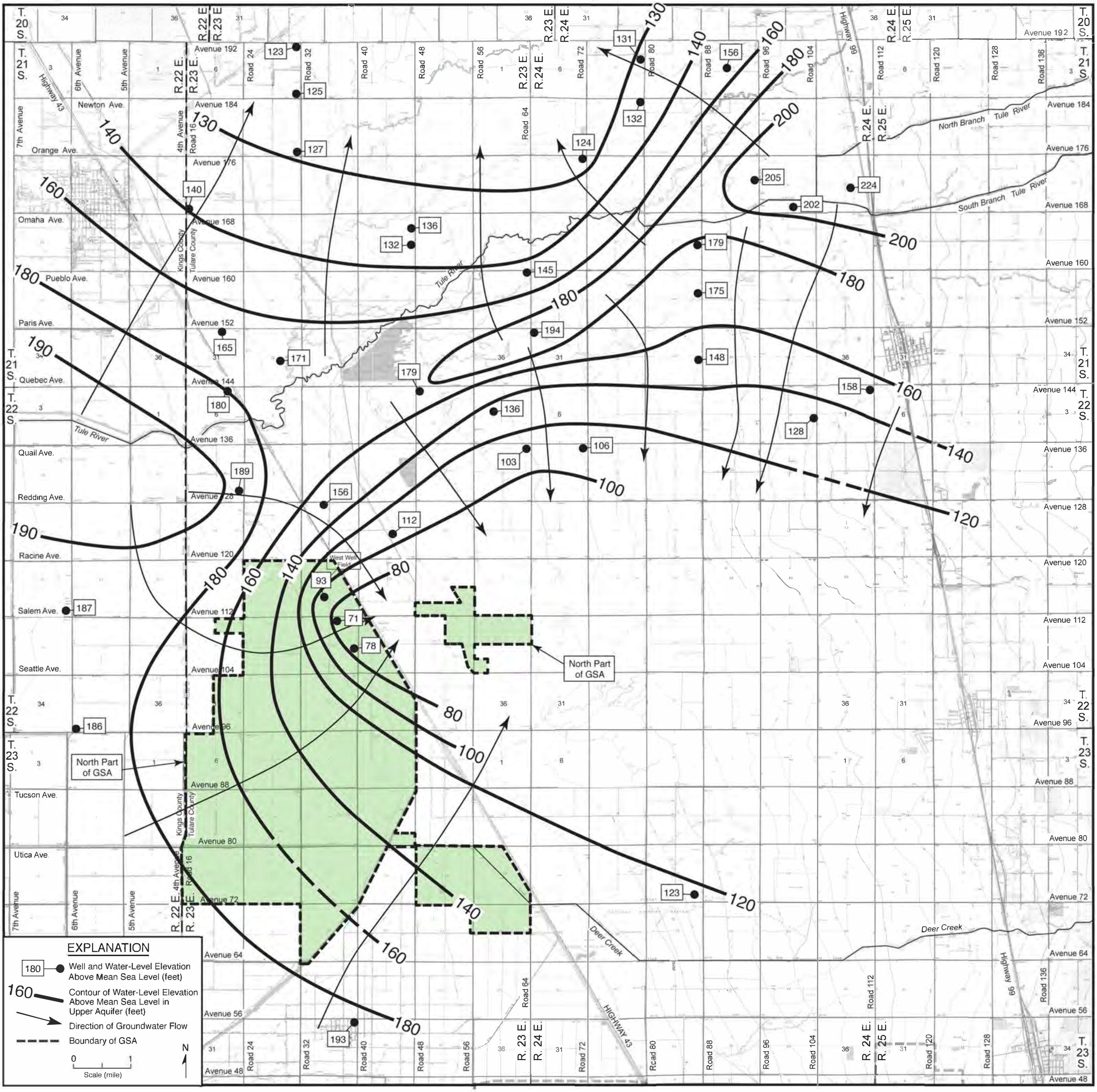


FIGURE 2.2.1 - WATER-LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW IN THE UPPER AQUIFER IN AND EAST OF NORTH PART OF GSA (SPRING 2007)

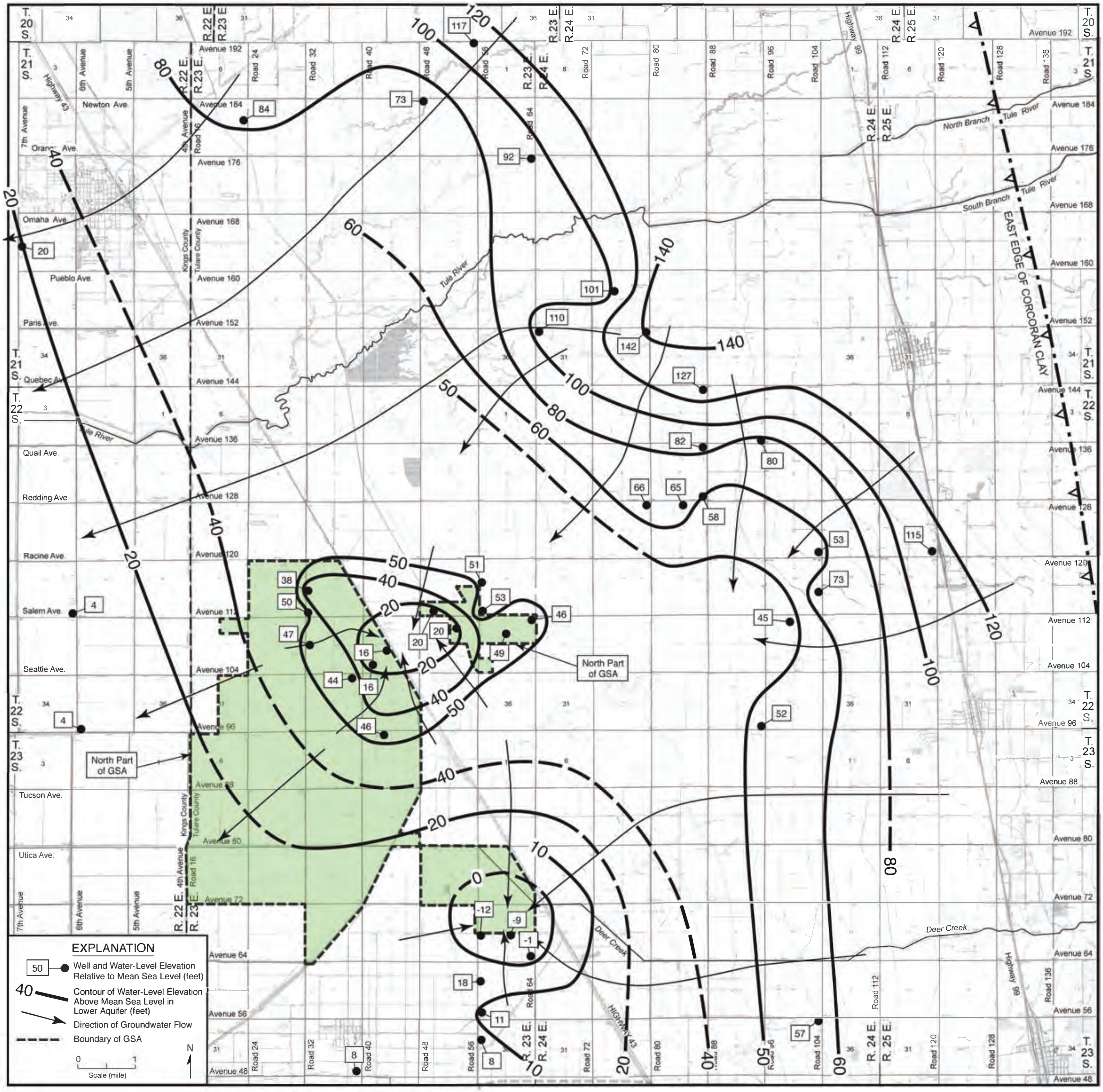


FIGURE 2.2.2- WATER-LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW IN THE LOWER AQUIFER IN AND EAST OF NORTH PART OF GSA (SPRING 2007)

Southeast Part of GSA

Thomas Harder & Co (2017) provided annual water-level elevation maps for the shallower groundwater for Fall 1998 through Fall 2007, and Fall 2010 for the Tule Sub-basin, which includes most of the north and southeast parts of the GSA. They defined shallow as above a depth of about 450 feet (above the Corcoran Clay) in the west part of the Tule Sub-basin and above a depth of about 300 feet in the east part of the basin (i.e. near Porterville). They also provided water-level elevations maps for the deeper groundwater (below the previously referenced depths) for Fall 1998, Fall 1999, and Fall 2010. The Thomas Harder & Co. (2017) map for the shallower groundwater for Fall 2010 was modified for the southeastern part of the GSA and is presented herein as Figure 2.2.3. A water-level elevation map for Fall 2010 from the monitoring program in Kern County associated with the Semitropic WSD water banking project was used to supplement data farther north. The direction of groundwater flow in Fall 2010 beneath the southeast part of the GSA was generally to the north, toward a cone of depression west of Pixley. Higher water-level elevations in the upper aquifer in the north part of Kern County and west of Highway 43 are indicated to be partly due to recharge from streamflow in Poso Creek. The average water-level slope near the Kern County line was indicated to be about ten feet per mile. Overall, there was a lack of data in large parts of the area.

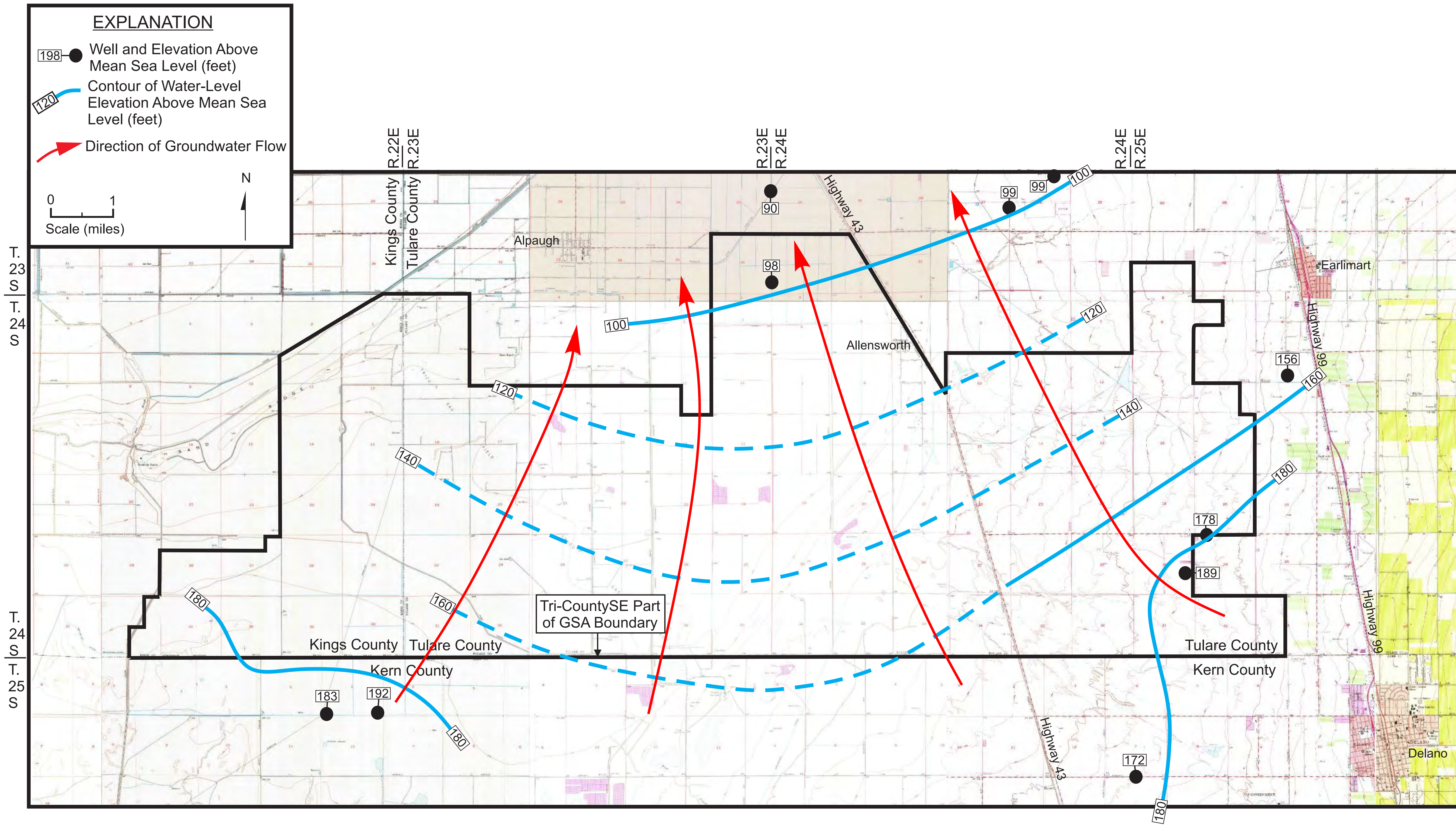


FIGURE 2.2.3 - WATER-LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW FOR UPPER AQUIFER IN SOUTHEAST PART OF GSA (FALL 2010)

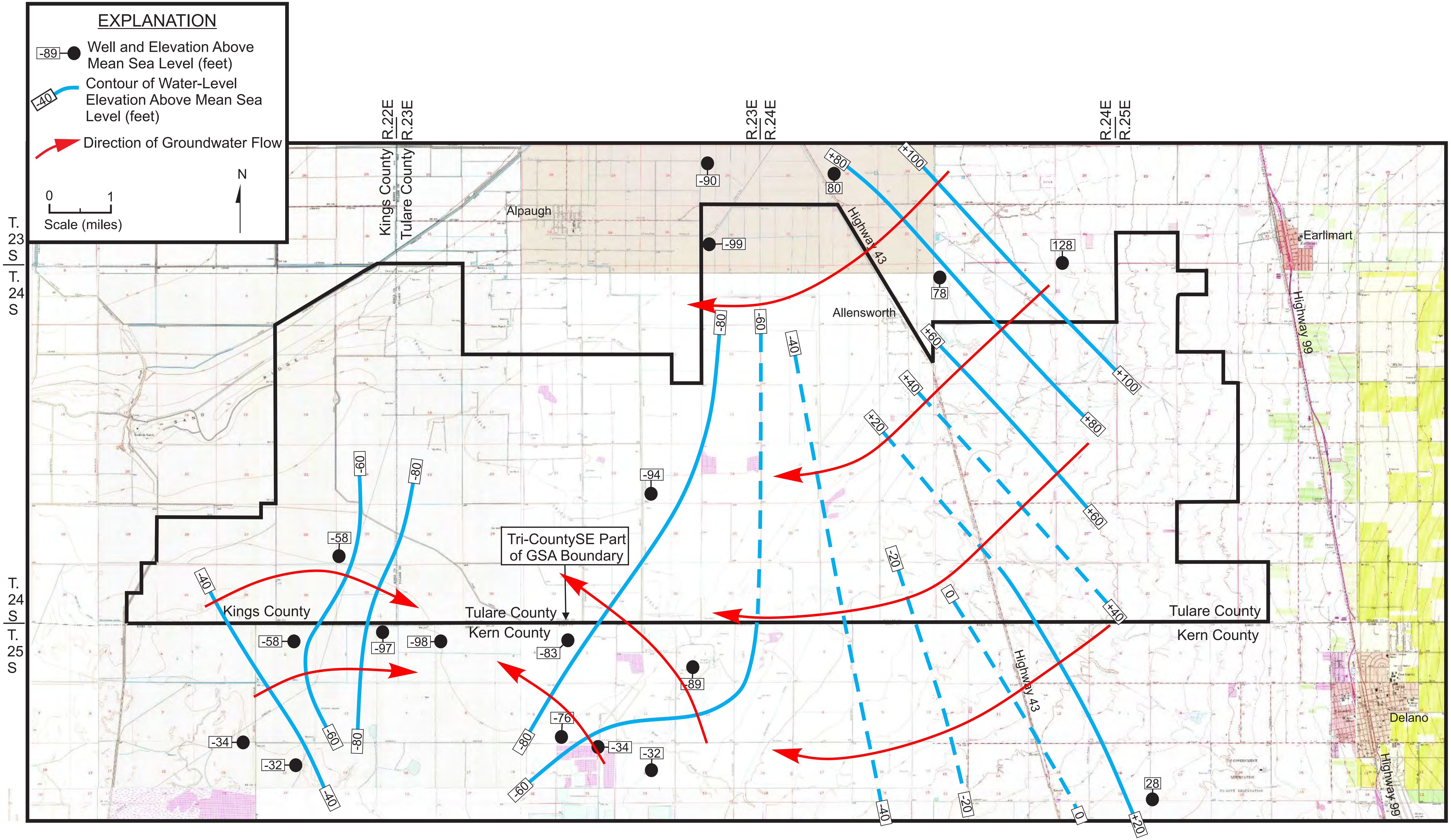


FIGURE 2.2.4- WATER-LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW FOR LOWER AQUIFER IN SOUTHEAST PART OF GSA (FALL 2010)

The Thomas Harder & Co. (2017) map for the deeper groundwater for Fall 2010 was modified for the southeastern part of the GSA and is presented as Figure 2.2.4. Overall, little net groundwater flow was indicated across the Kern County line in Fall 2010. However, annual spring water-level elevation maps prepared by KDSA for the lower aquifer in the Semitropic WSD (south of the Kern County line) have generally indicated a northerly flow in much of the area west of Highway 43. Farther north, a westerly direction of flow was indicated toward a groundwater depression in the Alpaugh areas.

There is a data gap in terms of water level measurements for both aquifers in the southeast part of the GSA. A program is presented later in this GSP to address these gaps.

§354.16 Groundwater Conditions

b) A graph depicting estimates of the change in groundwater in storage, based on data, demonstrating the annual and cumulative change in the volume of groundwater in storage between seasonal high groundwater conditions, including the annual groundwater use and water year type.

2.2.2 GROUNDWATER STORAGE FLUCTUATIONS [§354.16(b)]

Water Level Trends

KDSA (2011) provided water-level hydrographs for upper and lower aquifer wells in the north part of the GSP. Figure 2.2.5 shows the locations of wells for which these hydrographs were available (refer to Appendix D).

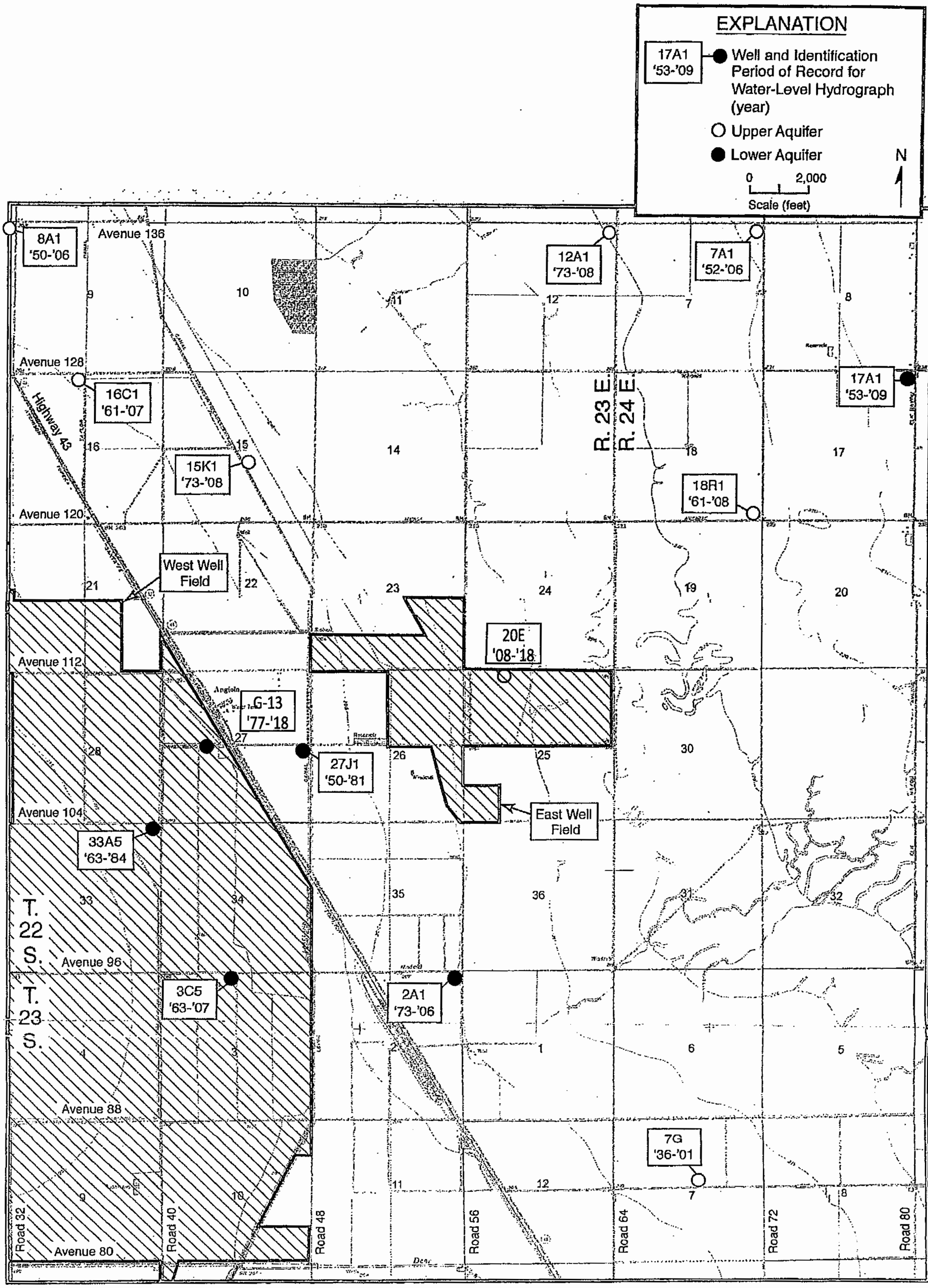


FIGURE 2.2.5 - LOCATIONS OF WELLS WITH WATER-LEVEL HYDROGRAPHS IN NORTH PART OF GSA

North Part of the GSA

Upper Aquifer. Water-level measurements and hydrographs were obtained from the California Department of Water Resources (DWR) website for seven wells in the vicinity that tap the upper aquifer. A representative hydrograph for the upper aquifer in the north part of the GSA is provided in Figure 2.2.6. Well T22S/ R23E-16C1 is located near Avenue 128 and Taylor Avenue, about a mile and a half north of the north edge of the AWD's West Well Field. Since 1960, depth to water in this well has ranged from about 25 to 110 feet. The water level rose during wet periods and fell during droughts. The deepest water levels for this well are consistent with measurements in two AWD wells in late December 1991, during a severe drought. No long-term water-level change was apparent for any of the hydrographs for wells tapping the upper aquifer. No groundwater overdraft of the upper aquifer was indicated since 1961.

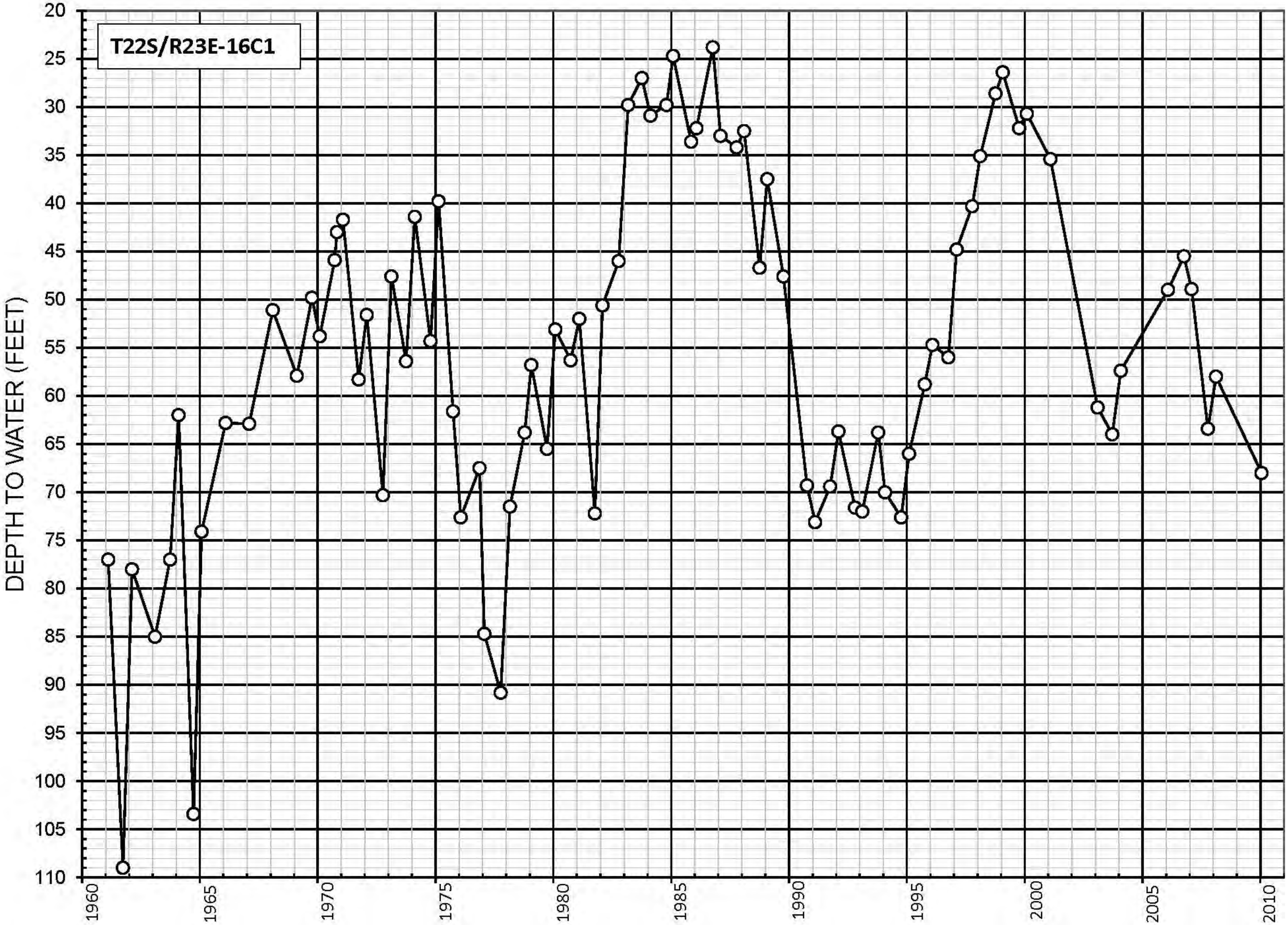


FIGURE 2.2.6 - LONG-TERM WATER-LEVEL HYDROGRAPH FOR UPPER AQUIFER WELL IN NORTH PART OF GSA

Lower Aquifer. Water-level hydrographs were available for five wells that tap the lower aquifer in the vicinity of the AWD's well fields. Figure 2.2.8 is a representative water-level hydrograph for a well tapping the lower aquifer. Well T23S/R23E-3C5 is AWD Well No. G-12. Pressure levels in wells tapping the lower aquifer have also risen during wet periods and fallen during droughts. For example, water levels in Well G-12 have commonly been in the range of about 110 to 160 feet deep during wet periods, and about 180 to 230 feet deep during droughts. No long-term water-level declines are shown by hydrographs for the deep wells in the AWD area, and there is no indication of overdraft of the lower aquifer since 1963.

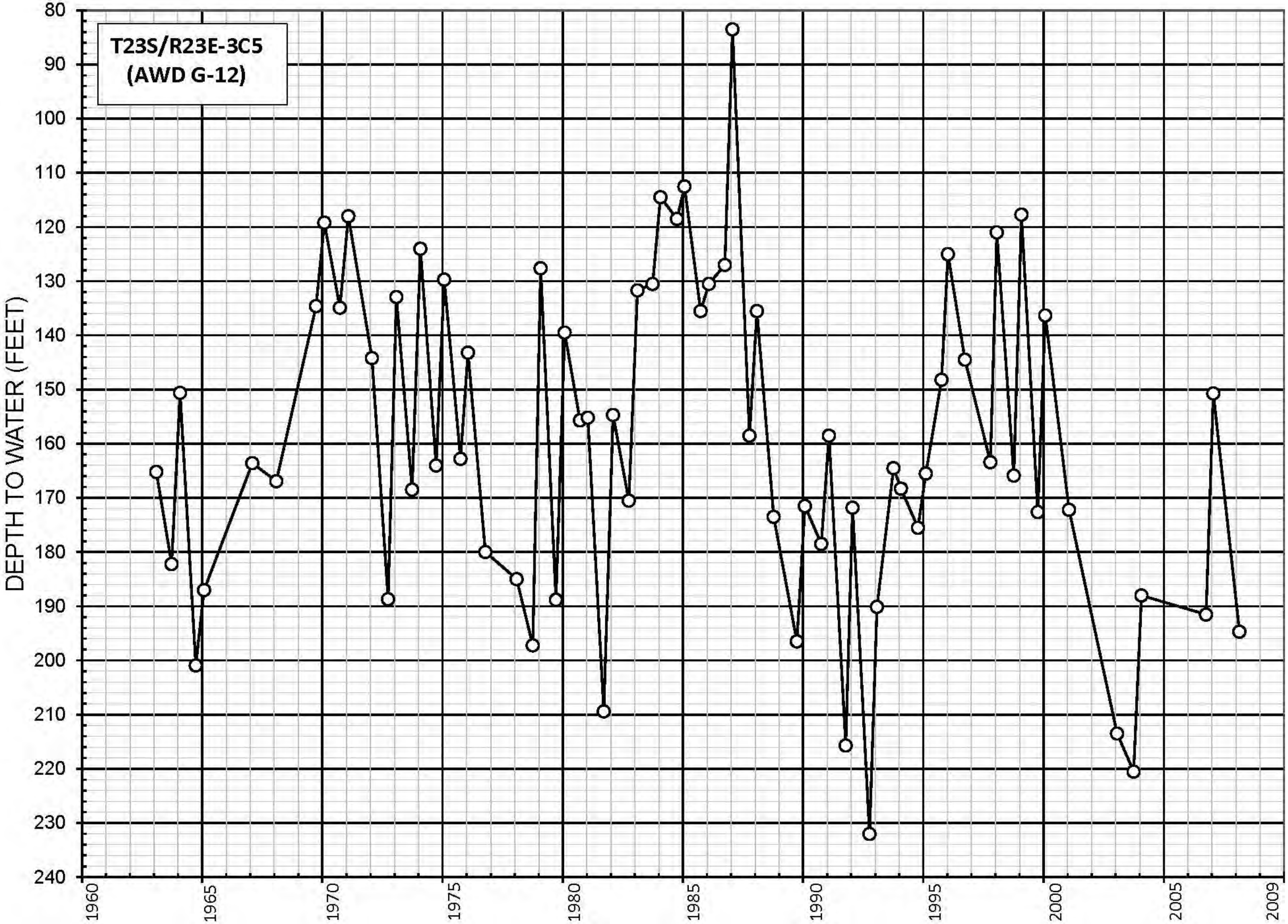


FIGURE 2.2.8 - LONG-TERM WATER-LEVEL HYDROGRAPH FOR LOWER AQUIFER WELL IN NORTH PART OF GSA

Southeast Part of GSA

Water-level hydrographs were available from the DWR for six upper aquifer wells and for seven lower aquifer wells in the southeast part of the GSA.

Upper Aquifer

Figures 2.2.7 and 2.2.9 are representative hydrographs for the upper aquifer in the southeast part of the GSA. Well T24S/R23E-22E1 (Figure 2.2.7) is located about four and a half miles south of Alpaugh. Records are available starting in the early 1960's. Water levels fell from 1962 through 1972, then rose from 1973 through the late 1980's. Water-levels were relatively stable through 1993, then rose through 2000. The shallowest levels of record were in 1997-2000. The water level then fell through 2007.

Figure 2.2.9 is a long-term water-level hydrograph for Well T24S/R24E-34F1, located near the Kern County line and about half mile west of Highway 43. Depth to water in this well fell from 1940 through the early 1970's. Water levels were relatively stable through the end of the 1970's, then rose through the late 1980's. Water levels were then relatively stable through 2007. This well is not far north of the Semitropic WSD, and the water- level trends appear to be related to the importation of surface water to that District beginning in the late 1970's.

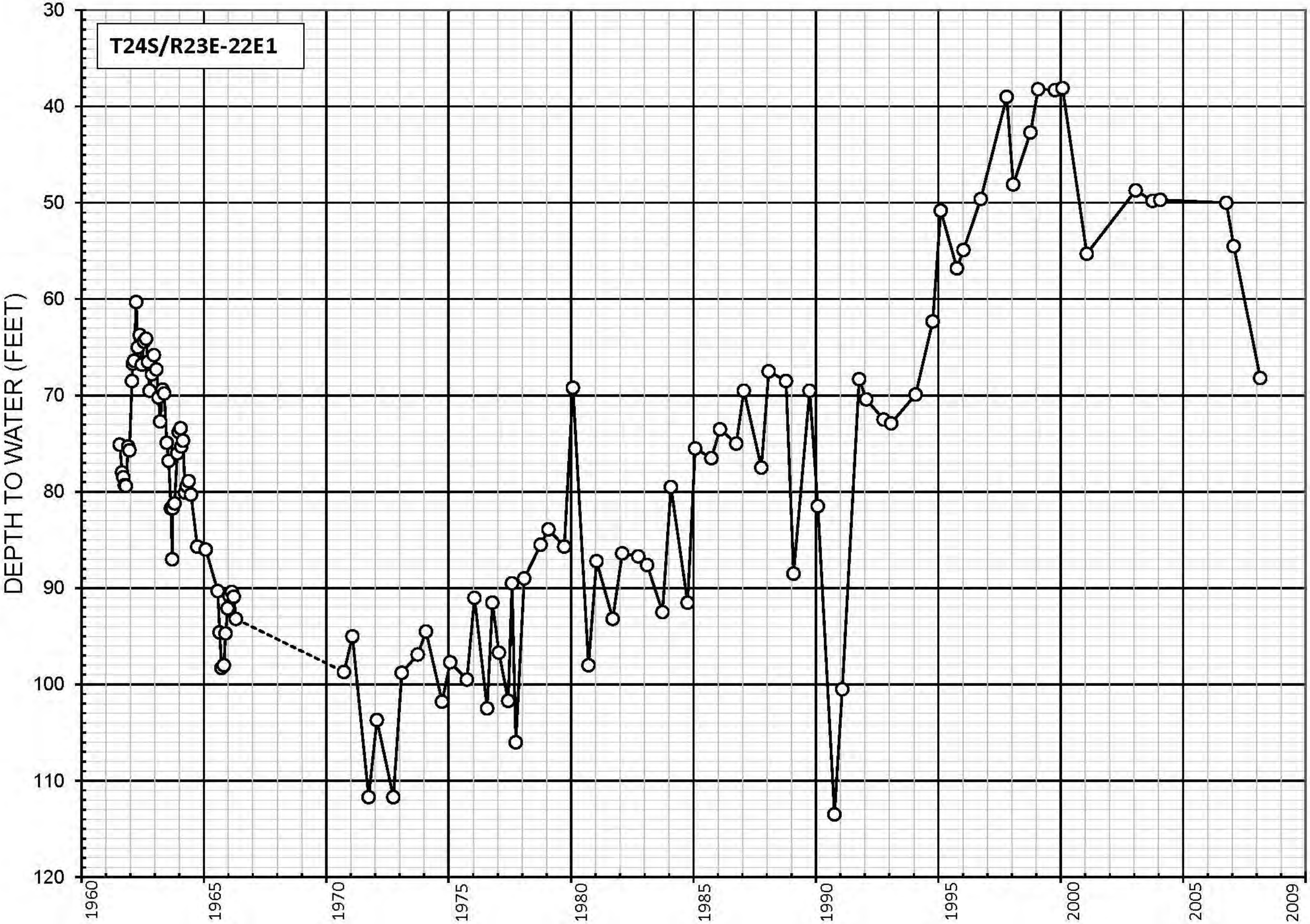


FIGURE 2.2.7- LONG-TERM WATER-LEVEL HYDROGRAPH
FOR UPPER AQUIFER WELL T24S/R23E-22E1

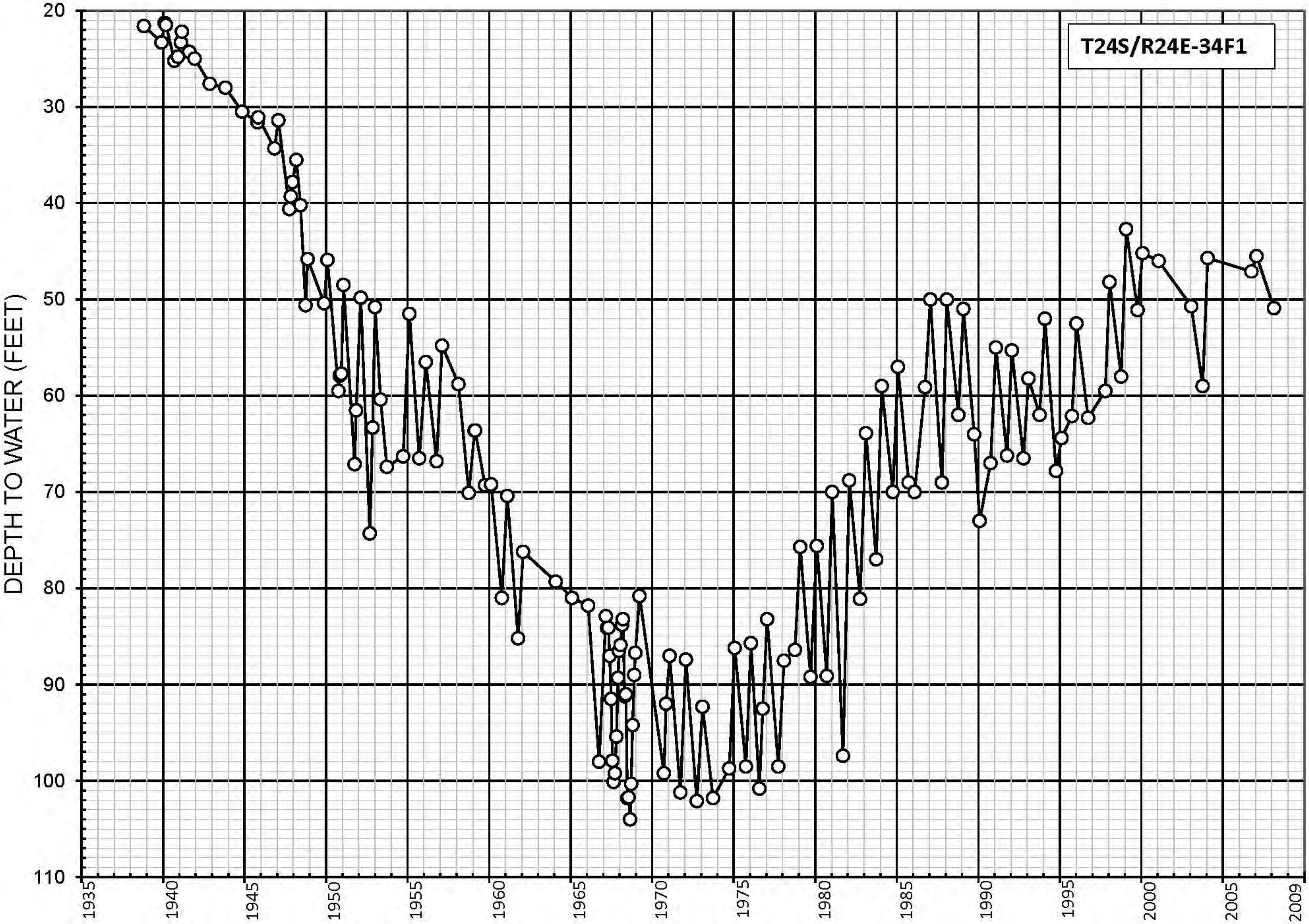


FIGURE 2.2.9 - LONG-TERM WATER-LEVEL HYDROGRAPH
FOR UPPER AQUIFER WELLT24S/R24E-34F1

Lower Aquifer. Figures 2.2.10 and 2.2.11 are representative water-level hydrographs for two lower aquifer wells in the southeast part of the GSA. The larger seasonal water-level variations for these wells compared to those shown in Figures 2.2.7 and 2.2.9 are indicative of a confined aquifer.

Well T24S/R22E-27B1 (Figure 2.2.10) is located two miles north of the Kern County Line and about two and a half miles west of the Tulare County-Kings County Line. The water level in this well fell from the late 1950's through 1978, then rose through 1987, then fell through the early 1990's. The water level then rose and was stable through the end of the late 2000's, then fell during 2007-2017. Overall, water levels in this well were relatively stable from about 1978 to 2007, then fell during the recent drought.

Figure 2.2.11 is a long-term water-level hydrograph for Well T24S/ R23E-22R2. This well is located about five miles south of Alpaugh. The water level in this well fell from 1970 to 1978, then rose from 1978 through 1987, then fell through the early 1990's. Thereafter, the water level was relatively stable prior to 2008. The water level then fell from 2008-2009, then rose through 2012. The water level then fell through 2015. Overall, the water levels in this well were relatively stable from about 1980 through 2006, then fell during the recent drought.

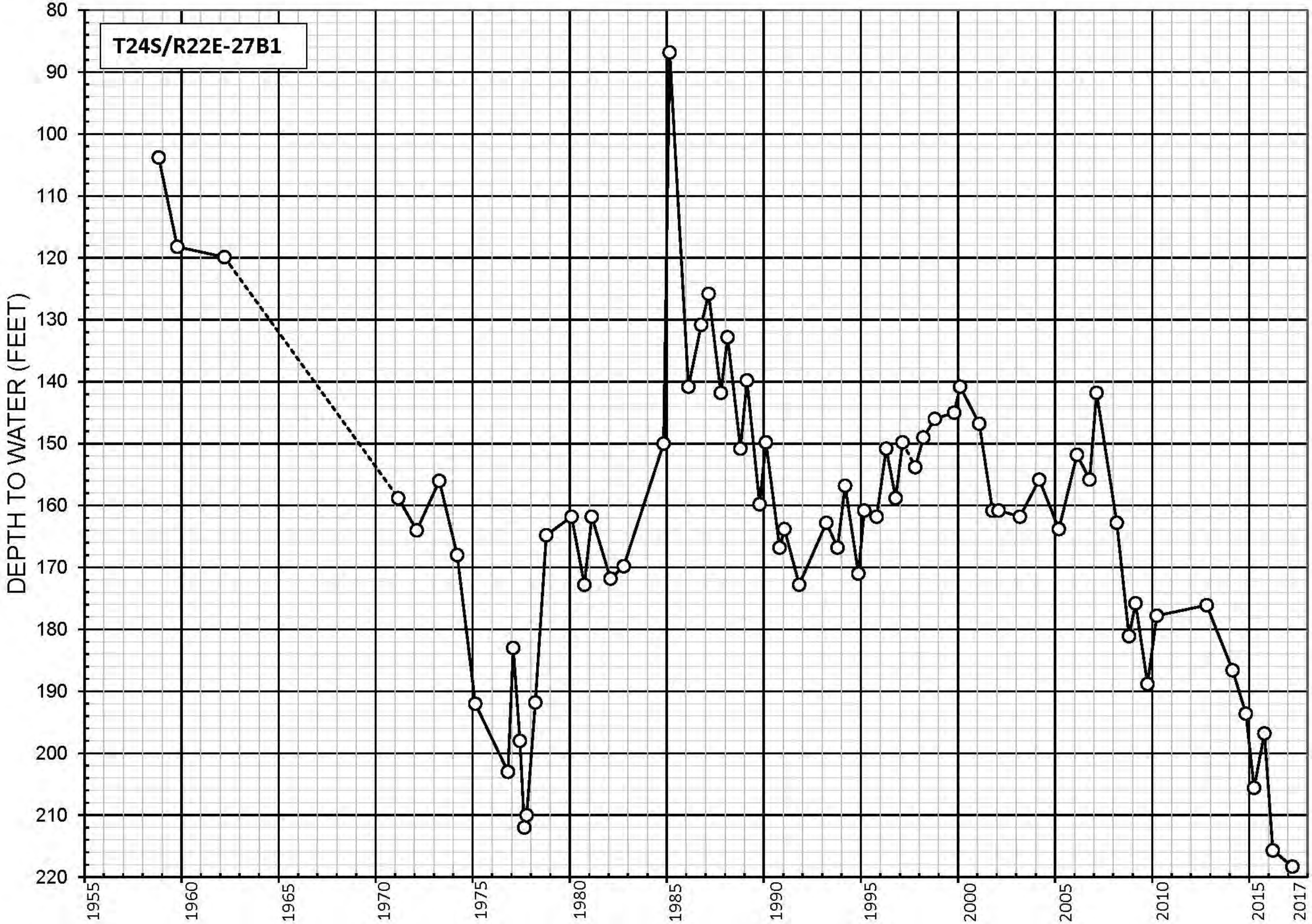


FIGURE 2.2.10 - LONG-TERM WATER-LEVEL HYDROGRAPH
FOR LOWER AQUIFER WELL T24S/R22E-27B1

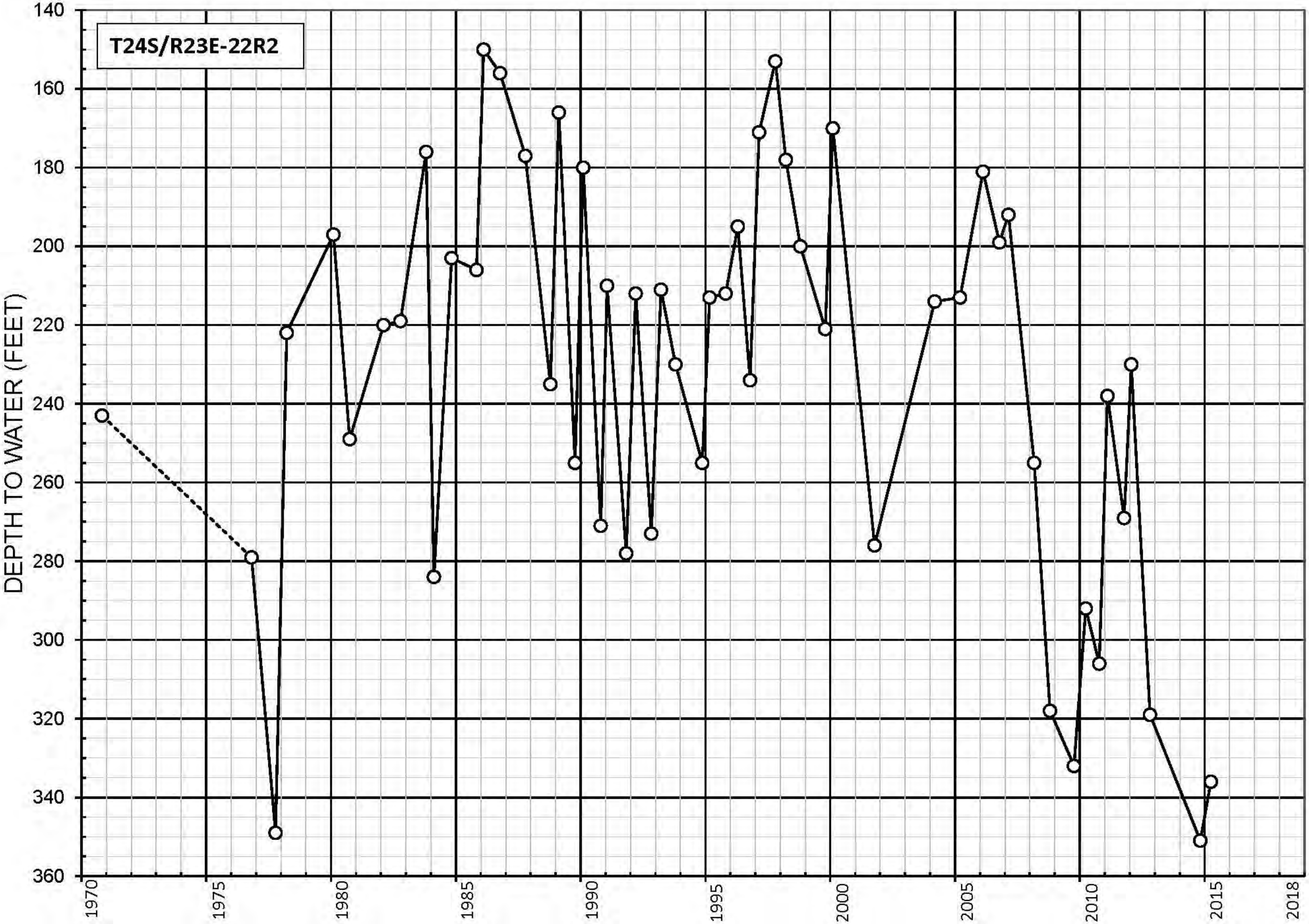


FIGURE 2.2.11- LONG-TERM WATER-LEVEL HYDROGRAPH
FOR LOWER AQUIFER WELL T24S/R23E-22R2

Changes in Groundwater Storage

Changes in groundwater storage for the upper aquifer are best determined from water level changes in wells tapping strata above the Corcoran Clay and specific yields for the upper aquifer. Figure 2.2.12 shows annual changes in storage for the upper aquifer in the north part of the GSA, based on water-level changes for Well T22S/R23S-16C1.

Figure 2.2.13 shows annual changes in storage in the southeast part of the area, based on water-level changes for Well T24S/R23E-22E1. Although there have been water-level declines in wells tapping the lower aquifer, storage changes are minimal in this aquifer, because this aquifer essentially stays full of water. The lower aquifer water-level changes represent pressure changes only. For the Corcoran Clay and deeper confining bed, there has been a storage change due to the compaction of these deposits. This change in storage can be estimated from land subsidence records. It is considered a one-time change in storage.

FIGURE 2.2.12 - ANNUAL CHANGE IN STORAGE (UNCONFINED) - NORTH AREA

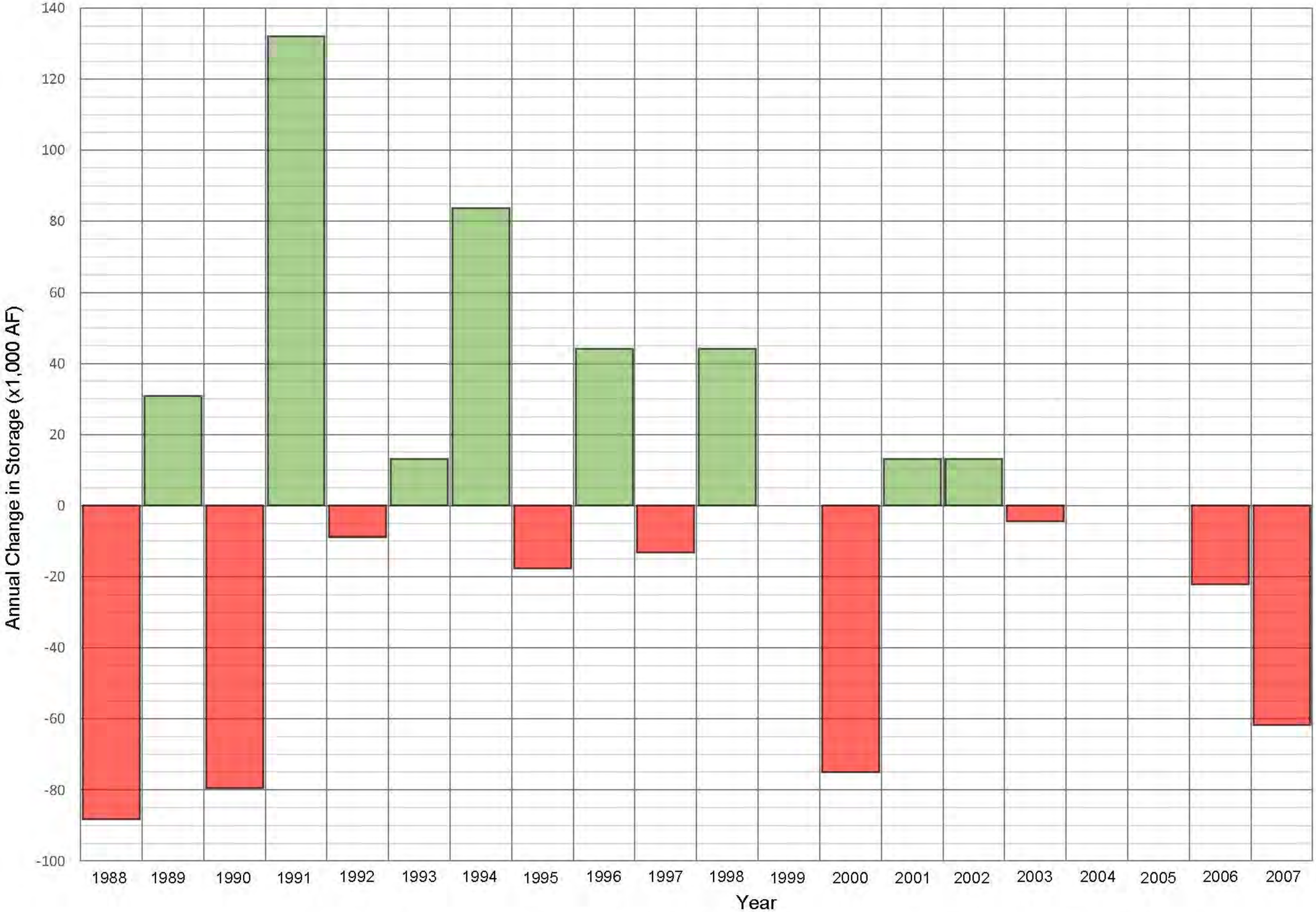


FIGURE 2.2.13 - ANNUAL CHANGE IN STORAGE (UNCONFINED) - SOUTHEAST AREA

The amount of this decrease in storage can be estimated by considering historical subsidence (Figure 2.2.14-A). Figure 2.2.14-A was used to estimate the volume of subsidence between 1949 and 2005. Land subsidence during that period was probably about 70 to 75 percent of the total subsidence through 2017.

More recent studies of land displacement derived from (InSAR) data collected by the European Space Agency Sentinel 1-A satellite and processed by NASA's Jet Propulsion Laboratory shows the change in the ground surface from March 2015 to April 2017. This is a period of drought and reflects the changes in land surface elevations over a two-year period. See Figure 2.2.14-B.

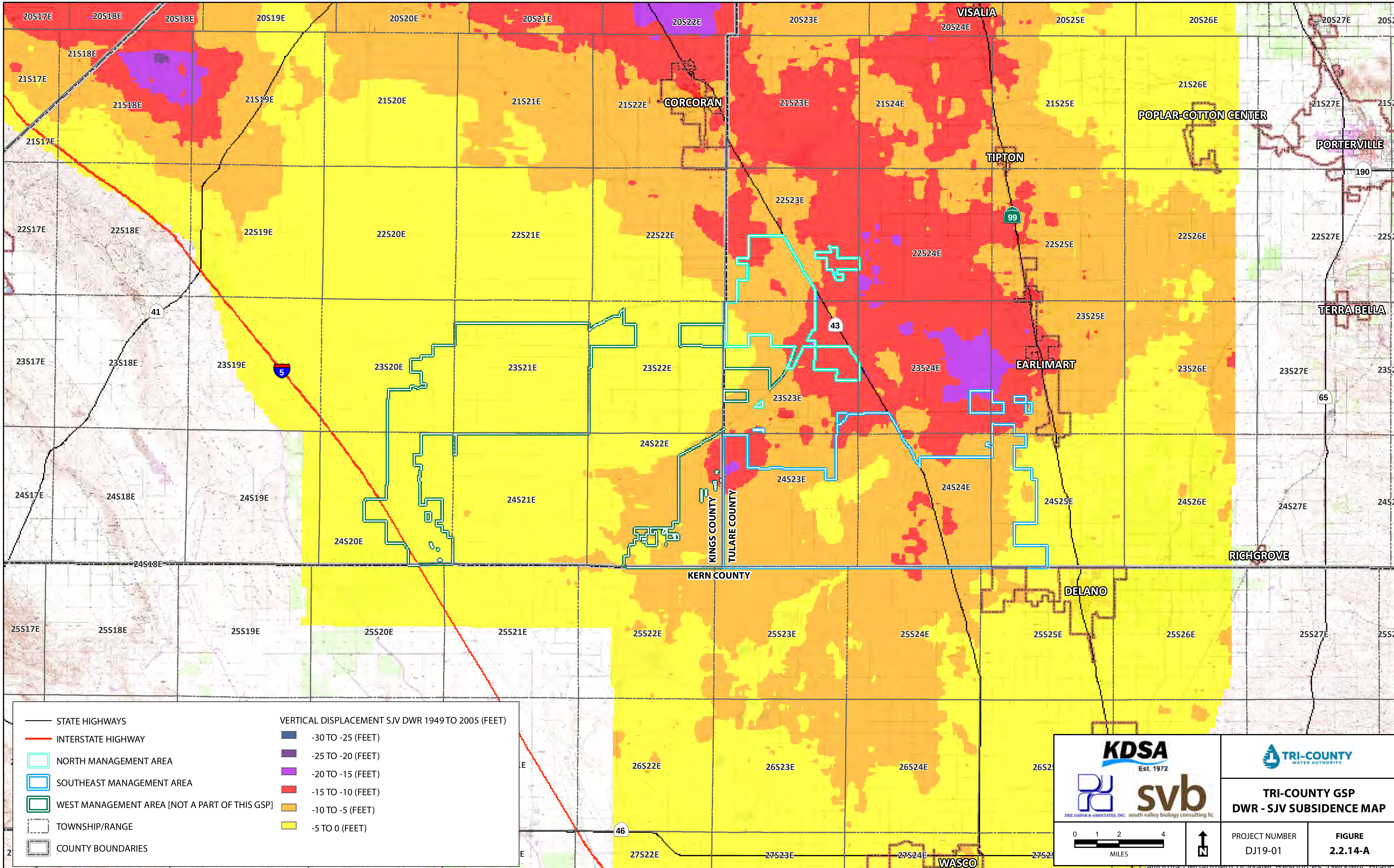
North Area

Subsidence varied from 3 to 6 inches in the southwest part of the North Area to 12 to 15 inches in the northeast part of the area (including the East Well Field). Maximum rates of 1.5 to 7.5 inches per year. This compares to an average maximum rate of 3.3 inches per year for the period of 1949 – 2005 (Figure 2.2.14-A).

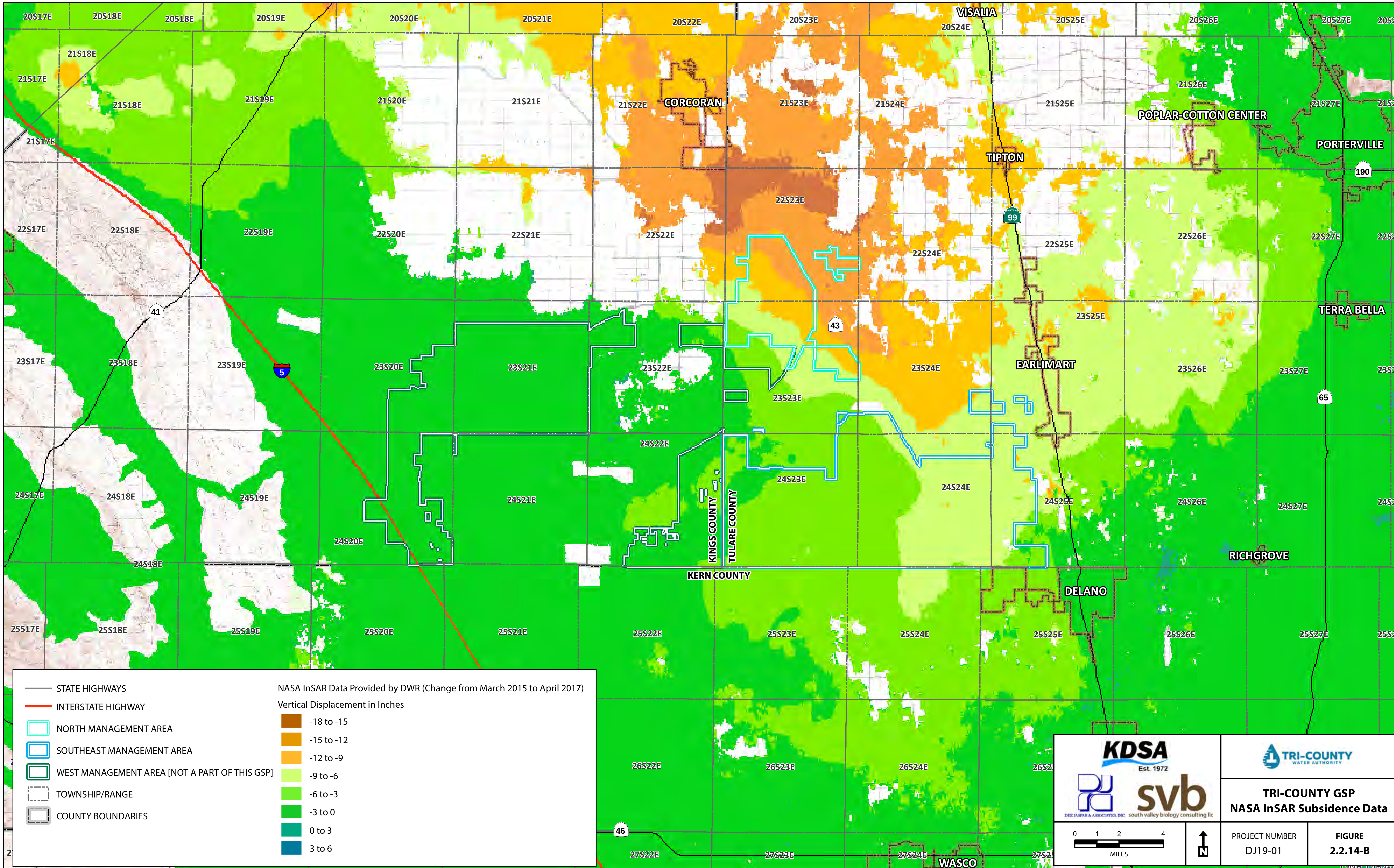
Southeast Area

Subsidence varied from 3 to 6 inches in the west part of the area to 6 to 9 inches in the east part of the area. Maximum rates of 3 to 4.5 inches per year. This compares to an average maximum rate of 2.2 inches per year for the west part of the Southeast Area to 3.3 inches per year for the central part of the Southeast Area for the period of 1949 – 2005 (Figure 2.2.14-A).

A repetition of the same drought period under the same farming and water supply conditions that prevailed in 2015-2017 would result in similar land surface displacements. If this condition were to prevail for a period of five years, a displacement of 7.5 to 37.5 inches could be anticipated in the North Area and 15 to 22.5 inches in the Southeast Area.



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/U.S. CENSUS BUREAU



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/U.S. CENSUS BUREAU

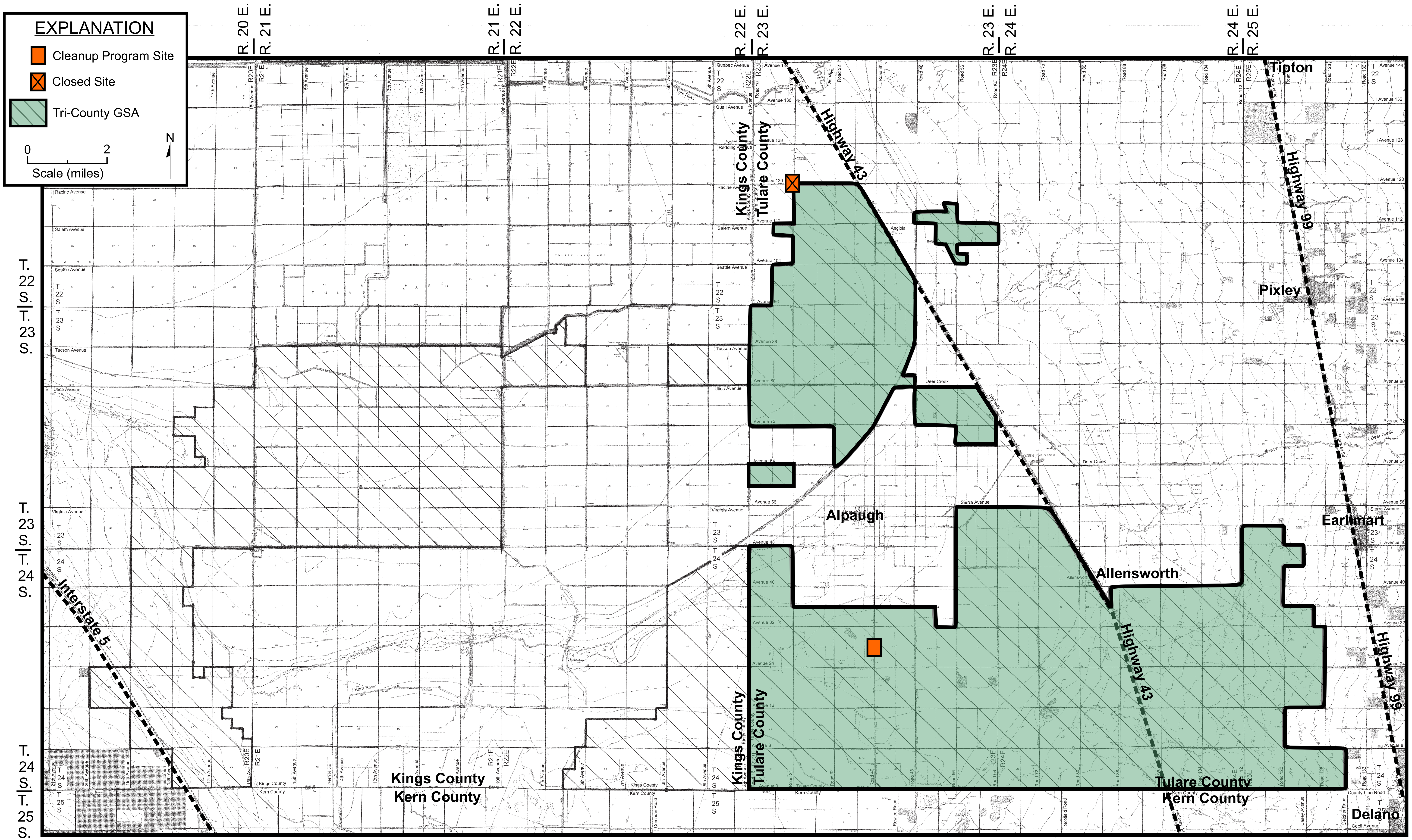


FIGURE **2.2.15** - KNOWN CONTAMINATION SITES

In the north and southeast parts of the GSA, the average of the ranges shown for the three categories (2.5 feet, 7.5 feet, and 12.5 feet) were used. There were about 146,000 acre-feet of groundwater expelled from clay layers in the north part of the GSA, and 460,000 acre-feet in the southeast part of the GSA for that period. In total, the combined amount was 606,000 acre-feet, or an average of 10,800 acre-feet per year. Assuming that the amount of subsidence during 1949 to 2005 was 75 percent of that for 1949 to 2017, this average would be about 14,400 acre-feet per year for this period. This was the one-time loss in groundwater storage from compaction of clay strata. .

§354.16 Groundwater Conditions

c) Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.

2.2.3 SEAWATER INTRUSION [§354.16(c)]

Seawater intrusion is not possible in TCWA due to its great distance from the Sacramento - San Joaquin River Delta.

§354.16 Groundwater Conditions

d) Groundwater quality issues that may affect the supply and beneficial uses of groundwater, including a description and map of the location of known groundwater contamination sites and plumes.

2.2.4 GROUNDWATER QUALITY [§354.16(d)]

Upper Aquifer

Problems with methane gas in the groundwater are common in the Corcoran-AWD area. Water in the upper aquifer in the vicinity often has higher total dissolved solids (TDS) concentrations than present in the lower aquifer. In October 2006, water samples were collected from two of the AWD upper aquifer wells after at least three days of continuous pumping. In addition, a water sample was collected during the pump test on the new Sweetwater Dairy well. An earlier analysis (August 2004) was available for Well G-5.

TABLE 2.2.1-CHEMICAL ANALYSES OF WATER FROM AWD UPPER AQUIFER WELLS

Constituents	G-3	G-5		Sweetwater Dairy
Calcium	11	10	9	13
Magnesium	2	2	2	5
Sodium	-	56	-	-
Potassium	-	2	-	-
Carbonate	-	1	-	-
Bicarbonate	-	154	-	-
Sulfate	17	12	19	39
Chloride	24	18	22	64
Nitrate	<0.4	-	<0.4	<0.4
Fluoride	0.4	-	0.5	0.7
pH	8.1	8.2	8.2	8.3
Total Dissolved Solids (@ 180°C)	190	188	210	470
Iron	<0.05	0.02	<0.05	0.14
Manganese	0.02	<0.01	0.01	0.09
Arsenic	0.002		0.003	0.042
Color	4	-	6	-
Alpha Activity (pc/l)	0.3	-	0.7	1.9
Date	10/3/06	8/18/04	10/3/06	10/23/06
Perforated Interval (ft)	200-500	200-504		240-540

Samples for 2006 analyzed by FGL Environmental of Santa Paula (inorganics and alpha activity) and APPL, Inc. of Fresno (color). The 2004 sample was analyzed by Dellavalle Laboratory of Fresno

TABLE 2.2.2-CHEMICAL ANALYSES OF WATER FROM ALLENSWORTH CSD SUPPLY WELLS

	Well No.	
Constituent (mg/l)	No. 1	No. 2
Calcium	26	78
Magnesium	-	5
Sodium	29	43
Carbonate	<10	<10
Bicarbonate	122	98
Sulfate	15	44
Chloride	20	138
Nitrate	9	21
Fluoride	<0.1	<0.1
pH	7.9	7.9
Electrical Conductivity (micromhos/cm @ 25°C)	275	701
Total Dissolved Solids (@ 180°C)	170	510
Iron	<0.05	0.09
Manganese	<0.01	<0.01
Arsenic (ppb)	11	10
Hexavalent Chromium (ppb)	10	9.5
Alpha Activity (pc/l)	1.7	1.3
DBCP (ppb)	<0.01	<0.01
EDB (ppb)	<0.02	<0.02
Date	11/16/11	12/16/13

Table 2.2.1 summarizes the results of these analyses. Total dissolved solid (TDS) concentrations ranged from about 190 to 470 mg/l and increased to the south in the West Well Field. The water is indicated to be of the sodium bicarbonate type. Nitrate concentrations in all of the samples were non-detectable, indicative of reduced or anaerobic conditions in the groundwater. Iron and fluoride concentrations in water from these wells were below the respective MCLs. The manganese concentration in the sample from the Sweetwater Dairy was 0.09 mg/l, exceeding the recommended MCL of 0.05 mg/l. Manganese concentrations in water from the other wells were well below the MCL. Arsenic concentrations in water from the two AWD wells ranged from 2 to 3 ppb, well below the MCL of 10 ppb. The arsenic concentration in water from the Sweetwater Dairy well was 42 ppb, exceeding the MCL. Color values ranged from 4 to 6 units in water from the AWD wells, less than the recommended MCL of 15 units. Alpha activities in the samples were less than 2 picocuries per liter, well below the MCL of 15 picocuries per liter.

Table 2.2.2 shows the results of analyses of water from the two Allensworth CSD wells that were sampled during 2011-13. Both wells tap the upper aquifer. Total dissolved solids (TDS) concentrations ranged from 170 to 510 mg/l. Water from Well No. 1 was of the calcium-sodium bicarbonate type, the respective MCLs. Arsenic concentrations ranged from 10 to 11 ppb, compared to the MCL of 10 ppb. Hexavalent chromium concentrations ranged from 9.5 to 10 ppb, compared to the proposed MCL of 10 ppb. Alpha activities ranged from 1.3 to 1.7 picocuries per liter well below the MCL of 15 picocuries per liter.

<u>Lower Aquifer</u>

Table 2.2.3a & Table 2.2.3b shows the results of analyses of water from seven AWD lower aquifer wells that were sampled in October 2006. An analysis for 2004 was available for Well 7W. TDS concentrations ranged from 140 to 206 mg/l, and the waters were of the sodium bicarbonate type. Nitrate concentrations were also non-detectable in these samples, indicative of reduced conditions in the groundwater. pH values for the samples from most of the wells ranged from 8.9 to 9.4, typical of deep groundwater in the San Joaquin Valley. Fluoride and iron concentrations in all of the samples were well below the respective MCLs. Manganese concentrations in the samples were non-detectable, except for Well G-20 (0.05 mg/l, equal to the recommended MCL). Arsenic concentrations in water from five of the wells ranged from 12 to 89 ppb, exceeding the MCL of 10 ppb. Water from Well 14E, on the other hand, had an arsenic concentration of only 3 ppb. Alpha activities in water from five of the AWD lower aquifer wells ranged from about 1 to 13 picocuries per liter, below the MCL of 15 picocuries per liter. Water from Well 16E had an alpha activity of 16 picocuries per liter, exceeding the MCL. Color values in samples from the wells ranged from 13 to 19 units. Color values in water from four wells (13E, 14E, G-13, and 7W) exceeded the recommended MCL of 15 units.

TABLE 2.2.3a-CHEMICAL ANALYSES OF WATER FROM AWD LOWER AQUIFER WELLS

Constituents	13E	14E	16E	18E
Calcium	3	4	3	3
Magnesium	<1	<1	<1	<1
Sodium	-	-	-	-
Potassium	-	-	-	-
Carbonate	-	-	-	-
Bicarbonate	-	-	-	-
Sulfate	8	7	8	10
Chloride	8	16	7	8
Nitrate	<0.4	<0.4	<0.4	<0.4
Fluoride	0.8	0.7	0.6	0.8
pH	9.1	9.0	9.4	9.1
Total Dissolved Solids (@ 180°C)	180	200	140	140
Iron	<0.05	<0.05	0.06	0.08
Manganese	<0.01	<0.01	<0.01	<0.01
Arsenic	0.012	0.003	0.060	0.067
Color	18	19	14	13
Alpha Activity (pc/l)	4	6	16	13
Date	10/3/06	10/3/06	10/3/06	10/3/06
Perforated Interval (ft)	598-1,798	597-1,798	500-940	580-930

Continued:

TABLE 2.2.3b - CHEMICAL ANALYSES OF WATER FROM AWD LOWER AQUIFER WELLS (Continued)

Constituents	G-13	G-20	7W	
Calcium	3	13	6	4
Magnesium	<1	2	1	<1
Sodium	-	54	51	-
Potassium	-	3	1	-
Carbonate	-	<1	18	-
Bicarbonate	-	144	108	-
Sulfate	7	5	15	19
Chloride	7	11	19	12
Nitrate	<0.4	<0.4	-	<0.4
Fluoride	0.8	-	-	1.0
pH	9.2	8.2	8.7	8.9
Total Dissolved Solids (@ 180°C)	150	206	161	180
Iron	0.05	0.04	0.03	<0.05
Manganese	<0.01	0.05	<0.01	<0.01
Arsenic	0.070	-	-	0.089
Color	18	-	-	16
Alpha Activity (pc/l)	3.6	-	-	0.7
Date	10/3/06	8/18/04	8/18/04	10/3/06
Perforated Interval (ft)	782-1,604	620-940	500-1,200	

Water samples analyzed by FGL Environmental of Santa Paula (inorganics and alpha activity) and APPL, Inc. of Fresno (color), except 2004 samples, which were analyzed by Dellavalle Laboratory of Fresno.

§354.16 Groundwater Conditions

e) The extent, cumulative total, and annual rate of land subsidence, including maps depicting total subsidence, utilizing data available from the Department, as specified in Section 353.2, or the best available information.

2.2.5 LAND SUBSIDENCE [§354.16(e)]

Lofgren and Klausing (1969) reported on land subsidence in the Tulare-Wasco Area. The Tulare-Wasco area was bounded by Tulare and Lindsay on the north, Wasco on the south, near the edge of the alluvial groundwater basin on the east, and a north-south line about three miles west of the Kings County-Tulare County line on the west. The Tulare-Wasco Area included the north part and almost all of southeast part of the GSA. The greatest subsidence in this area by 1962 was south of Pixley and northwest of Delano, where more than ten feet had occurred. By 1967, land subsidence in most of the north and southeast parts of the GSA exceeded two feet. Much of the historical subsidence was due to groundwater pumping in areas that had no surface water for irrigation. Canal water become available in the Delano-Earlimart I.D. by the late 1950's, and in those same areas water levels recovered several hundred feet.

Estimates of land subsidence in the San Joaquin Valley for 1949-2005 have been made by the California Department of Water Resources (Figure 2.2.14-A). Subsidence was less than five feet during this period in the west part of the GSA. In most of the north and southeast parts of the GSA, land subsidence ranged from 5 to 15 feet. The greatest subsidence (greater than 15 feet) was north of the AWD East Well Field and west of Pixley.

Recent estimates of land subsidence in the San Joaquin Valley have been made by the Jet Propulsion Laboratory. Between May 7, 2015 and September 10, 2016, the land subsidence in the North Part of the GSA was indicated to range from about 1.7 to 2.0 feet. The land subsidence in the Southeast Part of the GSA ranged from about 0.7 to 1.7 feet. Further, this information, when extended to 2018 (Figure A1-8, Thomas Harder & Co., Tule Subbasin Monitoring Plan – Appendix G) shows land subsidence in the North Area increasing up to 2.50 feet, and increasing up to 1.75 feet in the Southeast Area. These values are considered relatively large for such a short time period.

The Tule Subbasin Monitoring Plan discusses the monitoring features that are proposed for the Subbasin. These include GPS surveys, extensometers, and satellite data (InSAR). Subsidence monitoring is addressed in Chapter 4 of this GSP. TCWA will implement the Tule Subbasin Subsidence Plan.

§354.16 Groundwater Conditions

f) Identification of interconnected surface water systems within the basin and an estimate of the quantity and timing of those systems, utilizing data available from the Department, as specified in Section 353.2, or the best available information.

2.2.6 INTERCONNECTED SURFACE WATER SYSTEMS [§354.16(f)]

Shallow groundwater (less than about 20 feet deep) is common beneath the Tulare Lakebed. In most cases, this shallow groundwater is located above the A-Clay. There is no indication that any of the streams in the GSA are in hydraulic connection with the shallow groundwater. However, when the Tulare Lakebed contains lake water, this water may temporarily be in hydraulic connection with the underlying shallow groundwater at some locations. There are a number of shallow observation wells and monitor wells in parts of the lakebed. Groundwater monitoring at agricultural drainage water evaporation ponds has not indicated a hydraulic connection between water in the ponds and the underlying groundwater. That is, water levels were below the bottom of the ponds. Also, there has been no known pumping of this shallow groundwater in the lakebed area, due to its high salinity. As noted in the Tule Subbasin Monitoring Plan (Tule SMP) prepared by Thomas Harder & Co. (TH&C), Surface water flow in the White River does not reach the Tulare Lake bed, and surface water flow in the Tule River and Deer Creek only flow into the historical Tulare Lake during periods of prolonged above-normal precipitation. A copy of the Tule SMP is provided in Appendix G.

§354.16 Groundwater Conditions

g) Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information.

2.2.7 GROUNDWATER DEPENDENT ECOSYSTEMS [§354.16(g)]

As provided in Section 1.4.7-12, GDEs present within the TCWA were mapped using data provided by DWR in cooperation with CDFW and TNC. Conducting a preliminary evaluation, the data was compared against existing (2017/2018) cropping data within the GSA to determine if any modifications would be needed. No GDEs were identified within existing agricultural lands, hence no changes were made to the existing dataset. As discussed in Section 1.4.7-12, additional data (specially depth to groundwater measurements to identify areas where shallow groundwater may occur) are needed in order to determine if the parcels displayed on Figure 1.4.9-A represent true GDEs (i.e., not having access to another water supply source). As currently mapped, approximately 125 acres of GDEs are present within the North Management Area, the majority of which are classified as bush seepweed (*Suaeda nigra*) (formerly shrubby seepweed (*Suaeda moquinii*)). A total of 3,391 acres of GDEs were identified within the Southeast Management Area, of which the majority is also bush seepweed (approximately 2,483 acres). The two other main plant species present within the Southeast Management Area are alkali goldenbush (*Isocoma acradenia*) (approximately 607 acres), and iodine bush (*Allenrolfea occidentalis*) (approximately 214 acres). Refer to Figure 1.4.9-A – Natural Communities Map, provided in Chapter 1. These numbers are preliminary, and the parcels mapped are therefore considered areas of potential GDEs to be confirmed as absent/present pending acquisition of additional data. As provided in Section 1.4.7-12, current available data does not allow for accurate mapping of depth to groundwater, hence this is recognized as a data gap. TCWA may consider, as funding becomes available, installing PVC monitor wells to determine if the water levels are shallow enough to support the ecosystems identified on Figure 1.4.9-A.

2.3 WATER BUDGET [§354.18]

§354.18 Water Budget

d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:

1) Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.

2) Current water budget information for temperature, water year type, evapotranspiration, and land use.

3) Projected water budget information for population, population growth, climate change, and sea level rise.

e) Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population, climate change, sea level rise, groundwater and surface water interaction, and subsurface groundwater flow. If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater, the Plan shall identify and describe an equally effective method, tool, or analytical model to evaluate projected water budget conditions.

f) The Department shall provide the California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) and the Integrated Water Flow Model (IWFM) for use by Agencies in developing the water budget. Each Agency may choose to use a different groundwater and surface water model, pursuant to Section 352.4.

§354.18 Water Budget

a) Each plan shall include a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored. Water budget information shall be reported in tabular and graphical form.

b) The water budget shall quantify the following, either through direct measurements or estimates based on data:

   1) Total surface water entering and leaving a basin by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems.

   2) Inflow to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems.

   3) Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.

   4) The change in the annual volume of groundwater in storage between seasonal high conditions.

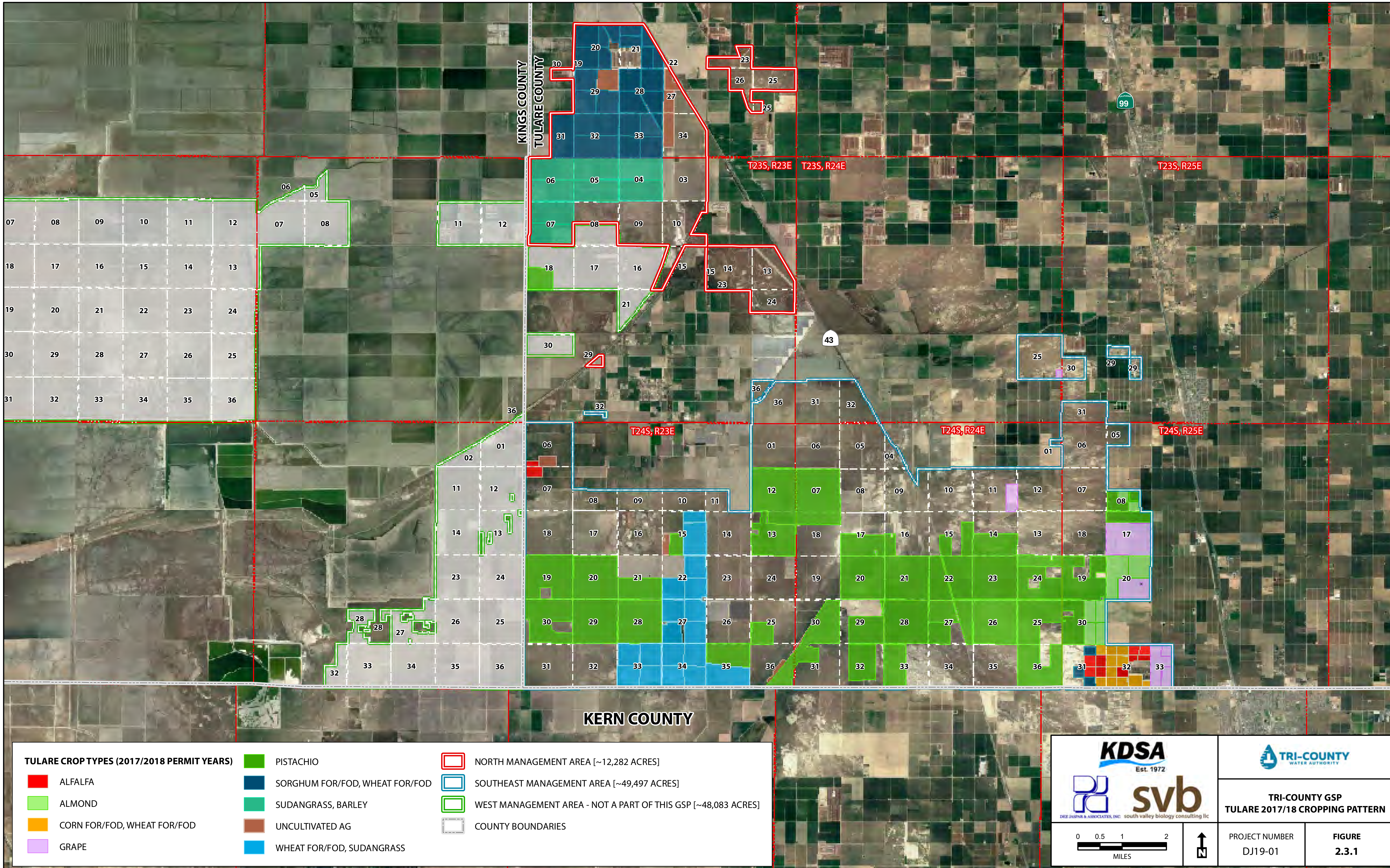
   5) If overdraft conditions occur, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.

   6) The water year type associated with the annual supply, demand, and change in groundwater stored.

   7) An estimate of sustainable yield for the basin.

2.3.1 WATER BUDGET CATEGORIES AND DATA SOURCES [354.18(d)(e)(f)]

The Tule Subbasin portion of the GSA has been divided into two Management / Monitoring Areas based on water supply conditions. The North Area - located north of Avenue 60 in Tulare County and served surface water by AWD; and the Southeast Area - bounded on the south by the Kern/Tulare county line, extending from 8 ½ Avenue on the west to Road 132 on the east. The southeast corner of this area is about one-mile northwest of the City of Delano. Allensworth CSD is the only public water supply entity in the Southeast Area. The Southeast Area does not have a surface water supply. It is defined as a "White Area", not being part of a water district. The current cropping pattern is shown on Figure 2.3.1.



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/TULARE COUNTY AGRICULTURAL COMMISSIONER

The land contained within the boundaries of TCWA within the Tule Subbasin is about 61,400 acres, of which about 29,000 acres are currently farmed. Permanent crops occupy about 18,500 acres, with the remaining 10,500 acres in field crops. Pistachios dominate the permanent crops with about 16,500 acres planted. The cropping pattern is based on the Tulare County Agricultural Commissioners' Office GIS mapping of the 2017/2018 crops based on the Restricted Materials Permitting information. Each field has a field area calculated by the CalAgPermits GIS and is thought to be a good representation of the field area. Field crops dominate the North Area while permanent crops dominate the Southeast Area. The worksheets supporting the following tables are in Appendix A-1.

The California Department of Water Resources separated California into 18 ETo Zones (ETo Zone Map - below). The methodology was developed using the United Nations Food and Agriculture Organization Irrigation and Drainage Publication No. 56, Guidelines for Computing Crop Water Requirements - published in 1998. For Irrigation Training & Research Center's (ITRC's) data development, 13 ETo Zones were used. These were the major irrigated agricultural areas in California. The ETc values were computed for four major soil types, however the ITRC averaged the values for all four soil types for use in the tables developed by ITRC. It is noted that the ITRC data tables include evaporation during non-growing periods, and therefore the ITRC values can be higher than those presented in other publications, but actually present a more realistic picture of the ET that will be experienced on the farm. ET values used in the water balance tables used in this GSP recognizes that fields are not blanketed by pristine conditions and that bare spots exist. Transpiration is lower on bare spots than in the rest of the field. However, evaporation from these areas is higher than in the rest of the field. The net result is that there is a reduction in actual field crop ET of 7-8%.

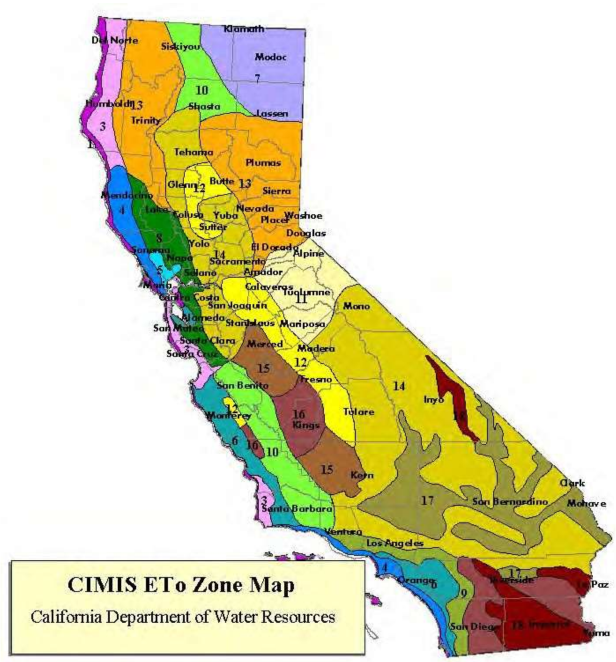


Figure 2.3.2

Table A-1a, Appendix A-1a, is a calculation of the current crop water demand for the GSA, assuming fully mature crops. It is based on the above cropping information, with ETc developed from Cal Poly ITRC data for Irrigation District Water Balances for Zone 15, with consideration given to ITRC estimates of rainfall contribution to crop ET. These deductions are shown on Table A-1e in Appendix A-1a. The tabulation deducts 5% of the gross farmed lands to account for field roads and other non-productive areas within the farmed acreage. ITRC developed its estimates of crop evapotranspiration for three types or classes of year depending on climate patterns: Dry, Typical, and Wet. Therefore, future crop demands can be estimated based on the historical weather patterns, assuming that future weather patterns will resemble past patterns, with adjustments in water supply and crop water requirements to reflect the forecast effects of climate change. The following Table 2.3.1a is a summary of Table A-1a (Appendix A-1a). Table 2.3.1a presents the crop water requirements for the North and Southeast Areas of the GSA based on the current (2017-18) cropping pattern. The Tables in Appendix A develop the crop water and applied water requirements for three climate conditions, based on the 2017/18 cropping patterns in the GSA. Table A-1a represents the current (2020) climate condition; Table A-1b represents the predicted conditions for Year 2040 due to climate change - which are increased ET and reduced precipitation and streamflow, and Table A-1c represents the effects of climate change in Year 2070. ET is estimated to increase 3% by Year 2030 and 6% by Year 2070. Precipitation and streamflow are estimated to decrease 2% by Year 2030 and 4% by Year 2070. Tables A-1a through A-1e reflect ET increase. Climate change effects on precipitation and surface water are considered in Tables 2.3.1. There are various estimates of the effects of climate change on ET, precipitation, and surface water supplies. DWR's "Guidance for Climate Change Data Use During Groundwater Sustainability Plan Development" along with the EPA / DWR "Climate Change Handbook for Regional Water Planning" documents were reviewed. Another reference reviewed was Hopkins and Maurer, UC Davis "Impact of Climate Change on Irrigation Water Availability, Crop Water Requirements and Soil Salinity in the San Joaquin Valley" (included in Appendix A-1c). Hopkins indicates that reference ET could increase up to 12% by the end of the century but that the changes in crop development could significantly offset the change, and that the change could be minus 13% to plus 7% in crop ET relative to the no-climate-change scenario. It was therefore decided to use the estimates of an increase of 6% crop ET by 2070 and 3% by 2030. Conversation with staff at Thomas Harder & Co. indicated that the estimates were within a reasonable range for estimation of these parameters for the Tule Subbasin at this time. These percentages will be reviewed and, if necessary, updated in 2025.

Decreases of 2% and 4% streamflow for 2030 and 2070 appear to be in the general range of what is predicted by the Harder HCM, and because this component is very small for AWD (total AWD surface water supplies to the North Area average around 3,000 afy), it was decided that these values were sufficient for the water balance for TCWA. These percentages will also be updated in 2025.

The Tule Subbasin HCM presents the annual precipitation for the Porterville weather station (Figure 2-28 – Tule Subbasin Basin Setting- Appendix G). Since the ET values and the precipitation contribution to crop ET is dependent on climate, records of precipitation are used for the determination of the ratio of dry – typical – and wet years for calculating crop water demands. Weather stations in proximity to TCWA are: Shafter – to the south, Stratford – to the northwest, and Porterville – to the northeast. The aforementioned Figure 2-28 is a graphical representation of ninety-one years of precipitation at Porterville. The ratios of water year types are calculated for the 91-year history of the Porterville weather station, together with calculation of the twenty-year ratios for Porterville, Shafter, and Stratford for comparison. These tabulations are included as Tables A7-a – d. The Porterville and Stratford stations show very similar patterns while Shafter exhibits slightly wetter pattern. The average of these percentages is: 32% Dry, 55% Typical, and 13% Wet. These percentages were used to approximate the number of Dry, Typical and Wet years in the study period.

Table 2.3.1a

Tri-County GSA Groundwater Demand - 2017/18 Cropping Pattern - Tule Subbasin Portion of GSA - Year 2020								
Management Area	Gross Acres	Irrigated Acres	Dry Year Conditions		Normal Year Conditions		Wet Year Conditions	
			Crop Water Requirement (Etc) Acre-Feet	Applied Water Requirement Acre-Feet	Crop Water Requirement (Etc) Acre-Feet	Applied Water Requirement Acre-Feet	Crop Water Requirement (Etc) Acre-Feet	Applied Water Requirement Acre-Feet
Total GSA	61,400	29,000	72,000	86,600	74,400	89,400	79,500	95,700
North Area	12,100	6,000	13,100	19,600	13,600	20,300	14,800	22,100
Southeast Area	49,300	23,000	58,900	67,000	60,800	69,100	64,700	73,600

Reference: Appendix Table A-1a

Table 2.3.1b

Tri-County GSA Groundwater Demand - 2017/18 Cropping Pattern - Tule Subbasin Portion of GSA - Year 2040								
Management Area	Gross Acres	Irrigated Acres	Dry Year Conditions		Normal Year Conditions		Wet Year Conditions	
			Crop Water Requirement (Etc) Acre-Feet	Applied Water Requirement Acre-Feet	Crop Water Requirement (Etc) Acre-Feet	Applied Water Requirement Acre-Feet	Crop Water Requirement (Etc) Acre-Feet	Applied Water Requirement Acre-Feet
Total GSA	61,400	29,000	74,700	89,800	77,200	92,900	82,500	99,300
North Area	12,100	6,000	13,600	20,300	14,100	21,100	15,400	22,900
Southeast Area	49,300	23,000	61,100	69,500	63,100	71,800	67,100	76,400

Refernce: Appendix Table A-1b

Table 2.3.1c

Tri-County GSA Groundwater Demand - 2017/18 Cropping Pattern - Tule Subbasin Portion of GSA - 2070								
Management Area	**Gross Acres**	**Irrigated Acres**	**Dry Year Conditions**		**Normal Year Conditions**		**Wet Year Conditions**	
			Crop Water Requirement (Etc) Acre-Feet	**Applied Water Requirement Acre-Feet**	**Crop Water Requirement (Etc) Acre-Feet**	**Applied Water Requirement Acre-Feet**	**Crop Water Requirement (Etc) Acre-Feet**	**Applied Water Requirement Acre-Feet**
Total GSA	61,400	29,000	76,300	91,800	78,800	94,800	84,300	101,400
North Area	12,100	6,000	13,900	20,800	14,400	21,500	15,700	23,400
Southeast Area	49,300	23,000	62,400	71,000	64,400	73,300	68,600	78,000

Reference: Appendix Table A-1c

The following tables are companion tables to Tables 2.3.1a, b and c. These tables incorporate the average annual Etc (crop evapotranspiration) and Applied Water requirements based on the distribution of dry, normal (typical), and wet years developed in the twenty-year period of record 1990/1991-2009/2010. This period of record is thought to be the best representation of current conditions, which reflect a slightly dryer climate than the 50-year record. The estimated effects of climate change are incorporated in the above projections and those that follow in the companion tables.

Tables 2.3.1a(1-3), b(1-3) and c(1-3)
Development of the 20-Year Average ET and Applied Water Requirements for Years 2020, 2040, and 2070

Year 2020

Table 2.3.1a(1)

TRI-COUNTY GSA - NORTH & SOUTHEAST AREAS COMBINED					
Tule Subbasin - North and Southeast Groundwater Management Areas Combined - 2017/18 Cropping Pattern - 2020					
Combined North & Southeast Groundwater Areas - 2020	**Dry Year Conditions**	**Normal Year Conditions**	**Wet Year Conditions**	**Results -20 Year Analysis Based on 2017/18 Cropping Pattern**	
Approximate Gross Acreage in Management Area	61,400 Acres	61,400 Acres	61,400 Acres		
Farmed Area	29,000 Acres	29,000 Acres	29,000 Acres		
Et Requirement	72,000 Acre-feet	74,400 Acre-feet	79,500 Acre-feet	**Average Et Reqmt.:**	**74,300 AFY**
Applied Water Requirement	86,600 Acre-feet	89,400 Acre-feet	95,700 Acre-feet	**Average Applied Water Reqmt.:**	**89,300 AFY**

Reference: Appendix Tables A-4a(1-3).

Table 2.3.1a(2)

TRI-COUNTY GSA - NORTH AREA					
Tule Subbasin - North Groundwater Management Area Groundwater Demand - 2017/18 Cropping Pattern - 2020					
North Groundwater Management Area - 2020	**Dry Year Conditions**	**Normal Year Conditions**	**Wet Year Conditions**	**Results - 20 Year Analysis Based on 2017/18 Cropping Pattern**	
Approximate Gross Acreage in Management Area	12,100 Acres	12,100 Acres	12,100 Acres		
Farmed Area	6,000 Acres	6,000 Acres	6,000 Acres		
Et Requirement	13,100 Acre-feet	13,600 Acre-feet	14,800 Acre-feet	**Average Et Reqmt.:**	**13,600 AFY**
Applied Water Requirement[2]	19,600 Acre-feet	20,300 Acre-feet	22,100 Acre-feet	**Average Applied Water Reqmt.:**	**20,300 AFY**

Reference: Appendix Tables A-4a(1-3).

Table 2.3.1a(3)

TRI-COUNTY GSA - SOUTHEAST AREA					
Tule Subbasin Southeast Groundwater Area Groundwater Demand - 2017/18 Cropping Pattern - 2020					
Southeast Groundwater Management Area - 2020	**Dry Year Conditions**	**Normal Year Conditions**	**Wet Year Conditions**	**Results - 20 Year Analysis Based on 2017/18 Cropping Pattern**	
Approximate Gross Acreage in Management Area	49,300 Acres	49,300 Acres	49,300 Acres		
Farmed Area	23,000 Acres	23,000 Acres	23,000 Acres		
Et Requirement	58,900 Acre-feet	60,800 Acre-feet	64,700 Acre-feet	**Average Et Reqmt.:**	**60,700 AFY**
Applied Water Requirement	67,000 Acre-feet	69,100 Acre-feet	73,600 Acre-feet	**Average Applied Water Reqmt.:**	**69,000 AFY**

Reference: Appendix Tables A-4a(1-3).

Year 2040

Table 2.3.1b(1)

TRI-COUNTY GSA - NORTH & SOUTHEAST AREAS COMBINED				
Tule Subbasin - North and Southeast Groundwater Management Areas Combined - 2017/18 Cropping Pattern - 2040				
Combined North & Southeast Groundwater Areas - 2040	**Dry Year Conditions**	**Normal Year Conditions**	**Wet Year Conditions**	**Results -20 Year Analysis Based on 2017/18 Cropping Pattern**
Approximate Gross Acreage in Management Area	61,400 Acres	61,400 Acres	61,400 Acres	
Farmed Area	29,000 Acres	29,000 Acres	29,000 Acres	
Et Requirement	74,700 Acre-feet	77,200 Acre-feet	82,500 Acre-feet	**Average Et Reqmt.: 77,100 AFY**
Applied Water Requirement	89,800 Acre-feet	92,900 Acre-feet	99,300 Acre-feet	**Average Applied Water Reqmt.: 92,800 AFY**

Reference: Appendix Tables A-4b(1-3).

Table 2.3.1b(2)

TRI-COUNTY GSA - NORTH AREA				
Tule Subbasin - North Groundwater Management Area Groundwater Demand - 2017/18 Cropping Pattern - 2040				
North Groundwater Management Area - 2040	**Dry Year Conditions**	**Normal Year Conditions**	**Wet Year Conditions**	**Results - 20 Year Analysis Based on 2017/18 Cropping Pattern**
Approximate Gross Acreage in Management Area	12,100 Acres	12,100 Acres	12,100 Acres	
Farmed Area	6,000 Acres	6,000 Acres	6,000 Acres	
Et Requirement	13,600 Acre-feet	14,100 Acre-feet	15,400 Acre-feet	**Average Et Reqmt.: 14,100 AFY**
Applied Water Requirement[2]	20,300 Acre-feet	21,100 Acre-feet	22,900 Acre-feet	**Average Applied Water Reqmt.: 21,100 AFY**

Reference: Appendix Tables A-4b(1-3).

Table 2.3.1b(3)

TRI-COUNTY GSA - SOUTHEAST AREA				
Tule Subbasin Southeast Groundwater Area Groundwater Demand - 2017/18 Cropping Pattern - 2040				
Southeast Groundwater Management Area - 2040	**Dry Year Conditions**	**Normal Year Conditions**	**Wet Year Conditions**	**Results - 20 Year Analysis Based on 2017/18 Cropping Pattern**
Approximate Gross Acreage in Management Area	49,300 Acres	49,300 Acres	49,300 Acres	
Farmed Area	23,000 Acres	23,000 Acres	23,000 Acres	
Et Requirement	61,100 Acre-feet	63,100 Acre-feet	67,100 Acre-feet	**Average Et Reqmt.: 63,000 AFY**
Applied Water Requirement	69,500 Acre-feet	71,800 Acre-feet	76,400 Acre-feet	**Average Applied Water Reqmt.: 71,700 AFY**

Reference: Appendix Tables A-4b(1-3).

Year 2070

Table 2.3.1c(1)

TRI-COUNTY GSA - NORTH & SOUTHEAST AREAS COMBINED				
Tule Subbasin - North and Southeast Groundwater Management Areas Combined - 2017/18 Cropping Pattern - 2070				
Combined North & Southeast Groundwater Areas - 2070	**Dry Year Conditions**	**Normal Year Conditions**	**Wet Year Conditions**	**Results -20 Year Analysis Based on 2017/18 Cropping Pattern**
Approximate Gross Acreage in Management Area	61,400 Acres	61,400 Acres	61,400 Acres	
Farmed Area	29,000 Acres	29,000 Acres	29,000 Acres	
Et Requirement	76,300 Acre-feet	78,800 Acre-feet	84,300 Acre-feet	**Average Et Reqmt.: 78,700 AFY**
Applied Water Requirement	91,800 Acre-feet	94,800 Acre-feet	101,400 Acre-feet	**Average Applied Water Reqmt.: 94,700 AFY**

Reference: Appendix Tables A-4c(1-3).

Table 2.3.1c(2)

TRI-COUNTY GSA - NORTH AREA				
Tule Subbasin - North Groundwater Management Area Groundwater Demand - 2017/18 Cropping Pattern - 2070				
North Groundwater Management Area - 2070	**Dry Year Conditions**	**Normal Year Conditions**	**Wet Year Conditions**	**Results - 20 Year Analysis Based on 2017/18 Cropping Pattern**
Approximate Gross Acreage in Management Area	12,100 Acres	12,100 Acres	12,100 Acres	
Farmed Area	6,000 Acres	6,000 Acres	6,000 Acres	
Et Requirement	13,900 Acre-feet	14,400 Acre-feet	15,700 Acre-feet	**Average Et Reqmt.: 14,400 AFY**
Applied Water Requirement[2]	20,800 Acre-feet	21,500 Acre-feet	23,400 Acre-feet	**Average Applied Water Reqmt.: 21,500 AFY**

Reference: Appendix Tables A-4c(1-3).

Table 2.3.1c(3)

TRI-COUNTY GSA - SOUTHEAST AREA				
Tule Subbasin Southeast Groundwater Area Groundwater Demand - 2017/18 Cropping Pattern - 2070				
Southeast Groundwater Management Area - 2070	**Dry Year Conditions**	**Normal Year Conditions**	**Wet Year Conditions**	**Results - 20 Year Analysis Based on 2017/18 Cropping Pattern**
Approximate Gross Acreage in Management Area	49,300 Acres	49,300 Acres	49,300 Acres	
Farmed Area	23,000 Acres	23,000 Acres	23,000 Acres	
Et Requirement	62,400 Acre-feet	64,400 Acre-feet	68,600 Acre-feet	**Average Et Reqmt.: 64,300 AFY**
Applied Water Requirement	71,000 Acre-feet	73,300 Acre-feet	78,000 Acre-feet	**Average Applied Water Reqmt.: 73,200 AFY**

Reference: Appendix Tables A-4c(1-3).

2.3.2 SURFACE WATER INFLOWS & OUTFLOWS [§354.18(b)(1)]

Angiola Water District Water Supplies

Table A-4 in Appendix A-4 is a 45-year record of AWD Water Deliveries. AWD has multiple water sources, among them are: The State Water Project (SWP), Kings River, Tule River, Deer Creek, Flood Water, Purchased Local Water, Other Water, and Groundwater. Total water deliveries averaged 39,000 afy for the 45-year period. The year 2003 is pivotal because the AWD marketed its SWP entitlement of Table A water that year. AWD has since relied on available SWP water and its other water sources to meet its water delivery obligations in its service area. AWD serves lands in the Tule Subbasin and the Tulare Lake Subbasin.

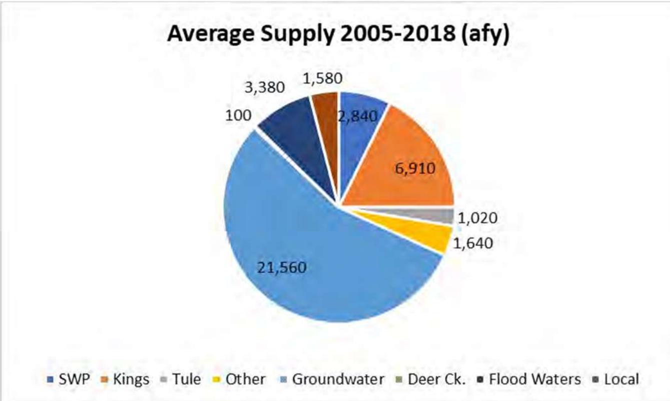
An inspection of the table shows that the AWD total water supply from all sources averaged about 39,000 acre-feet per year for both the 30-year period from 1974 – 2003 and the 15-year period from 2004-2018, the loss of surface water being made up by increased groundwater pumping. AWD exports surface water and groundwater. It is estimated that 13,000 acre-feet of groundwater pumping is exported from the GSA in about 80% of the years. Groundwater pumping from 1974 through 2003 averaged 11,900 acre-feet per year and increased to an average 21,900 per year from 2004 through 2018.

AWD's surface water supplies from all sources for the years 2004 -2018 averaged 14,100 acre-feet per year, excluding flood waters. AWD captures flood waters and transports them to irrigated lands within AWD through its system of canals and ditches. Flood waters averaged about 3,400 acre-feet per year for the years 2004-2018. The total average surface water supply, including flood waters is therefore about 17,500 acre-feet per year. It is estimated that 75% of this water is exported from the GSA, which amounts to exports of about 13,000 acre-feet per year. 25% of this supply, or about 4,500 afy are supplied to lands in the North Area. This results in a total estimated exported volume of 26,000 acre-feet per year in years of typical and dry water supply conditions. AWD has stated that there are no exports in wet years.

The Southeast Management Area receives no surface water supplies. It is totally dependent on groundwater.

The following water supply information is available from AWD. See the Table 2.3.2 below.

FIGURE 2.3.3



From 2005 through 2018, Angiola Water District imported an average of 6,900 afy from water rights it had from in the Kings River, and about 1,000 afy from the Tule River. Other sources of surface water for the District have included: SWP Article 21 water, flood water, and other surface water purchased locally. Deer Creek is an occasional source of water when excess water is available. From 2005 through 2018 these combined supplies have averaged 17,500 afy. Groundwater pumped from District wells averaged 21,500 afy, for a total AWD annual average water supply of 39,000 afy. AWD pumpage amounted to about 55% of the AWD water supply.

Table 2.3.2

Angiola Water District

Historical Water Deliveries (Acre-Feet)

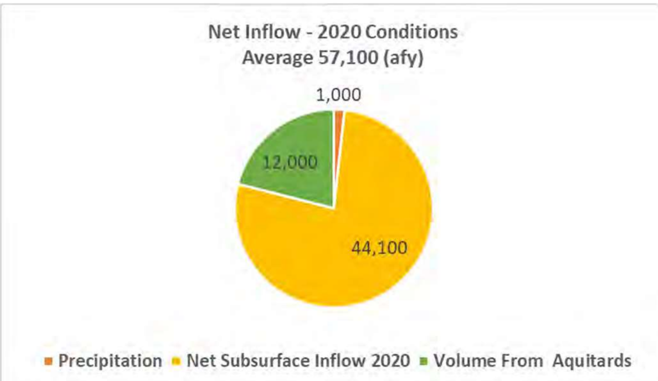
Angiola Water District 2004-2018 Water Supplies[1]												
Year	**State Water Project**			**Tule River**	**Kings River[2]**	**Other**	**Flood**	**Local**	**Deer Ck.**	**Total Surface Sources**	**AWD District Pumpage**	**Total Supply**
.	Total	Table A	Article 21	Total	Total	Total	Total	Total	Total	Total	Total	Total
2004	1,787	1,293	494	559	0	5,293	0	4,657	0	12,296	26805	39,101
2005	13,047	564	12,483	1,680	10,632	1,235	5,890	15,954	0	48,438	662	49,100
2006	11,289	614	10,675	795	14,253	0	7,973	6,134	0	40,444	141	40,585
2007	5,124	243	4,881	0	18,083	63	0	0	0	23,270	32,894	56,164
2008	762	761	1	828	4,756	0	0	0	0	6,346	32,502	38,848
2009	35	34	1	0	0	0	0	0	0	35	37,798	37,833
2010	13	12	1	1,676	10,587	282	0	0	0	12,558	22,568	35,126
2011	1,835	1,835	0	1,170	14,383	434	10,011	0	1,516	29,349	3,615	32,964
2012	1,413	1,413	0	271	4,326	1,760	0	0	0	7,770	33,097	40,867
2013	1,080	1,080	0	0	0	4,912	0	0	0	5,992	30,603	36,595
2014	0	0	0	0	0	3,174	0	0	0	3,174	27,783	30,957
2015	0	0	0	0	0	2,439	0	0	0	2,439	30,220	32,659
2016	0	0	0	252	0	1,710	0	0	0	1,962	29,036	30,998
2017	3,849	3,849	0	6,908	13,182	0	23,457	0	0	47,396	2,750	50,146
2018	1,300	1,300	0	714	6,596	6,921	0	0	0	15,531	18,193	33,724
Total	41,534	12,998	28,536	14,853	96,798	28,223	47,331	26,745	1,516	257,000	328,667	585,667
Average	2,769	867	1,902	990	6,453	1,882	3,155	1,783	101	17,133	21,911	39,044

1. Source: Angiola Water District Records.
2. AWD's holdings as a Kings River Water Member Unit are used in the Tulare Lake Subbasin in lieu of pumping in the Tule Subbasin.

2.3.3 GROUNDWATER INFLOWS & OUTFLOWS [§354.18(b)(2)(3)]

20-YEAR PROJECTION: 2020-2040

FIGURE 2.3.4



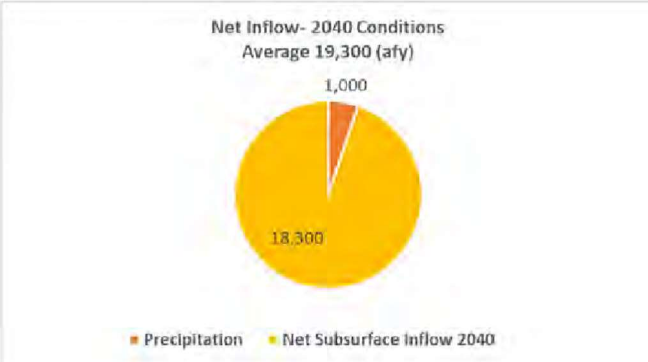
Draft Table E-2 by Thomas Harder & Co., "Tri-County Water Authority GSA Groundwater Budget 1986/87 to 2016/17" estimates that the average Sub-Surface Inflow was 112,000 acre-feet per year ("afy"). Average subsurface outflow was 71,000 afy. The net subsurface inflow to TCWA GSA was therefore 41,000 afy. Work by Ken Schmidt and Associates estimates the total net groundwater inflow into TCWA is 44,100 afy, which is in close agreement with the Harder estimate. Of this 44,100 afy 25,800 afy is considered to be "induced" groundwater flow, or flow that is due to pumping activity, leaving 18,300 afy as the "pre-development" groundwater flow (the amount of groundwater flow that is considered sustainable). Of the 44,100 afy that flows into TCWA, 24,700 afy flows to the North Management Area and 19,400 afy flows to the Southeast Management Area. Of these amounts, 12,400 afy groundwater inflow to the North Area is considered induced and 12,300 afy is considered pre-development. For the Southeast Area, of the 19,400 afy inflow, 13,700 afy is considered induced and 6,000 afy pre-development flow. The KDSA Memorandum Report is included in Appendix A-7. The applicable table (Table A-2) from the Harder report is included in Appendix A-2a.

The net water volume gain from the compression of aquitards was estimated by Harder to be 12,000 afy – a number that Ken Schmidt is in agreement with. This "inflow" is proportioned by area – resulting in 2,400 afy inflow to the North Area and 9,600 afy inflow to the Southeast Area.

A minor amount of precipitation (1,000 afy) is also included in the budget, bringing the total 2020 "inflow" to 54,000 afy (Harder) or 57,100 afy (Schmidt).

The net subsurface inflow estimate by Schmidt is used in the TCWA draft water budget, divided between the North Management Area and the Southeast Management Area. Only the pre-development amounts of groundwater flow (12,300 afy for the North Area and 6,000 afy for the Southeast Area) are used for the "sustainable yield" determination.

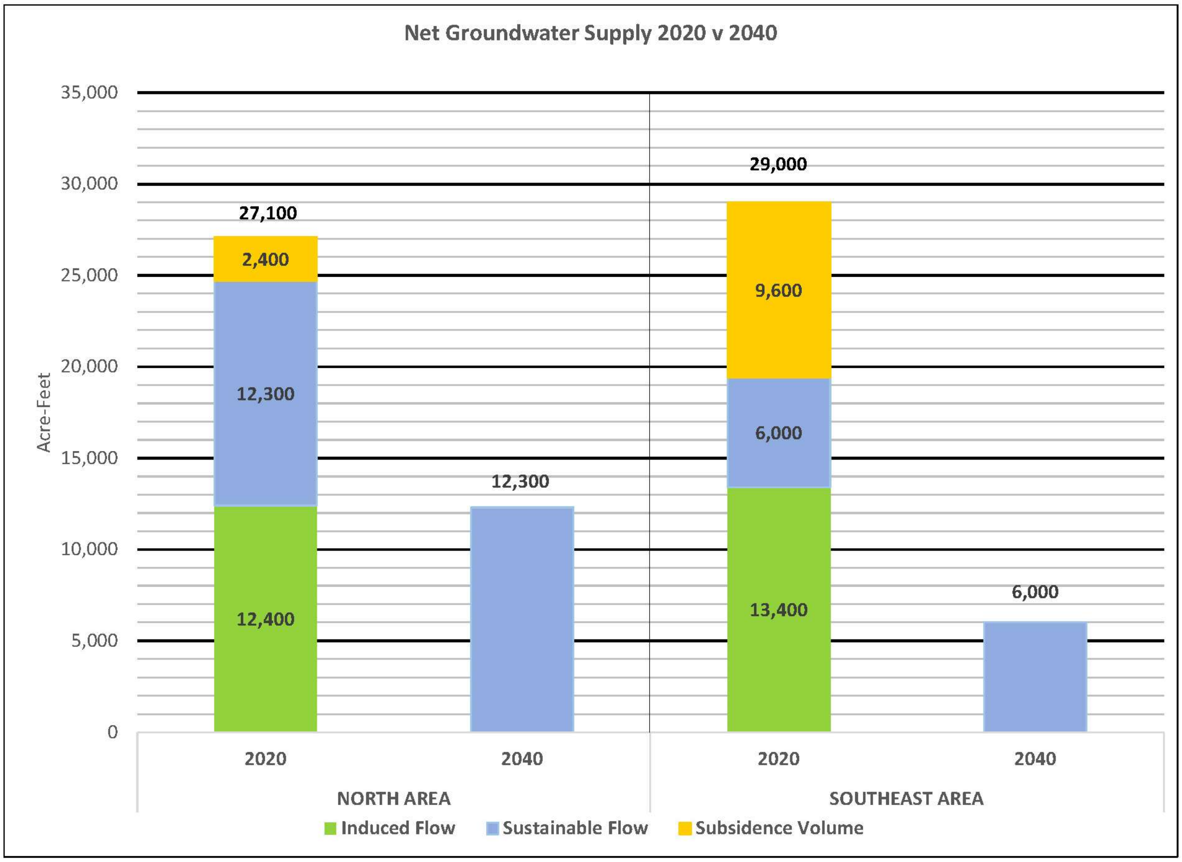
FIGURE 2.3.5



The objectives of this Plan are to improve groundwater conditions and reduce land subsidence while preserving as much agricultural productivity as possible. It is proposed to reduce the subsurface inflow over the next 20 years from 44,000 afy to 18,300 afy. Annual net water volume gain from the compression of aquitards is planned to be reduced to zero. This is to be accomplished by the combination of reducing groundwater extractions and replacing a number of deep wells with new shallow wells – moving a portion of the groundwater production from the lower aquifer to the upper aquifer, by idling croplands and by proposed increases in surface water supplies.

The following chart depicts the situation for each of the GSA's Management Areas with the planned corrective actions that will be taken over the next ten - twenty years. The net subsurface inflow for the North Management Area is predicted to decrease from 24,700 afy to 12,300 afy and the volume of water extracted from compression of aquitards is predicted to decrease from 2,400 afy to zero, a total reduction of 14,800 afy. The net subsurface inflow for the Southeast Management Area is predicted to decrease from 19,400 afy to 6,000 afy, and the volume of water extracted from compression of aquitards is projected to decreased from 9,600 afy to zero, a total decrease of 23,000 afy. This is planned to be achieved with pumping reductions and development of surface water supplies. Therefore, for TCWA, the total decrease in the volume of water from subsurface inflow is 25,800 afy (from 44,100 afy to 18,300 afy) and the total decrease in volume of water extracted from aquitards is 12,000 afy (from 12,000 afy to 0 afy), a total reduction of 37,800 afy.

Chart 2.3.3



2.3.4 FLUCTUATIONS IN ANNUAL GROUNDWATER STORAGE [§354.18(b)(4)(6)]

Section 2.2.2 addresses estimated fluctuations in groundwater storage in the North Management Area and the Southeast Management Area. Figure 2.2.12 "Annual Change in Storage (Unconfined) – North Area" shows changes in storage for the period 1990 – 2009. Figure 2.2.13 "Annual Change in Storage (Unconfined) – Southeast Area" shows annual changes in storage for the period 1988 – 2007.

2.3.5 WATER BUDGET REQUIREMENTS DURING OVERDRAFT CONDITIONS [§354.18(b)(5)]

California's recent drought from late 2011 through the first quarter of 2017, was one of the driest periods in California's history. The period from 2011 through 2014 being the driest in California's history. Inspection of Table 2.3.2 shows the effects of the drought on AWD' water supply and the reliance of AWD on groundwater during periods of drought. In the years 2004-2011, prior to the drought groundwater averaged about 50% of the District's supply, but during the drought period 2012-2016, groundwater averaged 90% of the District's supply.

North Area
During periods of extended drought, the District, and hence the North Area's groundwater supply amounts to about 90% of the total supply. In normal years the District's water supply is about 50% groundwater.

Southeast Area
The Southeast Area is totally dependent on groundwater. Currently there is not a surface water supply for this area. Therefore 100% of its water requirements are met by groundwater pumpage.

2.3.6 WATER YEAR TYPE [§354.18(b)(6)]

Tables A-4 (Appendix A-4), discussed previously (Section 2.3.1, p. 80), are based on water year conditions defined as "Dry", "Wet" and "Normal" (or "Typical") based on the analysis of the rainfall on the Valley floor, first looking at the 91-year record for the Porterville weather station and then at the 20-year period from 1991-2010 for Porterville along with two additional weather stations that span the valley floor area that contains TCWA (Stratford and Shafter CIMIS Stations). Also reviewed were the flows in the Tule River for the Tule Subbasin (Tule Subbasin HCM – Harder), determinations of water year types by Wood based on flows in the Kings River, together with a review of water year hydrologic classification indices developed by the DWR for the San Joaquin Valley ("WSIHIST" Water Year Hydrologic Classification Indices - runoff Tabulations are included in Appendix A-3b) – which, for the San Joaquin Valley, considers runoff from the Stanislaus, Tuolumne, Merced, and San Joaquin Rivers. The percentage of "Dry" years varies from 45% for the San Joaquin River, to 50% for the Kings River, to 60% for the Tule River. Likewise, the percentage of "Normal" years varies from 20% (San Joaquin and Kings Rivers) to 25% for the Tule River, and the percentage of "Wet" years varies from 35% for the San Joaquin River to 30% for the Kings River, to 15% for the Tule River. For this water balance, due to the methodology used to calculate crop water demands, which involved development of ET values based on ITRC crop ET information (previously discussed) it was decided that the best indicator for determining water year Types is rainfall on the Valley floor – as the weather pattern on the Valley floor determines crop water requirements. Year types for surface water supply frequencies were determined from the Wood tabulation.

Percentages used for water year Types for ET determination were: 32% Dry, 55% Typical, and 13% Wet. The "cut" line for this determination was: "Dry" years = 75% or less of the 20-year annual average rainfall and "Wet" years = 150% or greater of the 20-year annual average rainfall.

A comparison of ET calculations was made using the Type year determinations for the Kings River by Wood for the Tulare Lake Subbasin (44% Dry, 26% Typical, and 30% Wet) and the 20-Year averages are comparable: ET requirements of 74,800 afy (Wood – Kings River) compared to 74,300 afy (based on precipitation).

2.3.7 SUSTAINABLE YIELD [§354.18(b)(7)]

Table 2.3.7 shows the current sustainable yield calculation for the TCWA GSA. The components that are considered are: Average Precipitation, Net Subsurface Inflow, and Aquitard Compression. The goals of this Plan include elimination of chronic lowering of groundwater levels and chronic reductions in groundwater storage by reducing groundwater pumpage and reducing subsidence by decreasing groundwater pumpage from the lower aquifer. This will be achieved through procuring additional surface water supplies and reducing cropped acreage as required. Currently there is a net groundwater inflow of 44,100 afy from areas adjacent to the GSA. Additionally, compression of aquitards creates a release of 12,000 afy from fine-grained deposits beneath the GSA. Precipitation adds a minor amount of recharge in wet years, amounting to an average 1,000 afy. Therefore, the net groundwater inflow is 57,100 afy. The situation is not sustainable. Subsurface inflow affects neighboring GSAs negatively and must be reduced. Land subsidence must also be reduced. The groundwater pumpage goals of this Plan are to reduce net subsurface inflow to 18,300 afy (a 68% reduction), and reduce water volume from compression of aquitards to zero (a 100% reduction). Accomplishing this reduces the water available for groundwater pumpage to 19,300 afy.

Sustainable Yield is 19,300 afy.

Table 2.3.7

Sustainable Yield			
	North Area Inflow	SE Area Inflow	TCWA Total Inflow
Subsurface Inflow	12,300	6,000	18,300
Aquitard Compression	0	0	0
Excess Rainfall	200	800	1,000
Totals	**12,500**	**6,800**	**19,300**
Sustainable Yield = 19,300 afy			

§354.18 Water Budget

c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:

1) Current water budget information shall quantify current inflows and outflows for the basin using the most recent hydrology, water supply, water demand, and land use information.

2) Historical water budget information shall be used to evaluate availability or reliability of past surface water supply deliveries and aquifer response to water supply and demand trends relative to water year type. The historical water budget shall include the following:

A) A quantitative evaluation of the availability or reliability of historical surface water supply deliveries as a function of the historical planned versus actual annual surface water deliveries, by surface water source and water year type, and based on the most recent ten years of surface water supply information.

B) A quantitative assessment of the historical water budget, starting with the most recently available information and extending back a minimum of 10 years, or as is sufficient to calibrate and reduce the uncertainty of the tools and methods used to estimate and project future water budget information and future aquifer response to proposed sustainable groundwater management practices over the planning and implementation horizon.

C) A description of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability of the Agency to operate the basin within sustainable yield. Basin hydrology may be characterized and evaluated using water year type.

2.3.8 WATER BUDGET [§354.18(c)(1)]

The following Table 2.3.8 is a summary of Groundwater Balances based on Tables A-1a through A-1e in Appendix A-1a, which develop the No-Project Groundwater Balances for the Years 2020, 2040 and 2070. The values generated from Tables 2.3.8a(1) – 8a(3); Table 2.3.8b(1) – 8b(3); and Tables 2.3.8c(1) – 8c(3) are used to develop the information that appears in Tables 2.3.8a – Year 2020; 2.3.8b - Year 2040, and 2.3.8c – Year 2070. Totals for the GSA are a combination of the totals for the North and Southeast Management Areas.

Domestic water use is minimal in the GSA. Allensworth and West of Earlimart in the Southeast Area are the only extensively developed residential areas. Allensworth has a community services district that operates a public water system. West of Earlimart is a county area that is developed entirely on individual private wells. Together it is estimated that the net domestic use of these areas, together with scattered farmsteads, consume about 200 afy. There are scattered domestic wells in the North Area as well. It is estimated that the new domestic water use in the North Area is 100 afy. Therefore, the total estimated domestic water use in the GSA is 300 afy. Domestic water use is a data gap that will be filled during the first five years of operation of the TCWA GSP. A 3% annual growth factor was applied to the domestic water use volumes to estimate the 2040 and 2070 amounts.

Table 2.3.8

Tri-County Water Authority

Summary of Groundwater Balance Tabulations

Results of Twenty-Year Study Periods for Years 2020, 2040 and 2070 - No Project Conditions

A	B	C	D	E	F	G	H	I	J
Management Area	**Farmed Acreage[1]**	**Crop Water Requirement (Etc)[2] (af)**	**Surface Water Contribution to Et Requirement[3] (af)**	**Rainfall Contribution to Groundwater[4] (af)**	**Net Subsurface Inflow into the GSA[5] (af)**	**Net Inflow from Compression of Aquitards[6] (af)**	**Estimated Net Municipal and Domestic Water Use[7] (af)**	**Groundwater Extractions Exported from the GSA[8] (af)**	**Net Change in Groundwater Storage in Upper Aquifer[9] (af)**
2.3.8a									
YEAR 2020									
Total for TCWA	29,000	74,300	3,200	900	44,100	12,000	300	9,100	**-23,500**
North Management Area	6,000	13,600	3,200	200	24,700	2,400	100	9,100	**7,700**
SE Management Area	23,000	60,700	0	700	19,400	9,600	200	0	**-31,200**
2.3.8b									
YEAR 2040									
Total for TCWA in Tule Subb	29,000	77,100	3,100	900	18,300	0	600	9,100	**-64,500**
North Management Area	6,000	14,100	3,100	200	12,300	0	200	9,100	**-7,800**
SE Management Area	23,000	63,000	0	700	6,000	0	400	0	**-56,700**
2.3.8c									
YEAR 2070									
Total for TCWA	29,000	79,400	3,000	900	18,300	0	1,000	9,100	**-67,300**
North Management Area	6,000	14,600	3,000	200	12,300	0	400	9,100	**-8,600**
SE Management Area	23,000	64,800	0	700	6,000	0	600	0	**-58,700**

Notes

ET year type based on precipitation ratios, surface water year type based on Tule Subbasin rainfall year types.

1. Farmed acreage from 2017/18 Draft Water Balance, Ref. Appendix Tables A-1 (a), (b), and (c).
2. Crop water requirement from Appendix Tables A-1(a), (b), and (c), which develop the 20-year average based on the proportion of Wet, Dry and Typical Years in the 20-year period.
3. The surface water contribution is an estimate based on the historical surface water deliveries to Angiola Water District, reduced for clmate change effects.
4. Rainfall contribution to groundwater estimated to be minimal.
5. Net subsurface inflow is estimated to be 44,100 afy for TCWA GSA. The portion attributed to the North Area is 24,700 afy and 19,400 afy is attributed to the SE Area.
   Net Subsurface Inflow varies from year-to year depending on aquifer conditions both internal and external to TCWA, Therefore, the 20-Year Average is used in the gw storage determination.
   Net subsurface inflow is reduced from 44,100 afy in 2020 to 18,300 afy by 2040.
6. The current net gain from compression of aquitards is estimated to be 12,000 afy for TCWA GSA. The gain estimated for the North Area is 2,400 afy and 9,600 afy for the SE Area.
   The average is used herein. See Note 5.
7. Estimated Allensworth and West of Earlimart net domestic water use is 200 afy. Domestic water use estimated to be 100 afy for North Area. Number of actual farmsteads will be tallied over the next five years.
   Estimated domestic water use growth rate = 3% annually.
8. Water is not exported in wet years.
9. The Net Change in GW Storage reflects the net change in storage ascribed to the upper aquifer. This is also a 20--year average. Values are rounded to the nearest 100 af.
10. Habitat preservation will be addressed as more information is developed regarding habitat needs.

Note that groundwater storage in the Upper Aquifer decreases from 2020 to 2040. This is with the No Project (no projects or management actions) condition. That is – the cropping pattern remains unchanged from the present and no corrective actions are taken. This develops the impacts on groundwater storage in future years if no corrective action is taken. Note that in Tables 2.3.8 the major change in the operation of the GSA is the decrease in the amounts in Columns F and G. These two columns represent the net inflow into the GSA from neighboring GSAs and the volumetric gain to the aquifer from the compression of the aquitards due to pumping from below them. Both of these volumes will be decreased over the 20-Year time period with the implementation of projects and management actions. The net inflow from aquitards will be reduced to zero.

2.3.8.1 CURRENT WATER BUDGET [§354.18(c)(1)]

YEAR 2020

There is an average net change in groundwater storage of 7,700 acre-feet gain per year (afy) in the North Area and 31,200 acre-feet per year loss in the Southeast Area. (Table 2.3.8a). Both areas benefit from net inflow of groundwater from outside the GSA, however, the North Area takes the majority of the 44,100 afy net inflow with a 24,700 afy benefit (see KDSA Memorandum Report, Appendix A-7). Future groundwater studies may change these volumes. This is also the case with the water volume released from the compression of aquitards, with the Southeast Area taking 9,600 afy of the estimated 12,000 afy of water released (see Figure 2.3.8-A). This Figure also depicts the current water demands with the reduction of net groundwater inflow from 44,100 afy to 18,300 afy and reduction of net water released from the compression of aquitards from 12,000 afy to 0 afy. The result is sustainable yield of 18,300 afy from these sources. Rainfall contribution is estimated to be 1,000 afy, bringing the sustainable yield to 19,300 afy.

Following Chart 2.8.1 are copies of Table 2.3.8 and Tables 2.3.8a(1-3).

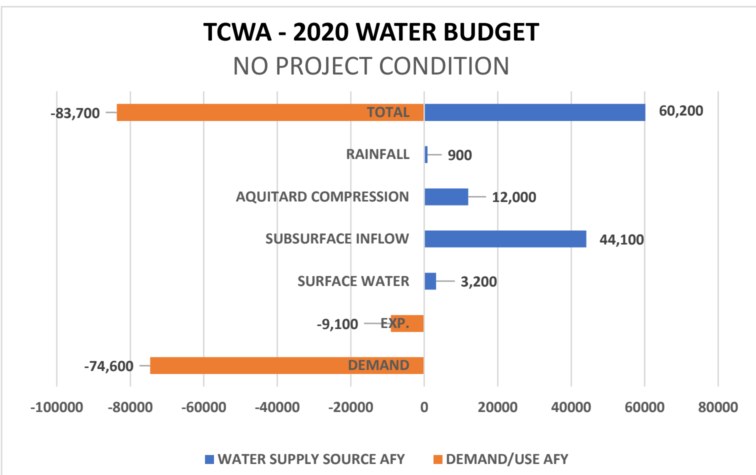
2020 NO PROJECT CONDITION

TCWA PORTION OF THE TULE SUBBASIN

GROSS LAND ACRES = 61,400 ACRES
IRRIGATED AREA = 29,000 ACRES

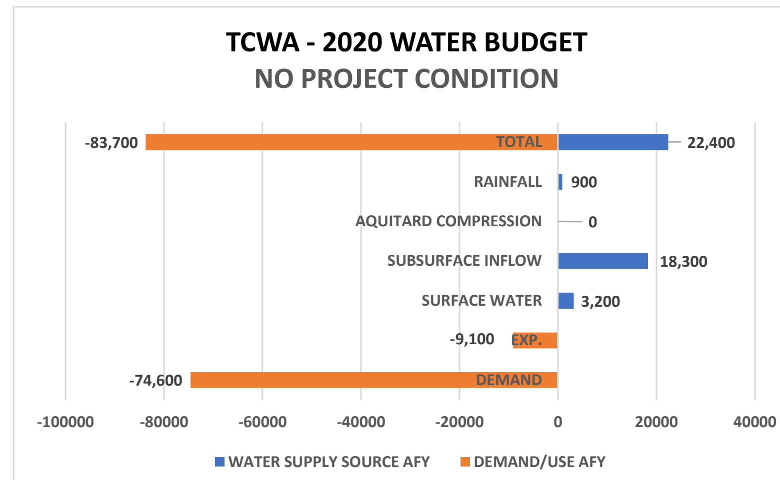
NET SUBSURFACE INFLOW & COMPRESSION OF AQUITARDS AT CURRENT LEVEL OF 56,100 AFY

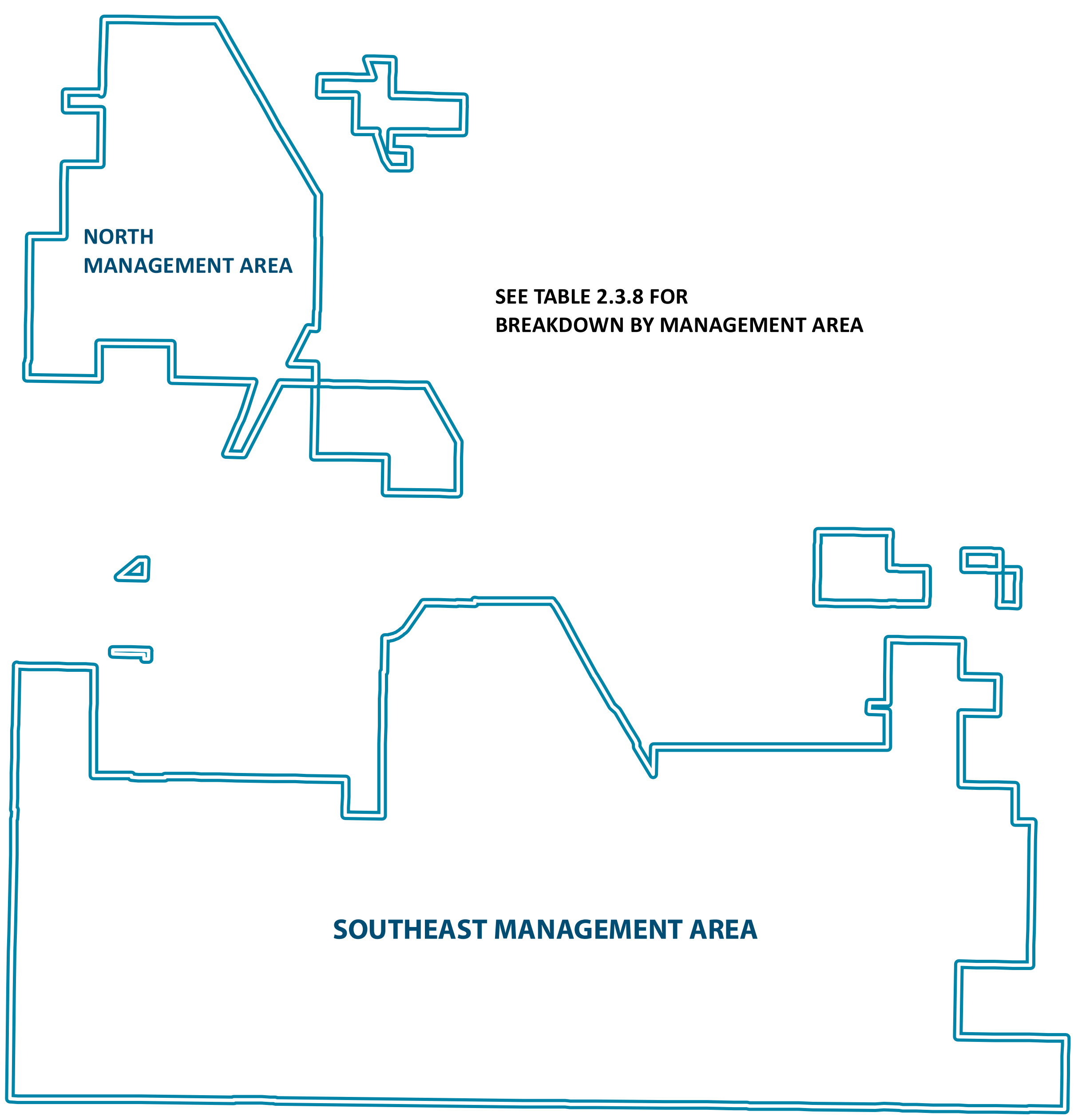
GROUNDWATER DEFICIT = 23,500 AFY



NET SUBSURFACE INFLOW & COMPRESSION OF AQUITARDS AT SUSTAINABLE LEVEL OF 18,300 AFY

GROUNDWATER DEFICIT = 61,300 AFY





TCWA GSA FOCUS AREA - TULE PORTION

KDSA Est. 1972
svb south valley biology consulting llc
TRI-COUNTY WATER AUTHORITY

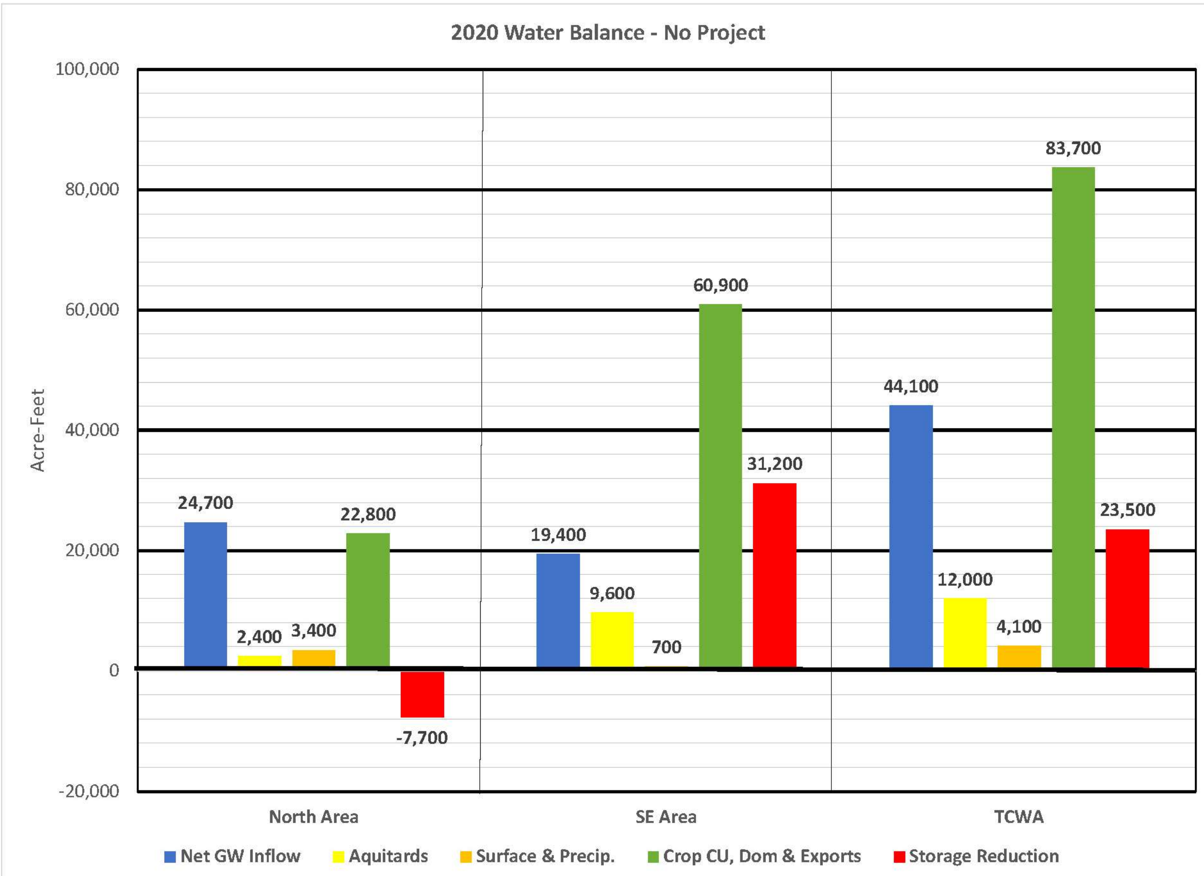
TRI-COUNTY GSP
TCWA - NORTH & SE AREAS
WATER BUDGET - 2020 CONDITIONS

0 0.5 1 2
MILES
N

PROJECT NUMBER	FIGURE
DJ19-01	2.3.8-A

SOURCE(S): CA DEPT. OF WATER RESOURCES/TRI-COUNTY WATER AUTHORITY/KDSA/DJA

Chart 2.8.1



The following Tables 2.3.8a(1-3) develop the net groundwater demand for the cropping patterns for the current conditions for TCWA. The effects of subsurface inflow and aquitard compression are not included in Tables 2.3.8a(1-3). However, the contributions from surface water deliveries and rainfall are included. Table 2.3.8a accounts for the effects of subsurface inflow and aquitard compression. These are source tables for Table 2.3.8a.

YEAR 2020

Table 2.3.8a
Tri-County Water Authority
Summary of Groundwater Balance Tabulations
Results of Twenty-Year Study Periods for Year 2020 - No Project Conditions

A	B	C	D	E	F	G	H	I	J
Management Area	**Farmed Acreage[1]**	**Crop Water Requirement (Etc)[2] (af)**	**Surface Water Contribution to Et Requirement[3] (af)**	**Rainfall Contribution to Groundwater[4] (af)**	**Net Subsurface Inflow into the GSA[5] (af)**	**Net Inflow from Compression of Aquitards[6] (af)**	**Estimated Net Municipal and Domestic Water Use[7] (af)**	**Groundwater Extractions Exported from the GSA[8] (af)**	**Net Change in Groundwater Storage in Upper Aquifer[9] (af)**
YEAR 2020									
Total for TCWA	29,000	74,300	3,200	900	44,100	12,000	300	9,100	**-23,500**
North Management Area	6,000	13,600	3,200	200	24,700	2,400	100	9,100	**7,700**
SE Management Area	23,000	60,700	0	700	19,400	9,600	200	0	**-31,200**

Reference: See Table 2.3.8 for footnotes

Table 2.3.8a(1)

TRI-COUNTY GSA					
Tri-County GSA Groundwater Demand - 2017/18 Cropping Pattern - TULE SUBBASIN PORTION OF TCWA - 2020					
2020 Combined North & Southeast Groundwater Areas	Dry Year Conditions	Normal Year Conditions	Wet Year Conditions	Results -20 Year Analysis Based on 2017/18 Cropping Pattern	
Approximate Gross Acreage in Management Area	61,400 Acres	61,400 Acres	61,400 Acres		
Farmed Area	29,000 Acres	29,000 Acres	29,000 Acres		
Et Requirement	72,000 Acre-feet	74,400 Acre-feet	79,500 Acre-feet	**Average Et Reqmt.:**	**74,300 AFY**
Applied Water Requirement	86,600 Acre-feet	89,400 Acre-feet	95,700 Acre-feet	**Average Applied Water Reqmt.:**	**89,300 AFY**
Surface Water Deliveries[1]	0 Acre-feet	1,800 Acre-feet	9,100 Acre-feet	**Average Surface Water Deliveries:**	**2,200 AFY**
Groundwater Requirement	86,600 Acre-feet	87,600 Acre-feet	86,600 Acre-feet	**Average Ground Water Reqmt.:**	**87,100 AFY**
Applied Water Return Flow[2]	14,600 Acre-feet	15,000 Acre-feet	16,200 Acre-feet	**Average Applied Water Return Flow:**	**15,000 AFY**
Net Groundwater Extractions	72,000 Acre-feet	72,600 Acre-feet	70,400 Acre-feet	**Average Net Groundwater Extractions:**	**72,100 AFY**
Areal Recharge from Precipitation[3]	0 Acre-feet	0 Acre-feet	3,000 Acre-feet	**Average Recharge from Precipitation:**	**400 AFY**
Net Groundwater Demand[4]	72,000 Acre-feet	72,600 Acre-feet	67,400 Acre-feet	**Average Net Groundwater Demand:**	**71,700 AFY**

Notes

1. Approximately 25% of gross surface water deliveries go to the North Groundwater Management Area.
2. Applied water requirement minus Et requirement (crop water demand).
3. Recharge from precipitation averaged by Thomas Harder for the period 1987-2017 = 1,000 afy for TCWA (Table E1-b - Harder).
Therefore precip. Contrib. = 1,000 afy average or 3,000 af/wet year.
4. The net groundwater demand is the Et requirement less the surface water return flow, less rainfall contribution in wet years.
5. 13% of years are "Wet", 32% of Years are "Dry", 55% of Years are "Typical" or "Average". Source: 1990 - 2010 Precip. records for Porterville (Harder HCM Table 2a) , CIMIS records for Shafter and Stratford.
6. See text for explanation of the estimates for subsurface inflow and aquitard compression.

Table 2.3.8a(2)

TRI-COUNTY GSA - NORTH AREA				
Tule Subbasin - North Groundwater Management Area Groundwater Demand - 2017/18 Cropping Pattern - 2020				
North Groundwater Management Area - 2020	**Dry Year Conditions**	**Normal Year Conditions**	**Wet Year Conditions**	**Results - 20 Year Analysis Based on 2017/18 Cropping Pattern**
Approximate Gross Acreage in Management Area	12,100 Acres	12,100 Acres	12,100 Acres	
Farmed Area	6,000 Acres	6,000 Acres	6,000 Acres	
Et Requirement	13,100 Acre-feet	13,600 Acre-feet	14,800 Acre-feet	**Average Et Reqmt.: 13,600 AFY**
Applied Water Requirement[2]	19,600 Acre-feet	20,300 Acre-feet	22,100 Acre-feet	**Average Applied Water Reqmt.: 20,300 AFY**
Surface Water Deliveries[1]	0 Acre-feet	1,800 Acre-feet	9,100 Acre-feet	**Average Surface Water Deliveries: 2,200 AFY**
Groundwater Requirement	19,600 Acre-feet	18,500 Acre-feet	13,000 Acre-feet	**Average Ground Water Reqmt.: 18,100 AFY**
Applied Water Return Flow	6,500 Acre-feet	6,700 Acre-feet	7,300 Acre-feet	**Average Applied Water Return Flow: 6,700 AFY**
Net Groundwater Extractions	13,100 Acre-feet	11,800 Acre-feet	5,700 Acre-feet	**Average Net Groundwater Extractions: 11,400 AFY**
Areal Recharge from Precipitation[3]	0 Acre-feet	0 Acre-feet	600 Acre-feet	**Average Recharge from Precipitation: 100 AFY**
Net Groundwater Demand[4]	13,100 Acre-feet	11,800 Acre-feet	5,100 Acre-feet	**Average Net Groundwater Demand: 11,300 AFY**

Notes

1. Approximately 25% of Angiola surface water deliveries go to the North Groundwater Management Area.
2. 67% irrigation efficiency assumed., 33% of applied water returned.
3. Recharge from precipitation averaged by Thomas Harder for the period 1987-2017 = 1,000 afy for TCWA (Table E1-b - Harder).
North area = 20% of TCWA land area (Tule Subbasin).Therefore average precip. contribution = 200 afy, and precip. average = 600 af/wet year.
4. The net groundwater demand is the Et requirement less the surface water return flow, less rainfall contribution in wet years.
5. 13% of years are "Wet", 32% of Years are "Dry", 55% of Years are "Typical" or "Average". Source: 1990 - 2010 Precip. records for Porterville (Harder HCM Table 2a) , CIMIS records for Shafter and Stratford.
6. See text for explanation of the estimates for subsurface inflow and aquitard compression.

Table 2.3.8a(3)

TRI-COUNTY GSA - SOUTHEAST AREA				
Tule Subbasin Southeast Groundwater Area Groundwater Demand - 2017/18 Cropping Pattern - 2020				
Southeast Groundwater Management Area - 2020	**Dry Year Conditions**	**Normal Year Conditions**	**Wet Year Conditions**	**Results - 20 Year Analysis Based on 2017/18 Cropping Pattern**
Approximate Gross Acreage in Management Area	49,300 Acres	49,300 Acres	49,300 Acres	
Farmed Area	23,000 Acres	23,000 Acres	23,000 Acres	
Et Requirement	58,900 Acre-feet	60,800 Acre-feet	64,700 Acre-feet	**Average Et Reqmt.: 60,700 AFY**
Applied Water Requirement	67,000 Acre-feet	69,100 Acre-feet	73,600 Acre-feet	**Average Applied Water Reqmt.: 69,000 AFY**
Surface Water Deliveries[1]	0 Acre-feet	0 Acre-feet	0 Acre-feet	**Average Surface Water Deliveries: 0 AFY**
Groundwater Requirement	67,000 Acre-feet	69,100 Acre-feet	73,600 Acre-feet	**Average Ground Water Reqmt.: 69,000 AFY**
Applied Water Return Flow[2]	8,100 Acre-feet	8,300 Acre-feet	8,900 Acre-feet	**Average Applied Water Return Flow: 8,300 AFY**
Net Groundwater Extractions	58,900 Acre-feet	60,800 Acre-feet	64,700 Acre-feet	**Average Net Groundwater Extractions: 60,700 AFY**
Areal Recharge from Precipitation[3]	0 Acre-feet	0 Acre-feet	2,400 Acre-feet	**Average Recharge from Precipitation: 300 AFY**
Net Groundwater Demand[4]	58,900 Acre-feet	60,800 Acre-feet	62,300 Acre-feet	**Average Net Groundwater Demand: 60,400 AFY**

Notes

1. Approximately 25% of Angiola surface water deliveries go to the North Groundwater Management Area. None go the the Southeast Groundwater Management Area.
2. Applied water requirement minus Et requirement (crop water demand).
3. Recharge from precipitation averaged by Thomas Harder for the period 1987-2017 = 1,000 afy for TCWA (Table E1-b - Harder). Southeast Area = 80% of total TCWA lan
Therefore precip. Contrib. = 800 afy average or 2,400 af/wet year.
4. The net groundwater demand is the Et requirement less the surface water return flow, less rainfall contribution in wet years.
5. 13% of years are "Wet", 32% of Years are "Dry", 55% of Years are "Typical" or "Average". Source: 1990 - 2010 Precip. records for Porterville (Harder HCM Table 2a) , CIMIS records for Shafter and Stratford.
6. See text for explanation of the estimates for subsurface inflow and aquitard compression.

2.3.8.2 FUTURE WATER BUDGET - 2040 [§354.18(c)(1)]

YEAR 2040

With the reduction of groundwater pumping, the net groundwater inflow to the GSA will decrease from 44,100 afy to 18,300 afy, a reduction of 58%. The reduction of groundwater pumping from below the aquitards beneath the GSA will result in a decrease from 12,000 afy to zero, a 100% decrease. The overall effect will be a reduction in groundwater pumping from 57,100 afy to 19,300 afy (including 1,000 afy rainfall contribution to groundwater), an overall decrease of 37,800 afy or 66% in these combined components (see Figure 2.3.8-B). It must be recognized that the net deficit of 23,500 afy in the TCWA GSA (Table 2.3.8a) includes subsurface inflow from areas external to TCWA, which exacerbates groundwater deficits in these neighboring areas. The reduction in subsurface inflow from 44,100 afy to 18,300 afy by TCWA's implementation of projects and management actions, recognizes this situation and asserts that the pre-development inflow from areas external to TCWA historically has been 18,300 afy.

Without projects and management actions, the North Area would experience a change from 7,700 acre-feet (af) annual increase of groundwater storage - (2020) - to a 7,800 af annual storage reduction (2040) in the Upper Aquifer (Tables 2.3.8a&b). The Southeast Area would experience an increased reduction of Upper Aquifer storage from 31,200 afy (2020) to 56,700 afy (2040). The net effect to the GSA would be an overall increase of from 26,600 acre-feet (af) annual reduction in groundwater storage to 64,500 af annual reduction in groundwater storage. Clearly, there is a need for projects and management actions to mitigate the decrease in groundwater storage. Net subsurface inflow must be reduced from 44,100 afy to 18,300 afy to reduce impacts on neighboring GSAs, and water extracted from aquitards must be decreased from 12,000 afy to zero to reduce land subsidence.

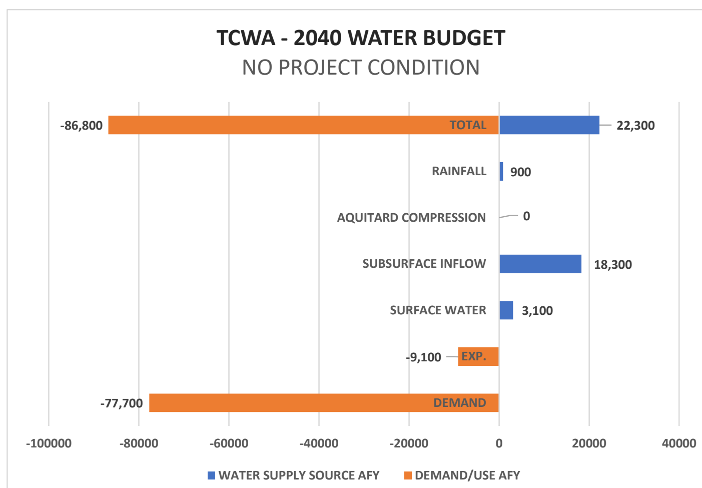
2040 NO PROJECT CONDITION

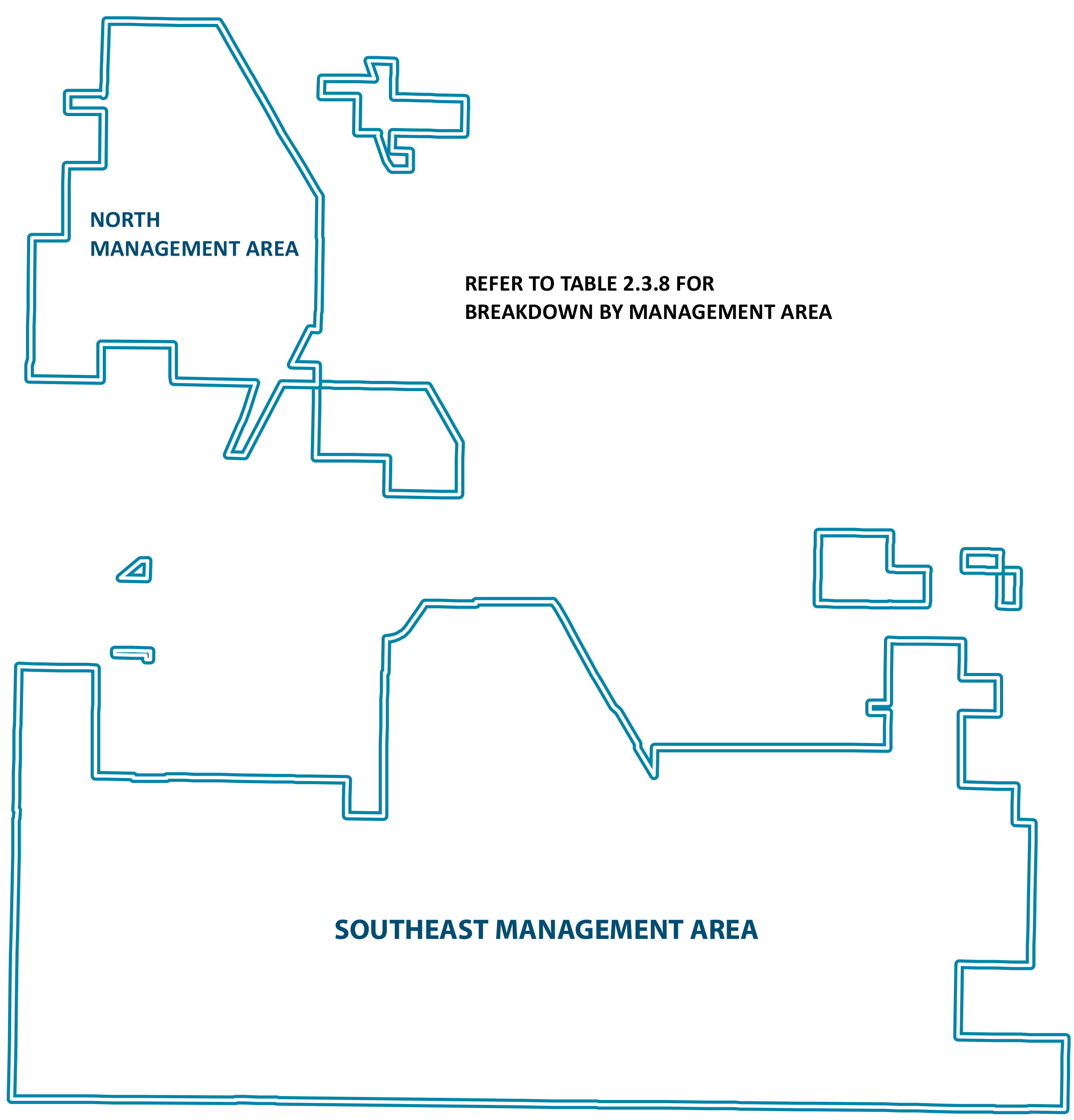
NET SUBSURFACE INFLOW & COMPRESSION OF AQUITARDS REDUCED TO 18,300 AFY

TCWA PORTION OF THE TULE SUBBASIN

GROSS LAND ACRES = 61,400 ACRES
IRRIGATED AREA = 29,000 ACRES

GROUNDWATER DEFICIT = 64,500 AFY





REFER TO TABLE 2.3.8 FOR BREAKDOWN BY MANAGEMENT AREA

TCWA GSA FOCUS AREA - TULE PORTION

KDSA Est. 1972
DEE JASPAR & ASSOCIATES, INC.
svb south valley biology consulting llc
TRI-COUNTY WATER AUTHORITY

TRI-COUNTY GSP
TCWA - NORTH & SE AREAS
WATER BUDGET - 2040 CONDITIONS

0 0.5 1 2
MILES
N

PROJECT NUMBER	FIGURE
DJ19-01	2.3.8-B

SOURCE(S): CA DEPT. OF WATER RESOURCES/TRI-COUNTY WATER AUTHORITY/KDSA/DJA

Chart 2.8.2

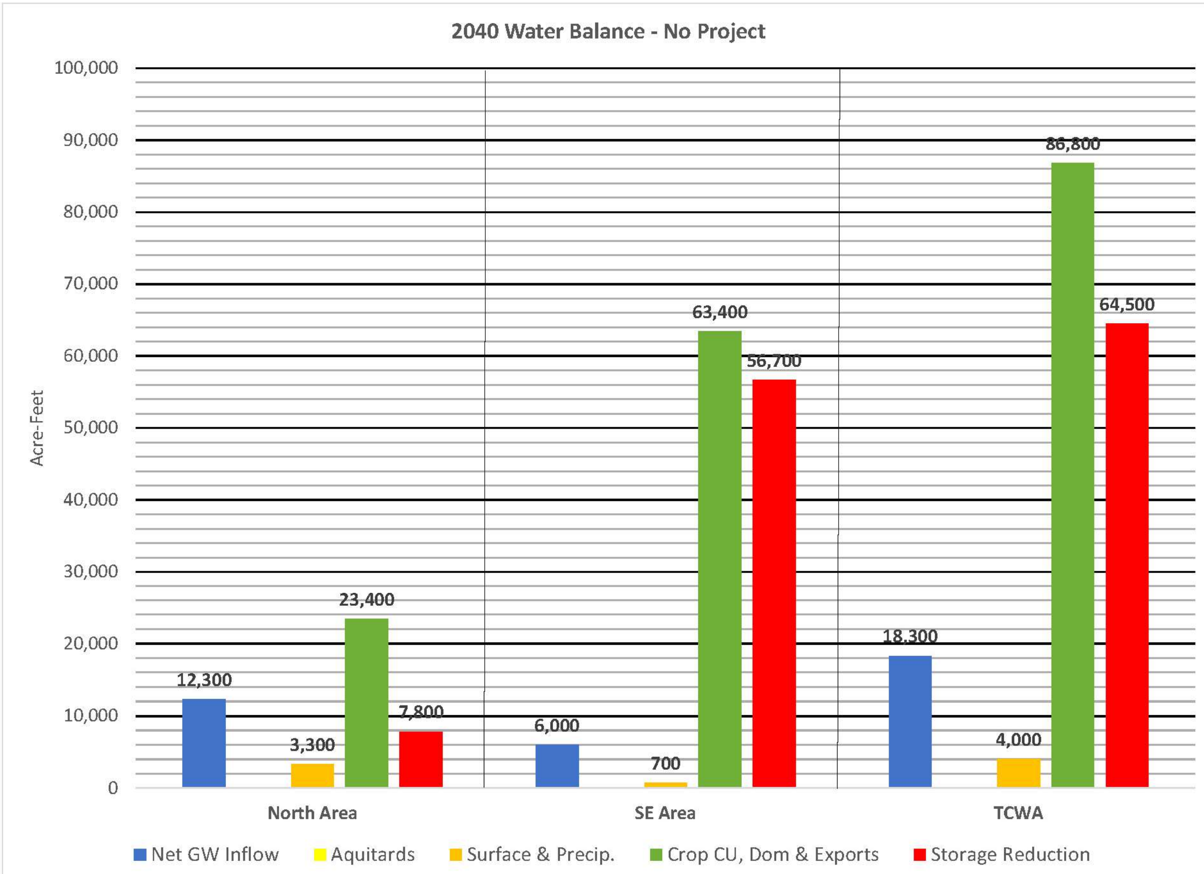

2040 Water Balance - No Project
Acre-Feet
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
12,300
3,300
23,400
7,800
6,000
700
63,400
56,700
18,300
4,000
86,800
64,500
North Area
SE Area
TCWA
Net GW Inflow
Aquitards
Surface & Precip.
Crop CU, Dom & Exports
Storage Reduction

Table 2.3.8b
Tri-County Water Authority
Summary of Groundwater Balance Tabulations
Results of Twenty-Year Study Periods for Year 2040 - No Project Conditions

A	B	C	D	E	F	G	H	I	J
Management Area	**Farmed Acreage[1]**	**Crop Water Requirement (Etc)[2] (af)**	**Surface Water Contribution to Et Requirement[3] (af)**	**Rainfall Contribution to Groundwater[4] (af)**	**Net Subsurface Inflow into the GSA[5] (af)**	**Net Inflow from Compression of Aquitards[6] (af)**	**Estimated Net Municipal and Domestic Water Use[7] (af)**	**Groundwater Extractions Exported from the GSA[8] (af)**	**Net Change in Groundwater Storage in Upper Aquifer[9] (af)**
YEAR 2040									
Total for TCWA	29,000	77,100	3,100	900	18,300	0	600	9,100	**-64,500**
North Management Area	6,000	14,100	3,100	200	12,300	0	200	9,100	**-7,800**
SE Management Area	23,000	63,000	0	700	6,000	0	400	0	**-56,700**

Reference: See Table 2.3.8 for footnotes

The following Tables 2.3.8b(1-3) develop the net groundwater demand for Year 2040. They are source tables for Table 2.3.8b.

Table 2.3.8b(1)

TRI-COUNTY GSA					
Tri-County GSA Groundwater Demand - 2017/18 Cropping Pattern - TULE SUBBASIN PORTION OF TCWA - 2040					
2040 Combined North & Southeast Groundwater Areas	**Dry Year Conditions**	**Normal Year Conditions**	**Wet Year Conditions**	**Results -20 Year Analysis Based on 2017 Cropping Pattern**	
Approximate Gross Acreage in Management Area	61,400 Acres	61,400 Acres	61,400 Acres		
Farmed Area	29,000 Acres	29,000 Acres	29,000 Acres		
Et Requirement	74,700 Acre-feet	77,200 Acre-feet	82,500 Acre-feet	**Average Et:**	**77,100 AFY**
Applied Water Requirement	89,800 Acre-feet	92,900 Acre-feet	99,300 Acre-feet	**Average AW:**	**92,800 AFY**
Surface Water Deliveries[1]	0 Acre-feet	1,800 Acre-feet	9,100 Acre-feet	**Average SWD:**	**2,200 AFY**
Groundwater Requirement	89,800 Acre-feet	91,100 Acre-feet	90,200 Acre-feet	**Average GWR:**	**90,600 AFY**
Applied Water Return Flow[2]	15,100 Acre-feet	15,700 Acre-feet	16,800 Acre-feet	**Average AWRF:**	**15,700 AFY**
Net Groundwater Extractions	74,700 Acre-feet	75,400 Acre-feet	73,400 Acre-feet	**Average NGWE:**	**74,900 AFY**
Areal Recharge from Precipitation[3]	0 Acre-feet	0 Acre-feet	3,000 Acre-feet	**Average RP:**	**400 AFY**
Net Groundwater Demand[4]	74,700 Acre-feet	75,400 Acre-feet	70,400 Acre-feet	**Average NGWD:**	**74,600 AFY**

Notes
1. Approximately 25% of gross surface water deliveries go to the North Groundwater Management Area.
2. Applied water requirement minus Et requirement (crop water demand).
3. Recharge from precipitation averaged by Thomas Harder for the period 1987-2017 = 1,000 afy for TCWA.
Therefore precip. Contrib. = 1,000 afy average or 3,000 af/wet year.
4. The net groundwater demand is the Et requirement less the surface water return flow, less rainfall contribution in wet years.
5. 13% of years are "Wet", 32% of Years are "Dry", 55% of Years are "Typical" or "Average". Source: 1990 - 2010 Precip. records for Porterville (Harder HCM Table 2a) , CIMIS records for Shafter and Stratford.
6. See text for explanation of the estimates for subsurface inflow and aquitard compression.

Table 2.3.8b(2)

TRI-COUNTY GSA - NORTH AREA					
Tule Subbasin - North Groundwater Management Area Groundwater Demand - 2017/18 Cropping Pattern - 2040					
North Groundwater Management Area - 2040	**Dry Year Conditions**	**Normal Year Conditions**	**Wet Year Conditions**	**Results - 20 Year Analysis Based on 2017 Cropping Pattern**	
Approximate Gross Acreage in Management Area	12,100 Acres	12,100 Acres	12,100 Acres		
Farmed Area	6,000 Acres	6,000 Acres	6,000 Acres		
Et Requirement	13,600 Acre-feet	14,100 Acre-feet	15,400 Acre-feet	**Average Et:**	**14,100 AFY**
Applied Water Requirement[2]	20,300 Acre-feet	21,100 Acre-feet	22,900 Acre-feet	**Average AW:**	**21,100 AFY**
Surface Water Deliveries[1]	0 Acre-feet	1,800 Acre-feet	9,100 Acre-feet	**Average SWD:**	**2,200 AFY**
Groundwater Requirement	20,300 Acre-feet	19,300 Acre-feet	13,800 Acre-feet	**Average GWR:**	**18,900 AFY**
Applied Water Return Flow	6,700 Acre-feet	7,000 Acre-feet	7,500 Acre-feet	**Average AWRF:**	**7,000 AFY**
Net Groundwater Extractions	13,600 Acre-feet	12,300 Acre-feet	6,300 Acre-feet	**Average NGWE:**	**11,900 AFY**
Areal Recharge from Precipitation[3]	0 Acre-feet	0 Acre-feet	600 Acre-feet	**Average RP:**	**100 AFY**
Net Groundwater Demand[4]	13,600 Acre-feet	12,300 Acre-feet	5,700 Acre-feet	**Average NGWD:**	**11,900 AFY**

Notes

1. Approximately 25% of Angiola surface water deliveries go to the North Groundwater Management Area.
2. 67% irrigation efficiency assumed., 33% of applied water returned.
3. Recharge from precipitation averaged by Thomas Harder for the period 1987-2017 = 1,000 afy for TCWA.
North area = 20% of TCWA land area (Tule Subbasin).Therefore average precip. contribution = 200 afy, and precip. average = 600 af/wet year.
4. The net groundwater demand is the Et requirement less the surface water return flow, less rainfall contribution in wet years.
5. 13% of years are "Wet", 32% of Years are "Dry", 55% of Years are "Typical" or "Average". Source: 1990 - 2010 Precip. records for Porterville (Harder HCM Table 2a) , CIMIS records for Shafter and Stratford.
6. See text for explanation of the estimates for subsurface inflow and aquitard compression.