East Kaweah Groundwater Sustainability Agency

2022 First Amended Groundwater Sustainability Plan

Tulare County, California • July 27, 2022



Prepared for:

EAST KAWEAH
GROUNDWATER SUSTAINABILITY AGENCY

Prepared by:

EST. 1968
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Prepared under the Kaweah Subbasin Coordination Agreement with Greater Kaweah GSA and Mid-Kaweah GSA

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Acronyms & Abbreviations

AB .... Assembly Bill
AC .... Advisory Committee
ADD .... Average Day Demands
AFY .... acre-feet per year
APN .... Assessor's Parcel Number(s)
BPM .... Best Management Practices
CASGEM .... California Statewide Groundwater Elevation Monitoring
CDFW .... California Department of Fish and Wildlife
CDHSD .... California Department of Health Services Division
CDP .... census-designated place
CDPH .... California Health and Safety Code
CDWR .... California Department of Water Resources
CEQA .... California Environmental Quality Act
City .... City of Lindsay
COC .... Constituents of Concern
CVP .... USBR Central Valley Project
CV-SALTS .... Central Valley Salinity Alternatives for Long-Term Sustainability
CWC .... California Water Code
DAC .... Disadvantaged Communitites
DCP .... Dust Control Plan
DHS .... Department of Health Services
DPR .... Department of Pesticide Regulation
DWR .... Department of Water Resources
DWSAP .... Drinking Water Source Assessment and Protection
ED .... Executive Director
EDF .... Environmental Defense Fund
EHD .... Tulare County Environmental Health Division
EID .... Exter Irrigation District
EKGSA .... East Kaweah Groundwater Sustainability Agency
EO .... Education and Outreach
FI .... Fees and Incentives
FKC .... Friant-Kern Canal

GA .... Groundwater Allocation
GEI .... GEI Consultants, Inc.
GKGSA .... Greater Kaweah Groundwater Sustainability Agency
GMT .... Groundwater Marketing/Trading
GP .... Groundwater Pumping Restrictions
GSA .... Groundwater Sustainabliity Agency
GSP .... Groundwater Sustainability Plan
HCM .... Hydrogeologic Conceptual Model
HDB .... Hamlet Development Boundaries
ID .... Irrigation District
IID .... Ivanhoe Irrigation District
IRWMP .... Integrated Regional Water Management Plans
KDWCD .... Kaweah Delta Water Conservation District
KSHM .... Kaweah Subbasin Hyrdologic Model
LID .... Lindmore Irrigaton District
LSID .... Lindsay-Strathmore Irrigation District
LU .... Land Use
MCL .... Maximum Contaminant Level
MGD .... million gallons per day
MKGSA .... Mid-Kaweah Grounwater Sustainability Agency
MO .... measurable objective
MT .... minimum threshold
NEPA .... National Environmental Policy Act
NPDES .... National Pollutant Discharge Elimination System
PMWC .... Plainview Mutual Water Company
PPB .... parts per billion
PPM .... parts per million
PUDs .... public utility districts
Reclamation .... United States Bureau of Reclamation
RWQCB .... Regional Water Quality Control Board
SAFER .... Safe and Affordable Fudning for Equity and Resilience
SB .... Senate Bill
SCID .... Stone Corral Irrigation District
SDAC .... severely disadvantaged communities
SDWA .... Safe Drinking Water Act

SGMA .... Sustainable Groundwater Management Act
SHE .... Self Help Enterprise
SJRRP .... San Joaquin River Restoration Program
SRT .... Sequoia Riverlands Trust
SWPPP .... Storm Water Pollution Prevention Plan
SWRCB .... State Water Resources Control Board
SWTP .... Surface Water Treatment Plant
TAC .... Technical Advisory Committee
TBWP .... Tulare Basin Wildlife Partners
TDS .... Total Dissolved Solids
UAB .... Urban Area Boundaries
UDB .... Urban Development Boundaries
UR .... Undesirable Result
USBR .... United States Bureau of Reclamation
USGS .... United States Geologic Survey
U.S. EPA .... United States Environmental Protection Agency
WAF .... Water Accounting Framework
WCR .... Well Completion Report
WHPA .... Wellhead Protection Area
WHPP .... Wellhead Protection Program
WR .... Water Resources

Executive Summary

The East Kaweah Groundwater Sustainability Agency (EKGSA) is a joint powers authority formed pursuant to California Government Code sections 6500, et. seq, between County of Tulare, City of Lindsay, Exeter Irrigation District, Ivanhoe Irrigation District, Lindmore Irrigation District, Lindsay-Strathmore Irrigation District, and Stone Corral Irrigation District. The agencies reside wholly within Tulare County. The EKGSA is one of three groundwater sustainability agencies (GSA's) formed in the Kaweah Subbasin of the San Joaquin Valley's Tulare Lake Basin (Groundwater Basin 5-22.11). It submitted formation documents to the State of California on June 6, 2017. The formation of the GSA was in response to the Sustainable Groundwater Management Act of 2014 (SGMA) that allows local agencies to form to develop and implement a Groundwater Sustainability Plan (GSP) with the intention of bringing the groundwater basin to sustainability.

SGMA requires governments and water agencies of high and medium priority basins to achieve sustainability by avoiding undesirable results. Under SGMA, these basins should reach sustainability within 20 years of implementing their GSP. For critically over-drafted basins, including the Kaweah Subbasin to which the EKGSA is a portion, the deadline for achieving sustainability will be 2040. This GSP is a planning document, based upon the currently available data and understanding for the area, laying the groundwork for implementing sustainable groundwater management. During implementation additional data will be gathered through studies, monitoring, and actions which will be utilized to fill data gaps to update and evaluate the understanding, planning, and decision-making processes. The EKGSA will coordinate with stakeholders and Subbasin partners to work towards sustainable groundwater management.

Within the Kaweah Subbasin, three separate GSPs were submitted by three GSAs (East Kaweah GSA, Greater Kaweah GSA, and Mid-Kaweah GSA) alongside a required coordination agreement to meet Water Code §10727 by January 31, 2020. The Kaweah Subbasin GSAs were notified by the California Department of Water Resources on January 28, 2022 via letter titled "Incomplete Determination of the 2020 Groundwater Sustainability Plans Submitted for the San Joaquin Valley – Kaweah Subbasin" (Determination Letter) that DWR deemed the Kaweah Subbasin's three GSPs to be incomplete. Specifically, DWR found that the three GSPs, "do not satisfy the requirements of SGMA nor substantially comply with the GSP Regulations" and recommended corrective actions for chronic lowering of groundwater levels, land subsidence, and interconnected surface water Sustainable Management Criteria (SMCs). EKGSA was given 180 days to address the identified deficiencies. This revised EKGSA GSP is being submitted, within the required timeframe, to address the deficiencies identified by DWR. The revisions are primarily located with Section 3 Sustainable Management Criteria and Section 5.4 Management Actions.

ES 1 Introduction and Plan Area

The EKGSA is made of seven participating member agencies including County of Tulare, City of Lindsay, and several irrigation districts. Of these agencies the County of Tulare and the City of Lindsay are the only member agencies with direct land use planning authority. However, all the member agencies have an interest in land use planning policies, and how it will impact their continued development and water supplies.

EKGSA covers approximately 117,300 acres. Beneficial users within the plan area were identified by the Advisory Committee during the development of the Communication and Engagement Plan. These users are described in detail in Section 1.5.2 of Chapter 1. There are approximately 1,680 wells within the EKGSA boundary, based on information available from the Well Completion Report (WCR) database. In the EKGSA and Kaweah Subbasin, the primary surface water sources for groundwater replenishment include precipitation, Kaweah River flows, and San Joaquin River water via Friant CVP contracts. Average annual precipitation is 7 to 13 inches, increasing eastward. The EKGSA goals are to develop several recharge, storage, conservation, and/or water recycling projects utilizing these supplies.

SGMA requires that all groundwater basins across the State develop actions and projects intended to address six Undesirable Results (UR). The EKGSA's GSP will define each UR and how the EKGSA will aim to avoid these negative issues to be within sustainable trends by January 31, 2040. For each UR, the GSP will describe how the EKGSA will measure the indicators relative to established minimum thresholds. It will also describe the reporting structures that will serve as updated understanding of UR trends. The EKGSA intends to develop and implement a GSP that uses a holistic approach that maintains the quality of life and reaches groundwater sustainability within its jurisdictional boundary.

As part of the effort to consider interests of all beneficial uses and users of groundwater, the EKGSA formed two committees, a Technical Advisory Committee (TAC) and an Advisory Committee (AC), to assist in developing policy and giving guidance from technical, social, and impacted party perspectives. The EKGSA is led by an Executive Director (ED) under direction of the EKGSA Board of Directors. The ED's role is to coordinate all the Board provided resources toward developing and implementing a GSP with the intention of achieving goals of SGMA by the year 2040.

ES 1.2 Summary of Basin Setting

The EKGSA is located on the eastern side of the Kaweah Subbasin and covers approximately one quarter of the Subbasin acreage. It is made up of two areas bisected by the Kaweah River. The unconsolidated sediments of the EKGSA form a single unconfined aquifer. Four different geomorphic regions are delineated in order to relate wells of similar hydrology. The major land use in the EKGSA is agriculture. Historical groundwater levels were examined, and the period from 1997 to 2017 was chosen as the base period. Using this 20-year base period, the GSP extensively evaluated water surface elevations (WSE) within the EKGSA.

The earliest records of groundwater levels in the EKGSA indicate that groundwater naturally flowed from the foothills of the Sierra Nevada east towards the valley trough to the southwest. Development of the Subbasin led to the formation of a vast cone of depression beneath the City of Lindsay in the first half of the twentieth century, which was initially remediated by deliveries from LSID's Kaweah River supplies, then further remediated by deliveries from the Friant-Kern Canal beginning in the 1950s. Groundwater contour maps of the region depict a gradual rebound of the Lindsay Cone that lasted until 1986, after which groundwater began to decline again.

Over the past 20 years, groundwater levels have continued to decline. Over the span base period, the Cottonwood Creek Interfan geomorphic region has lost approximately 40 feet of groundwater overall, with over 60 feet lost in a small area beneath Ivanhoe ID. The Kaweah River Alluvial Fan region has lost between 20 to 50 feet, with losses increasing with increase in distance from the Kaweah River. The Lewis Creek Interfan region has lost up to 150 feet of groundwater in the most critically impacted location west of Lindmore ID. A majority of the region exhibits groundwater declines between 70 and 100 feet. The wells in the upper foothill regions of the EKGSA have very sparse data available between 1997 and 2017. Declines in these regions have therefore not been quantified. Groundwater across the EKGSA is generally lower in 2017 than in 1997.

Defining the Basin Setting also requires an examination of groundwater quality issues. Through data obtained from public well sources within the Subbasin, several constituents of concern (COC) were designated, the most common being nitrate. Nitrate is prevalent throughout the Subbasin with higher concentrations tending to occur in the eastern portion of the Subbasin. Nitrate concentrations appear to correlate with areas that have greater than 50% of land use as orchards and vineyards. It was also noted that septic system density is greater in the eastern portion of Subbasin by comparison with the rest of the Subbasin. The nine COC that will be tracked within the EKGSA are listed in **Table ES-2.** These COC will be tracked through the Monitoring Network with respect to Undesirable Results with regard to agricultural or municipal use.

The water budget for the Subbasin provides an accounting and assessment of the average annual volume of groundwater and surface water entering (i.e., inflow) and leaving (i.e., outflow) the basin and enables an accounting of the cumulative change in groundwater in storage over time. From the data available for the base period from 1997 to 2017, the Kaweah Subbasin is currently estimated to have an annual overdraft of 77,600 acre-feet per year (AFY). The EKGSA is currently estimated to have an annual overdraft of approximately 28,000 AFY.

Through a Water Accounting Framework (WAF) coordinated amongst the Kaweah Subbasin GSAs, groundwater supplies were broken into three categories, Native, Foreign, and Salvaged. In general, this WAF defines Native portion of groundwater inflows to consist of those inflows which all well owners have access to on a pro-rata basis; Foreign portion to consist of all imported water entering the Subbasin from non-local sources under contract by local agencies or by purchase/exchange arrangements; and Salvaged portion to consist of all local surface and groundwater supplies stored, treated and otherwise managed by an appropriator/owner of the supply and associated water infrastructure systems (e.g. storm water disposal systems and waste water treatment plants). Accounting for supplies in this fashion, the EKGSA is allotted nearly 125,000 AFY of the approximately 660,000 AFY currently accounted for the Kaweah Subbasin.

ES 1.3 Overview of Sustainability Indicators, Minimum Thresholds, and Measurable Objectives

Sustainability Goal

Consistent with Appendix 6 of the Coordination Agreement (Appendix 1-A), the broadly stated sustainability goal for the Kaweah Subbasin is for each GSA to manage groundwater resources to preserve the viability of existing agricultural enterprises of the region, domestic wells, and the smaller communities that provide much of their job base in the Subbasin, including the school districts serving these communities. The goal will also strive to fulfill the water needs of existing and amended county and city general plans that commit to continued economic and population growth within Tulare County and within portions of Kings County.

This goal statement complies with §354.24 of the Regulations. This Goal will be achieved by:

- The implementation of the EKGSA, GKGSA and MKGSA GSPs, each designed to identify phased implementation of measures (projects and management actions) targeted to ensure that the Kaweah Subbasin is managed to avoid undesirable results and achieve measurable objectives by 2040 or as may be otherwise extended by DWR.
- Collaboration with other agencies and entities to arrest chronic groundwater-level and groundwater storage declines, reduce or minimize land subsidence where significant and unreasonable, decelerate ongoing water quality degradation where feasible, and protect the local beneficial uses and users.
- Assessments at each interim milestone of implemented projects and management actions and their achievements towards avoiding undesirable results as defined herein.
- Continuance of projects and management action implementation by the three GSAs, as appropriate, through the planning and implementation horizon to maintain this sustainability goal.

To achieve the Subbasin's sustainability goal, a combination of projects and management actions will be implemented over the next 20 years. It is currently estimated that there is approximately 28,000 AF/year of overdraft associated with the EKGSA. Interim goals for 5, 10, and 15 years were set to create a glide path for reaching sustainability goals by 2040. This "glide path" will mitigate groundwater level depletion by 5, 25, and 55 percent, respectively before reaching 100 percent by the 2040 deadline. By the time all projects and management actions have been completed, sustainable yield operation is currently estimated between 660,000 and 720,000 AF/year for the Kaweah Subbasin.

The key to demonstrating the Kaweah Subbasin is meeting its sustainability goal is by avoiding undesirable results. Sustainability indicators are the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, become undesirable results. Within the Kaweah Subbasin, five sustainability indicators are present in the basin:

1. *Chronic lowering of groundwater levels resulting in a significant and unreasonable depletion of supply.*
2. *Significant and unreasonable reduction of groundwater storage.*
3. *Significant and unreasonable degraded water quality.*
4. *Significant and unreasonable land subsidence.*
5. *Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of surface water.*

The sixth sustainability indicator, seawater intrusion, has been deemed to not be applicable within the Kaweah Subbasin due to the large distance from the Central California coast.

Management Areas and Threshold Regions

To facilitate GSP implementation, the EKGSA subdivided the GSA into nine management areas and ten threshold regions. Management area boundaries were determined leaning on the jurisdictional boundaries of the member irrigation districts (ID) located within the EKGSA. Non-districted areas, regions of the EKGSA that generally are not covered by an irrigation district, were demarcated and named using their intercardinal direction. Management areas include:

1. *Exeter ID Management Area*
2. *Ivanhoe ID Management Area*
3. *Lindmore ID Management Area*
4. *Lindsay-Strathmore ID Management Area*
5. *Northeast Management Area*
6. *Northwest Management Area*
7. *Stone Corral ID Management Area*
8. *Southeast Management Area*
9. *Southwest Management Area*

The EKGSA recognizes that groundwater behavior is unlikely to mirror the political boundaries of irrigation districts. Therefore, to adequately account for differences in hydrogeologic behavior and pumping rates while forming minimum thresholds and measurable objectives, the EKGSA was further subdivided into threshold regions that grouped wells that would experience similar impacts by accounting for GSP management areas, groundwater elevations, base of aquifer, aquifer type, beneficial user type, land use, and similar completed well depths. Minimum thresholds were then developed to be protective of greater than the 90^{th} percentile of all beneficial users and uses in each threshold region. In cases where projected groundwater levels set at the 90^{th} percentile protective level would exceed the undesirable groundwater levels experienced in the EKGSA prior to Central Valley Project surface water imports, or were not sufficiently protective of aquifer storage capacity, minimum thresholds were increased to be more protective of beneficial users by ensuring the minimum thresholds do not exceed the historic base period depletion rate (1997-2017)., The EKGSA also intended to capture the intricate nuances of hydrogeology while setting minimum thresholds and measurable objectives to be protective of beneficial users and uses in the Subbasin. In total, each overlying management area contains one to three threshold regions, grouped by similar hydrogeologic characteristics. See **Figure ES-1** for a map showing the management areas and corresponding threshold regions. If, based upon collected data, it is determined there is need for different and/or additional monitoring and analysis for a sustainability indicator in a specific threshold region, it will be communicated in the required annual reports or five-year updates to this GSP.

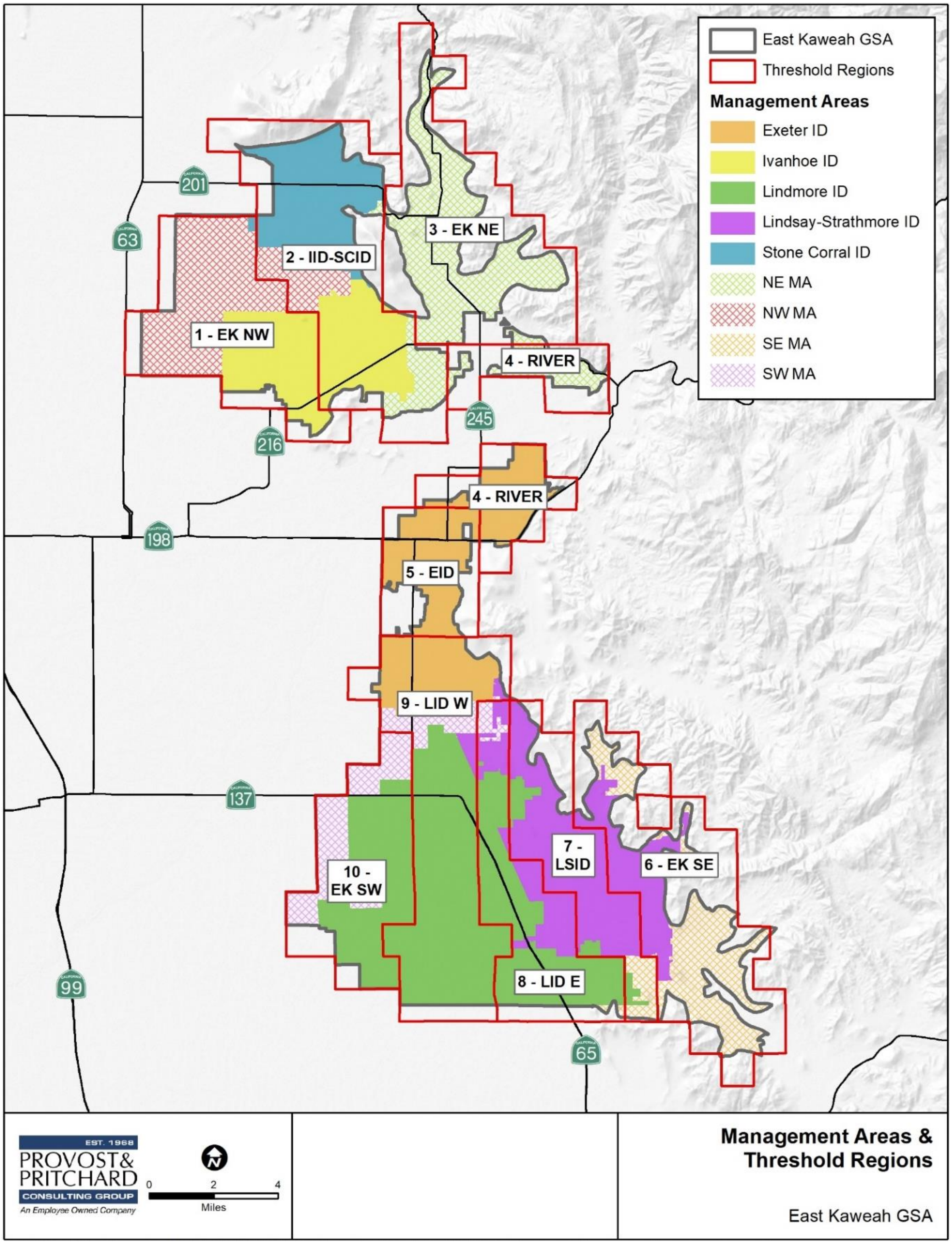

Figure ES-1 Map of EKGSA Management Areas and Overlapping Threshold Regions

Undesirable Results, Minimum Thresholds, and Measurable Objectives

To meet the goal of SGMA, the EKGSA has set undesirable results, minimum thresholds, and measurable objectives to provide quantitative support of the EKGSA's ability to reach sustainability by 2040. Demonstration of the absence of undesirable results for the five applicable sustainability indicators supports a determination that a basin is operating within its sustainable yield and, thus, that the sustainability goal has been achieved.

Undesirable results for each sustainability indicator were determined using an extensive, Subbasin coordinated, data informed, and stakeholder-inclusive process. The EKGSA Board of Directors (Board), considered stakeholder input and Technical Advisory Committee (TAC) expert advice, determined undesirable results based upon the relative levels would create significant and unreasonable results. The undesirable results would not only impact communities with the Kaweah Subbasin, historical and biological quality of life, but would also severely threaten regional agricultural economy and impact the world's food chain supply.

In addition to the qualitative description for each undesirable result, each undesirable result must also be substantiated using a quantitative minimum threshold. A minimum threshold is a quantitative value that represents the groundwater conditions at a representative monitoring site that, when exceeded individually or in combination with minimum thresholds at other monitoring sites, may cause an undesirable result(s) in the Subbasin. When setting minimum thresholds for each sustainability indicator, the relevant beneficial uses and users of groundwater were considered. In addition, EKGSA minimum thresholds were set at levels that are believed to not impede adjacent GSAs or subbasins from meeting their minimum thresholds or sustainability goals.

Measurable objectives are quantitative goals that reflect the desired groundwater conditions and allow the EKGSA to achieve the sustainability goal within 20 years. Measurable objectives were set so that there is a reasonable margin of operational flexibility between the minimum threshold and measurable objective that provides accommodation for droughts, climate change, conjunctive use operations, and other groundwater management activities. Interim milestones for the EKGSA implementation timeline were designed to allow the EKGSA to make progress over time toward the sustainability goal and are presented for each sustainability indicator. A summary of the undesirable results, minimum thresholds, measurable objective, and interim milestone for each sustainability indicator is presented in **Table ES-1**.

Table ES-1. Sustainable management criteria overview for the EKGSA

Sustainability Indicator	GW Elevation	GW Storage	SW-GW Connection	GW Quality	Land Subsidence
Undesirable Result	Unreasonable lowering of groundwater levels resulting in significant impacts to supply wells	Unreasonable reduction in groundwater storage	Unreasonable depletion of interconnected surface waterways, where present	Unreasonable long-term changes of water quality concentrations from baseline conditions to significantly impact users of groundwater	Loss of the functionality of a structure or a facility to the point that, due to subsidence, the structure or facility cannot reasonably operate without either significant repair or replacement
Measurement Methodology	Groundwater Levels	Groundwater Levels (Proxy)	Surface water depletion rate	Sampling for 3 COCs at Ag wells in Monitoring Network; Utilize public system Title 22 quality monitoring	Annual survey of set Mile Posts along the FKC and InSAR data when available and Plainview well point
Minimum Threshold	The most protective groundwater level in a threshold region based on the protective level of at least the 90th percentile of all beneficial uses and users without allowing a greater rate of the historical groundwater decline experienced between 1997-2017	The most protective groundwater level in a threshold region based on the protective level of at least the 90th percentile of all beneficial uses and users without allowing a greater rate of the historical groundwater decline experienced between 1997-2017	More than 50% losses in interconnected surface waterways when water is present	No long-term (10-yr. running average) increase in concentration beyond recognized Ag or Urban standards for those wells under the threshold. For those wells over the recognized Ag or Urban standards, no long-term increases by 20% in concentration	9.5" of subsidence in a year and cumulative (relate to no more than 10% capacity reduction in current capacity of the FKC)
Measurable Objective	Spring 2017 groundwater levels	Spring 2017 groundwater levels	Equal to or less than 30% losses in interconnected surface waterways when water is present	No unreasonable increase in concentration caused by groundwater pumping and recharge efforts	No subsidence throughout the GSA
Interim Milestones	Proportionate to % of overdraft to be corrected in 5-year intervals through implementation period	Proportionate to % of overdraft to be corrected in 5-year intervals through implementation period	Proportionate to % of depletion rate to be corrected in 5-year intervals through implementation period	No change from current Objective (re-evaluate at the 5-year milestone pending data collection)	No change from current Objective

ES 1.4 Monitoring Network

The monitoring network is the method by which progress toward reaching measurable objectives and the goal of groundwater sustainability is ascertained. The GSP outlines the monitoring networks for the five sustainability indicators used in the Subbasin. The objective of these monitoring networks is to establish and evaluate baseline conditions across the Subbasin and to detect trends related to undesirable results. Specifically, the monitoring network was developed to do the following:

- Monitor impacts to the beneficial uses or users of groundwater
- Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds
- Demonstrate progress toward achieving measurable objectives described in the GSP

To monitor the five sustainability indicators, the EKGSA is proposing to monitor groundwater levels, quality, surface water depletion rates and timing, and land surface subsidence. Groundwater levels will be used to track change in groundwater storage by proxy. Monitoring sites and methodology for interconnected surface water depletions will be implemented according to the Interconnected Surface Water Data Gap Work Plan (**Section 5.3.7**). Quality will be monitored through the network for constituents based on the use of the water, agricultural or municipal demand. Wells supplying agricultural demand will be sampled for three COC: Chloride, Sodium, and Total Dissolved Solids (TDS). Wells supplying municipal demand will be sampled for the nine COC shown in **Table ES-2**.

Table ES-2 Constituents of Concern with Respective Minimum Threshold

Constituent	*Threshold Level*		*Threshold Type*
1,2,3-Trichloropropane (1,2,3 TCP)	*0.005 ug/L*	*5 ppt*	*Primary MCL*
1,2-Dibromo-3-chloropropane (DBCP)	*0.2 ug/L*	*0.2 ppb*	*Primary MCL*
Arsenic	*10 ug/L*	*10 ppb*	*Primary MCL*
Chloride	*500 mg/L*	*500 ppm*	*Action Level*
	106 mg/L	*106 ppm*	*Agricultural Water Quality Goal*
Hexavalent Chromium	*20 ug/L*	*20 ppb*	*Health-Based Screening Level*
Nitrate (as N)	*10 mg/L*	*10 ppm*	*Primary MCL*
Perchlorate	*6 ug/L*	*6 ppb*	*Primary MCL*
Sodium	*50 mg/L*	*50 ppm*	*Action Level*
	69 mg/L	*69 ppm*	*Agricultural Water Quality Goal*
Total Dissolved Solids (TDS)	*1000 mg/L*	*1000 ppm*	*Secondary MCL*

The groundwater monitoring networks were largely developed and designed through existing data sources including wells from the California Statewide Groundwater Elevation Monitoring (CASGEM) Program, member irrigation districts, and public water systems. The intent of the EKGSA monitoring network is to initially rely on currently used monitoring sites within the area and focus on data gap regions by adding to the monitoring network to bolster coverage in lacking areas. EKGSA plans to install new, dedicated monitoring wells through different funding sources and programs such as DWR's Technical Support Services program. Most wells in the monitoring network are already measured on the planned semi-annual basis. Historical and future measurements will be catalogued in the Kaweah Subbasin Data Management System (DMS). **Figure ES-2** shows the initial EGKSA Monitoring Network. The EKGSA in conjunction with the member agencies in the management areas will be responsible for oversight and reporting monitoring results. The requirements of all five sustainability indicators will met through the consistent monitoring of groundwater levels, interconnected surface water depletions, quality and land-based monuments located on key infrastructure within the EKGSA.

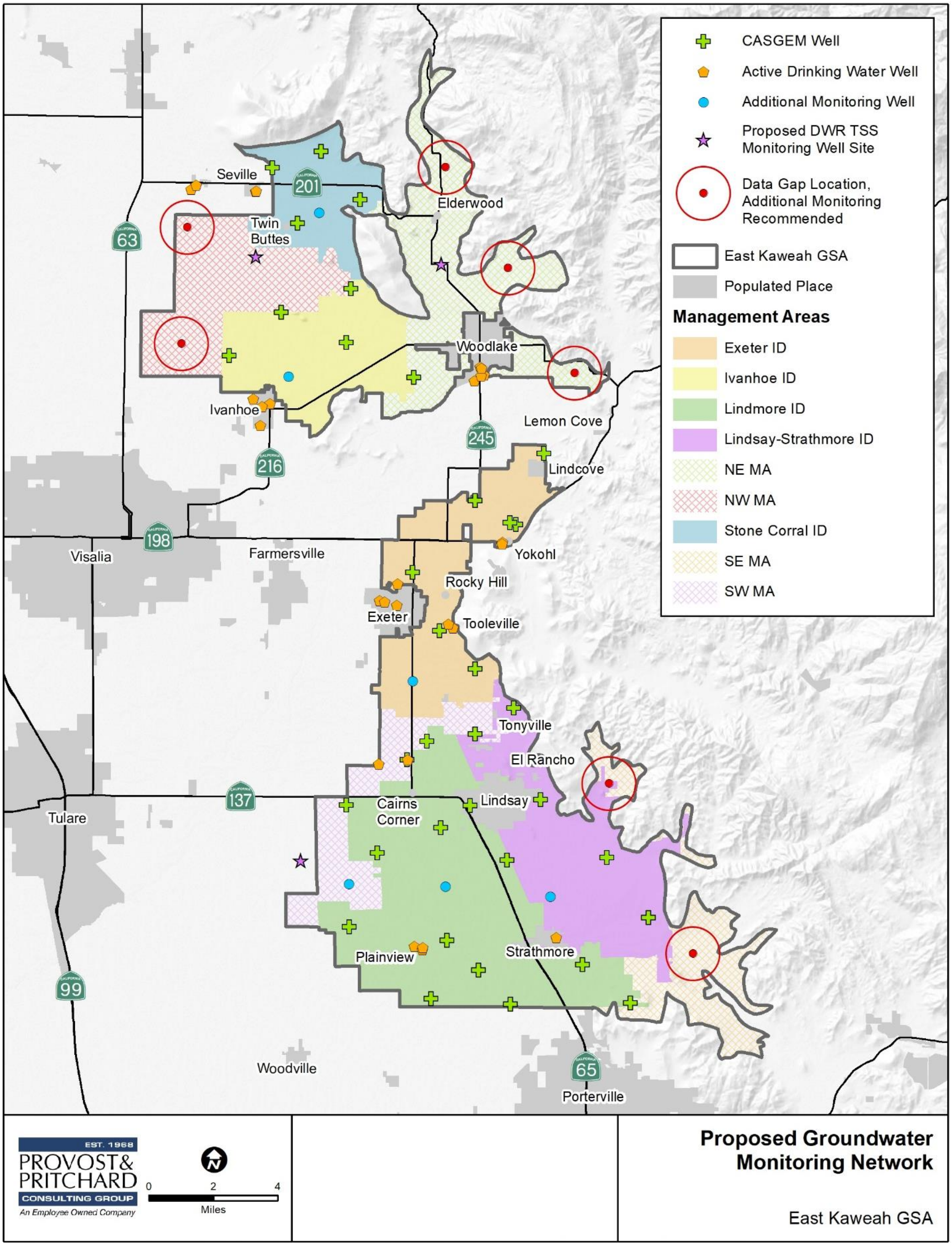

Figure ES-2 Initial EKGSA Groundwater Monitoring Network

ES 1.5 Overview of Projects and Management Actions

Two primary tools for sustainable groundwater management are project development for water supply augmentation and management actions for data collection and demand reduction. The goal of the EKGSA is to first develop projects to augment the water supply to overcome groundwater overdraft. However, if project development alone is unable to achieve the desired goals (i.e. avoiding Undesirable Results and achieving Measurable Objectives), then management actions or programs will need to be initiated. The projects described herein primarily focus on the capture, use, and recharge of available surface water supplies within the EKGSA to augment the water supply and reduce the impacts of groundwater pumping. Additionally, management actions have been developed that primarily focus on reducing water demand and associated reduction of groundwater pumping, along with increased data collection and associated actions including education and outreach, regulatory policies, incentive-based programs, and enforcement actions. The EKGSA considered many potential projects and management actions that could mitigate the groundwater overdraft within the area and help achieve sustainability, but ultimately determined that not all the identified potential projects and management actions are currently feasible for implementation. Projects that are currently envisioned for implementation are shown in **Table ES-3** and discussed in more detail in Chapter 5. Potential management actions that may be implemented are also discussed in more detail in **Chapter 5**.

Table ES-3 EKGSA Currently Identified Projects

Project ID	Project Title	Project Type	Estimated Annual Benefits AF/yr.	Generalized Priority
EK1	Lewis Creek Recharge	Recharge	3,000	High
EK2	Cottonwood Creek Recharge	Recharge	1,800	High
EK3	Yokohl Creek Recharge	Recharge	1,800	High
EK4	Rancho de Kaweah Water Management, Recharge, & Banking Project	Recharge	9,000	High
EK5	Lindmore/Exeter Dry Wells	Recharge	2,010	Medium
EK6	Lindsay Recharge Basin	Recharge	150	Medium
EK7	Wutchumna Ditch Recharge	Recharge	480	Medium
	Subtotal		18,240	AF/yr.

Projects and management actions may be implemented on different timelines. The EKGSA understands there are various levels of uncertainty with project and program implementation, and it is not unusual for it to take longer than originally estimated. In addition, some projects and management actions build upon others, and the accrual of expected benefits may take multiple years to be individually realized and vary substantially from year to year. Depending upon the success or failure of the initial GSP project and management action efforts to increase water supplies, reduce groundwater demands, and improve data collection, proposed implementation timelines may change and will be reevaluated each time this GSP is updated.

The projects that are currently being considered would yield an estimated average annual volume of approximately 18,200 AF/year if fully implemented as envisioned, which is over 60% of the currently estimated overdraft (28,000 AF/year) in the EKGSA. The remainder will be saved through projects yet to be developed and/or management actions, if necessary.

ES 1.6 Plan Implementation

The adoption of the GSP will be the official start of the Plan Implementation. The EKGSA will continue its efforts to engage the public and secure the necessary funding to successfully monitor and manage groundwater resources within the area in a sustainable manner. While the GSP was being reviewed by DWR, the EKGSA began to coordinate with various stakeholders and beneficial users to improve the monitoring networks and begin the implementation of projects and management actions.

The GSP includes a preliminary estimate of implementation costs, identifies funding alternatives, and includes a preliminary implementation schedule for the potential projects and management actions of the EKGSA. All identified projects have been evaluated as potential investments that would assist in achieving the long-term goals of the EKGSA. The potential schedules and budgets presented in the GSP are estimates and may be adapted or eliminated should the EKGSA Board deem it necessary. **Figure ES-3** represents the estimated glide path to sustainability for the EKGSA, shown as cumulative mitigation.

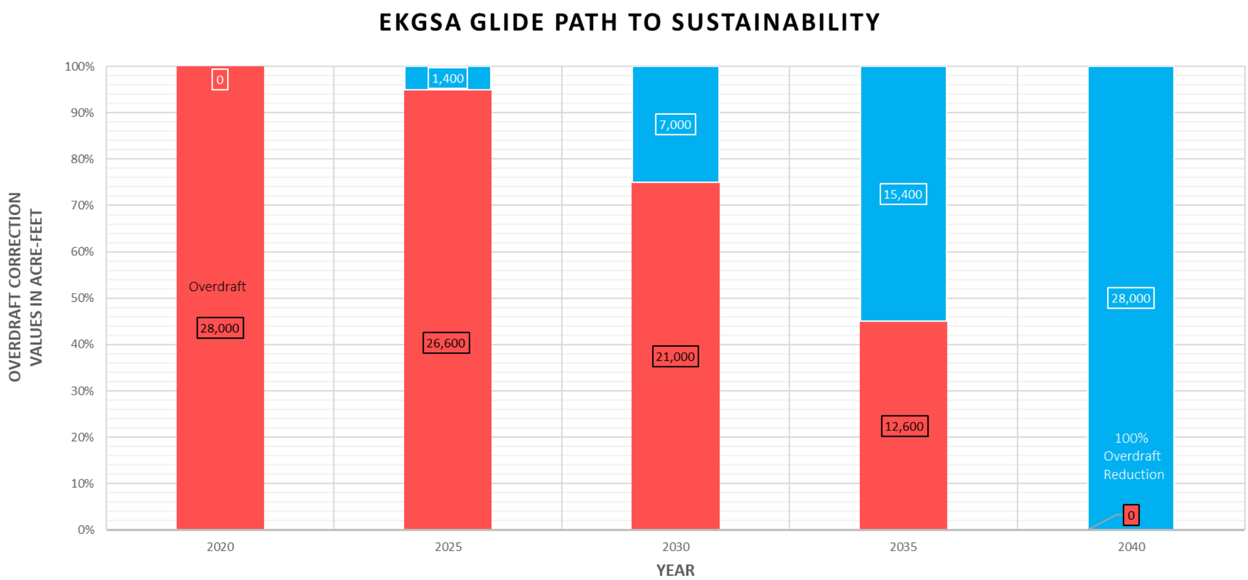

Figure ES-3 EKGSA Glide Path to Sustainability

Successful implementation of this GSP over the planning horizon will require ongoing efforts to engage stakeholders and the general public in the sustainability process, communicating the statutory requirement, the objectives of the GSP, and progress toward each identified measurable objective. In the context of this on-going public communication, announcements of upcoming environmental hearings, project presentations, bid openings, and project construction schedules will be released on a regular basis. Public forums will include opportunities for public comment and feedback to be addressed in an appropriate manner by EKGSA staff and/or consultants. The EKGSA, in conjunction with the member agencies, will provide notice to the public and other agencies through public meetings, newsletters, and its website (www.ekgsa.org) as the implementation of each project or management action is being considered. The EKGSA will report Subbasin operations, including current groundwater levels, extraction volume, surface water use, total water use, groundwater storage change, and progress of GSP implementation to the public and DWR on an annual basis. Additionally, the EKGSA will report to the public and DWR at least every five years, and when the GSP is amended, Subbasin operations and progress in achieving sustainability. This will include current groundwater conditions, status of projects or management actions, evaluation of undesirable results relating to measurable objectives and minimum thresholds, changes in monitoring network, summary of enforcement or legal actions, and agency coordination efforts.

1 Introduction & Plan Area

1.1 General Information

1.1.1 Purpose of Groundwater Sustainability Plan

On September 16, 2014, Governor Jerry Brown signed into law a three-bill legislative package, composed of AB 1739 (Dickinson), SB 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act (SGMA) and is codified in Section 10720 et seq. of the California Water Code. In his signing statement, Governor Edmund G. Brown, Jr., emphasized that "groundwater management in California is best accomplished locally." This legislation created a statutory framework for groundwater management in a manner that can be sustained during the planning and implementation horizon without causing undesirable results.

SGMA requires governments and water agencies of high and medium priority basins to achieve sustainability by avoiding undesirable results. Under SGMA, these basins should reach sustainability within 20 years of implementing their sustainability plans. For critically over-drafted basins, including the Kaweah Subbasin to which the East Kaweah Groundwater Sustainability Agency (EKGSA) is a portion, the deadline for achieving sustainability is 2040.

In order to comply with the requirements of SGMA, the EKGSA and the two other Kaweah Subbasin Groundwater Sustainability Agencies (GSA) have contracted with GEI Consultants, Inc. (GEI) for development of the basin setting. Montgomery and Associates (M&A) and Provost & Pritchard coordinated revisions across the Coordination Agreement and Groundwater Sustainability Plans (GSP). The EKGSA has additionally contracted with Provost & Pritchard for the preparation of its GSP. The GSP serves to do the following:

- *Describe the basin setting (Hydrogeologic Conceptual Model) to define and describe the geographic and geologic setting of the EKGSA boundaries*
- *Identify and describe the Sustainability Goal for the Kaweah Sub*basin *and the EKGSA area.*
- *Identify and describe the Six Undesirable Results set forth in SGMA, as they pertain to the Kaweah Sub-Basin and the EKGSA jurisdictional area.*
- *Identify and describe the Specific Minimum Thresholds and Measurable Objectives required for the EKGSA to achieve the Sustainability Goal*
- *Define and identify Projects and Management Actions proposed by EKGSA to achieve the Sustainability Goal.*

1.1.2 Sustainability Goal

SGMA requires that all subbasins develop actions and projects intended to address six Undesirable Results. The EKGSA's GSP will define each Undesirable Result (UR) and how the EKGSA will avoid these negative issues to be within sustainable trends by January 31, 2040. For each UR, the GSP will describe how the EKGSA will measure the indicators relative to each against established minimum thresholds. It will also describe the reporting structures that will serve as updated understanding of UR trends. EKGSA intends to develop and implement a GSP that uses a holistic approach to reach groundwater sustainability within its jurisdictional boundary.

1.2 Agency Information

1.2.1 Organization and Management Structure of the GSA

Legal Requirements:
§354.6(a) The name and mailing address of the Agency
§354.6(b) The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan.
§354.6(c) The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.

Agency's Name: East Kaweah GSA (EKGSA)
Agency's Address: 315 E. Lindmore Street, Lindsay, CA 93247
Agency's Mailing Address: P.O. Box 908, Lindsay, CA 93247
Agency's Phone Number: (559) 562-2534
Agency's Fax Number: (559) 562-5642
Agency's Website: ekgsa.org
Contact Person: Michael D. Hagman
Contact Person's Title: Executive Director, EKGSA
Contact Person's Email: mhagman@lindmoreid.com

The EKGSA is a Joint Powers Authority (JPA), formed pursuant to California Government Code sections 6500, et. seq, between the County of Tulare, City of Lindsay, Exeter Irrigation District (ID), Ivanhoe ID, Lindmore ID, Lindsay-Strathmore ID, and Stone Corral ID. The County of Tulare has land use authority over the entirety of EKGSA's jurisdiction. The EKGSA is one of three GSA's formed in the Kaweah Subbasin of the San Joaquin Valley's Tulare Lake Basin (Groundwater Basin 5-22.11). It submitted formation documents to the State of California on June 6, 2017.

The EKGSA has a governing board of eleven individuals all of whom are appointed. Seven of EKGSA's board members are elected officials from the member agencies and are appointed by their respective agency boards (one per agency). Two of the members are appointed by two water companies (Wutchumna Water Company and Sentinel Butte Mutual Water Company, which are special districts formed pursuant to various provisions of the California Water Code and California Water Code Appendix with the power to acquire water supplies for their districts and manage such supply) residing within the EKGSA boundaries. One member is appointed by the County of Tulare and approved by the EKGSA Board of Directors. One board member is appointed at-large by the EKGSA Board of Directors.

The EKGSA has two committees to assist in developing policy and giving guidance from technical, social, and interested party perspectives. The committees are as follows:

Technical Advisory Committee (TAC) – Each EKGSA Board member can appoint one representative to the EKGSA TAC. Therefore, there are eleven TAC representative positions. The TAC reviews, develops, and guides the Board, consultants and staff on technical issues relative to groundwater management and plan development/implementation. This includes development of the Basin Setting, water budget, and required measurable objectives, minimum thresholds and undesirable results on a Subbasin and GSA perspective.

Advisory Committee (AC) – There are eleven members of the advisory committee, and it is chaired by an EKGSA Board member. This Board member leads the AC but does not vote on the AC. Membership in the AC is on an appointment basis. As the board desired participation from a variety of disciples and interests, committee members were appointed via application process which identified the applicants interests and background as it pertained to water (community, agricultural, management, environmental, etc.) The Board created seats for agriculture (3 members), domestic well user (1 member), rural community (3 members), environmental (2 members), water company (1 member) and, other (1 member - science). The AC considers stakeholder interest in GSP development and implementation from a variety of disciplines and assists in the communication of the EKGSA efforts through the development of a communication and engagement plan.

The EKGSA is led by an Executive Director (ED) under direction of the EKGSA Board of Directors. The ED's role is to coordinate all the Board provided resources toward developing and implementing a GSP with the intention of achieving the goals of SGMA by the year 2040.

Resources Provided:

- Subbasin setting (HCM and Numeric Model) consultants (GEI)
- Engineering/Hydrogeologic support consultants (Provost & Pritchard and Montgomery & Associates)
- Legal Counsel (Klein, DeNatale, Goldner, Attorneys at Law)
- Other staff as necessary

1.2.2 Legal Authority of the GSA

Legal Requirements:
§354.6(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.
§354.6(e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.

In accordance with the State of California's Sustainable Groundwater Management Act (AB1739, SB1168, SB1319) signed into law on September 16, 2014 by Governor Jerry Brown, agencies on the eastern portion of the Kaweah Subbasin formed a JPA with the goal of complying with SGMA. Per the law, a public agency or agencies were permitted to form GSAs within the Subbasin (Division 6 of the Water Code, Part 2.74, Chapter 4, Section (§) 10723 et seq. and amendments made to SGMA by Senate Bill (SB) 13 in September 2015). On December 14, 2016 the Board of the EKGSA voted, in Resolution 2016-02, to form an exclusive GSA wholly within the Kaweah Subbasin.

1.2.3 Coordination

1.2.3.1 Kaweah Subbasin Coordination Agreement

Legal Requirements:
§ 357.4. Coordination Agreements
(a) Agencies intending to develop and implement multiple Plans pursuant to Water Code Section 10727(b)(3) shall enter into a coordination agreement to ensure that the Plans are developed and implemented utilizing the same data and methodologies, and that elements of the Plans necessary to achieve the sustainability goal for the basin are based upon consistent interpretations of the basin setting.
(b) Coordination agreements shall describe the following:
(1) A point of contact with the Department.
(2) The responsibilities of each Agency for meeting the terms of the agreement, the procedures for the timely exchange of information between Agencies, and procedures for resolving conflicts between Agencies.
(3) How the Agencies have used the same data and methodologies for assumptions described in Water Code Section 10727.6 to prepare coordinated Plans, including the following:
(A) Groundwater elevation data, supported by the quality, frequency, and spatial distribution of data in the monitoring network and the monitoring objectives as described in Subarticle 4 of Article 5.
(B) A coordinated water budget for the basin, as described in Section 354.18, including groundwater extraction data, surface water supply, total water use, and change in groundwater in storage.
(C) Sustainable yield for the basin, supported by a description of the undesirable results for the basin, and an explanation of how the minimum thresholds and measurable objectives defined by each Plan relate to those undesirable results, based on information described in the basin setting.
(c) The coordination agreement shall explain how the Plans implemented together, satisfy the requirements of the Act and are in substantial compliance with this Subchapter
(d) The coordination agreement shall describe a process for submitting all Plans, Plan amendments, supporting information, all monitoring data and other pertinent information, along with annual reports and periodic evaluations.
(e) The coordination agreement shall describe a coordinated data management system for the basin, as described in Section 352.6.
(f) Coordination agreements shall identify adjudicated areas within the basin, and any local agencies that have adopted an Alternative that has been accepted by the Department. If an Agency forms in a basin managed by an Alternative, the Agency shall evaluate the agreement with the Alternative prepared pursuant to Section 358.2 and determine whether it satisfies the requirements of this Section.
(g) The coordination agreement shall be submitted to the Department together with the Plans for the basin and, if approved, shall become part of the Plan for each participating Agency.
(h) The Department shall evaluate a coordination agreement for compliance with the procedural and technical requirements of this Section, to ensure that the agreement is binding on all parties, and that provisions of the agreement are sufficient to address any disputes between or among parties to the agreement.
(i) Coordination agreements shall be reviewed as part of the five-year assessment, revised as necessary, dated, and signed by all parties.

The Kaweah Subbasin GSAs worked to coordinate Subbasin-wide sustainability goal, undesirable results, and sustainability criteria, amongst many other items. An approved Coordination Agreement will be submitted with this GSP and is also included as **Appendix 1-A**.

1.2.3.2 Inter-Basin Agreements

Legal Requirements:
§ 357.2. Inter-basin Agreements

Two or more Agencies may enter into an agreement to establish compatible sustainability goals and understanding regarding fundamental elements of the Plans of each Agency as they relate to sustainable groundwater management. Inter-basin agreements may be included in the Plan to support a finding that implementation of the Plan will not adversely affect an adjacent basin's ability to implement its Plan or impede the ability to achieve its sustainability goal. Inter-basin agreements should facilitate the exchange of technical information between Agencies and include a process to resolve disputes concerning the interpretation of that information. Inter-basin agreements may include any information the participating Agencies deem appropriate, such as the following:

(a) General information:
(1) Identity of each basin participating in and covered by the terms of the agreement.
(2) A list of the Agencies or other public agencies or other entities with groundwater management responsibilities in each basin.
(3) A list of the Plans, Alternatives, or adjudicated areas in each basin.
(b) Technical information:
(1) An estimate of groundwater flow across basin boundaries, including consistent and coordinated data, methods and assumptions.
(2) An estimate of stream-aquifer interactions at boundaries.
(3) A common understanding of the geology and hydrology of the basins and the hydraulic connectivity as it applies to the Agency's determination of groundwater flow across basin boundaries and description of the different assumptions utilized by different Plans and how the Agencies reconciled those differences.
(4) Sustainable management criteria and a monitoring network that would confirm that no adverse impacts result from the implementation of the Plans of any party to the agreement. If minimum thresholds or measurable objectives differ substantially between basins, the agreement should specify how the Agencies will reconcile those differences and manage the basins to avoid undesirable results. The Agreement should identify the differences that the parties consider significant and include a plan and schedule to reduce uncertainties to collectively resolve those uncertainties and differences.
(c) A description of the process for identifying and resolving conflicts between Agencies that are parties to the agreement.
(d) Inter-basin agreements submitted to the Department shall be posted on the Department's website.

During the development of the GSP, Kaweah Subbasin technical staff met with neighboring Subbasin technical staff to coordinate and share data for modeling boundary conditions and ensuring compatibility of sustainable management criteria. Inter-basin agreements and policies are anticipated to begin shortly into the Implementation period.

1.3 GSP Implementation Costs

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

The EKGSA, on behalf of its member agencies and stakeholders, will incur costs to develop and implement its GSP, report the plan efforts annually, and maintain the plan via 5-year updates. Costs and sources of funding are identified as:

- Governance – Estimated costs are $210,000 annually (plus inflationary increases going forward). Member agencies pay equal share of annual governance costs on a quarterly basis.
- Initial Plan Development – Estimated costs for plan development (including EKGSA's share of sub-basin setting costs) are $1.27 million and will be funded as follows:

Table 1-1 Summary of GSP Development Costs

Activity	Cost	Revenue Source	Amount
Basin Setting (GEI, Inc) EKGSA Share	$437,670	Tulare County Grant Proposition 1 Grant	$ 64,640 $373,030
EKGSA Groundwater Sustainability Plan	$829,000	Proposition 1 Grant GSA Cost Assignment	$126,970 $702,030
Totals	$1,266,670	Tulare County Grant Proposition 1 Grant GSA Cost Assignment	$ 64,640 $500,000 $702,030

1.3.1 Costs Generated by GSP Implementation

Table 1-2 presents a description and an estimate of the costs associated with the implementation of the EKGSA GSP and measures associated with SGMA compliance.

1.3.2 GSP Implementation Funding

Through the SGMA Legislation, the EKGSA has the authority to collect funds through different means within its jurisdictional boundaries. These may include, but are not limited to:

- Per-Acre Assessments
- Extraction Fees
- Fines for Over-extraction
- Water Market Fees

In addition to various fee collection options, the EKGSA also has the authority to pursue local, State, and Federal grant funding on behalf of its member agencies for the development of projects within the EKGSA's jurisdiction for the purposes of satisfying the requirements of SGMA.

Table 1-2 Estimated Costs for GSP Implementation

Item	Description	Estimated Cost
Monitoring	The EKGSA will incorporate a monitoring network tracking groundwater levels, groundwater quality, and land surface subsidence. The EKGSA also proposes to monitor agricultural demand via satellite imagery.	$463,000 annually
Projects	The EKGSA proposes to incorporate more projects in the area to bolster water supplies by better use of contract supplies and wet-year water supplies.	$15,535,000 (one-time costs amongst the various projects[1]).
Management Actions/Programs	The EKGSA will implement various management polices to manage, monitor, and correct overdraft conditions and fill data gaps to reach sustainability	~$2.3 million (various components are annual, others one-time)
Annual Report	The EKGSA will annually report data collected in the previous water year.	$25,000 annually
5-Year GSP Update & Report	The EKGSA will evaluate data collected and projects and actions implemented to evaluate the GSP and make updates as necessary.	$375,000 ($75,000 per year of 5-year increment)

[1] Project costs to potentially be paid by individual project beneficiaries.

1.4 Description of Plan Area

Legal Requirements:
§354.8 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 best available information.

1.4.1 Geographic Areas Covered

The Kaweah Subbasin is surrounded by the Kings Groundwater Subbasin on the north, the Tule Groundwater Subbasin on the south, crystalline bedrock of the Sierra Nevada foothills on the east, and the Tulare Lake Subbasin on the west. **Figure 1-1** shows the bordering Subbasins to the Kaweah Subbasin. The Kaweah Subbasin is generally comprised of lands in the Kaweah Delta Water Conservation District. Major rivers and streams in the Subbasin include the Kaweah and St. Johns Rivers. The Kaweah River is the primary source of recharge to the area. Average annual precipitation is 7 to 13 inches, increasing eastward.

The EKGSA is one of three GSAs within the Kaweah Subbasin. There is no overlap among the GSAs and there are no adjudicated areas within the Subbasin. **Figure 1-2** shows the Groundwater Sustainability Agencies within Kaweah Subbasin. There are no adjudicated areas, nor tribal lands within the EKGSA area. State and federal lands are limited to those depicted in **Figure 1-3**. Two small areas in Stone Corral are owned by the California Department of Fish and Game, and the land around Lake Success owned by the Department of Defense slightly cross into the EKGSA area in the southeastern corner. The local entities participating in the East Kaweah GSP are shown in **Figure 1-4**.

1.4.2 Plan Area Setting

Tulare County land use survey was updated by Department of Water Resources (DWR) in 2014. The survey classifications can be seen in **Figure 1-5**. The figure provides a general idea of the local land uses. The area consists of a combination of large and small farming operations that generally host permanent crops such as citrus, fruit and nut trees, and vineyards. The farmed agricultural land represents nearly 90% of the total area.

Figure 1-6 is a map of well density in the GSA area. It illustrates wells per entire section, regardless of the proportion of the section that is within the GSA boundary. There are 2,932 wells shown. The map is based on information available from California's DWR database. It includes all wells for which a well completion report has been submitted and maintained. If a well was destroyed without issuance of a permit, then it will show up on the map as still active. The map does not necessarily show where pumping is concentrated since there is no differentiation between the different well uses. The figure generally indicates higher well densities in rural residential areas that are dependent on groundwater, so each household likely has its own well. **Figure 1-7** depicts the disadvantaged and severely disadvantaged communities (DAC, SDAC). Some of these communities have access to surface water, but most largely rely on groundwater through private or small system wells.

Table 1-3 shows the percent of area for each land-use classification. Permanent crops represent approximately 80.9%, followed by field/hay crops and idle/pasture each making up approximately 14.6%. The urban area is primarily made up by the City of Lindsay. A few small census designated places and single rural family help round out the approximately 4.5% of the total area.

Table 1-3 Land-Use in East Kaweah GSA

Land-Use Classification	Percent of Total Area
Citrus and Subtropical	69.5
Deciduous Fruits and Nuts	*8.1*
Field Crops	*6.5*
Grain and Hay Crops	*0.8*
Idle	*4.1*
Pasture	*3.2*
Truck Nursery and Berry Crops	*0.2*
Urban	4.5
Vineyard	3.1
Total	100

Water use and water source for several agencies in the EKGSA are shown in **Table 1-4**. The only community water systems within EKGSA are for the City of Lindsay and communities of Strathmore, Tooleville, Tonyville, and Plainview. **Table 1-5** summarizes the water supply availability for CVP and Kaweah supplies since 1977.

Table 1-4 Water Uses and Water Sources

Agency / Water Company	Water Use	Water Source			
		CVP	Kaweah	Other Local	Groundwater*
City of Lindsay	Residential	X			X
Exeter Irrigation District	Agricultural	X			
Ivanhoe Irrigation District	Agricultural	X	X		
Lewis Creek Water District	Agricultural	X			
Lindmore Irrigation District	Agricultural	X			
Lindsay-Strathmore Irrigation District	Agricultural	X	X		X
Pioneer Ditch Company	Agricultural			X	
Plainview Mutual Water Company	Residential				X
Sentinel Butte Mutual Water Company	Agricultural		X		
Stone Corral Irrigation District	Agricultural	X			
Strathmore Public Utility District	Residential	X			X
Tooleville Mutual Nonprofit Water Assoc.	Residential				X
Tulare County	Agricultural	X			
Wutchumna Water Company	Agricultural		X		

**Landowners within the EKGSA and agencies own groundwater wells.*

Table 1-5 History of Water Availability

Year	Friant - Class 1	Friant - Class 2	Kaweah River
2018	88%	UcS*	60%
2017	100%	UcS	235%
2016	100%	0%	72%
2015	0%	0%	21%
2014	0%	0%	24%
2013	62%	0%	36%
2012	57%	0%	60%
2011	100%	20%	203%
2010	100%	15%	136%
2009	77%	18%	74%
2008	100%	5%	78%
2007	65%	0%	40%
2006	100%	UcS	167%
2005	100%	UcS	148%
2004	100%	8%	56%
2003	100%	5%	100%
2002	100%	8%	72%
2001	100%	5%	62%
2000	100%	17%	87%
1999	100%	20%	63%
1998	100%	10%	219%
1997	100%	60%	180%
1996	100%	58%	124%
1995	100%	100%	204%
1994	80%	0%	45%
1993	100%	90%	129%
1992	83%	0%	35%
1991	100%	0%	59%
1990	68%	0%	31%
No deficiencies on water deliveries 1978-1989			
1977	25%	0%	22%

**UcS indicates Uncontrolled Season*

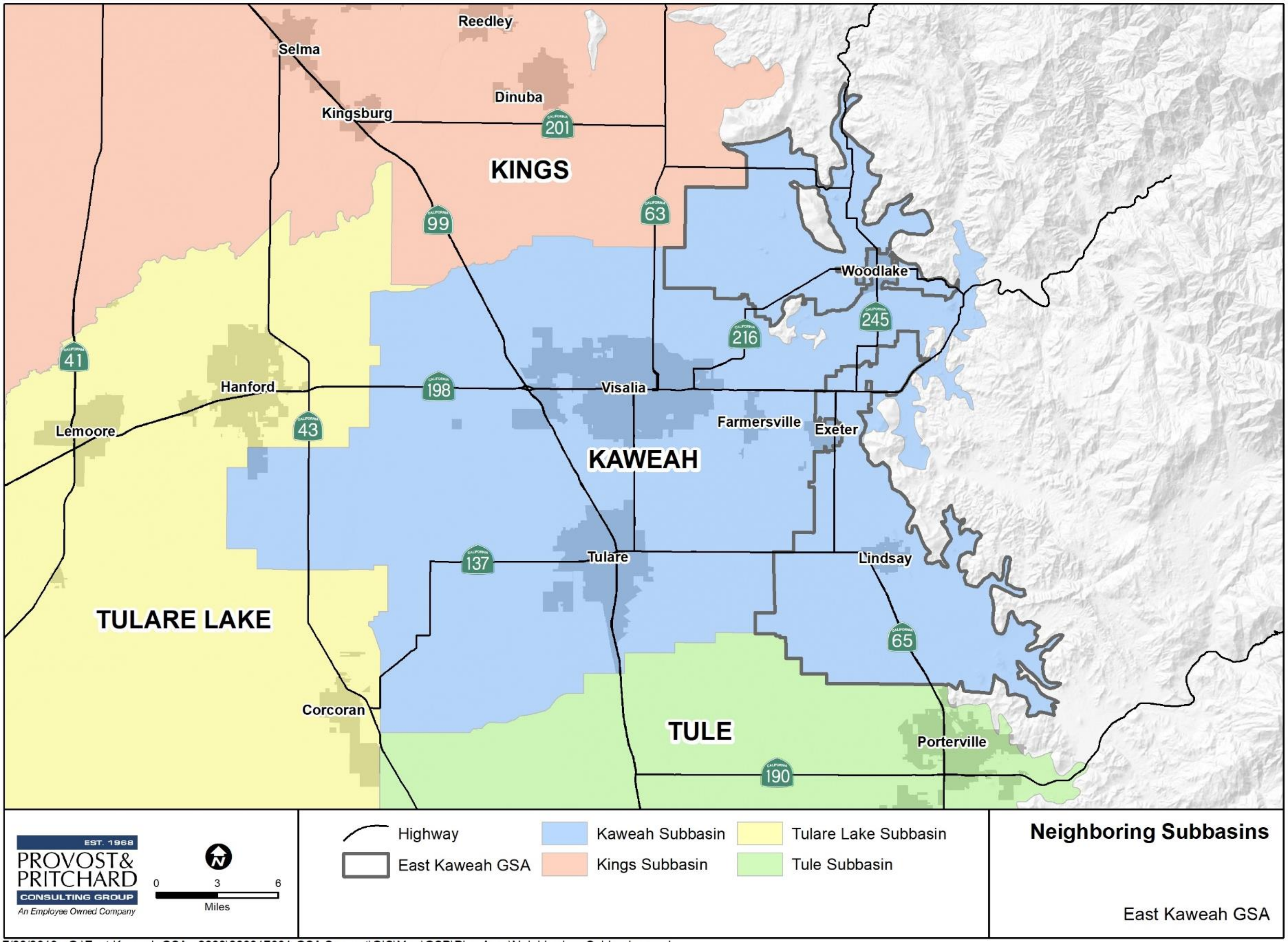

Figure 1-1 Groundwater Subbasins

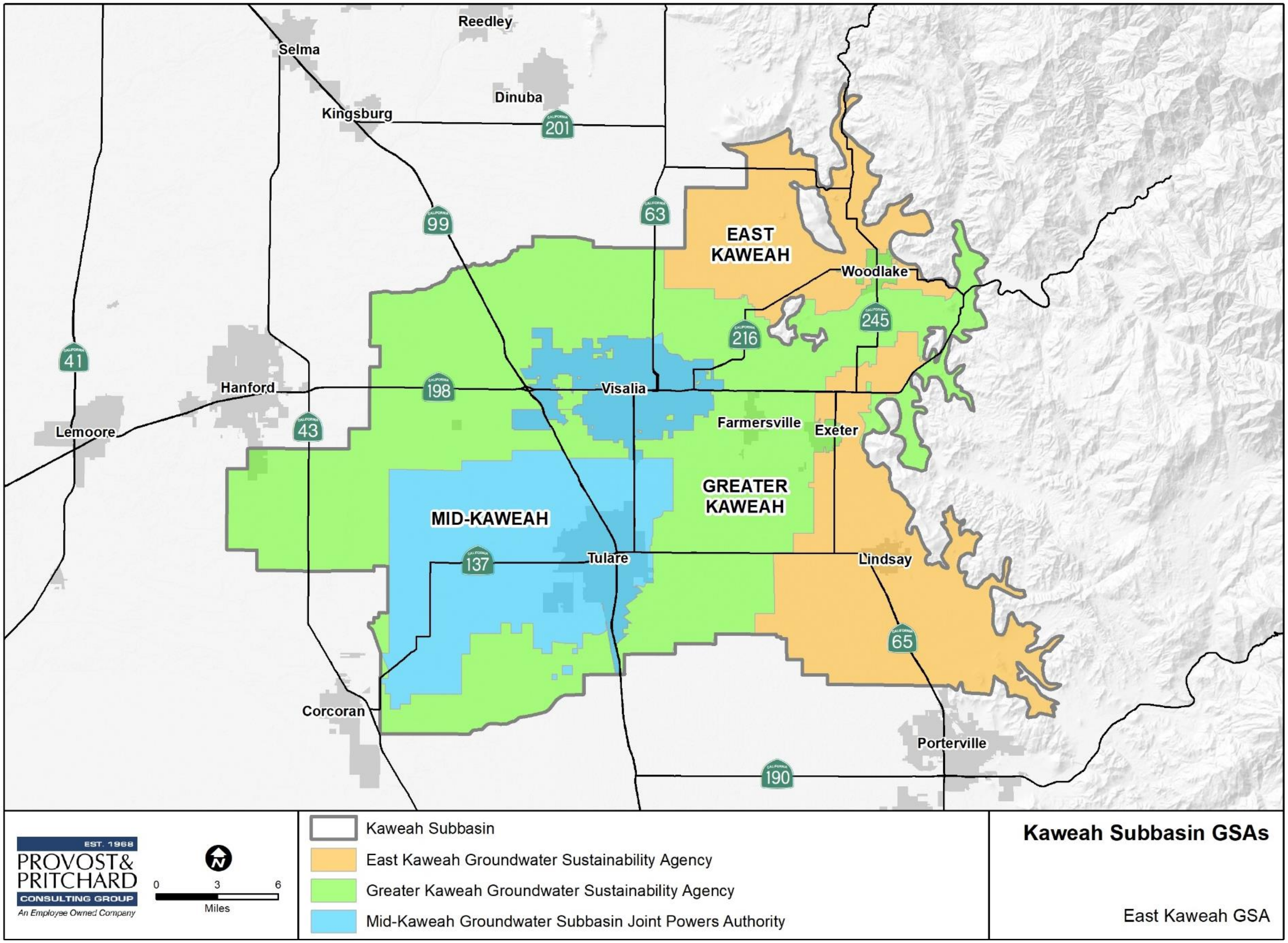

Figure 1-2 Groundwater Sustainability Agencies

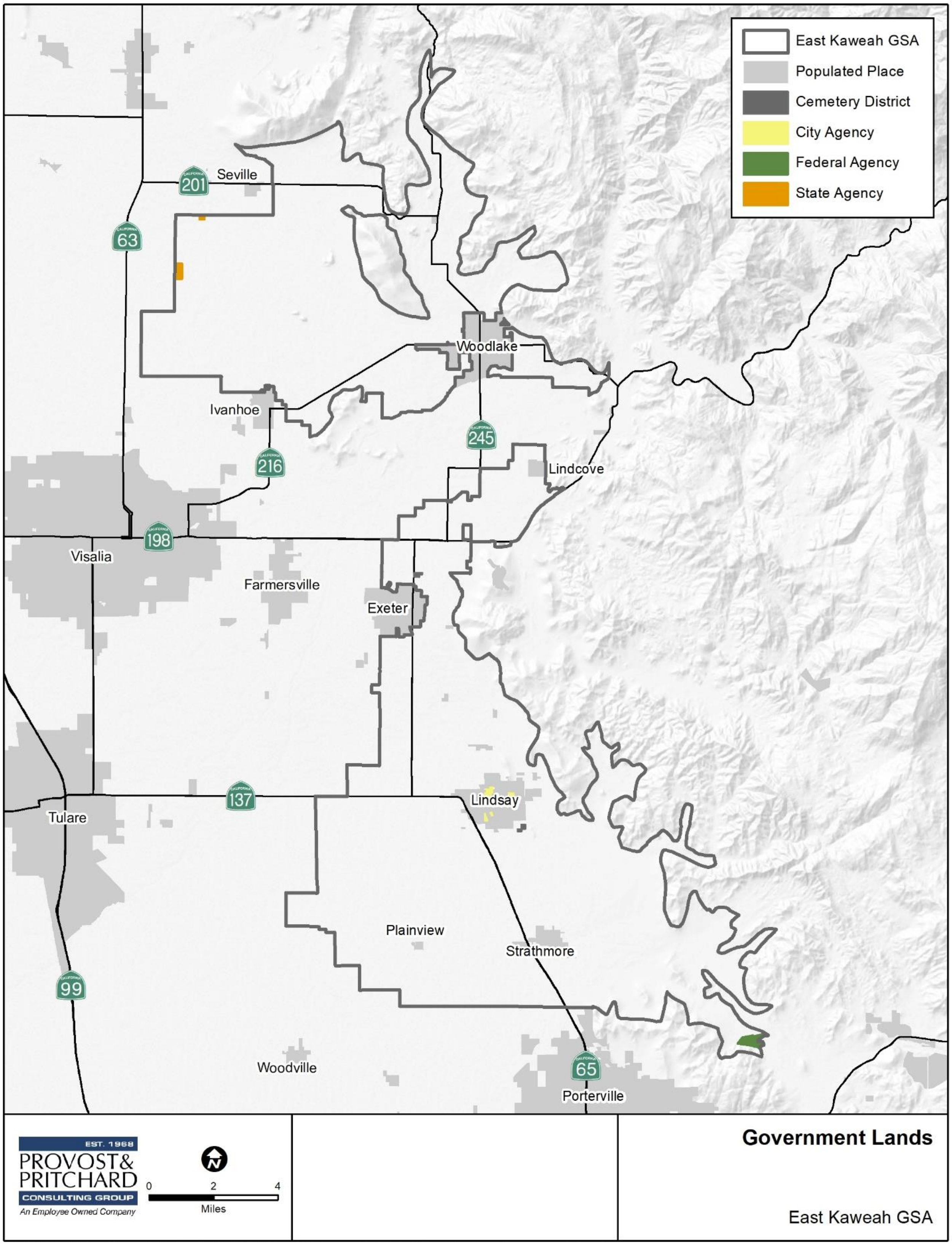

Figure 1-3 Government Lands

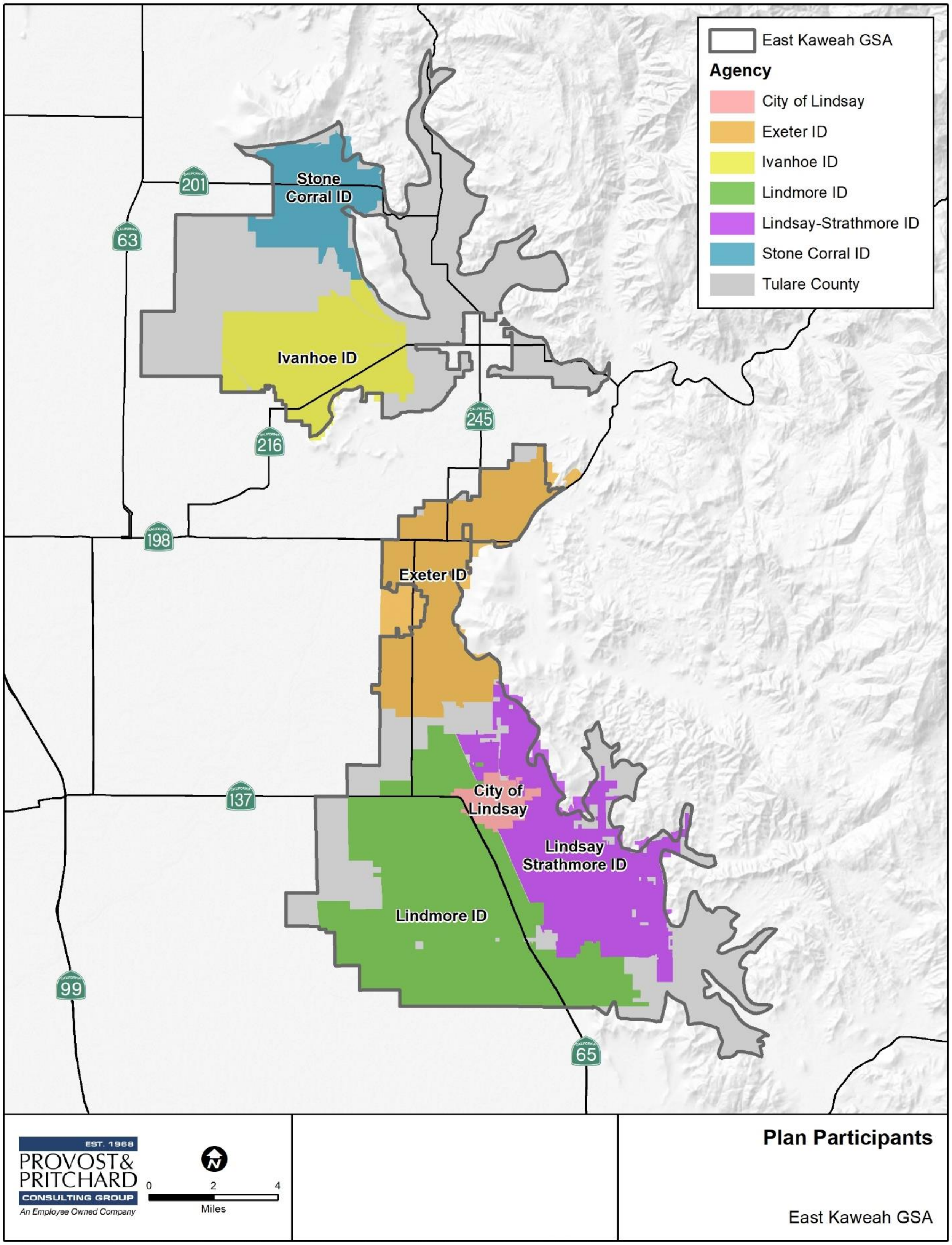

Figure 1-4 EKGSA Plan Participants

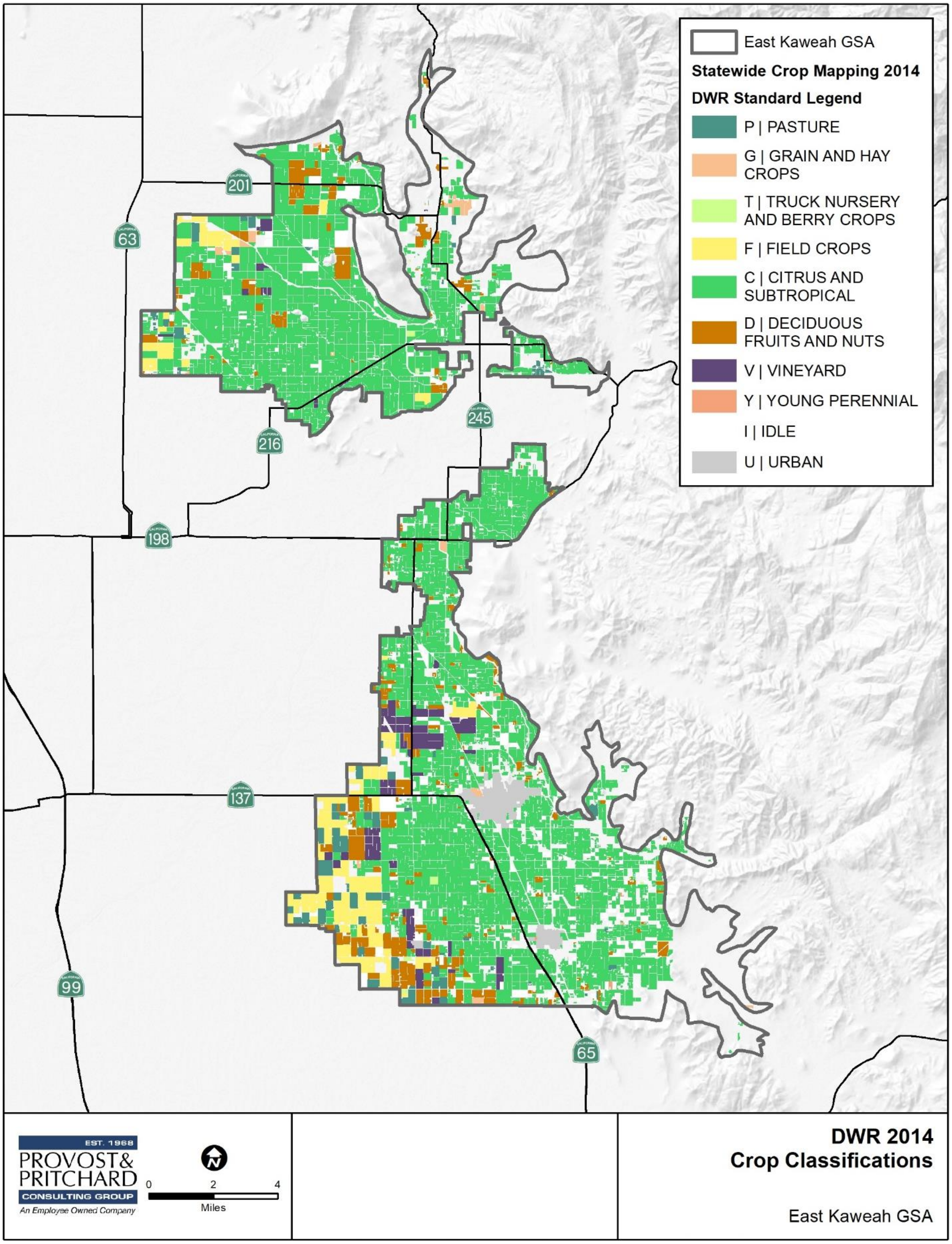

Figure 1-5 EKGSA Land Use

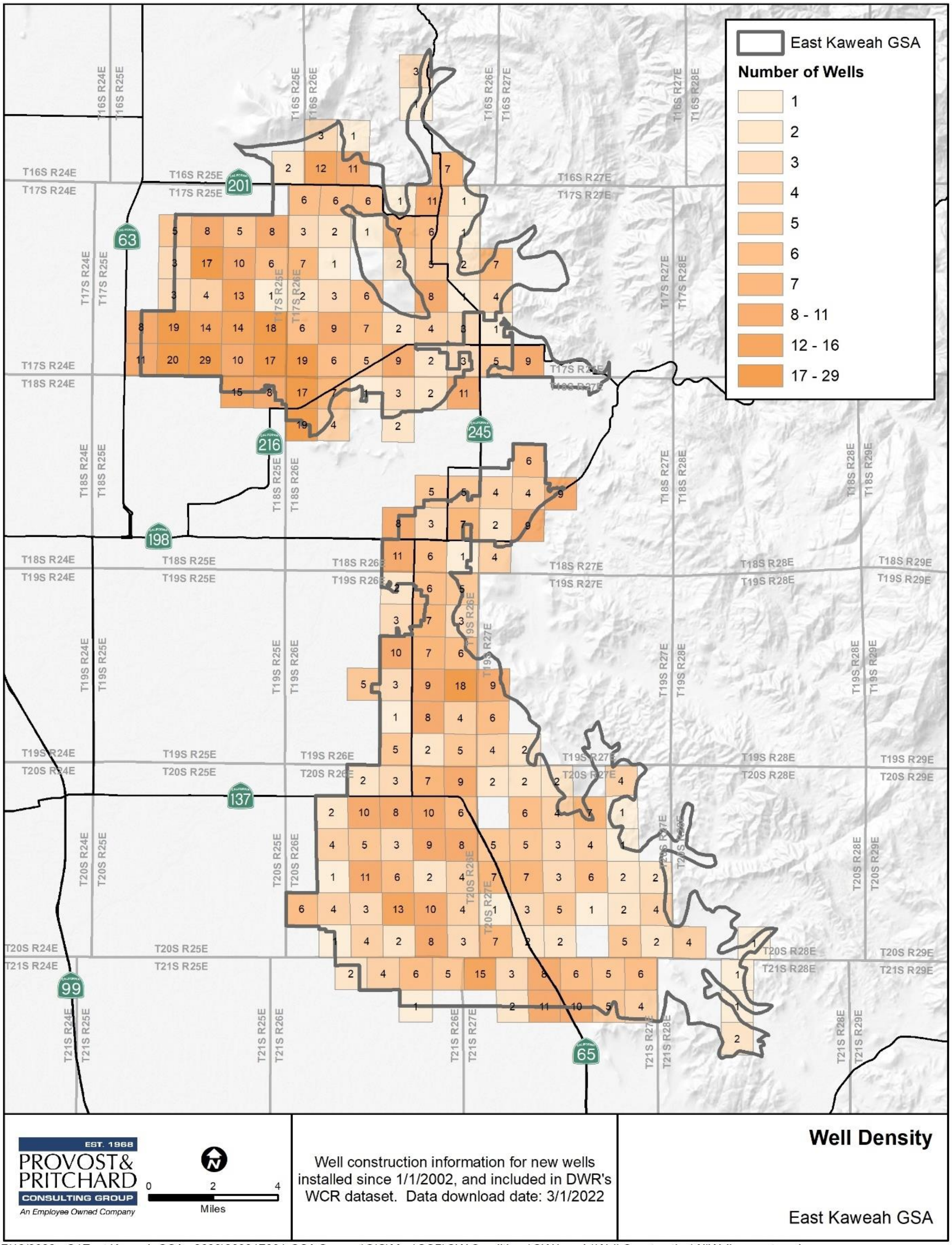

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Figure 1-6 Well Density

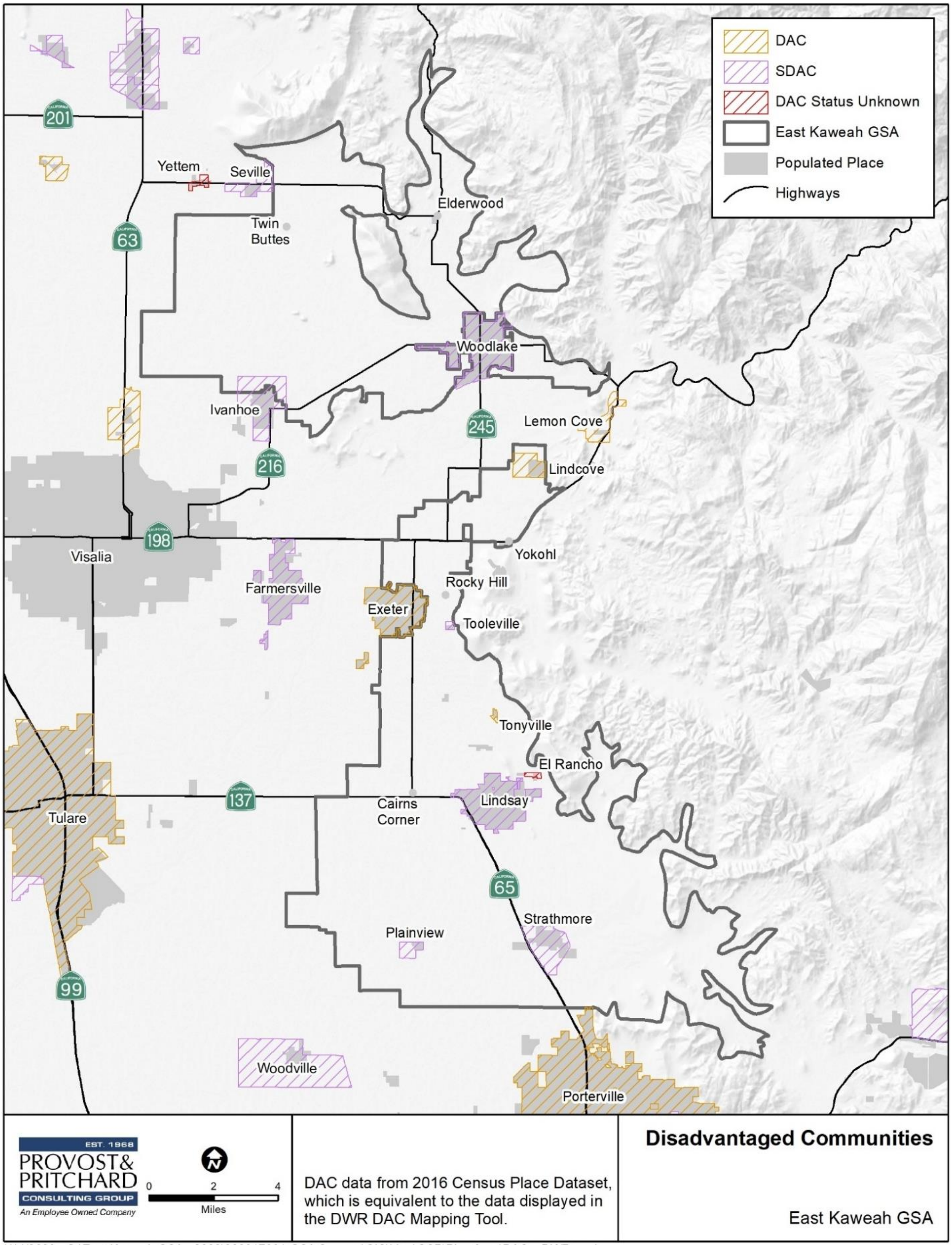


Figure 1-7 S/DAC in the EKGSA

1.4.3 General Plans in Plan Area

The GSA is subject to the Tulare County General Plan 2030 Update, which addresses seven mandatory elements: land use, circulation, housing, open-space, conservation, safety, and noise as those topics exist in the planning area.

A small portion of District 2 within Lindmore ID is subject to the Lindsay Land Use and Circulation Plan, Amendment 81-04 adopted by the Tulare County Board of Supervisors, Resolution 81-2346, on November 24, 1981. The document amended the Land Use and Circulation Elements of the Tulare County General Plan for the Lindsay Area.

The GSP area is subject to the Tulare County Zoning Ordinance, regulated by the Tulare County Resource Management Agency. The Ordinance establishes zones within the County and classifications of land uses and regulating land uses in such zones. Regulations also extend to the height of buildings, open spaces for light and ventilation. It also defines the terms and penalties for violation for adjustment, amendment and enforcement.

The GSP area is subject to the City of Lindsay's General Plan, adopted in July 1989. The General Plan addresses five elements: community development, resource management, hazardous management, and directions for interpretation and implementation.

1.4.3.1 County of Tulare General Plan

Tulare County's General Plan 2030 Update identifies policies and goals for growth within the County. Agriculturally designated areas will be maintained and will divert urban development from valuable agricultural lands (LU-2.1, Tulare County General Plan 2030 Update). The County will also encourage new major residential development near existing infrastructure and employment centers (LU-3.1, Tulare County General Plan 2030 Update). Industrial development is also planned near existing industrial development (LU-5.1, Tulare County General Plan 2030 Update). The GSP area is primarily rural and low density residential, outside of urban development boundaries (UDB), established by Tulare County. The County will require more water as industrial, residential and agricultural lands increase development. Although the GSP area is outside of most planned growth areas; the aquifers are not confined to the same planning boundaries. Tulare County's General Plan 2030 Update developed goals and policies to encourage sustainable groundwater management, some of which are listed below. The efforts established in the listed goals and policies are supportive of sustainable management alluded to in this GSP.

> LU-7.16 Water Conservation. The County shall encourage the inclusion of "extra-ordinary' water conservation and demand management measures for residential, commercial, and industrial indoor and outdoor water uses in all new urban development.
>
> WR-1.4 Conversion of Agricultural Water Resources. For new urban development, the County shall discourage the transfer of water used for agricultural purposes (within the prior ten years) for domestic consumption except in the following circumstances:
>
> > 1. The water remaining for the agricultural operation is sufficient to maintain the land as an economically viable agricultural use,
> >
> > 2. The reduction in infiltration from agricultural activities as a source of groundwater recharge will not significantly impact the groundwater basin.
>
> WR-1.5 Expand Use of Reclaimed Wastewater. To augment groundwater supplies and to conserve potable water for domestic purposes, the County shall seek opportunities to expand groundwater recharge efforts.

WR-1.6 Expand Use of Reclaimed Water. The County shall encourage the use of tertiary treated wastewater and household gray water for irrigation of agricultural lands, recreation and open space areas, and large landscaped areas as a means of reducing demand for groundwater resources.

WR-2.1 Protect Water Quality. All major land use and development plans shall be evaluated as to their potential to create surface and groundwater contamination hazards from point and non-point sources. The County shall confer with other appropriate agencies, as necessary, to assure adequate water quality review to prevent soil erosion; direct discharge of potentially harmful substances; ground leaching from storage of raw materials, petroleum products, or wastes; floating debris; and runoff from the site.

WR-2.2 National Pollutant Discharge Elimination System (NPDES) Enforcement. The County shall continue to support the State in monitoring and enforcing provisions to control non-point source water pollution contained in the U.S. EPA NPDES program as implemented by the Water Quality Control Board.

WR-2.3 Best Management Practices (BMPs). The County shall continue to require the use of feasible BMPs and other mitigation measures designed to protect surface water and groundwater from the adverse effects of construction activities, agricultural operations requiring a County Permit and urban runoff in coordination with the Water Quality Control Board.

WR-3.1 Develop Additional Water Sources. The County shall encourage, support and, as warranted, require the identification and development of additional water sources through the expansion of water storage reservoirs, development of groundwater banking for recharge and infiltration, promotion of water conservation programs, and support other projects and programs that intend to increase the water resources available to the County and reduce the individual demands of urban and agricultural users.

WR-3.2 Develop an Integrated Regional Water Management Plan. The County will participate with other agencies and organizations that share water management responsibilities in the County to enhance modeling, data collection, reporting and public outreach efforts to support the development and implementation of appropriate Integrated Regional Water Management Plans (IRWMP) within the County.

WR-3.3 Adequate Water Availability. The County shall review new development proposals to ensure the intensity and timing of growth will be consistent with the availability of adequate water supplies. Projects must submit a Will-Serve letter as part of the application process and provide evidence of adequate and sustainable water availability prior to approval of the tentative map or other urban development entitlement.

WR-3.4 Water Resource Planning. The County shall continue participation in State, regional, and local water resource planning efforts affecting water resource supply and quality.

WR-3.7 Emergency Water Conservation Plan. The County shall develop an emergency water conservation plan for County operated water systems to identify appropriate conservation policies that can be implemented during times of water shortages caused by drought, loss of one or more major sources of supply, contamination of one or more sources of supply, or other natural or man-made events.

WR-3.9 Establish Critical Water Supply Areas. The County shall designate Critical Water Supply Areas to include the specific areas used by a municipality or community for its water supply system, areas critical to groundwater recharge, and other areas possessing a vital role in the management of the water resources in the County, including those areas with degraded groundwater quality.

WR-3.10 Diversion of Surface Water. Diversions of surface water or runoff from precipitation should be prevented where such diversions may cause a reduction in water available for groundwater recharge.

PFS-1.3 Impact Mitigation. The County shall review development proposals for their impacts on infrastructure (for example, sewer, water, fire stations, libraries, streets, etc.). New development shall be required to pay its proportionate share of the costs of infrastructure improvements required to serve the project to the extent permitted by State law. The lack of available public or private services or adequate infrastructure to serve a project, which cannot be satisfactorily mitigated by the project, may be grounds for denial of a project or cause for the modification of size, density, and/or intensity of the project.

PF-1.4 Available Infrastructure. The County shall encourage urban development to locate in existing UDBs and Hamlet Development Boundaries (HDBs) where infrastructure is available or may be established in conjunction with development. The County shall ensure that development does not occur unless adequate infrastructure is available, that sufficient water supplies are available or can be made available, and that there are adequate provisions for long term management and maintenance of infrastructure and identified water supplies.

PF-2.2 Modification of Community UDB.

> 2. Prior to approval of a UDB boundary expansion, the County shall ensure that infrastructure can be provided to serve the new areas added to the UDB and that sufficient water supplies are also available. This may require preparation of an infrastructure master plan that includes methods of financing of improvements and maintenance, as well as representation/documentation of availability and sufficiency of long-term water supplies.

PFS-2.3 Well Testing. The County shall require new development that includes the use of water wells to be accompanied by evidence that the site can produce the required volume of water without impacting the ability of existing wells to meet their needs.

PFS-2.4 Water Connections. The County shall require all new development in UDBs, Urban Area Boundaries (UABs), Community Plans, Hamlet Plans, Planned Communities, Corridor Areas, Area Plans, existing water district service areas, or zones of benefit, to connect to the community water system, where such system exists. The County may grant exceptions in extraordinary circumstances, but in these cases, the new development shall be required to connect to the water system when service becomes readily available.

PFS-2.5 New Systems or Individual Wells. Where connection to a community water system is not feasible per PFS-2.4: Water Connections, service by individual wells or new community systems may be allowed if the water source meets standards for quality and quantity.

PFS-4.5 Detention/Retention Basins Design. The County shall require that stormwater detention/ retention basins be visually unobtrusive and provide a secondary use, such as recreation, when feasible.

PFS-4.6 Agency Coordination. The County shall work with the Army Corps of Engineers and other appropriate agencies to develop stormwater detention/retention facilities and recharge facilities that enhance flood protection and improve groundwater recharge.

PFS-4.7 NPDES Enforcement. The County shall continue to monitor and enforce provisions to control non-point source water pollution contained in the U.S. Environmental Protection Agency NPDES program.

PFS-7.2 Fire Protection Standards. The County shall require all new development to be adequately served by water supplies, storage, and conveyance facilities supplying adequate volume, pressure, and capacity for fire protection.

Housing Policy 2.21. Require all proposed housing within the development boundaries of unincorporated communities is either (1) served by community water and sewer, or (2) that physical conditions permit safe treatment of liquid waste by septic tank systems and the use of private wells.

Housing Policy 4.13. Promote energy efficiency and water conservation.

Table 1-6 lists all General Plan water resources policies. These policies can be found in their entirety in the Tulare County General Plan.

Table 1-6. Tulare County General Plan Policies

Tulare County General Plan Policies	
Policy Number	**Title**
WATER SUPPLY	
WR-1.1	Groundwater Withdrawal
WR-1.3	Water Export Outside County
WR-1.4	Conversion of Agricultural Water Resources
WR-1.5	Expand Use of Reclaimed Wastewater
WR-1.6	Expand Use of Reclaimed Water
WR-1.7	Collection of Additional Groundwater Information
WR-1.8	Groundwater Basin Management
WR-1.9	Collection of additional Surface Water Information
WR-1.10	Channel Modification
WR-3.1	Develop Additional Water Sources
WR-3.2	Develop an Integrated Regional Water Master Plan
WR-3.3	Adequate Water Availability
WR-3-4	Water Resource Planning
WR-3.5	Use of Native and Drought Tolerant Landscaping
WR-3.6	Agricultural Irrigation Efficiency
WR-3.7	Emergency Water Conservation Plan
WR-3.8	Educational Programs
WR-3.9	Establish Critical Water Supply Areas
WR-3.10	Diversion of Surface Water
WR-3.11	Policy Impacts to Water Resources
WR-3.12	Joint Water Projects with Neighboring Counties
WR-3.13	Coordination of Watershed Management on Public Land
PFS-2.1	Water Supply
PFS-2.2	Adequate Systems
PFS-2.3	Well Testing

Tulare County General Plan Policies	
Policy Number	**Title**
WATER SUPPLY	
PFS-2.5	New Systems or Individual Wells
WATER QUALITY	
WR-1.2	Groundwater Monitoring
WR-1.7	Collection of Additional Groundwater Information
WR-1.8	Groundwater Basin Management
WR-2.1	Protect Water Quality
WR-2.2	NPDES Enforcement
WR-2.3	Best Management Practices
WR-2.4	Construction Site Sediment
WR-2.5	Major Drainage Management
WR-2.6	Degraded Water Resources
WR-2.7	Industrial and Agricultural Sources
WR-2.8	Point Source Control
WR-2.9	Private Wells
PFS-2.1	Water Supply
PFS-2.5	New Systems or Individual Wells

The following are a list of communities within EKGSA that have a Hamlet, Community or Legacy Plan. These communities are in unincorporated areas and they fall under the jurisdiction of Tulare County and as such are subject to the goals, objectives and policies found within the Tulare County General Plan. The EKGSA will consider growth, water quality, and water quantity within these communities when assessing potential actions and management while implementing the GSP.

1.4.3.1.1 Lindcove Hamlet Plan

Lindcove is currently designated as a Hamlet in the 2030 Tulare County General Plan (2012). Lindcove is a census-designated place (CDP) located in the northeastern portion of Tulare County. It is bounded by Avenue 312 in the south, Boston Avenue in the north, Road 226 in the west, and Road 228 in the east and encompasses 0.7 square miles of land. It is not directly served by any State Route.

Lindcove is a private well community where residents own and maintain their own well. Residents have expressed that they are interested in exploring their options for connecting to a neighboring community water system, they understand that this may include an initial cost and would result in paying a monthly water bill. Some residents are concerned with their water quality and perceive their water to be unsafe to drink. Most families do not drink the water from their tap, they either buy bottled water or have a water filtration system. In 2014, Self-Help Enterprises (SHE) tested nine water wells in Lindcove. Four of the nine wells had Total Coliform present, all nine wells tested over the MCL for Nitrates and four wells exceeded the MCL for 1,2,3-TCP. Lindcove also lacks a sanitary sewer service and relies on individual or community septic systems.

According to the Lindcove Hamlet Plan (2017), Lindcove has a projected growth rate of 1.3%, which is consistent with the rest of the County. Any development within the community of Lindcove is subject to the goals and policies set forth in the Tulare County General Plan encouraging sustainable groundwater management.

1.4.3.1.2 Plainview Community Plan

As an unincorporated community, Plainview contains a mixture of residential, neighborhood commercial, religious establishments, and limited industrial areas similar to the type of land uses found in incorporated places within Tulare County. Farm and Agricultural land use bound Plainview on the north, east, south, and western portions of Plainview's urbanized area. Plainview is currently designated an unincorporated community in the 2030 Tulare County General Plan (2012).

Plainview is located within the Lindmore ID. Lindmore ID serves agricultural water to properties in the vicinity of the community of Plainview. The Plainview Mutual Water Company (PMWC) provides water to Plainview residents. According to the Plainview Community Plan (2019), Plainview has a projected growth rate of 1.3%, which is consistent with the rest of the unincorporated areas within the County.

Any development within the community of Plainview is subject to the goals and policies set forth in the Tulare County General Plan encouraging sustainable groundwater management.

1.4.3.1.3 Strathmore Community Plan

Strathmore is currently designated an unincorporated community in the 2030 Tulare County General Plan (2012). It is located on the east side of the San Joaquin Valley near the base of the Sierra Nevada Mountains in the southeastern area of the EKGSA. Strathmore lies within the Kaweah Watershed and receives its water supply primarily from the Friant Division CVP and operations of Lake Millerton. The Strathmore Public Utility District operates a water supply and distribution system under the jurisdiction of the California Department of Health Services Division (CDHSD) of Drinking Water and Environmental Management. Strathmore has approximately 455 drinking water connections as of May 2012.

According to the Strathmore Community Plan (2017), Strathmore has a projected growth rate of 1.3%, which is consistent with the rest of the unincorporated areas within the County.

Any development within the community of Strathmore is subject to the goals and policies set forth in the Tulare County General Plan encouraging sustainable groundwater management.

1.4.3.1.4 Tonyville Hamlet Plan

The community of Tonyville is located on the east side of the San Joaquin Valley and is a CDP located in Tulare County. It is bounded by Avenue 252 to the south, Avenue 254 to the north, and Road 216 to the west and encompasses 0.05 square miles of land. Tonyville is currently designated as a Hamlet in the 2030 Tulare County General Plan (2012).

Domestic water service in Tonyville is provided by the Lindsay-Strathmore ID and sanitary sewer service is provided by Tulare County. Tonyville does not currently have a storm drainage system.

According to the Tonyville Hamlet Plan (2017), Tonyville has a projected growth rate of 1.3%, which is consistent with the rest of the unincorporated areas within the County.

Any development within the community of Tonyville is subject to the goals and policies set forth in the Tulare County General Plan encouraging sustainable groundwater management.

1.4.3.1.5 Tooleville Legacy Plan

The Tooleville CDP is a small rural community located on the east side of Spruce Road (Road 204) roughly a mile and a half east of the City of Exeter in Tulare County.

Tooleville Mutual Non-Profit Water Association is a small mutual water company run by a five-member board. Tooleville has two undependable water wells and is planning to drill a new well once the location has been determined. They are activity searching for potential well sites in Tooleville and neighboring Exeter. Tooleville is exploring the different ways that could potentially partner with Exeter by reviewing three options: water wheeling, master meter or full consolidation with the City of Exeter. Tooleville residents report that the community does not have adequate storm water drainage.

Any development within the community of Tooleville is subject to the goals and policies set forth in the Tulare County General Plan encouraging sustainable groundwater management.

1.4.3.2 City of Lindsay General Plan

The City of Lindsay's 1989 General Plan is due for an update, and is missing additional mandatory elements, (mandated by the State), that would analyze groundwater sustainability, as it applies in current and projected times. A General Plan Update for the City of Lindsay is currently underway, completion of the general plan update is anticipated in late 2019.

1.4.4 Plan Elements from CWC Section 10727.4

Legal Requirements:
§354.8(g) A description of any of the additional Plan elements included in the Water Code Section 10727.4 that the Agency determines to be appropriate.

The EKGSA and Kaweah Subbasin agencies already have several protective practices for groundwater sustainability and protection. This section will describe some of those elements applicable to SGMA compliance that may not be further discussed in the GSP.

1.4.4.1 Wellhead Protection

A wellhead protection area (WHPA) is a surface and subsurface land area regulated to prevent contamination of a well or well-field supplying a public water system. This program, established under the Safe Drinking Water Act (SDWA) (42 U.S.C. 330f-300j), is implemented through state governments. The WHPA may also be the recharge area that provides the water to a well or wellfield. WHPAs can vary in size and shape depending on subsurface geologic conditions, the direction of groundwater flow, pumping rates and aquifer characteristics.

While the Wellhead Protection Program (WHPP) was established following the 1986 amendments to the Federal SDWA, the program was designed to protect groundwaters that supply drinking water to wells at public water systems across the nation. The 1996 Federal SDWA amendments require each state to develop and implement a Source Water Assessment Program. Section 11672.60 of the California Health and Safety Code requires the Department of Health Services (DHS, the precursor to CDPH) to develop and implement a program to protect sources of drinking water, specifying that the program must include both a source water assessment program and a wellhead protection program. In response to both legal mandates, DHS developed the Drinking Water Source Assessment and Protection (DWSAP) Program.

California's DWSAP Program addresses both groundwater and surface water sources. The groundwater portion of the DWSAP Program serves as the State's wellhead protection program. In developing the surface water components of the DWSAP Program, DHS integrated the existing requirements for watershed sanitary surveys. DHS submitted the DWSAP Program in January 1999. The United States Environmental Protection Agency (EPA) approved the DWSAP as California's wellhead protection program in January 1999. In November 1999, EPA gave final approval of the DWSAP Program as California's sources water assessment and protection program. DHS was responsible for the completion of all assessments by May 2003.

http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/Documents/DWSAPGuidance/DWSAP_document.pdf.

WHPPs are not regulatory in nature, nor do they address specific sources. They are designed to focus on the management of the resource rather than control a limited set of activities or contaminant sources. Contaminants from the surface can enter an improperly designed or constructed well along the outside edge of the well casing or directly through openings in the wellhead. A well is also the direct supply source to the customer, and such contaminants entering the well could then be pumped out and discharged directly into the distribution system. Therefore, essential to any WHPP are proper well design, construction, and site grading to prevent intrusion of contaminants into the well from surface sources.

Wellhead protection is performed primarily during design and can include requiring annular seals at the well surface, providing adequate drainage around wells, constructing wells at high locations, and avoiding well locations that may be subject to nearby contaminated flows. Wellhead protection is required for potable water supplies and is not generally required, but is still recommended, for agricultural wells.

Municipal and agricultural wells constructed by the member agencies are designed and constructed in accordance with Tulare County code requirements. A permit is needed from the County to construct a new well. In addition, the member agencies encourage landowners to follow the same standard for privately owned wells. Tulare County Code Part IV. Article 9 provides specifications pertaining to wellhead protection:

- Location of wells
- Casings – casing materials and casing thickness
- Methods for sealing the well from intrusion of surface contaminants
- Covering or protecting the boring at the end of each day from potential pollution sources or vandalism
- Site grading to assure drainage is away from the wellhead.

1.4.4.2 Well Construction Policies

Proper well construction is important to ensure reliability, longevity, and protection of groundwater resources from contamination. Tulare County has adopted a well construction permitting program consistent with State Well Standards (DWR Bulletin 74-81 and 74-90) to help assure proper construction of private wells. The County maintains records of all wells drilled in the area. As of September 2017, the implementation of the Tulare county new well ordinance took effect. This ordinance among other things place restrictions on the drilling of new wells on previously non-irrigated land where the land has not had a well or has not had surface water in the past. Drilling a new well or deepening or destroying existing wells requires a County permit. Usually, the process takes about a week. Under the authority of the Health Officer, staff from Tulare County Environmental Health Division can assist to ensure accuracy and timeliness of permits processed for the unincorporated areas of Tulare County. Electrical connection and other associated permits may be required by the Tulare County Resource Management Agency. State Well Standards also address annular seals, surface features, well development, water quality testing and various other topics. Well construction policies intended to ensure proper wellhead protection are discussed in Wellhead Protection Section above.

1.4.4.3 Well Abandonment/Well Destruction Program

Well abandonment generally includes properly capping and locking a well. Tulare County Code stipulates that any well, which has been placed inactive for a period of more than one (1) year shall be deemed abandoned and be required to properly destroyed unless the owner provides evidence of his intentions for continued use. Well destruction includes completely filling in a well in accordance with standard procedures. Proper well destruction and abandonment accomplishes the following: 1) eliminates the physical hazard of the well, 2) eliminates a pathway for migration of contamination, and 3) prevents hydrologic changes in the aquifer system, such as the changes in hydraulic head and the mixing of water between aquifers. They are necessary to protect groundwater resources and public safety.

The administration of a well construction, abandonment, and destruction program has been delegated to the Counties by the State legislature. Tulare County requires that wells be abandoned according to Tulare Code Part IV. Article 13. Defective, Inactive, and Well Destruction Standards. Enforcement of the well abandonment policies is faced with the limitations in staff and funding.

The EKGSA, in cooperation with the County, will strive to properly destroy any of their wells that are no longer used and will encourage proper well destruction procedures for private wells. In addition, the EKGSA may request that some unusable wells be converted to monitoring wells, rather than destroy them, so that they can become a cost-effective way to bolster the EKGSA's groundwater monitoring network.

1.4.4.4 Replenishment of Groundwater

Groundwater replenishment happens through direct recharge and in-lieu recharge. According to DWR, water used for direct recharge most often comes from flood flows, water conservation, recycled water, desalination and water transfers. During the hydrologic cycle, replenishment occurs naturally when rain, stormwater, and the flow from rivers, streams and creeks seep into an aquifer. Water also gets into ground as farmers irrigate fields and orchards. Replenishment within the context of groundwater management is accomplished through recharge at a rate that exceeds baseline conditions, maintaining or improving groundwater elevation levels. Primary recharge methods available in the Kaweah Subbasin are direct spreading of water and in-lieu recharge where an alternative source (i.e. surface water) is provided to users who would normally use groundwater, thereby leaving groundwater in place for later use and increasing the potential to improve groundwater levels.

In the EKGSA and Kaweah Subbasin, the primary surface water sources for groundwater replenishment include precipitation, Kaweah River flows, and San Joaquin River water via Friant CVP contracts. The EKGSA aims to develop several recharge, storage, conservation, and/or water recycling projects utilizing these supplies. The EKGSA will also strive to identify funding and implement regional projects that help the region achieve groundwater sustainability. This can include recharge projects that take advantage of areas conducive to recharge and areas where recharge provides the most benefits, thereby reducing the burden on certain agencies from having to recharge in their boundaries if they do not have suitable land or soils. The Project and Management Actions to Achieve Sustainability Chapter (Chapter 5) provides descriptions, estimated costs, and estimated yield for numerous proposed projects.

1.4.4.5 Conjunctive Use

Conjunctive use of water relates to the combined use of ground and surface water, thus augmenting the water supply and providing higher water reliability. Conjunctive use functions such that surface water supplies are used during wet years, so that groundwater can be saved for use during dry periods. Many of the agencies within the East Kaweah, like much of the Kaweah Subbasin, operate the aquifer in a conjunctive manner. Agencies use their surface water, when available, to meet demands, or to recharge for later use. When surface water supplies are not available, agencies utilize groundwater to meet demands.

1.4.4.6 Efficient Water Management Practices

Water management is an important element of irrigated crop production. Efficient irrigation systems and water management practices can help maintain farm profitability in an era of limited, higher-cost water supplies. Efficient water management may also reduce the impact of irrigated production on offsite water quantity and quality. As is often the case, technology is not the whole solution anywhere, but part of the solution almost everywhere. Water conservation has been, and will continue to be, an important tool in local water management, as well as a key strategy in achieving sustainable groundwater management. Recycled water use is considered as an efficient water practice. Where possible, this practice is already being utilized by members of the EKGSA. Future efforts will look to bolster efficient water management and use of recycled water.

1.4.4.7 Relationships with State and Federal Agencies

From a regulatory standpoint, the EKGSA members have numerous relationships with State and Federal agencies related to flood water supply, water quality, and water management. The relationship most unique to the EKGSA area is the relationship with the United States Bureau of Reclamation (Reclamation) for Friant CVP supplies of the San Joaquin River. Six of the seven EKGSA member agencies have contracts with Reclamation. The Friant Dam is owned and operated by Reclamation. Reclamation is also the lead agency for the San Joaquin River Restoration, which has resulted in significant delivery curtailments to Friant contractors.

EKGSA members are also eligible to receive grants from various agencies for water-related projects. Grants can be obtained from Reclamation, DWR, SWRCB, and others. The EKGSA will work to track grant programs and, when successful, administer and implement grant contracts.

1.4.4.8 Land Use Planning

Tulare County and the City of Lindsay are the only member agencies with direct land use planning authority. However, all the member agencies have an interest in land use planning policies, and how it will impact their continued development and water supplies. **Figure 1-5** is a map showing land use in the EKGSA area, including areas that are developed for agriculture and urban use.

Land use policies are documented in various reports such as General Plans, Specific Plans, and plans for proposed developments. Updating some of these plans is a multi-year process and not all could be fully updated concurrently with the GSP development. These plans are anticipated to be modified gradually over time as the EKGSA and Tulare County work to meet the goals and objectives of this GSP. Some smaller communities have no formal land use policies or rely on County policies.

1.5 Notice and Communication

1.5.1 Participating Agencies

Legal Requirements: **§354.8(b)** A written description of the Plan area, including a summary of the jurisdictional areas and other features depicted on the map.

There are seven participating member agencies in the EKGSA. They are: City of Lindsay, County of Tulare, Exeter ID, Ivanhoe ID, Lindmore ID, Lindsay-Strathmore ID, and Stone Corral ID. A description of these entities is provided below.

1.5.1.1 City of Lindsay

The City of Lindsay (City) is in Tulare County, near the base of the Sierra Nevada Mountains in the San Joaquin Valley. The City has a small, but growing population of 13,417 in 2015 and is expected to reach 15,408 by year 2030. Average Day Demands (ADD) for 2015 is estimated at 2.48 million gallons per day (MGD). By sustaining a usage rate of 199 gallon per capita per day, the City's 2030 ADD would be 2.82 MGD. The City's water is supplied from both surface and groundwater sources. Surface water is provided through a CVP Class 1 long-term contract from Reclamation for 2,500 AF. The City has 3 existing deep wells. Two wells are active, and one well is emergency standby only. Surface water enters the City's infrastructure through a turnout at the FKC, located 1.3 miles east of the City limits, and travels through dual 12-inch pipes to the Surface Water Treatment Plant (SWTP). The SWTP is capable of producing up to 1,800 gallon per minute (GPM). During peak demand periods when surface water is available, the SWTP is the primary water supply source with the groundwater supplementing the supply as necessary. Annual Reclamation allocations can affect how Lindsay manages primary and supplemental water sources. Surface water deliveries are halted when the FKC is taken offline for general maintenance or dewatering. Typical FKC timeframe for maintenance and dewatering is every third year targeting low demand months November through February. When surface water supply is unavailable, the City is dependent exclusively on groundwater.

1.5.1.2 County of Tulare

Tulare County was first formed in 1852 with a larger land area. Sections of the County were later given to Fresno, Kern, Inyo, and Kings Counties with the most recent separation in 1893. The county has a total area of 4,839 square miles of which 4,824 square miles is land and 14 square miles (0.3%) is water. Major watercourses are the Kaweah River, St. John's River, Tule River, and Friant-Kern Canal. The western side of the County is within the San Joaquin Valley and is bordered by Kings County, while eastern part stretches across the Sierra Nevada and is bordered by Inyo County to the east. The San Joaquin Valley floor, between the Sierra Nevada and coastal ranges, is fifty to sixty miles wide and has an elevation near the City of Visalia (the county seat) of about 330 feet. The United States Census reported that as of July 1, 2017 Tulare County is estimated to have a population of 464,493. Tulare County is home to 8 incorporated communities, all located on the Valley floor. Over 40% of the County's total population resides in the Visalia and Tulare metropolitan area. Within the EKGSA area, about 41,428 acres (approximately 35% of the GSA area) are located outside of the irrigation/water districts' service areas and constitute the County's "white spaces" area *(SGMA legislation addresses unmanaged areas or "white spaces" within a groundwater basin through the presumption that the overlying county(s) will become the responsible for these areas (Water Code §10724(a))*). They rely solely on private groundwater wells. Domestic water demands are met by private domestic and/or community wells.

1.5.1.3 Exeter Irrigation District

The Exeter Irrigation District (EID) is located in northwest Tulare County east of Visalia with headquarters in Exeter, California. The district encompasses approximately 15,000 acres, of which about 12,700 acres are irrigated, and serves agricultural landowners primarily growing permanent crops.

EID has a contract with Reclamation for Friant Division CVP supplies, EID's contract (Contract No. 175r-2508D) is for 11,500 AF Class 1 and 19,000 AF Class 2. The District has 60 miles of reinforced concrete pipeline. The District does not own wells; therefore, groundwater is extracted through privately owned wells when surface supplies are unavailable.

1.5.1.4 Ivanhoe Irrigation District

Ivanhoe Irrigation District (IID) is located in Tulare County northeast of Visalia. IID encompasses approximately 11,000 acres, of which 10,000 are irrigated. The St. Johns River lies to the south, and Cottonwood Creek cuts through the northeastern corner of the District.

IID was formed in 1948, and in 1949 entered into a long-term contact with Reclamation for Friant CVP supplies. The Contract amounts are for 6,500 AF Class 1 and 500 AF of Class 2 water. In addition, Ivanhoe ID owns shares of Wutchumna Water Company stock for water from the Kaweah River.

In 2010, IID along with the Kaweah Delta Water Conservation District (KDWCD), executed a resources exchange in which KDWCD became a long-term Friant Division CVP contractor through a partial contract assignment from IID totaling 1,200 AF of Class 1 water and 7,400 AF of Class 2 water. In exchange for the partial assignment, IID received KDWCD's water supply from the Longs Canal Company, 2,500 AF of storage capacity in Lake Kaweah, and a cash payment.

IID has 48 miles of pipeline and three groundwater recharge areas over approximately 15 acres, as well as approximately three miles of Cottonwood Creek which are also used for recharge purposes. IID does not own or operate groundwater extraction facilities. Therefore, landowners must provide their own wells to sustain irrigation during periods when IID does not have surface water supplies available.

1.5.1.5 Lindmore Irrigation District

The Lindmore Irrigation District (LID) is located in Tulare County near the City of Lindsay, approximately 18.7 miles southeast of Visalia and is adjacent to the northern edge of the City of Porterville limits. Lewis Creek runs through the northern portion of the District. LID has over 27,000 acres, of which between 23,000 and 24,000 are irrigated. LID lands are contained entirely within the Kaweah Subbasin. The District was organized March 6, 1937, for securing a supplemental water supply from the United States Bureau of Reclamation's (Reclamation) Central Valley Project (CVP). The District was organized under California laws pertaining to the formation and operation of irrigation districts.

The District had no canal or ditch system and development had been brought about entirely by irrigation from privately owned wells. Accordingly, on February 28, 1948, Contract No. 174r-1635 was entered with Reclamation for a water supply from the Friant-Kern Canal (FKC) as part of the Friant Division of the CVP. The CVP contract amounts are 33,000 AF Class 1 and 22,000 AF Class 2. The Contract also included the construction of LID's concrete pipe distribution system, which includes approximately 170 miles of pipeline. LID has six reservoirs, two of which are unlined lending to approximately 35 acres for groundwater recharge, as well two pilot dry-wells used for recharge purposes. LID does not own or operate groundwater extraction facilities. Therefore, landowners must provide their own wells to sustain irrigation during periods when LID does not have surface water supplies available.

1.5.1.6 Lindsay-Strathmore Irrigation District

The Lindsay-Strathmore Irrigation District (LSID) is located in Tulare County with headquarters in Lindsay. The District extends approximately from Tonyville to Strathmore. Lewis Creek runs through the northern portion of the District and the FKC runs the length of the District from north to south. LSID was formed in 1915 and encompasses approximately 15,400 acres, of which about 12,700 acres are irrigated, and serves both agricultural and municipal/industrial water users including the disadvantaged communities of Tonyville and a portion of Strathmore.

LSID has a contract with Reclamation for Friant Division CVP supplies, LSID's contract is for 27,500 AF Class 1 water. The District has 115 miles of pipeline. Groundwater is extracted via four district-owned wells to supply residents during winter months when the CVP supplies are low or the FKC is dewatered for maintenance. The LSID does not currently recharge groundwater within the district as most underlying soils provide for low infiltration rates with the exception of Lewis Creek and certain other areas that will be evaluated for recharge in the future.

In addition to CVP supplies, LSID also has ownership of shares in the Wutchumna Water Company for water from the Kaweah River. LSID utilizes all its available surface supplies to provide for a reliable dry-year supply and annually minimize the amount of groundwater used in the District. As a result, groundwater use is minimal except in extreme dry years and during FKC outages.

1.5.1.7 Stone Corral Irrigation District

The Stone Corral Irrigation District (SCID) is located in Tulare County, north of the city of Visalia and west of the city of Woodlake. SCID was organized in July 1948, for the purpose of contracting for a water supply from Reclamation for Friant Division CVP supplies, and for the construction of a distribution system which is 27 miles of pipeline. The district encompasses approximately 6,500 acres, of which about 5,500 acres are irrigated, and serves approximately 100 agricultural landowners growing predominately permanent crops.

SCID's contract is for 10,000 AF Friant Division CVP – Class 1 (Contract #I75R-2555-D). Additionally, SCID has an annual entitlement for 950 AF of Cross Valley Canal – CVP (Contract # 14-06-200-8293A-IR16). SCID does not own or operate groundwater extraction facilities. Therefore, landowners must provide their own wells to sustain irrigation during periods when SCID does not have surface water supplies available.

1.5.2 Description of Beneficial Uses and Users

Legal Requirements:
§354.10 Each plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:
(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 interests, and the nature of consultation with those parties.

Beneficial users within the EKGSA area were identified through discussions with the Advisory Committee during development of the Communication and Engagement Plan. The identified beneficial users from this process are described below.

Agricultural Users – Most of the EKGSA's area is composed of agricultural users. Agricultural users are represented on the EKGSA Board of Directors through the member agencies, as well as through members on the Advisory Committee. The EKGSA has developed and continues to improve blanket mailing and emailing lists which were and will continue to be used to notice landowner outreach events. These lists will continue to be expanded and maintained throughout the development of the GSP and GSP implementation to ensure overlying users stay informed and have a reasonable opportunity to participate in the process.

Domestic Well Users – There is a significant number of rural residents within the GSA boundaries that are reliant upon groundwater to meet their domestic needs. The EKGSA aims to include rural residents in the process through direct communications and public meetings. The EKGSA will afford rural residents every opportunity to engage in groundwater planning and management efforts that may have an impact on their domestic wells.

Municipal Well Operators – The primary municipal well operators within the boundaries of the EKGSA are for the City of Lindsay. The City of Lindsay utilizes both surface water and groundwater to supply its demands. The City is represented on the EKGSA Board of Directors and also participates on the Technical Advisory Committee. Strathmore Public Utility District would be the next largest municipal user, however most their demand is met with surface water from Friant CVP supplies.

Public Water Systems – Several small communities in unincorporated areas of Tulare County are served groundwater through small water systems. Such communities include Plainview, Lindcove, and Tooleville. These communities are represented in multiple ways. The County is a participating member with representation on the EKGSA Board of Directors. Additionally, there are members and agencies representing communities through the Advisory Committee.

Environmental Users of Groundwater - There are two primary local environmental organizations within the EKGSA boundary, and both entities have a representative on the GSA's Advisory Committee: Sequoia Riverlands Trust (SRT) and the Tulare Basin Wildlife Partners (TBWP). SRT is a regional nonprofit land trust dedicated to strengthening California's heartland and the natural and agricultural legacy of the San Joaquin Valley, with a vision focused on creating a future where productive land and healthy natural systems are protected to generate community vitality and economic prosperity. The mission of the TBWP is to engage in multi-benefit projects that promote ecological and economic health, sustaining the area's agricultural heritage, and enhancing the quality of life in the Tulare Basin for current and future generations. In addition to representation on the Advisory Committee, collaboration meetings will be held with these organizations to make sure their organizational visions and groundwater needs for land conservation and a healthy regional watershed with ecologically functional waterways are taken into consideration during GSP development and implementation phases. Environmental uses in the area include creeks, species, and habitat such as groundwater dependent ecosystems (GDE). The California Department of Fish & Wildlife (CDFW) is the State Trustee for fish and wildlife resources. The EKGSA and CDFW will be coordinating and interacting on behalf of these users, at a minimum, through the CEQA process as GSP Implementation activities such as projects and management actions are evaluated and moved forward.

Surface Water Users – There are many users of surface water, agricultural and municipal, in the EKGSA boundary. Most of the surface water used is imported from Friant Division CVP supplies for irrigation purposes. Additionally, private water companies bring in additional surface water supplies to the EKGSA from the Kaweah River. The community of Tonyville receives surface water from LSID. The various users of surface water are represented on the EKGSA Board of Directors and/or within the Advisory Committee.

Disadvantaged Communities – Communication and educational outreach efforts with disadvantaged communities (DAC) and severely disadvantaged communities (SDAC) is essential for the development and implementation of the EKGSA's GSP, and residents are generally dedicated to bettering their communities, particularly when it comes to their water supplies. Important information that will be essential to communicate to and engage DACs will include an explanation of SGMA, water conservation education, and soliciting feedback from community members on water quantity and water quality challenges their communities may face. By including DACs and SDACs in communication efforts during the development, public review and implementation phases of the GSA, residents will be more likely to participate and provide feedback that could be crucial to long-term solutions for groundwater sustainability within their communities. Any feedback received from DAC stakeholders were reviewed by the Advisory Committee and Technical Advisory Committee and taken into consideration during the GSP development phase.

1.5.3 Public Engagement/Public Outreach Plan

Legal Requirements:
§354.10 Each plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:
(b) A list of public meetings at which the Plan was discussed or considered by the Agency.
(c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.
(d)(2) Identification of opportunities for public engagement and a discussion of how public input and response will be used

The development of the EKGSA GSP is an inclusive, transparent effort requiring ongoing engagement with a variety of stakeholders to allow public input and response during various stages of development. In addition to this GSP, the EKGSA has also developed a Communication & Engagement (C&E) Plan. The purpose of the C&E Plan is to guide EKGSA's stakeholder involvement efforts. It will be a living document that is intended to be flexible and adaptive to reflect stakeholders' needs and best practices for stakeholder involvement. The current version of the C&E Plan is included in **Appendix 1-B**. In the future, as updates and adjustments are made, the most current version of the C&E Plan can be found on the EKGSA website at http://www.ekgsa.org.

The C&E Plan's overarching goal is to inform, encourage engagement, and build stakeholder support for EKGSA's direction in reaching groundwater sustainability. A diverse, active, engaged public will help better identify issues, form solutions, and create a partnership between the EKGSA Board and stakeholders.

Goals that the C&E Plan seeks to accomplish include:

- Build stakeholder and public understanding of SGMA including purpose, timeline, and requirements.
- Inform and raise awareness about EKGSA including governance structure and powers.

- Provide accurate, easy-to-understand, and timely information for ongoing Board activities and GSP development activities.
- Promote communication between stakeholders and the EKGSA Board.
- Describe how EKGSA stakeholders relate to the broad sustainability goals of the Kaweah Subbasin.
- Encourage and solicit public comments before key decision points of GSP development.
- Implement SGMA in a transparent manner.

The EKGSA will incorporate key messages in all its communications and engagement activities to help foster clear and accurate communications. This will ensure a level of consistency across all outreach efforts, instill trust by stakeholders, and provide the opportunity for EKGSA staff to engage with stakeholders and communicate a common message. Messages will continue to be developed beyond the submittal of the GSP, as implementation of the GSP will be critical to the success of the stakeholders within the area.

Being open and involving stakeholders creates a process that produces a more robust outcome. Accountability and transparency are important to the success of implementing SGMA within the East Kaweah area. The EKGSA Board is committed to transparency in a public decision process and will adhere to practices that help ensure accountability and transparency to ensure the best possible solutions are developed. Some of these practices include:

- Advanced notifications of meeting times, locations, and agendas.
- Web posting of EKGSA materials.
- Solicitation of input from stakeholders and good faith effort to incorporate stakeholder interests.

The EKGSA also intends to develop a Drinking Water Well Monitoring Program (**Section 5.3.8.1**) and Mitigation Program (**Section 5.3.8**) with review and input from water supply well users and representatives. The intent of this program would be to evaluate conditions of water supply wells, investigate potential impacts, distribute information to water supply well users within the EKGSA, and, as appropriate, mitigate well impacts if groundwater levels begin to approach minimum thresholds.

A list of the public meetings and outreach events is included in **Appendix 1-C.**

1.5.4 Comments Received

This section will be completed as the GSP is circulated to the public and the EKGSA's committees for review and comment. A system for managing public comments and responses will be developed to track comments received and status of comments. The comment tracking document will be included in **Appendix 1-D**.

1.6 GSP Organization and Preparation Checklist

This GSP, developed in compliance with SGMA, consists of the following chapters:

- Basin Setting
- Sustainable Management Criteria
- Monitoring Networks
- Projects & Management Actions to Achieve Sustainability

GSP Implementation

2 Basin Setting

2.1 Overview

The three Kaweah Subbasin GSAs (EKGSA, GKGSA, and MKGSA) jointly developed a Subbasin Basin Setting document through their coordinated efforts. The Kaweah Subbasin Basin Setting document is included with this EKGSA GSP in **Appendix 2-A**. The focus of this Basin Setting Chapter will be on the EKGSA and how it fits within the Kaweah Subbasin. The EKGSA is located on the eastern side of the Kaweah Subbasin and covers approximately a quarter of the Subbasin acreage. The EKGSA is made up of two areas bisected by the Kaweah River. The major land use in the EKGSA is agriculture.

2.2 Hydrogeologic Conceptual Model

Legal Requirements:
§354.14(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.

The purpose of a Hydrogeologic Conceptual Model (HCM) is to provide an easy to understand description of the general physical characteristics of the regional hydrology, land use, geology, geologic structure, water quality, principal aquifers, and principal aquitards in the basin setting. Once developed, an HCM is useful in providing the context to develop water budgets, monitoring networks, and identification of data gaps.

An HCM is not a numerical groundwater model or a water budget model. An HCM is a written and graphical description of the hydrologic and hydrogeologic conditions that lay the foundation for future water budget models. This HCM has been written by adhering to the requirements set forth by the SGMA legislation in the California Code of Regulations. Several topics are touched on in the HCM, including groundwater quality, groundwater flow, and groundwater budget which are discussed in greater detail in Groundwater Conditions (Section 2.4) and Water Budget (Section 2.5).

The narrative HCM description provided in this chapter is accompanied by graphical representations of the EKGSA portion of the Kaweah Subbasin that attempt to clearly portray the geographic setting, regional geology, basin geometry, and general water quality. This HCM has been prepared utilizing published studies and resources and will be periodically updated as data gaps are addressed when new information is available.

2.2.1 Information Sources

The Subbasin HCM is based largely on data compiled from two recent Water Resources Investigations (WRIs) within the Subbasin (Fugro, 2007; Fugro, 2016), as well as additional data and analyses derived from well completion reports, geophysical electric logs, pumping test data, and monitoring well data collected from DWR, KDWCD, and other GSA member agencies within the Subbasin. This information is provided in detail in the Kaweah Subbasin Basin Setting document located in **Appendix 2-A**. Additional sources of information were used for further development of the HCM and Basin Setting for the EKGSA area. These sources include:

- Geologic Study of the Lindmore Irrigation District, U.S. Bureau of Reclamation, 1948.
- Technical Studies in Support of Factual Report: Exeter ID, Ivanhoe ID, and Stone Corral ID, U.S. Bureau of Reclamation, 1948 – 1950.
- Groundwater Conditions and Storage Capacity in the San Joaquin Valley, CA. U.S. Geological Survey, 1964.

- Geology, hydrology, and quality of water in the Hanford-Visalia area, San Joaquin Valley, California; Croft & Gordon, 1968.

2.2.2 Regional Geologic and Structural Setting

Legal Requirements
§354.14(b)(1) The hydrogeologic conceptual model shall be summarized in a written description that includes the regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.

The San Joaquin Valley is a structural trough up to 200 miles long and 70 miles wide that comprises the southern portion of the Great Central Valley of California. The Sierra Nevada rises along its eastern boundary, the coast ranges hem it in to the west, and the Tehachapi mountains rise to the south. Continental deposits shed from the mountains form an alluvial wedge that thickens from the valley edges toward the axis of the structural trough. This process, in addition to periodic inundation by the Pacific Ocean, has resulted in an accumulation of sediments up to 32,000 feet thick. The depositional axis is slightly west of the series of rivers, lakes, sloughs, and marshes which mark the current and historic axis of surface drainage in the San Joaquin Valley (CDWR, 2016), as illustrated by **Figure 2-1**. South of the San Joaquin River the valley is currently a basin of interior drainage. Water flows to several depressions in the valley trough. The largest of these is the Tulare Lakebed, which receives runoff from the Kaweah, Tule, and Kings Rivers (Croft and Gordon, 1968).

The geologic structure of the EKGSA area is divided between the sedimentary deposits of the surface and near-surface, and a basement complex beneath. The sedimentary deposits dip gently to west on the uptilted western slope of the Sierra Nevada. En echelon faulting (i.e., faulting that occurs as a series of small parallel to sub-parallel faults oblique to the overall structural trend) is inferred to parallel the Sierra Nevada, which likely accounts for steep contacts between the sedimentary deposits and bedrock units. Bedrock outcrops within the sedimentary deposits are inferred to be the result of upfaulting, as no such outcrops occur to the west of the inferred fault zone (Croft and Gordon, 1968).

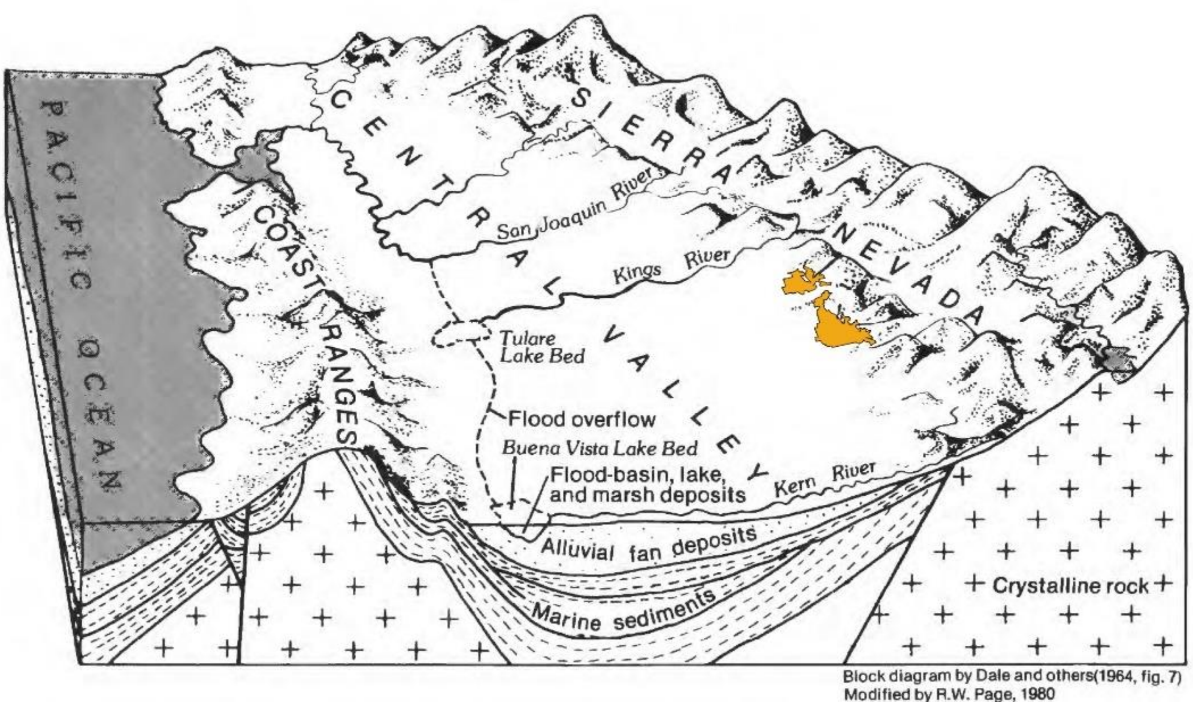


Figure 2-1 Isometric Block Diagram of the Central San Joaquin Valley

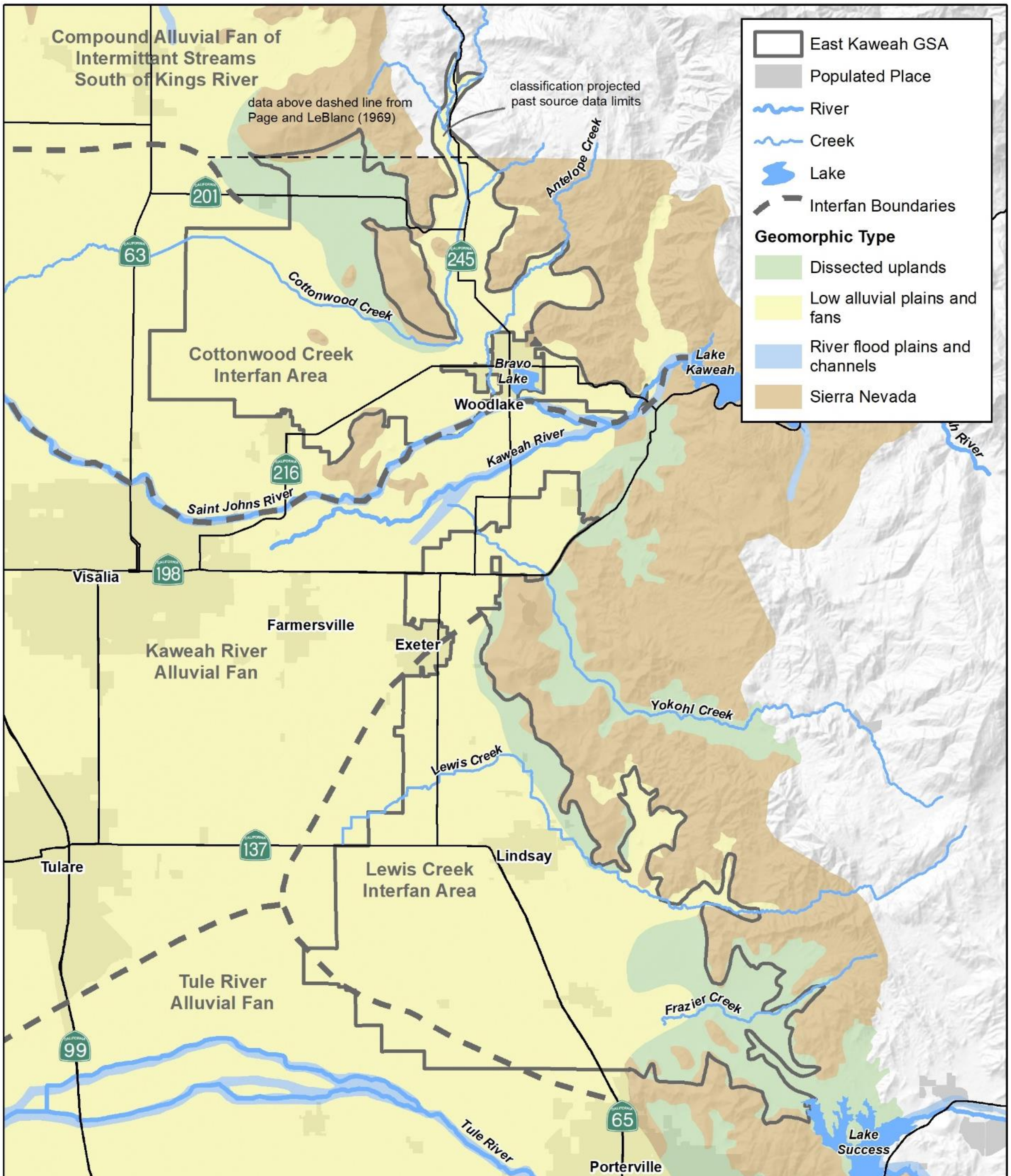
2.2.2.1 Subbasin Features and Topographic Information

Legal Requirements:
§354.14(d)(1) Physical characteristics of the basin shall be represented on one or more maps that depict topographic information derived from the U.S. Geological Survey or another reliable source.

The east side of the San Joaquin Valley is a broad plain formed by large coalescing alluvial fans of streams draining the western slope of the Sierra Nevada. The EKGSA is located entirely in this geomorphic setting. Croft & Gordon (1968) mapped the geomorphic features of the EKGSA and surrounding areas, as shown in **Figure 2-2.** The Kaweah River and Tule River alluvial fans account for significant contributions to the area's geomorphology. The Lewis Creek Interfan Area between these two fans comprises most of the southern lobe of the EKGSA. The northern lobe of the EKGSA is dominated by the Cottonwood Creek Interfan Area between the Kaweah River fan and the compound alluvial fan of intermittent streams south of the Kings River as mapped by Page and LeBlanc (1969).

The Kaweah River fan is the most prominent fan complex in the Kaweah watershed and is characterized by a surface of low topographic relief. As is illustrated in **Figure 2-3**, the fan generally slopes in a west-southwesterly direction at about 10 feet per mile, with the slope lessening further away from the mountains. The Kaweah River fan is characterized by a network of natural channels of the Kaweah River and its distributaries (Fugro, 2016).

Figure 2-3 shows that in the intermontane valleys of the southern lobe of the EKGSA, the topography climbs to elevations exceeding 800 feet above sea level. On the eastern edge of the valley floor the topography reaches heights of about 520 feet and gently slopes toward the center of the valley, descending to 320 feet above sea level on the far western edge of the EKGSA. In the northern lobe the topographic relief is less extreme. The highest contour is at 720 feet to the northeast of Colvin Mountain. Topography descends to 480 feet on Colvin Mountain's eastern flank. On the western side of Colvin Mountain, the topography begins at heights of about 460 feet above sea level and slopes gently westward, so that the western edge of the EKGSA is 340 feet above sea level.



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Geomorphology was digitized from Plate 1 of Open-File Report 68-67, Geology, Hydrology and Quality of Water in the Hanford-Visalia Area, San Joaquin Valley, California by M.G. Croft and G.V. Gordon, 1968.

Geomorphology

East Kaweah GSA

Figure 2-2 Geomorphic Features

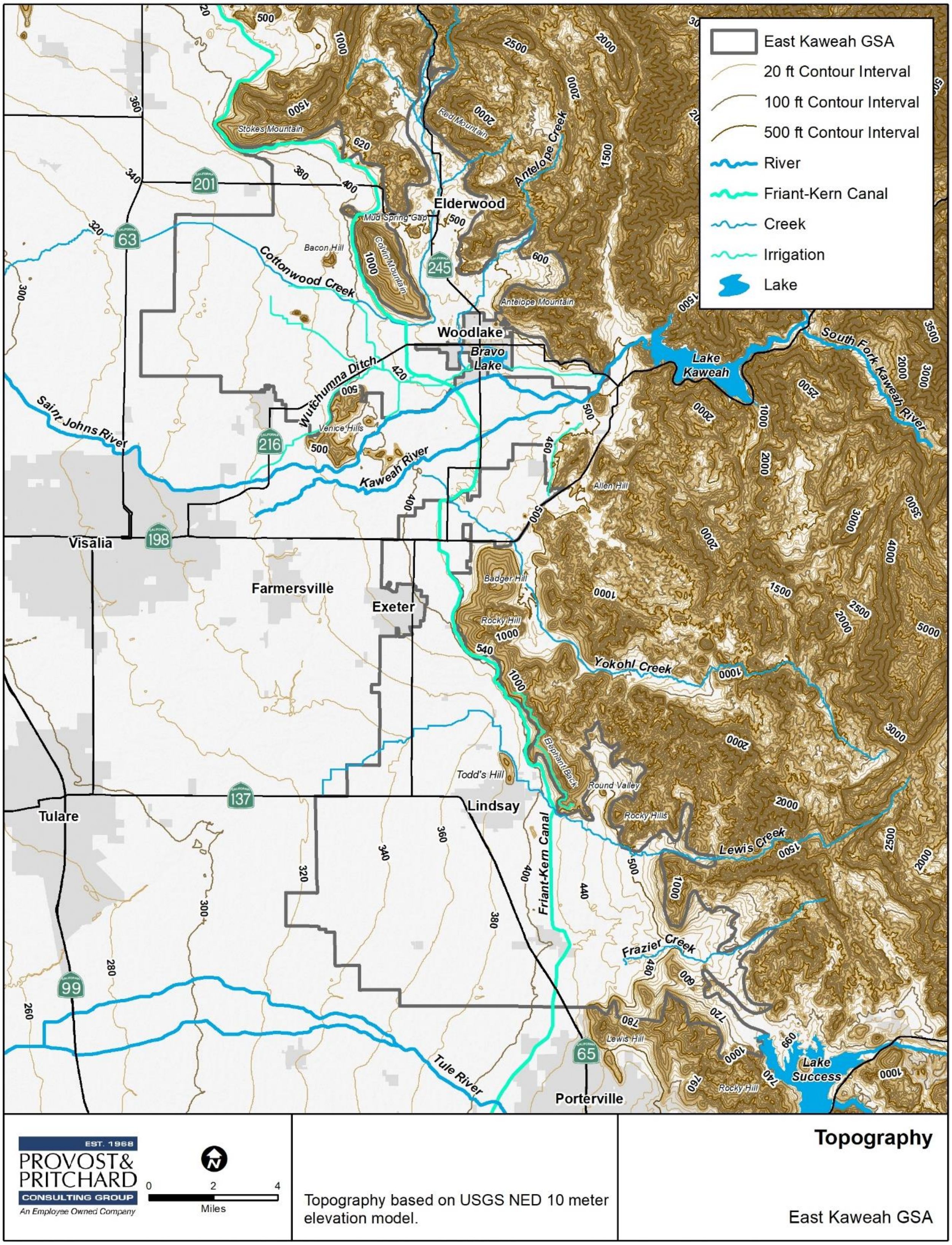


Figure 2-3 Topography

2.2.2.2 Regional Geologic Conditions

The generalized regional subsurface geologic conditions with corresponding hydrologic units is described below in **Table 2-1**. This table, adapted from Page, 1986 and Bertoldi et. al., 1991, provides a general overview of geologic deposits in the region within the context of regional hydrologic units. Flood plain and river deposits from recent fluvial processes overlie older lacustrine, marsh, and other continental deposits. Below the continental deposits are Tertiary marine deposits and pre-Tertiary crystalline basement rock. More detailed discussion is included in the Kaweah Subbasin Basin Setting document in **Appendix 2-A**.

Table 2-1 Generalized Regional Geologic & Hydrologic Units of the San Joaquin Valley

	Generalized Regional Geology (adapted from Page, 1986, table 2 and Bertoldi et. al. 1991).	Generalized Regional Hydrologic Units
Quaternary	**Flood basin deposits (0 to 100 ft thick) –** Primarily clay, silt, and some sand; including muck, peat, and other organic soils in Delta area. These restrict yield to wells and impede vertical movement of water. **River deposits (0 to 100 ft thick) –** Primarily gravel, sand, and silt; include minor amounts of clay. Among the more permeable deposits in valley.	Undifferentiated upper water-bearing zone; unconfined to semiconfined. Principal confining unit (modified E Clay)
Tertiary and Quaternary	**Lacustrine and marsh deposits (up to 3,600± ft thick)** – Primarily clay and silt; include some sand. Thickest beneath Tulare Lakebed. Include three widespread clay units – A, C, and modified E clay. Modified E clay includes the Corcoran Clay Member of the Tulare Formation. These impede vertical movement of water. **Continental rocks and deposits (15,000± ft thick)** – Heterogeneous mix of poorly sorted clay, silt, sand, and gravel; includes some beds of mudstone, claystone, shale, siltstone, and conglomerate. They form the major aquifer system in the valley.	Undifferentiated lower water-bearing zone; semiconfined to confined. Extends to base of freshwater which is variable.
Tertiary	**Marine rocks and deposits –** Primarily sand, clay, silt, sandstone, shale, mudstone, and siltstone. Locally they yield fresh water to wells, mainly on the southeast side of the valley but also on the west side near Kettleman Hills.	Below the base of freshwater and depth of water wells. In many areas, post-Eocene deposits contain saline water.
Pre-Tertiary	**Crystalline basement rocks –** Non-water-bearing granitic and metamorphic rocks, except where fractured.	

2.2.2.3 Kaweah Subbasin Geology

Legal Requirements:
§354.14(b)(4)(a) Formation names, if defined.

The geology underlying the Kaweah Subbasin is generally consistent with the regional geology. Details of the local geology, as it affects the occurrence and movement of groundwater, are provided below based on previous investigations in the area (i.e. USBR Technical Studies and Fugro WRI). The following units are presented from the ground surface downward (roughly youngest to oldest):

- **Alluvium (Q), unconsolidated deposits:** Non-marine, water-bearing material comprised of the Tulare Formation and equivalent units. Alluvium is generally mapped in the Subbasin except where the following specific units are provided.
  - **Flood basin deposits (Qb):** Clay, silt, and some sand on the lateral edges of fanned sediment distal of Kaweah River.
  - **Younger alluvium (Qya), oxidized older alluvium (Qoa[o]) and reduced older alluvium (Qoa[r]):** Coarse-grained, water-bearing alluvial fan and stream deposits.

  - **Lacustrine and Marsh Deposits – (QTl):** Fine-grained sediments representing a lake and marsh phase of equivalent continental and alluvial fan deposition. Includes the Tulare Formation and Corcoran Clay Member.
- **Continental Deposits (QTc):** Heterogeneous mix of water-bearing poorly sorted clay, silt, sand, and gravel.
- **Marine Rocks – (Tmc):** Non-water-bearing marine sediments including the San Joaquin Formation. Historically, the top contact of Tmc marked the effective base of the Kaweah aquifer system because of the low permeability of Tmc and the general occurrence of brackish to saline water (B-E, 1972).
- **Basement Rocks – (pT):** Insignificant water-bearing granitic and metamorphic rocks, except where highly fractured near the foothills on the eastern side of the Subbasin.

The listed units correlate to the geologic units listed in **Table 2-1**. Discussion of key units in the EKGSA is provided below. A more detailed discussion is included in the Kaweah Subbasin Basin Setting document in **Appendix 2-A**. Additional discussion and figures are provided in **Section 2.2.2.5** (Subsurface Geologic Cross-Sections).

Unconsolidated Deposits (Q). The unconsolidated deposits include undifferentiated Alluvium (Q), younger alluvium (Qya), older alluvium (Qoa), lacustrine and marsh deposits (QTl), and unconsolidated continental (QTc) deposits. Unconsolidated deposits were eroded from the adjacent mountains, transported by streams and mudflows, and deposited in lakes, swamps, or on alluvial fans (Fugro West, 2007). The base of the unconsolidated deposits within the Kaweah Subbasin is projected by electric log correlation from the top of the marine rocks (Tmc) (Woodring et al., 1940). The unconsolidated deposits gradually thicken from along the western front of the Sierra Nevada to a maximum of at least 1,800 feet at the western boundary of the EKGSA.

Younger Alluvium - Qya. The Younger Alluvium is generally above the water table and does not constitute a major water-bearing unit. It consists of gravelly sand, silty sand, silt, and clay deposited along stream channels (Fugro West, 2007). The deposits are moderately sorted and generally loose. The deepest Younger Alluvium deposit is found along the Kaweah fan axis, where it is unlikely to exceed 100 feet of thickness (Ivanhoe USBR Report, 1949). The younger alluvium interfingers and/or grades laterally into the flood basin deposits (Qb) and undifferentiated alluvium. It overlies the older alluvium (Fugro West, 2007).

Older Alluvium – Qoa. The older alluvium is subdivided into "oxidized" and "reduced" variants based on environment of deposition (Fugro West, 2007). Oxidized deposits generally represent subaerial deposition, and reduced deposits generally represent subaqueous deposition (Davis et al., 1957). Oxidized deposits are red, yellow, and brown, consist of gravel, sand, silt and clay, and generally have well-developed soil profiles. Groundwater in oxidized deposits is typically aerobic (citation needed). Reduced deposits are typically black, gray, green, and blue. Anaerobic bacteria present in organic matter beneath the water table may further contribute to the reduction of iron compounds (Davis et al., 1957).

The older alluvium unconformably overlies the continental deposits. The contact of the older alluvium with the underlying oxidized continental deposits is well defined in electric logs. It thickens irregularly from east to west, and probably has filled gorges cut by the ancient Tule River in the underlying oxidized continental deposits near the city of Porterville. The older alluvium and continental deposits interfinger and/or grade laterally into the lacustrine and marsh deposits or into undifferentiated alluvium. (Fugro West, 2007).

Oxidized Older Alluvium - Qoa(o). The oxidized older alluvium is unconfined in the EKGSA. It underlies the younger alluvium, though it dominates the surficial deposits within the interfan areas. They are 200 to 500 feet thick (Croft, 1968) and consist mainly of deeply weathered, reddish brown, calcareous sandy silts and clays. Beds of coarse sand and gravel are rare, but, where present, they commonly contain significant silt and clay. The highly oxidized character of the deposits is the result of deep and prolonged weathering. Many of the easily weathered minerals have altered to clay and are therefore poorly permeable (Fugro West, 2007). The beds consist of fine to very coarse sand, gravel, silt, and clay derived primarily from granitic rocks of the Sierra Nevada. Beneath the channels of the Kaweah and Tule rivers, electric logs indicate that the beds are very coarse. In the inter-fan areas, metamorphic rocks and older sedimentary units locally contributed to the deposits and, in those areas, the beds are typically not as coarse as the beds beneath the rivers (Fugro West, 2007). The base of the deposits occurs approximately 195 feet below land surface near the City Exeter (Fugro West, 2007).

Reduced Older Alluvium - Qoa(r). The reduced older alluvium consists mainly of fine to coarse sand, silty sand, and clay. It was likely deposited in a flood plain or similar subaqueous low-energy environment. Gravel such as occurs in the oxidized older alluvium is generally absent. The deposits are sporadically cemented with calcium carbonate, but less prevalently than is found in the underlying reduced continental deposits (Fugro West, 2007).

Continental Deposits – QTc. The continental deposits are poorly sorted clays, silts, sands, gravels, claystones, shales, siltstones, and conglomerates that grade into and/or underlie the older alluvium. These continental deposits are underlain by the Tertiary marine rocks (Tmc) (Fugro West, 2007). The Porterville Clays are a subset of QTc that occupy distinctive smooth concave slopes at the base of the foothills. They consist of weathered outwash from the Sierra Nevada, transported by "creep" and slope-wash, and veneer the other materials at shallow depths. The clays interfinger with both the younger and older alluvial units, indicating they have likely been accumulating during most of Quaternary time (Ivanhoe USBR Report, 1949).

Marine Rocks (non-water bearing) - Tmc. Tertiary rocks of mainly marine origin underlie the unconsolidated deposits and overlie the basement complex. This unit may locally include beds of continental origin in its upper strata (Croft, 1968). The marine rocks do not outcrop in the EKGSA. They range in age from Eocene to late Pliocene and consist of consolidated to semi-consolidated sandstone, siltstone, and shale. They generally contain brackish and saline connate or dilute connate water unsuitable for most uses (Fugro West, 2007). The top contact of Tmc marks the effective base of the Kaweah aquifer system due to its low permeability and the degraded quality of its (B-E, 1972).

Basement Complex (essentially non-water bearing) – pT. The basement complex consists of metamorphic and igneous rocks which are predominantly Triassic or Late Jurassic in age (Ivanhoe USBR Report, 1949). These rocks outcrop as resistant inliers in the alluvium and as linear ridges in the foothills in the EKGSA. In the subsurface, the basement slopes westward from the Sierra Nevada beneath the deposits of Cretaceous and younger rocks and sediment that compose the Valley fill. Escarpments interpreted as buried fault scarps are associated with the Rocky Hill fault. West of the escarpments, the slope of the basement complex steepens (Fugro West, 2007).

The basement complex is considered to be non-water bearing in most areas, as it is composed of impermeable crystalline rock. However, fractures within the basement frequently contain fresh water of useful quantities. In the areas of Lindsay, Strathmore, Ivanhoe, and in the intermontane valleys these fractured rock aquifers are tapped by many water wells. Near Farmersville and Exeter, the basement complex forms a broad, gently westward-sloping shelf overlain by 100 to 1,000 feet of unconsolidated deposits (Fugro West, 2007).

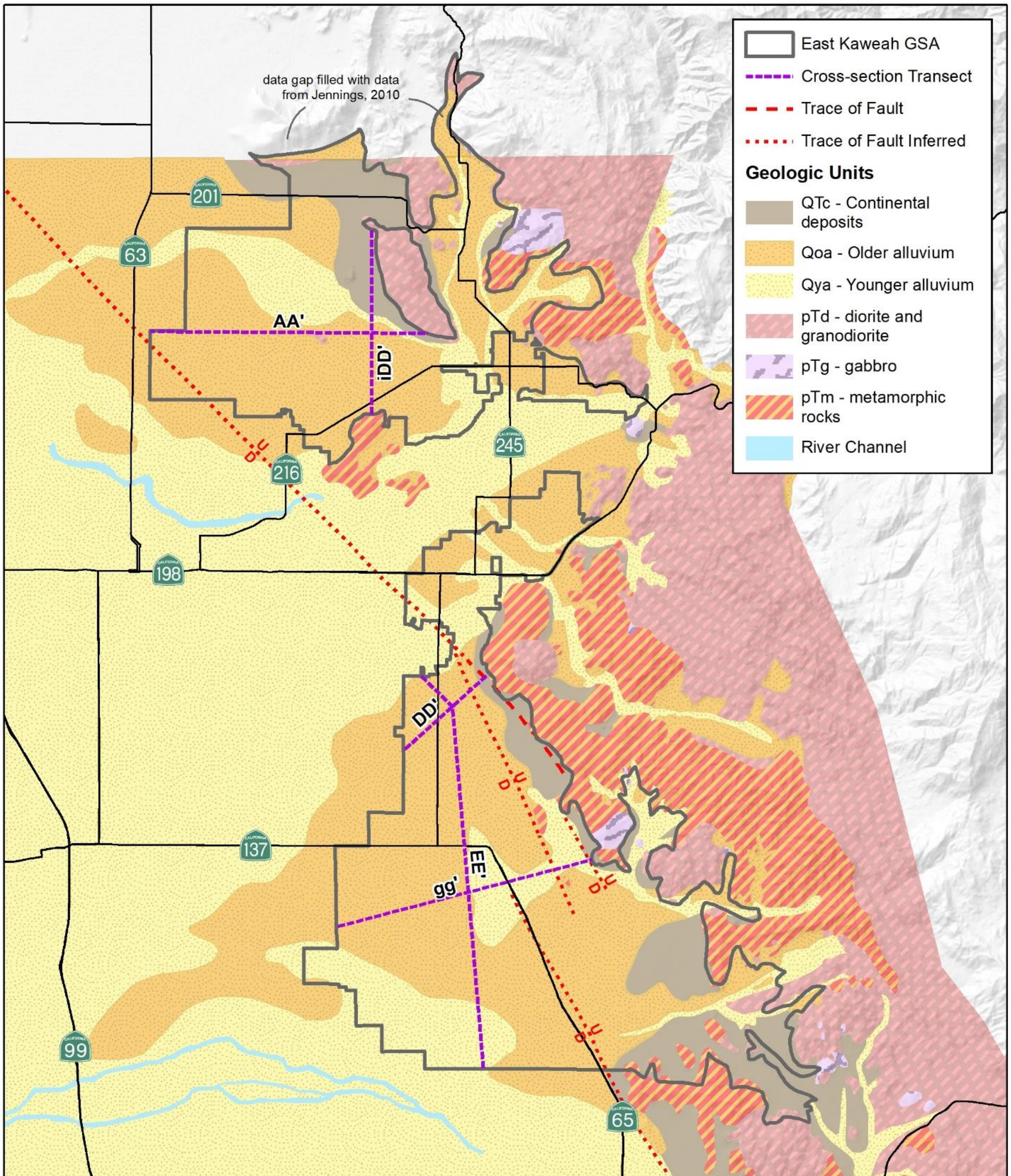
2.2.2.4 Surficial Geology

Legal Requirements:
§354.14(d)(2) Physical characteristics of the basin shall be represented on one or more maps that depict surficial geology derived from a qualified map including the locations of cross-sections required by this Section.

With the exception of scattered inliers of the basement complex, the surficial geology in the EKGSA is comprised of unconsolidated Quaternary deposits as represented in **Figure 2-4** (Croft & Gordon, 1968). Data gaps in the northern section of the map were filled with data from the California Geological Survey 2010

Geologic Map of California (Jennings, 2010). The major units are the Young Alluvium, Old Alluvium, and Continental Deposits (also known as the Porterville Clays) (Ivanhoe USBR Report, 1949).

The Young Alluvium is extensively developed in areas that have regularly experienced recent flow, primarily in the alluvial fans, and overlies the Old Alluvium (Ivanhoe USBR Report, 1949). The Old Alluvium crops out in the interfan areas, where recent deposition is not as common as on the active fans (Exeter and Stone Corral USBR Report, 1949). The Porterville clays occur in a discontinuous belt between the basement complex outcrops of the foothills and the alluvium of the valley floor. The clays consist of weathered outwash from the Basement Complex and have been observed interfingering with both alluvial units, indicating they have likely been accumulating during most of Quaternary time (Ivanhoe USBR Report, 1949).



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An Employee Owned Company

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Geologic units digitized from Plate 2 in USGS Open File Report 68-67, Geology, hydrology, and quality of water in the Hanford-Visalia area, San Joaquin Valley, California by M.G. Croft and G.V. Gordon. 1968.

Geologic Units

East Kaweah GSA

Figure 2-4 Geologic Units and Cross-Section Locations

2.2.2.5 Geologic Cross-Sections

Legal Requirements:
§354.14(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.

Cross sections that transverse the EKGSA area are presented as **Figure 2-5** through **Figure 2-9**. Cross section locations are shown on the Surficial Deposits Map (**Figure 2-4**). They include two cross sections parallel, and three cross sections perpendicular, to the structural grain of the San Joaquin Valley.

No single data source provided ample coverage of the EKGSA, so cross sections were selected from several sources to provide the best available coverage. As such, they provide varying degrees of detail. Cross sections AA' and iDD' are from the Ivanhoe USBR Technical Report (1949). Sections DD' and EE' are from Croft & Gordon (1968), with section gg' from USGS Water Supply Paper 1469 (Davis et. al. 1959). The cross sections presented herein represent a portion of the original regional geologic cross sections, to more prominently display the subsurface conditions within the EKGSA.

Ivanhoe section AA' traverses west-east through the northern lobe of the EKGSA and is presented in **Figure 2-5**. Ivanhoe section iDD' traverses south-north through the northern lobe and is presented in **Figure 2-6**. These sections do not differentiate between sedimentary units (i.e. Young Alluvium or Old Alluvium). Clay is shown in frequent proximity to the rocks of the Sierra Nevada Batholith (a batholith being a mass of igneous rock formed deep within the crust and being larger than 40 square miles), interfingering with the alluvial sediments. The basement is depicted within 100 feet of the ground surface across most of the eastern side of this area. West of the plutonic outcropping of Twin Buttes the surface of the batholith dips steeply to the west.

Section DD' from Croft & Gordon (1968) traverses southwest-northeast through the EKGSA in the vicinity of Exeter as presented in **Figure 2-7**. Section EE', from the same publication, traverses the southern lobe of the EKGSA from north to south, entering the GSA just south of Exeter as presented in **Figure 2-8**. The Basement Complex (pTu) is shown to dip steeply beneath the sediments of the valley, which is exacerbated by the presence of a fault. The fault appears to cut the QTc (Continental deposits) but does not extend into the alluvial units. By the base of the foothills in the far east of cross section DD' is an approximate 300-foot wedge of QTc, presumably representing (at least in part) the Porterville Clays. The Qoao (Older Alluvium) constitutes the upper 200 feet of the alluvial wedge dipping west from the mountains. In the western half of cross section DD' consolidated marine and continental rocks are shown resting on the batholith at a depth of 600-700 feet below the ground surface. Croft & Gordon inferred that the presence of the marine rocks within a few hundred feet of the surface was likely the result of upfaulting. The foothills are much closer to the trace of section EE' in the northern part of its transect than in the southern. In the subsurface this can be seen in the way the pTu (Basement complex) "peaks" in the vicinity of Exeter, where the cross section is closest to the hills. To the south of this peak the basement plunges to depths not fully defined in the cross section. Lenses of Qya (Younger Alluvium) indicate recent deposition, and particularly thicken towards the south where alluvium from the Tule River has been depositing. Between 500 to 700 feet beneath the ground surface is where the authors estimated the top of the brackish water to begin in the northern two-thirds of the cross-section, a depth that increased to be in excess of 900 feet towards the far south of the EKGSA.

The final cross section is Davis et al. (1959) gg', depicted in **Figure 2-9**. This section was created as part of a regional study and lacks the detail found in the previous cross-sections, but it is useful in extending the information reported above to the large southern lobe of the EKGSA. The Sierra Nevada hardrock plunges from the near surface in the east to deeper than 1,300 feet below the ground surface in the west. The marine sedimentary rocks overlie the basement beginning at approximately 1,000 feet below the surface towards the center of the southern EKGSA lobe.

Despite the differences in detail and format between geologic cross sections from these reports, it is possible to use the knowledge gleaned from one to help inform interpretations of another. The outcrops of pTu (Twin

Buttes, Colvin Mountain, and the Venice Hills) apparent in the Ivanhoe cross sections could be attributed to the presence of the fault indicated in Croft & Gordon section DD'. Cross section gg', while lacking detail, nevertheless corroborates the interpretations of Croft & Gordon sections DD' and EE' in showing the steepness of the basement complex and the presence of consolidated marine deposits at depth.

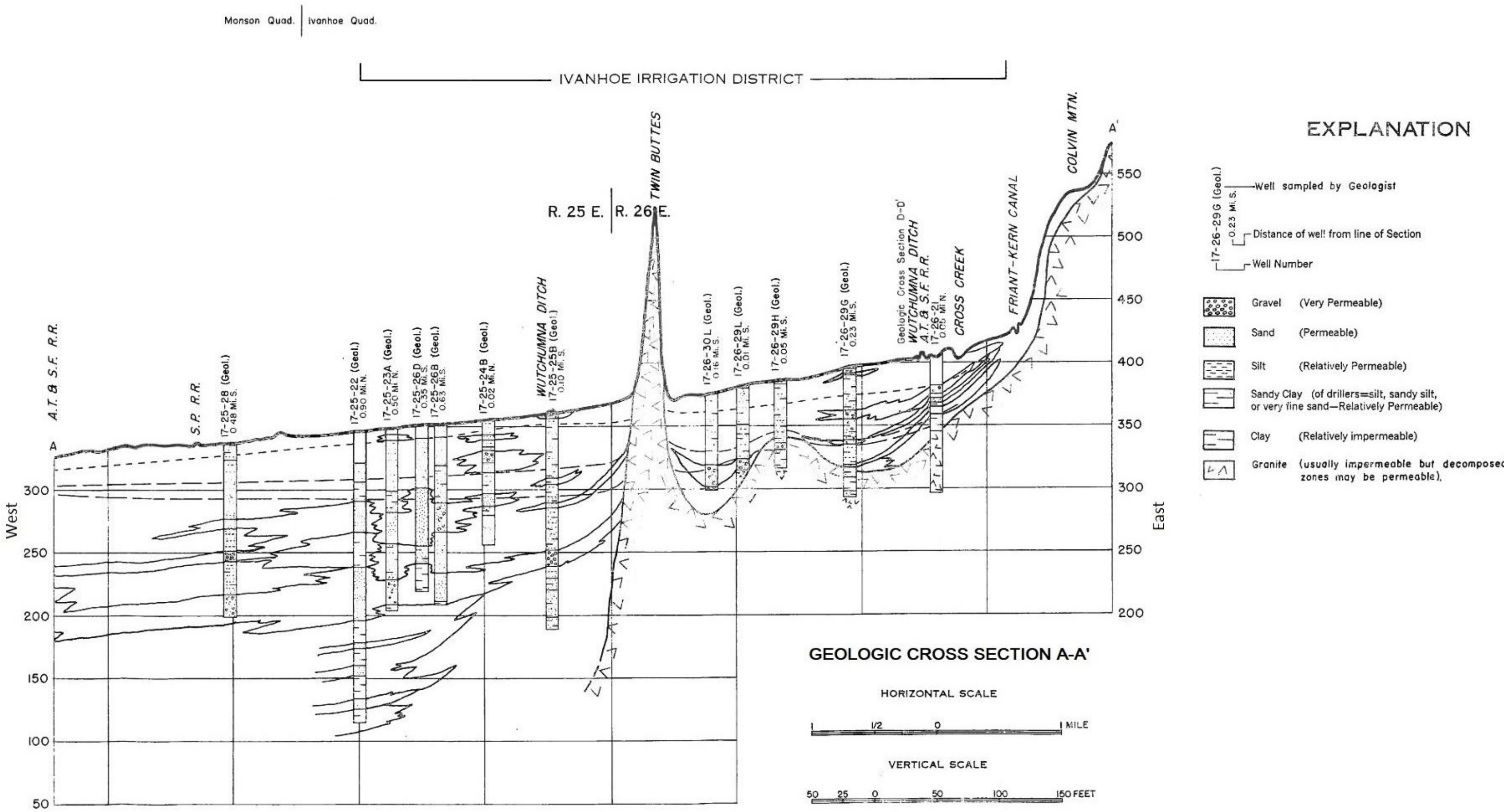

Figure 2-5 Regional Cross-Section AA', modified from Ivanhoe USBR Technical Report (1949)

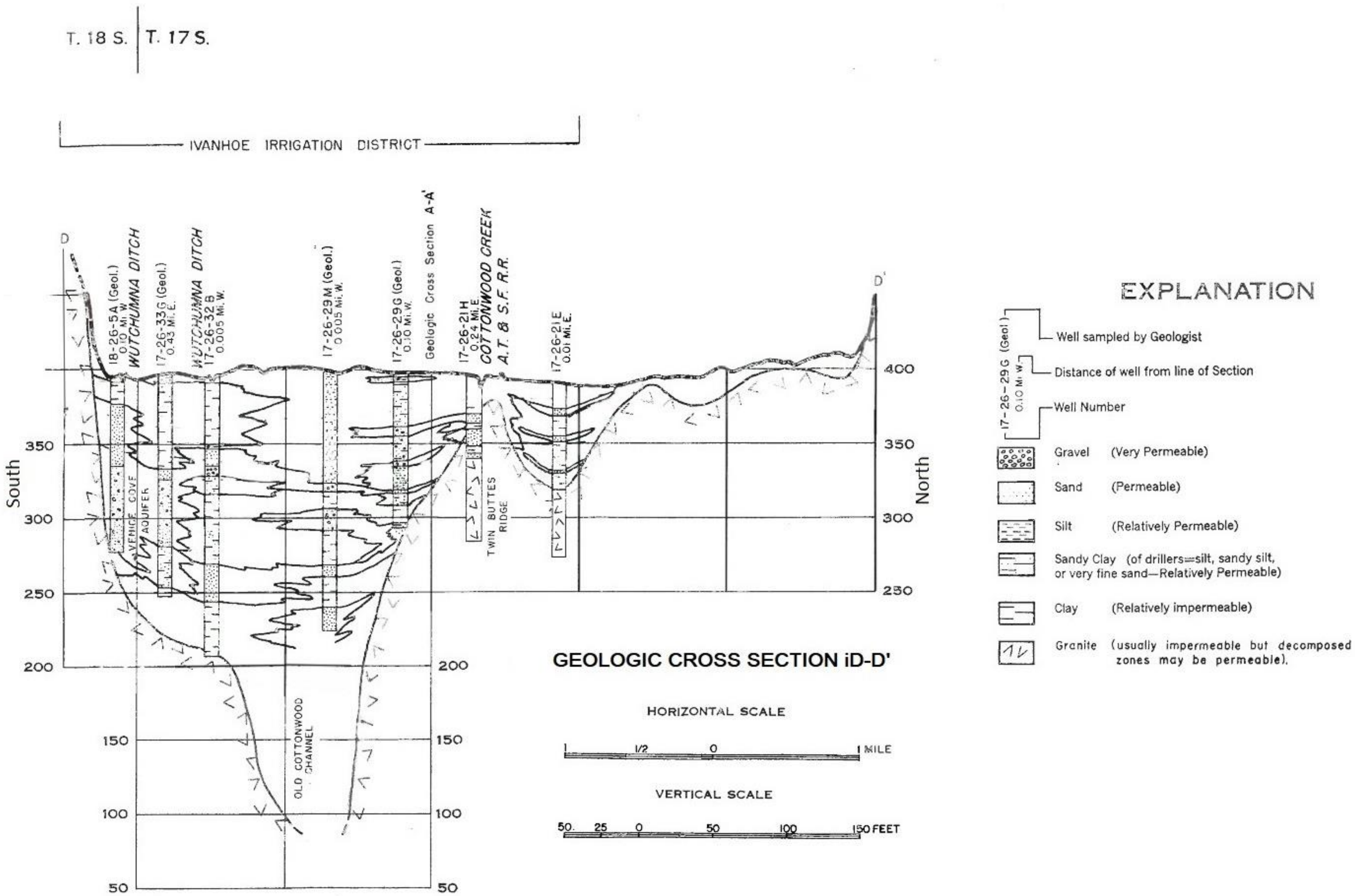

Figure 2-6 Regional Cross-Section iDD', modified from Ivanhoe USBR Technical Report (1949)

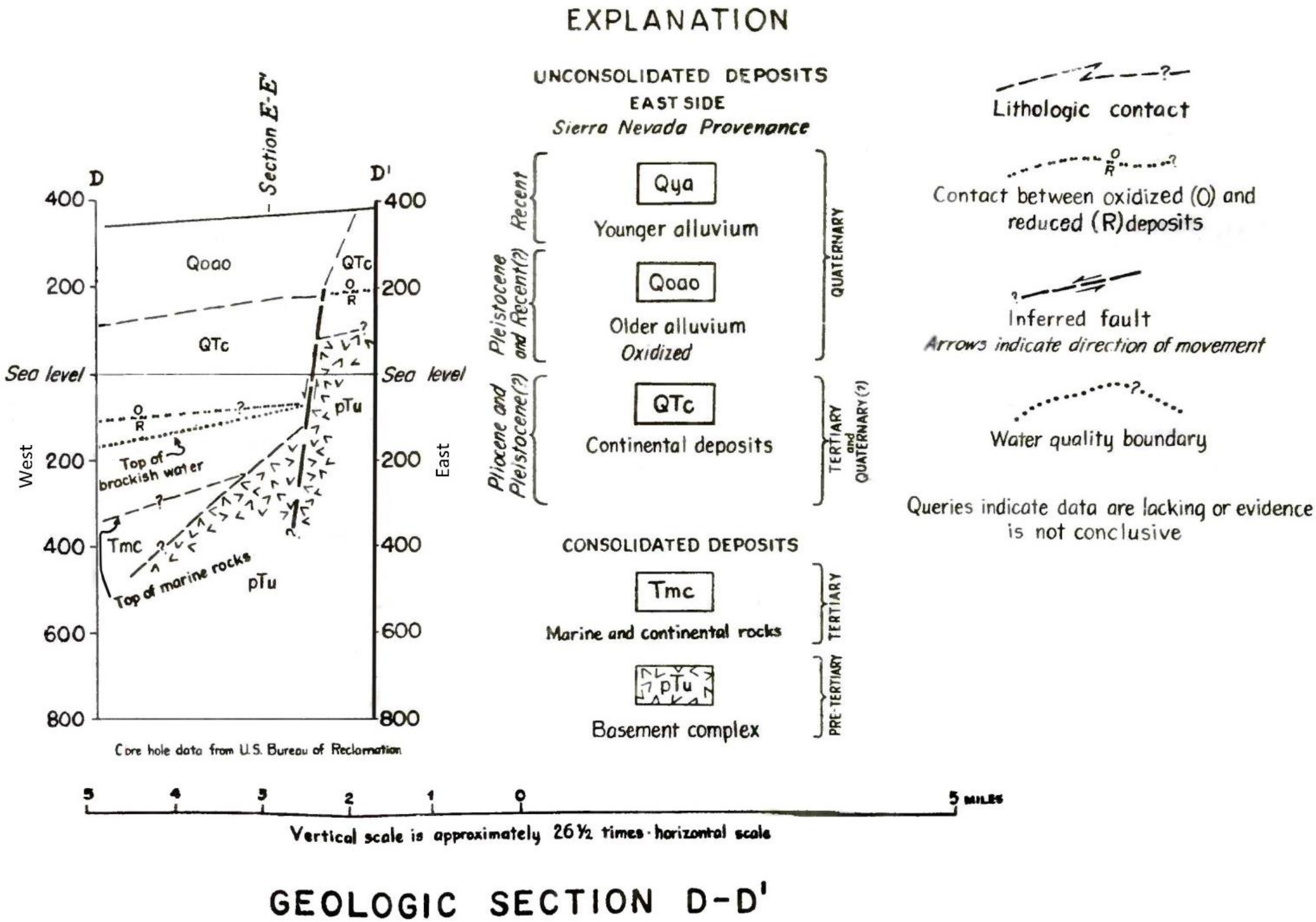

Figure 2-7 Regional Cross-Section DD', modified from Croft & Gordon (1968)

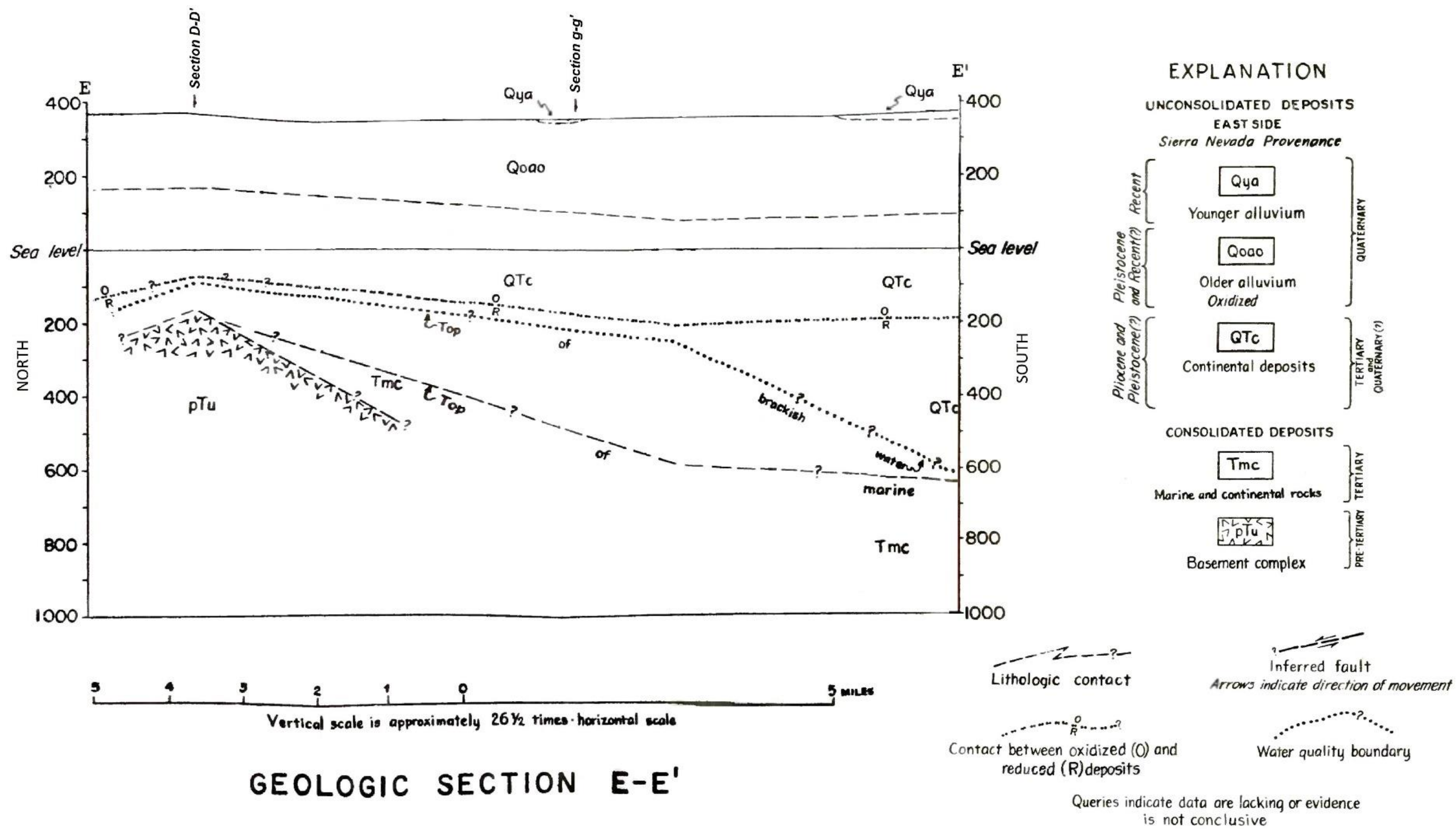

Figure 2-8 Regional Cross-Section EE', modified from Croft & Gordon (1968)

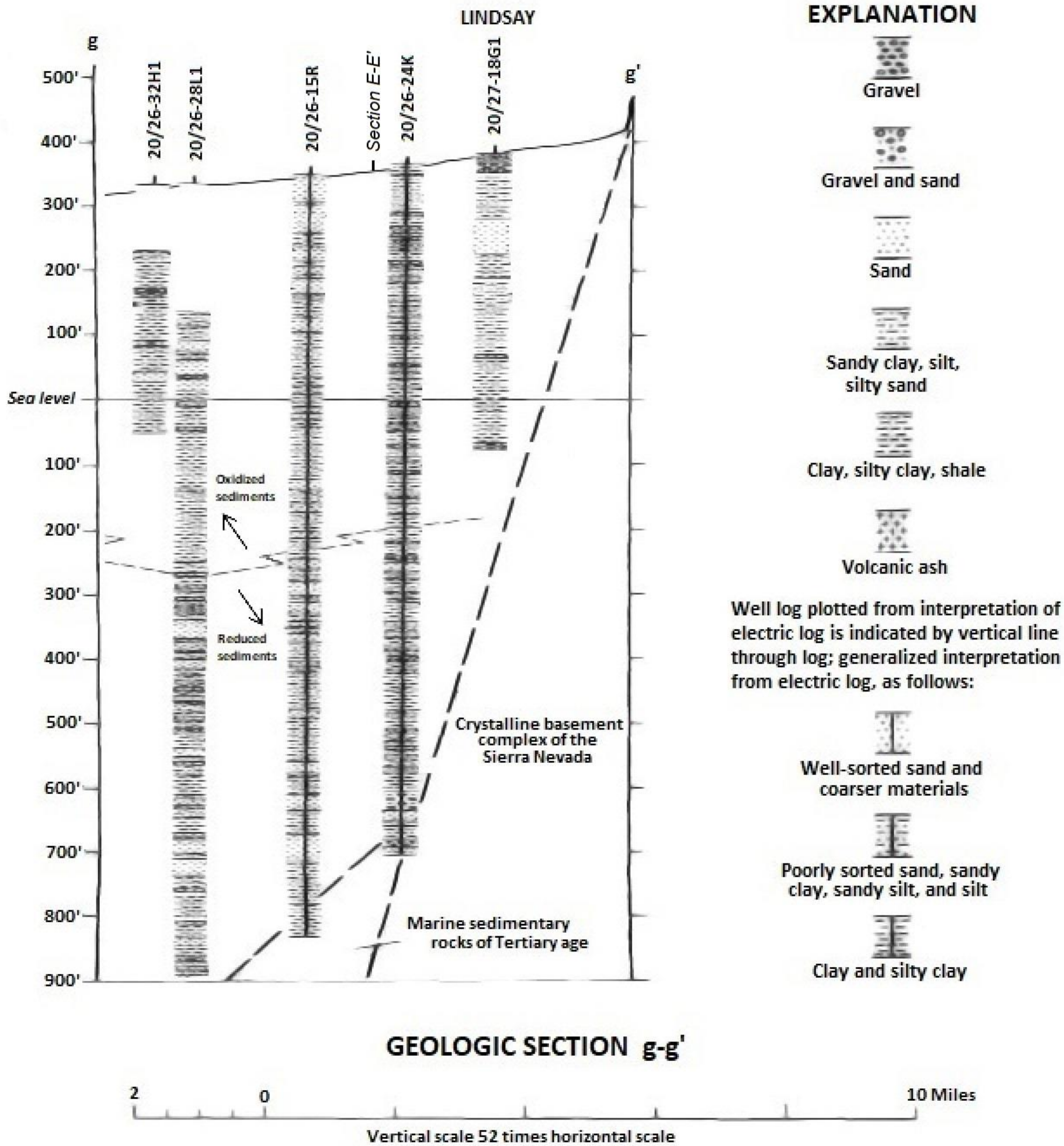

Figure 2-9 Regional Cross-Section gg', modified from Davis et al. (1959)

2.2.3 Lateral Basin Boundaries

Legal Requirements:
§354.14(b)(2) The hydrogeologic conceptual model shall be summarized in a written description that includes lateral basin boundaries, including major geologic features that significantly affect groundwater flow.

The EKGSA is in the eastern part of the Kaweah Subbasin and is bounded to the north by the Kings Subbasin, to the south by the Tule Subbasin, and the GKGSA to the west. To the east the gentle topography of the valley floor rises into the towering Sierra Nevada, where the Kaweah Subbasin's watershed is located.

Figure 2-10 illustrates the Spring 2015 groundwater levels within the EKGSA. This groundwater map was created using data from the Water Data Library and with water level data directly from the irrigation districts. The map illustrates a generally westward flow of groundwater. Water levels appear higher in the vicinity of the Kaweah River, which runs between the two lobes of the EKGSA. The Sierra Nevada mountains significantly influence groundwater flow, acting as an absolute barrier to groundwater and channeling water towards the valley. This map, and water level maps for other years, is discussed in greater detail in **Section 2.4.1.1**.

2.2.4 Bottom of the Subbasin

Legal Requirements:
§354.14(b)(3) The hydrogeologic conceptual model shall be summarized in a written description that includes the definable bottom of the basin.

The bottom of the basin is the top of the basement complex where brackish groundwater is not present at depth. Where brackish groundwater is present, the bottom of the basin is the base of the fresh groundwater. The base of freshwater is generally defined as the elevation below which total dissolved solids are greater than 2,000 mg/l (Bertoldi et al, 1991). Where present, the top contact of Tmc marks the effective base of the Kaweah aquifer system due to its low permeability and the brackish quality of its water (B-E, 1972). The base of freshwater is complex and its elevation varies significantly within the unconsolidated deposits, though it generally deepens towards the west.

In the eastern parts of the EKGSA, the sedimentary veneer over the basement is so shallow that the basement complex itself serves as the base of aquifer. East of the Rocky Hill fault the base of the aquifer is as shallow as 50 feet, coinciding with the depth of crystalline bedrock uplifted by the fault. To the west of the Rocky Hill fault the depth of the aquifer increases rapidly. Aquifer thickness is shown in the geologic cross-sections discussed in the previous section and in **Figure 2-11** discussed later in this chapter.

2.2.5 Principal Aquifers and Aquitards of the Subbasin

Legal Requirements:
§354.14(b)(4) The hydrogeologic conceptual model shall be summarized in a written description that includes the principal aquifers and aquitards.

The aquifer system of the EKGSA is currently classified as an unconfined single aquifer system. It is understood that the system consists of alluvial fan materials of both Old and Young Alluvium and are the upper part of a great wedge of continental sediments which thicken westerly toward the trough of the San Joaquin Valley. Each constituent fan of this alluvial plain is elongate and mimics the topography of the surface of the fans. These deposits are lenticular in character. These are interlayered with less permeable sediments which slow the migration of groundwater, but no sediments that would act as absolute groundwater barriers are known to exist within the EKGSA (Exeter & Stone Corral USBR Report, 1949). Groundwater flows southwest toward the Tulare Lakebed, generally following topography (Croft and Gordon, 1968). During GSP Implementation continued data gathering and analyses (i.e. SkyTEM) will be utilized to better understand the aquifer system of the EKGSA and Kaweah Subbasin.

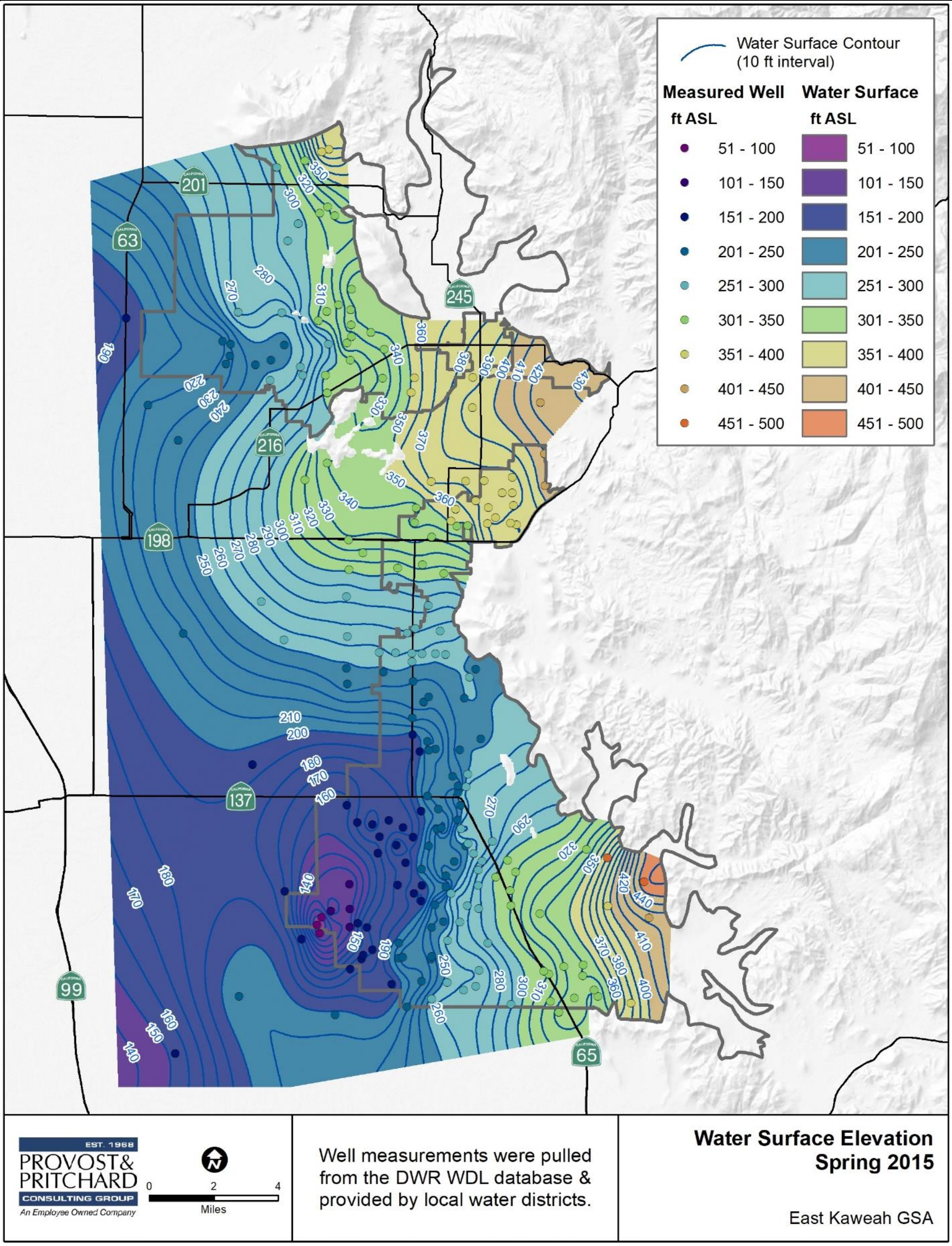

Figure 2-10 Generalized Groundwater Contour Map, Spring 2015

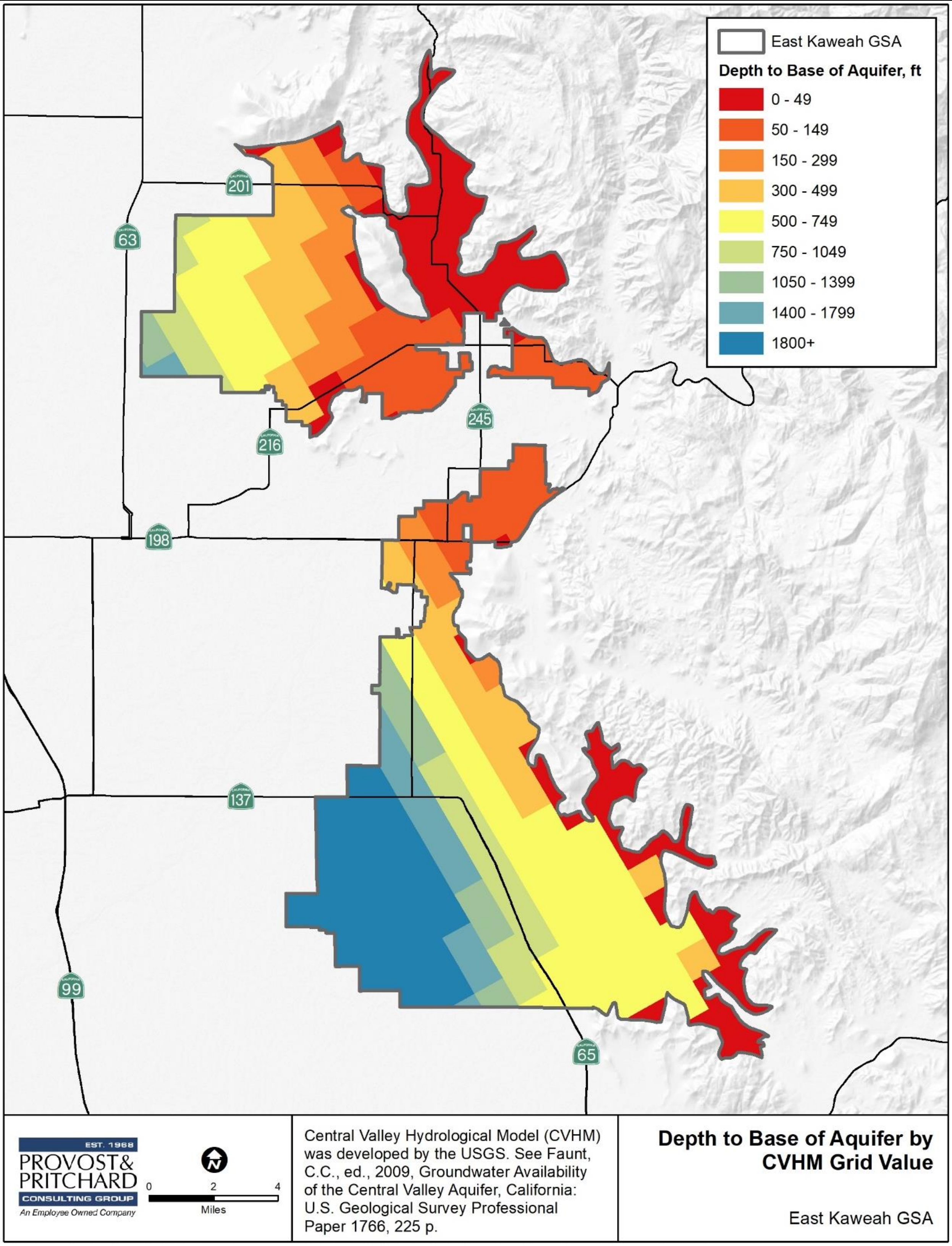

Figure 2-11 Base of Aquifer

2.2.6 Aquifer Characteristics

Legal Requirements:
§354.14(b)(4)(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.

The principle aquifer characteristics of importance to the EKGSA are transmissivity, hydraulic conductivity, and storativity. Hydraulic conductivity is the rate at which water can move through a permeable medium. Transmissivity is the amount of water that can be transmitted horizontally by the fully saturated thickness of the aquifer under a hydraulic gradient of 1. These two properties are related in that transmissivity is the hydraulic conductivity multiplied by saturated aquifer thickness. Storativity is the volume of water that a permeable unit will absorb or expel from storage per unit surface area per unit change in head, i.e., the amount of space available for groundwater to be stored within the unit (Meinzer, 1932). Storativity is approximately equal to the specific yield in unconfined aquifers. As such, this section discusses specific yield as a close approximation of storativity.

Specific Yield of the Deposits

Specific yield estimates are shown in **Figure 2-12**. They are a composite from Davis et al. (1959) and USGS Professional Paper 1401-D (Williamson et al., 1989). These studies found average specific yields over large areas. Values are mostly from Davis et al. 1959, wherever that data is available. Neither source provided data for the area near the foothills where alluvium interfingers laterally with the Sierra Nevada batholith. **Figure 2-12** shows estimated specific yields across all depth intervals. When change in storage is calculated, it will be calculated using the specific yield of the depth interval in question.

USBR reports developed for Friant Contractors (i.e. Exeter, Ivanhoe, Lindmore, and Stone Corral) provide localized specific yield values. These values are more detailed than those from the USGS reports but cover far less of the area. As a result, the values from these studies were used to check the larger reports and to extend the values found in the larger reports into some data gap areas. The values from the USBR reports are not otherwise represented on the map. **Table 2-2** includes a summary of specific yield values from each report.

Table 2-2 Summary of Specific Yield Estimates

Publication	Estimated Specific Yield Range (%)	Description/Notes
Davis et al. (1959)	6.4 to 11.3	Based on textures in all zones (10 to 50 feet deep, 50 to 100 feet deep, and 100 to 200 feet deep).
Williamson et al. (1989)	6 to 13	Based on textures in all zones.
Exeter & Stone Corral USBR Report (1949)	4 to 14	Based on a zone which approximates the depth of ground water fluctuations between 1921 and 1946 in the Exeter ID.
Ivanhoe USBR Report (1949)	8 to 20	Based on a zone spanning between 45 feet below the ground surface to 4 feet below the surface of the basement complex.
Lindmore USBR Report (1948)	4 to 18	Based on a zone between the fall positions of the water table in 1921 and 1946.
Stone Corral USBR Report (1950)	6 to 14	Based on a zone spanning 20-70 feet below the ground surface, which approximates the depth of ground water fluctuations between 1921 and 1947.

Hydraulic Conductivity and Transmissivity

The hydraulic conductivity of a saturated, porous medium is the volume of water it will transmit in a unit time, through a cross-section of unit area, under a hydraulic gradient of a unit change in head through a unit length of flow (or more simply, it is the ease with which a fluid can move through a medium) (Lohman, 1972). In

USGS Professional Paper 1401-D, Williamson et al. (1989) compiled hydraulic conductivity values estimated from more than 7,400 drillers' logs in the San Joaquin Valley and from power company pump-efficiency tests. Within the aquifer of the EKGSA, estimates of hydraulic conductivity range from a high of 9.8 feet/day (ft/d) in the eastern portion of the Kaweah alluvial fan to a low of 2.9 ft/d in the interfan areas along the eastern side by the foothills.

Transmissivity is the property of an aquifer that is defined as the ability of the aquifer to transmit groundwater flow laterally. It can be calculated by multiplying the thickness of the water producing strata by the hydraulic conductivity of the same strata. Typically, transmissivity values can be determined from the results of aquifer tests. They can also be estimated from the specific capacity values of wells. A conversion between specific capacity and transmissivity was developed by Thomasson et al. (1960), by which an estimate of transmissivity could be calculated by multiplying the specific capacity of a well in an unconfined aquifer by 1,500, or by 2,000 for a well in a confined aquifer.

Transmissivity values for the EKGSA can be estimated from specific capacity values by Davis et al. (1964). Estimates of transmissivity in the EKGSA range from a low of 9,000 gallons per day per foot (gpd/ft) to a high of 97,000 gpd/ft. **Table 2-3** includes an estimated transmissivity value summary. **Figure 2-13** depicts these estimates. In general, transmissivity values increase in areas further away from the base of the foothills and decrease in the interfan areas.

Table 2-3 Transmissivity Estimates Summary

Publication	TR	Estimate of Transmissivity (gpd/ft)	Description / Notes
Davis et al. (1964)	16S25E	37,500	Based on specific capacity estimates from Davis et al. (1964) and Thomasson et al. (1960), and the empirical relationship between specific capacity and transmissivity. It should be noted that since these studies wells have been drilled deeper essentially making the aquifer thickness deeper than that studied. Actual transmissivity values may differ than this table summary as a result.
	16S26E	39,000	
	17S25E	45,000	
	17S26E	39,000	
	17S27E	12,000	
	18S25E	97,500	
	18S26E	61,500	
	18S27E	25,500	
	19S26E	49,500	
	19S27E	42,000	
	20S26E	21,000	
	20S27E	9,000	
	21S26E	64,500	
	21S27E	30,000	
	21S28E	66,000	

Vertical Extent

The basement complex is considered to be the base of the aquifer within the EKGSA. **Figure 2-11** shows the depth to the base of the aquifer according to the Central Valley Hydrological Model (CVHM) developed by the USGS (Faunt, 2009). Where the EKGSA abuts the foothills, the proximity of the basement complex to the ground surface prevents the existence of an appreciable aquifer. The calculated depth to the base of the aquifer rapidly increases moving southwest through the EKGSA, extending to depths exceeding 1,800 feet west of California State Highway 65 in the southern lobe of the EKGSA.

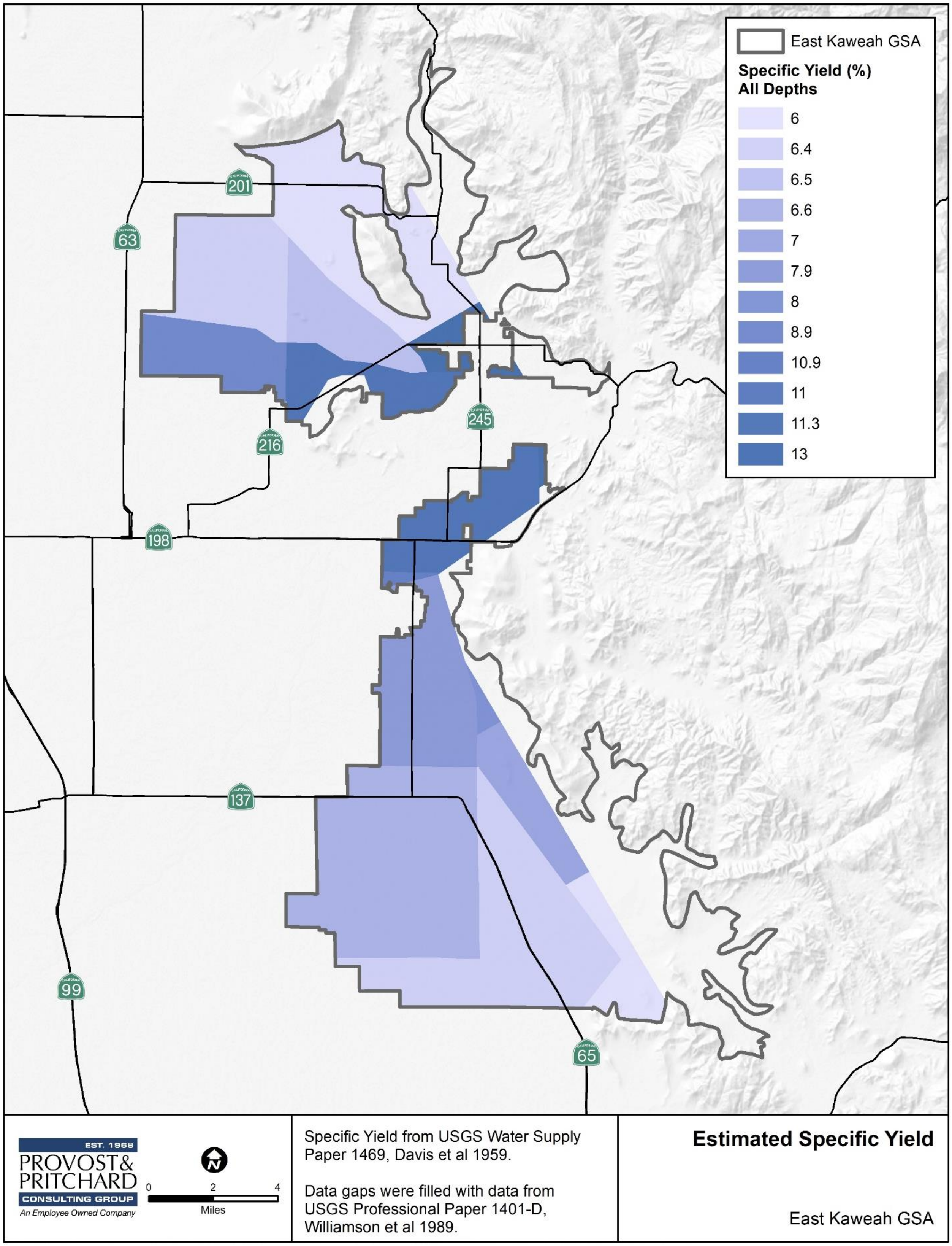

Figure 2-12 Estimated Specific Yields

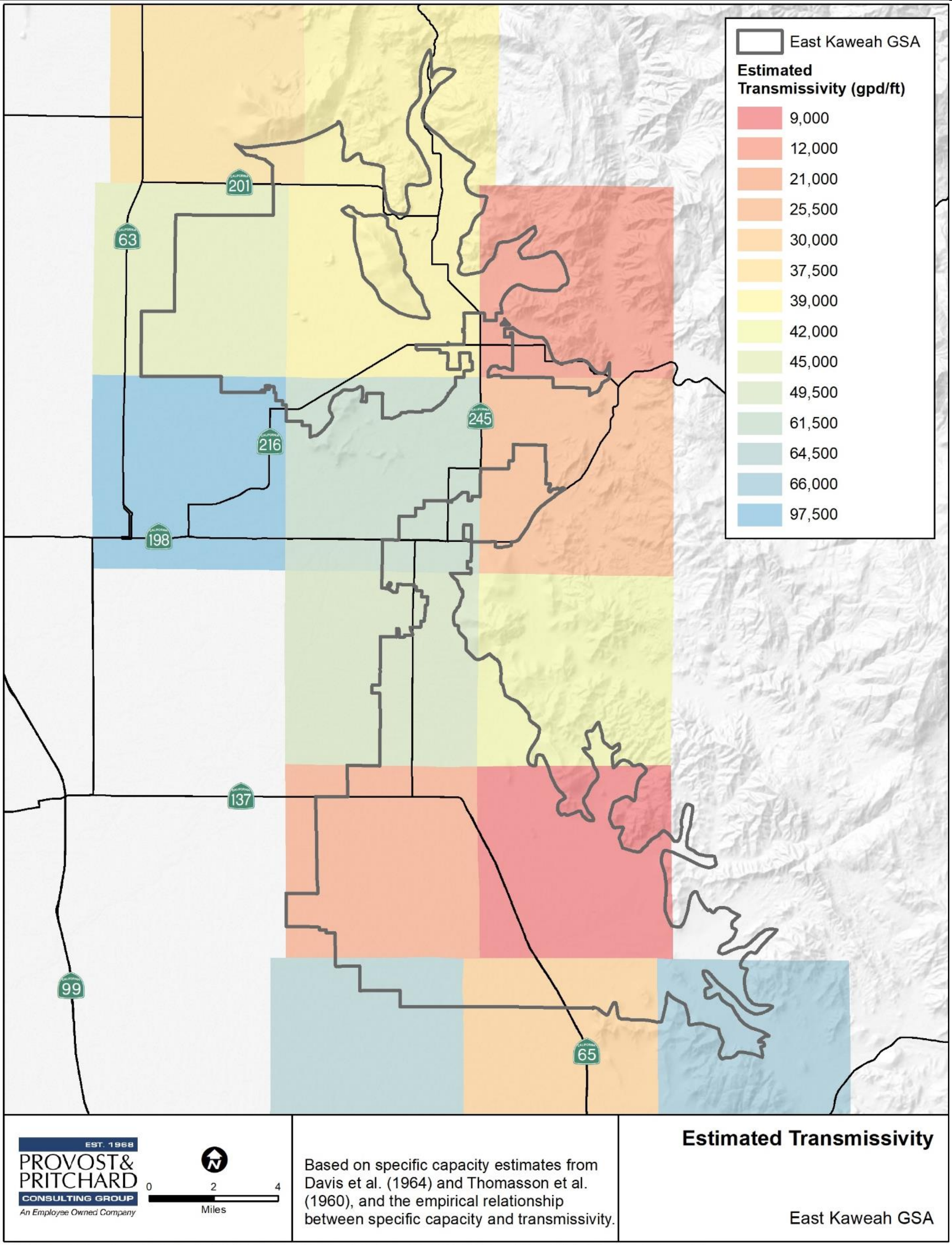

Figure 2-13 Estimated Transmissivity

2.2.6.1 Structural Properties that Restrict Groundwater Flow

Legal Requirements:
§354.14(b)(4)(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.

According to DWR's Bulletin 118 (2003), there are no reported groundwater barriers restricting horizontal flow in and out of the Kaweah Subbasin. There is, however, the Rocky Hill fault zone that may affect groundwater flow inside of the Subbasin and potentially cross gradient of flow along the north and south boundaries. Located in the eastern portion of the Subbasin, the Rocky Hill fault disrupts pre-Eocene deposits and may locally penetrate older alluvial deposits. The linearity of ridges in this area defines the fault line (Refer to **Figure 2-4** for the Cross Section Location Map and **Figure 2-7** and **Figure 2-9** for Cross Sections DD' and gg'). The Rocky Hill fault does not offset younger alluvium based on water level data (Croft, 1968); however, lithology data from boreholes suggest that older alluvium may be offset or varied in thickness at the Rocky Hill fault. In addition, Fugro West (2007), suggested that the hydrologic connection of the oxidized alluvial aquifer may be restricted near the Rocky Hill fault; this represents a data gap in groundwater flow across the Rocky Hill fault, and should be evaluated in the future, both within the Subbasin and in association with the northern and southern boundaries of the Subbasin.

The influx of water entering the groundwater from rivers creates a high in the groundwater surface, causing water to flow away from them. Groundwater that would have naturally flowed through the area beneath the river is instead redirected to flow around the river, which amounts to flowing alongside the river instead. The Sierra Nevada mountains are so influential to groundwater flow that all groundwater flows away from them towards the west, and groundwater levels cannot be taken within them as their hydrogeology acts independently from the valley. Outliers of Sierra Nevada basement act as similar (yet less absolute) barriers to groundwater flow, preventing water from flowing through their impermeable roots but allowing water to flow around them with little issue. Colvin mountain (in the north) and the Venice Hills (between Ivanhoe I.D. and the St. Johns River) are prominent examples of these basement outliers.

2.2.6.2 General Water Quality of Principal Aquifers

Legal Requirements
§354.14(b)(4)(d) General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.

The discussion presented below is intended to present a generalized view of groundwater quality in the EKGSA portion of the Kaweah Subbasin. A more detailed discussion on groundwater quality will be included in **Section 2.4** as part of the Groundwater Conditions. According to DWR Bulletin 118 (CDWR, 2003), water in the region is generally safe for most beneficial uses, including agriculture and municipal use.

Groundwater in the oxidized older alluvium and younger alluvium is generally of the calcium bicarbonate type. In the unconsolidated deposits beneath the alluvial fans groundwater is generally low in dissolved constituents. Where recharge is from the major streams, sodium constitutes less than 42% of the cations and TDS ranges from 100 to 270 mg/l. Sodium and bicarbonate are the principal ions in groundwater in the continental deposits and in reduced older alluvial deposits. Sodium accounts for more than 70 percent of the cations in the water from these deposits. TDS ranges from 100 to 500 mg/l. In the interfan areas, where recharge is from intermittent streams, dissolved constituents range from 270 to 650 mg/l and magnesium and chloride are major constituents (Croft & Gordon, 1968).

2.2.6.3 Primary Use of Aquifers

Legal Requirements:
§354.14(b)(4)(e) Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.

The EKGSA's aquifers are used for agricultural, domestic, industrial, and municipal purposes. There is no formal tabulation of meter records to estimate how much groundwater is pumped in the EKGSA. It is likely that the majority of agricultural wells in the EKGSA do not have totalizing flow meters, although it is recognized that some agricultural pumpers may keep detailed meter records of groundwater use. The amount of water pumped varies based on the crop demand. The estimated amounts of pumping will be described in more detail in **Section 2.5** as part of the Water Budget.

2.2.7 Physical Characteristics

2.2.7.1 Soil Characteristics

Legal Requirements
§354.14(d)(3) Physical characteristics of the basin shall be represented on one or more maps that depict soil characteristics as described by the appropriate Natural Resource Conservation Service soil survey or other applicable studies.

The University of California, Davis, in conjunction with the University of California Division of Agriculture and Natural Resources, developed the Soil Agricultural Groundwater Banking Index (SAGBI). The Index is a composite evaluation of groundwater recharge feasibility on agricultural land (also called Irrigation Field Flooding). The following five parameters are incorporated into the Index:

- Deep percolation is dependent upon the saturated hydraulic conductivity of the limiting layer.
- Root zone residence time estimates drainage within the root zone shortly after water application.
- Topography is scored according to slope classes based on ranges of slope percent.
- Chemical limitations are quantified using the electrical conductivity (EC) of the soil.
- Soil surface condition is identified by the soil erosion factor and the sodium adsorption ratio.

Proximity to a water conveyance system is not a factor considered in the SAGBI composite evaluation. Each factor was scored on a range, rather than discretely, and weighted according to significance. Adjustments were then made to reflect soil modification by deep tillage (i.e., shallow hard pan is assumed to have been removed by historic farming activities) (modified SAGBI). Ultimately, SAGBI seeks to categorize recharge potential according to risk of crop damage at the recharge site. Usefulness of the index is diminished when evaluating locations for dedicated recharge basins. In these cases, a soil profile illustrating deep percolation potential may prove to be more useful. As is the case with any model, the SAGBI is best applied in conjunction with other available data and on-site evaluation.

Figure 2-14 illustrates the modified SAGBI for the EKGSA. The modified Index indicates that a majority of the land within the GSA is favorable for recharge. This model assumes that hardpans have been largely removed by previous farming practices. Hardpans are still extensive within the EKGSA, though, and so this model should be considered in conjunction with the unmodified SAGBI, illustrated in **Figure 2-15**. It is locally well known that surface recharge is ineffective in the area, but water introduced deep enough into the strata infiltrates easily in those areas identified in the modified SAGBI as "good."

2.2.7.2 Delineation of Recharge Areas, Potential Recharge Areas, and Discharge Areas, Including Springs, Seeps, and Wetlands

Legal Requirements:
§354.14(d)(4) Physical characteristics of the basin shall be represented on one or more maps that depict 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.

This section discusses existing and potential groundwater recharge areas, and areas of groundwater discharge. The information is presented on a regional scale and provides a general assessment of the EKGSA's recharge potential. This information would need to be supplemented with local information for developing site-specific groundwater recharge projects.

Existing Recharge Areas

Recharge in the EKGSA is derived from seepage from the Kaweah and Tule Rivers, Yokohl Creek, Cottonwood Creek, the Wutchumna Ditch, and intermittent stream flows. Seepage of water from rivers, streams, irrigation ditches, and irrigation water applied in excess of plant and soil-moisture requirements constitute the principal sources of water infiltrating to the aquifers. Direct precipitation contributes minor quantities of water to these aquifers (Croft and Gordon, 1968).

Historically groundwater use has been offset though in-lieu recharge, the use of surface water for irrigation instead of groundwater, when supplies are available (Stone Corral ID, Five Year Update Ag Water Management Plan June 2013). In the late 1940s Exeter, Ivanhoe, Lindmore, Lindsay-Strathmore, and Stone Corral Irrigation Districts compiled USBR reports that outlined the need for additional surface water supplies. These reports established allocations through the Central Valley Project (CVP) to correct the levels of groundwater overdraft at the time. CVP water deliveries promptly began in 1951, however, actions such as the San Joaquin River Restoration and issues with Delta diversions, less surface water has been available in recent years which results in more need to pump more groundwater.

Potential Recharge Areas

Potential recharge areas can be identified using the soil and geologic maps described in **Figure 2-4**, **Figure 2-14**, and **Figure 2-15**. These maps provide a regional assessment of recharge potential and can be useful for initial screening. It should be recognized that land availability is generally a limiting factor in the selection of recharge areas. Local permeability, geologic structure, and an overall lack of suitable land inhibit the recharge potential of much of the GSA (Geologic Study of the Lindmore ID, 1948). Soil borings of at least 50 ft depth are necessary to determine the suitability of specific potential recharge sites.

Discharge Areas

East of McKays Point the Kaweah River is anecdotally understood to be a gaining stream, meaning that it derives some of its flow from influent groundwater. There are currently no other known groundwater discharges (springs, seeps, etc.) originating in the area. Groundwater level maps will be presented in the Current and Historic Groundwater Conditions chapter of the EKGSA GSP.

Wetland Areas

Areas indicated as being wetlands in the National Wetland Inventory are illustrated in **Figure 2-16**. Some areas of freshwater emergent wetlands are present in the eastern margins of the EKGSA, where small waterways come down from the foothills. Areas identified as being potential Groundwater Dependent Ecosystems (GDEs) are presented in **Figure 2-17**, and further discussed in **Section 2.4.6**. The EKGSA has determined that the location of potential wetlands and other GDEs are a data gap and a plan for filling that data gap is presented in the Interconnected Surface Water Data Gap Work Plan (**Section 5.3.7**).

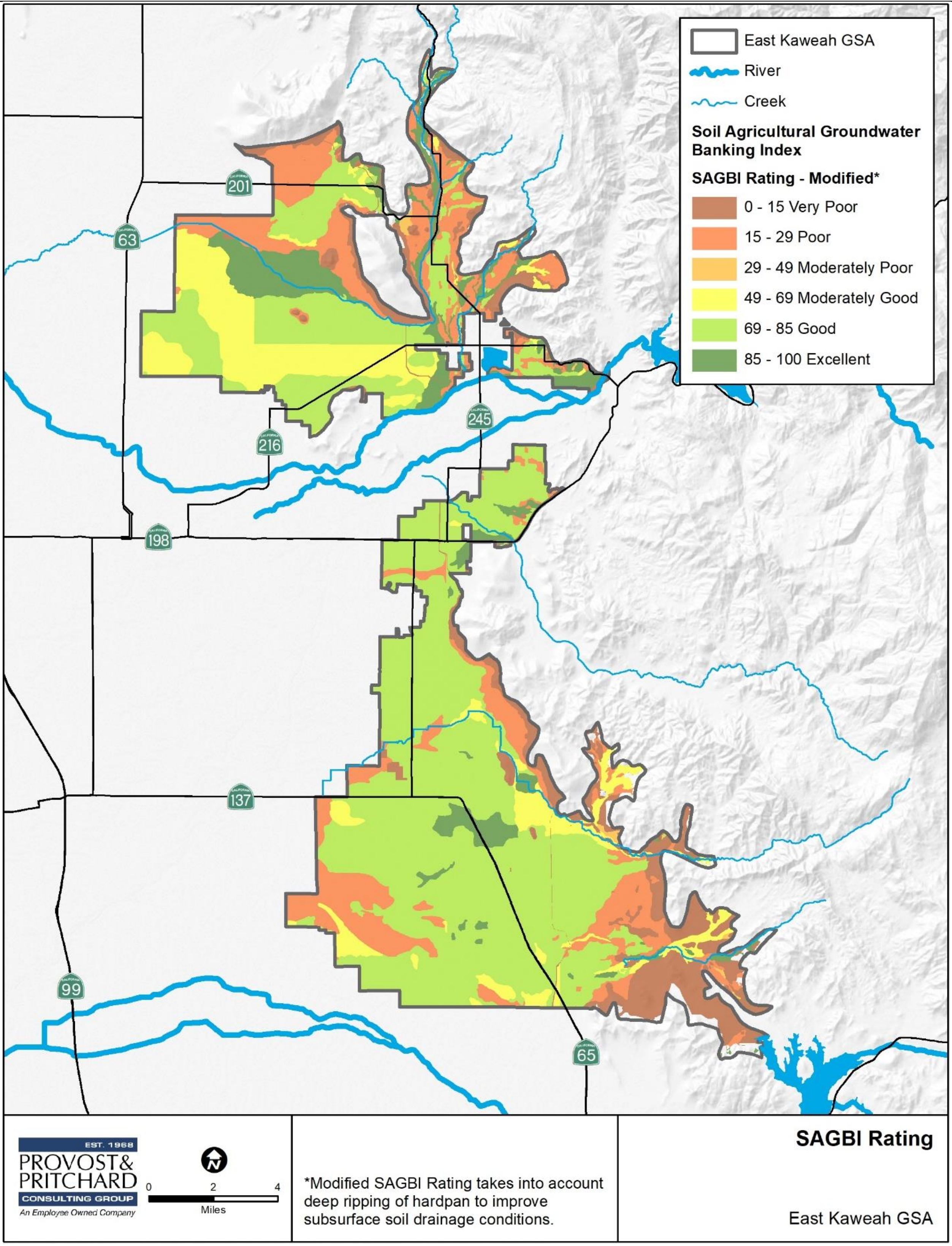

Figure 2-14 Modified Soil Agricultural Groundwater Banking Index (SAGBI) Rating

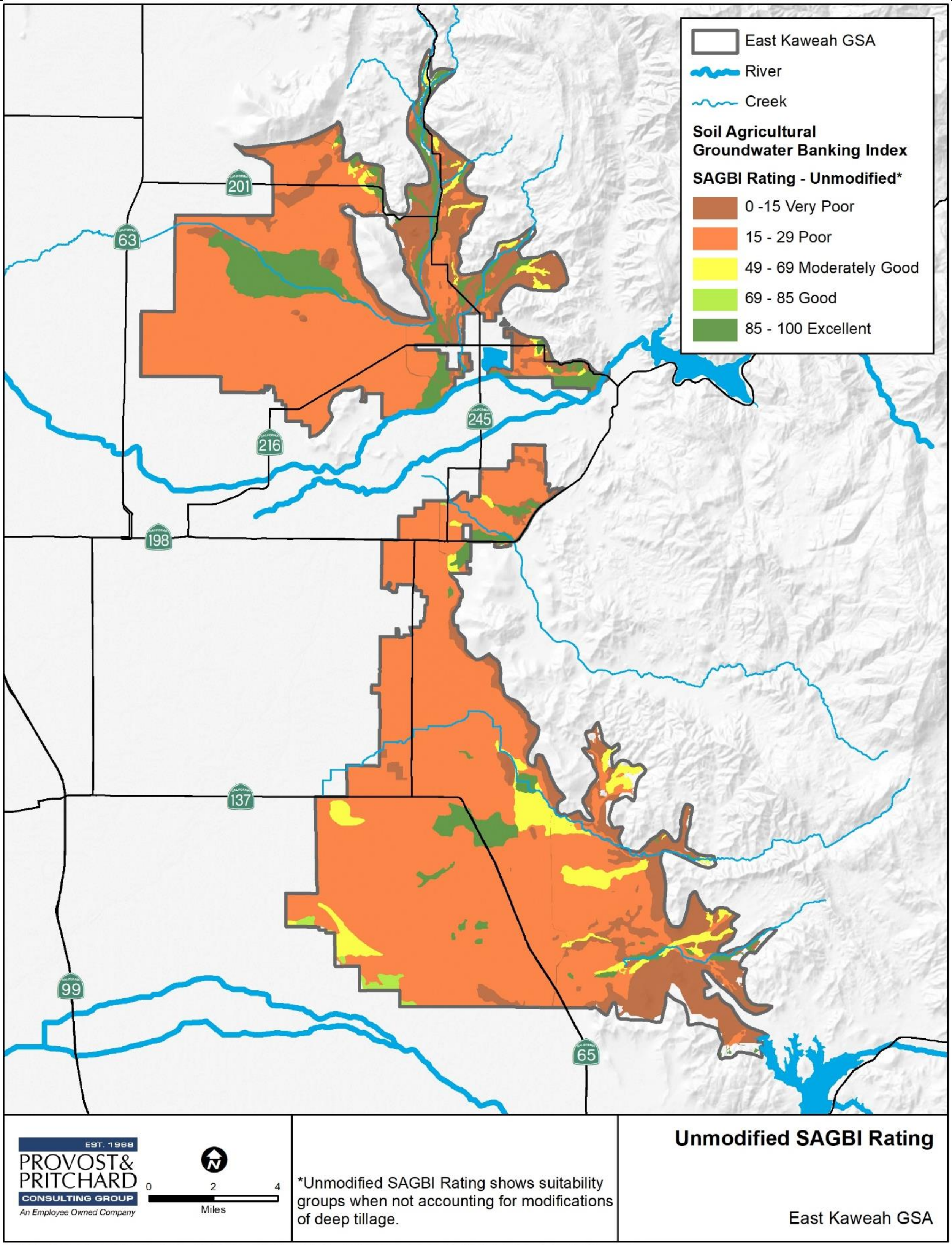

Figure 2-15 Unmodified Soil Agricultural Groundwater Banking Index (SAGBI) Rating

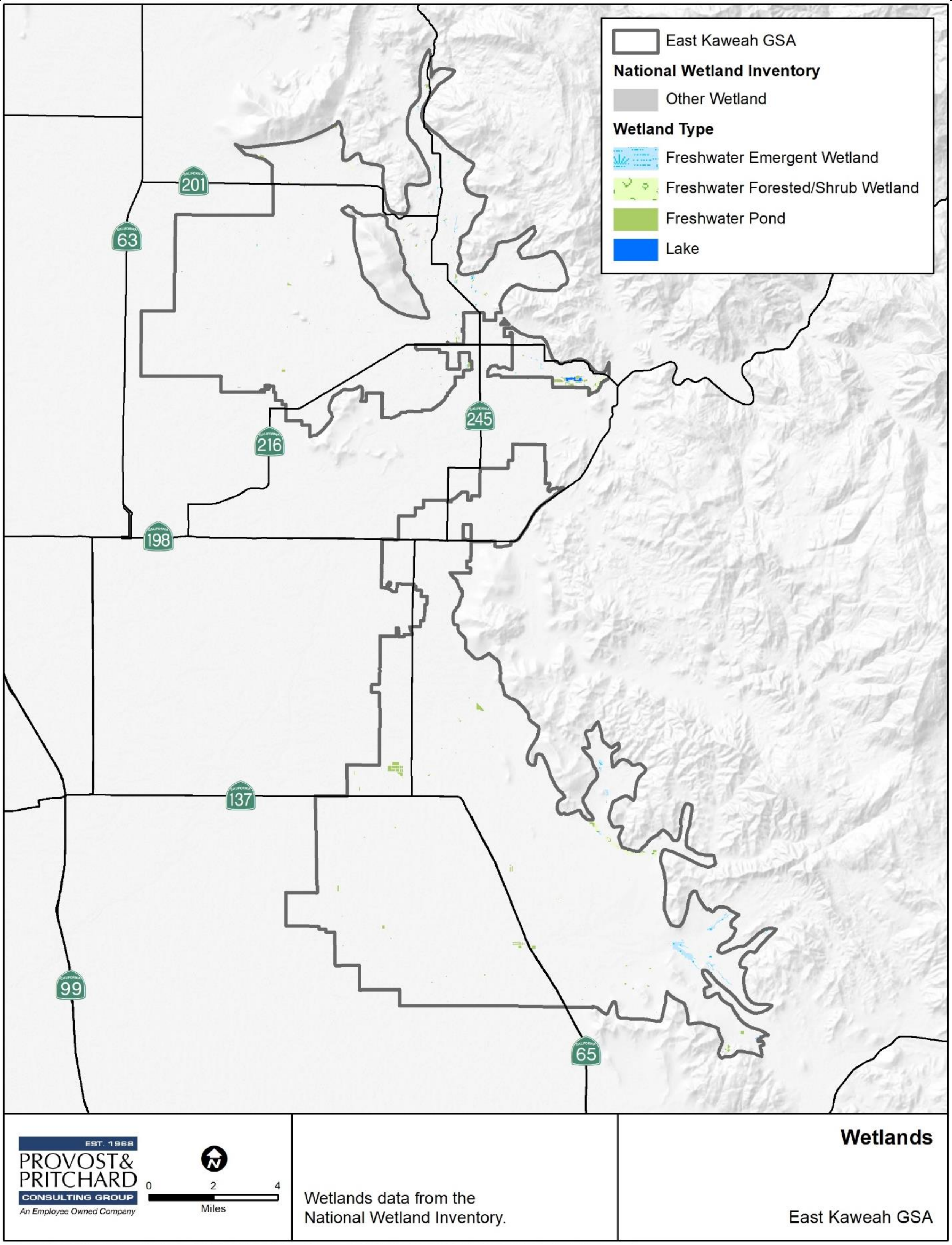

Figure 2-16 Wetlands Map

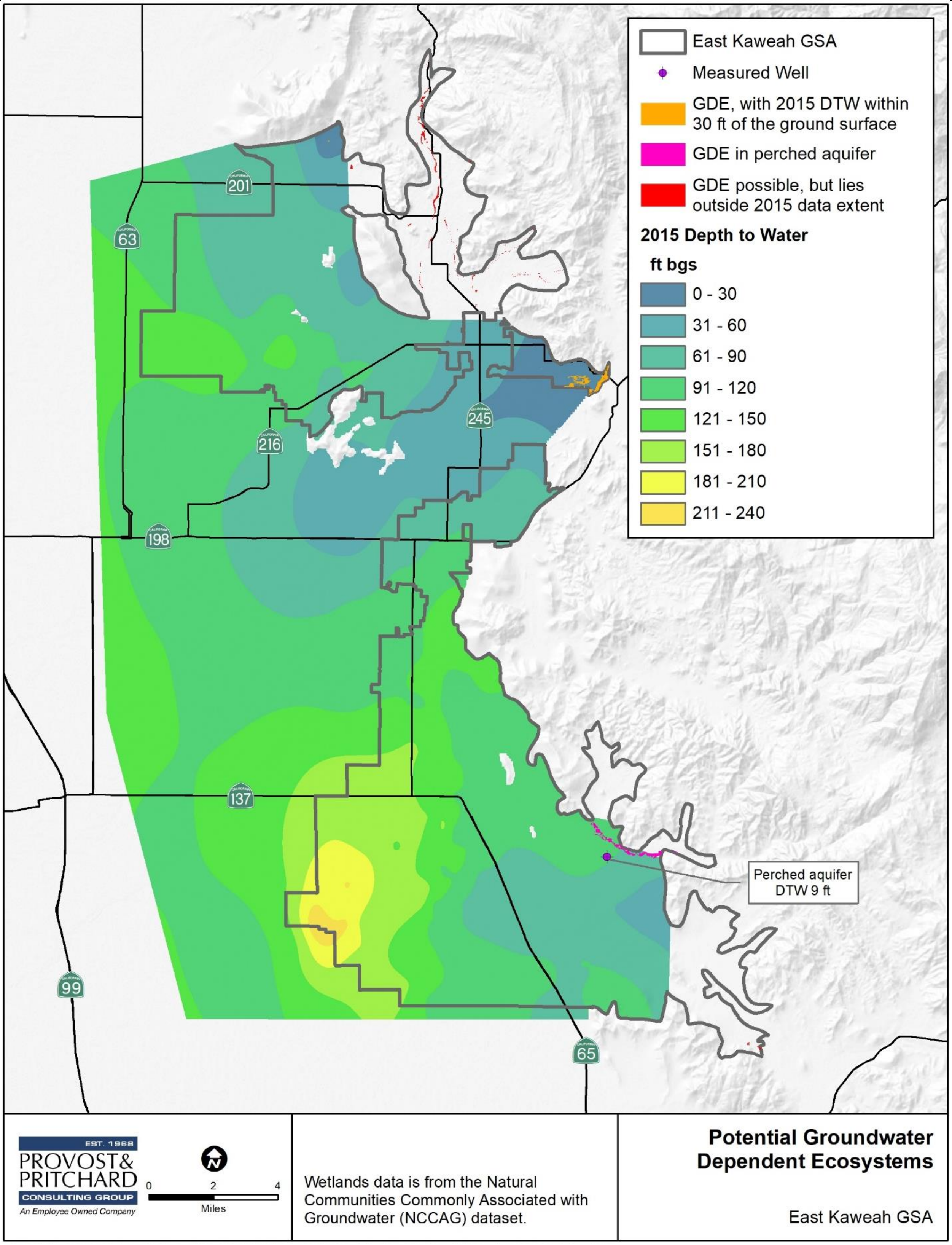

Figure 2-17 Potential Groundwater Dependent Ecosystems

2.2.7.3 Surface Water Bodies

Legal Requirements:
§354.14(d)(5) Physical characteristics of the basin shall be represented on one or more maps that depict surface water bodies that are significant to the management of the basin.

Surface water features important to the management of the EKGSA are shown in **Figure 2-18**.

The Friant-Kern Canal is a primary source of surface water for much of the EKGSA. It runs the length of the EKGSA, usually following the eastern border. East of the City of Lindsay it turns south and runs through the interior of the GSA, skirting Strathmore and continuing to the south. It is managed by Reclamation.

The Kaweah River has its headwaters in the high Sierra Nevada and enters the San Joaquin Valley near the EKGSA. It runs between the two lobes of the EKGSA and is a significant source of recharge to the entire Kaweah Subbasin. The St. Johns River diverges from the Kaweah River at McKays Point, flowing in and out of the northern lobe of the EKGSA. The Wutchumna Ditch is the principal man-made open channel through the northern lobe of the EKGSA. It diverts water from the Kaweah about 1.5 miles above McKays Point and is operated by the Wutchumna Water Company. It flows parallel to and slightly north of the St. Johns River.

Several intermittent streams have courses that flow into the EKGSA from the Sierra Nevada Mountains. Prominent among these are Cottonwood Creek in the northern lobe of the EKGSA, and Yokohl, Lewis, and Frazier Creeks in the southern lobe.

Lastly, the Tule River flows to the south of the EKGSA. Seepage from the River can contribute to recharge within the EKGSA in wetter periods (Water Supply Study of the Lindmore ID, 1948).

2.2.7.4 Source and Point of Delivery for Imported Water Supplies

Legal Requirements:
§354.14(d)(6) Physical characteristics of the basin shall be represented on one or more maps that depict the source and point of delivery for imported water supplies.

Groundwater use in the EKGSA is directly impacted by the availability and delivery of surface water to lands within the Central Valley Project (CVP) service area. The Friant-Kern Canal (shown in **Figure 2-18**) provides the imported surface-water supplies in the EKGSA (Croft and Gordon, 1968). CVP water is delivered to the Friant CVP contractors within the EKGSA.

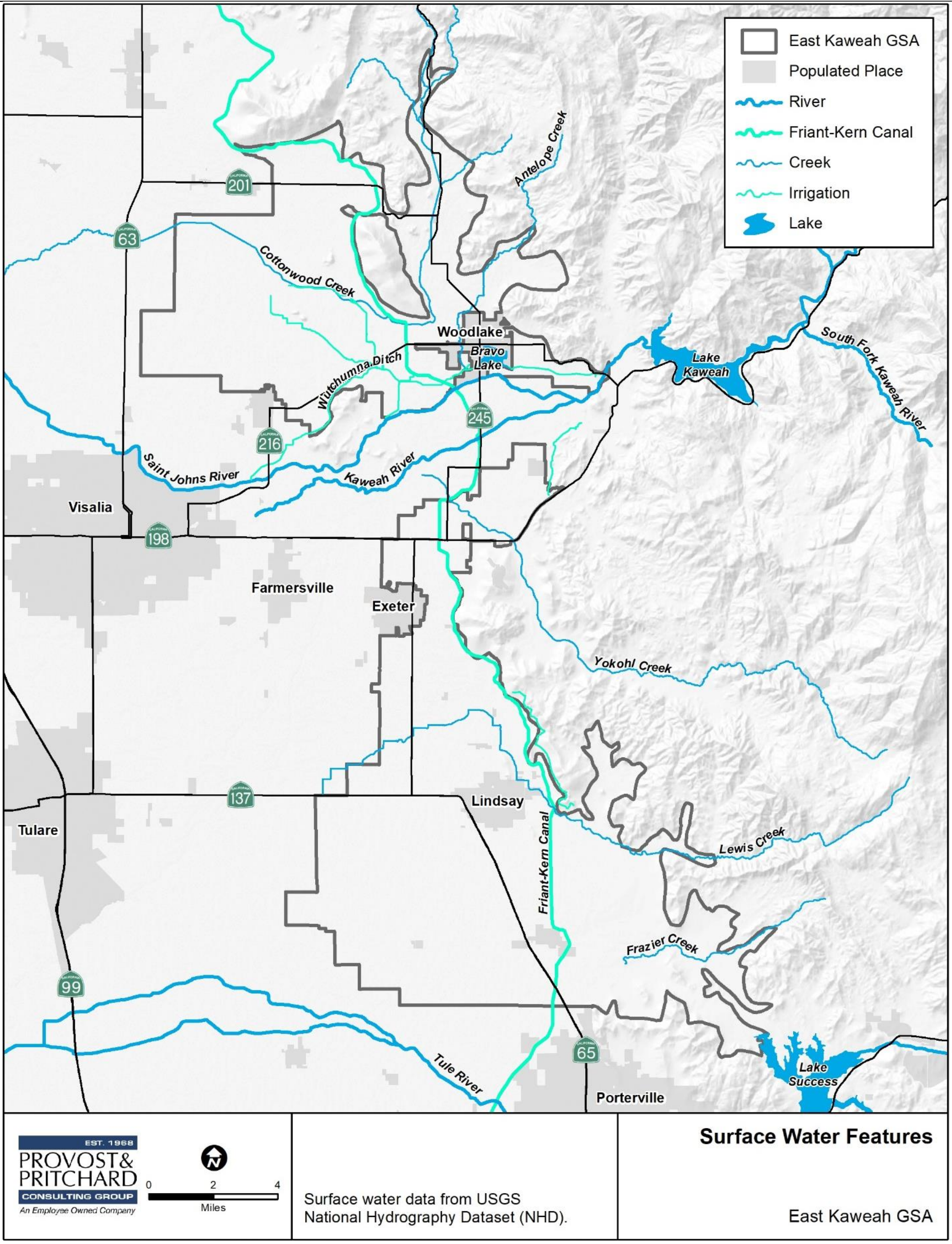

Figure 2-18 Surface Water Features Significant to the Management of the East Kaweah GSA Basin

2.3 Overview of Existing Monitoring Programs

Monitoring is and will be a fundamental component of a groundwater management program and is needed to measure progress towards groundwater sustainability. Monitoring programs needed to comply with SGMA will largely relate to the Undesirable Results, such as groundwater level monitoring, land subsidence monitoring, and groundwater quality monitoring. Existing monitoring programs as they relate to SGMA compliance, their history and adequacy for the EKGSA Monitoring Network are described in this section. Additional information is also available in the Kaweah Subbasin Setting document in **Appendix 2-A**. In general, water levels and water quality have been monitored annually, or twice a year where possible, and data reported biennially. Where viable, these existing monitoring networks will be incorporated into the defined monitoring networks for this GSP to be leveraged with monitoring network requirements for SGMA.

2.3.1 Existing Groundwater Level Monitoring Programs

While most member agencies maintain groundwater level records (Friant Contractors per requirements of CVP Contract), there is no comprehensive network throughout the EKGSA area. Many existing local water level monitoring networks were further developed by local water districts in part due to AB-3030 groundwater management planning. The most robust monitoring program is directly west of the EKGSA area, where more than 300 wells are semiannually monitored in the Kaweah Delta Water Conservation District (KDWCD). Many of the redundant and disjointed groundwater level monitoring programs may cease when a SGMA approved groundwater monitoring program is developed and implemented by the GSAs in the Kaweah Subbasin.

2.3.2 Existing Groundwater Quality Monitoring Programs

Legal Requirements:
§354.16(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.

Most of the wells in EKGSA are used for agricultural purposes. These wells have been monitored by the well operators to ensure crop productivity. These monitoring records are typically kept private and are not public information. Water quality monitoring of drinking water sources has been performed by public water systems under the California Safe Drinking Water Act and overseen by the Division of Drinking Water (DDW). Public water systems are defined by California Health & Safety Code § 116275(h) as systems that have either: (1) 15 or more service connections, or (2) serve at least 25 individuals daily at least 60 days out of the year. Private domestic wells that serve one to four connections are not subject to any water quality regulation. Additional testing may be done if a site has specific constituents of concern that need to be monitored. Some limited data is available in smaller communities that include clusters of domestic wells.

Groundwater quality monitoring and reporting is currently conducted through numerous public agencies. The following sections provide a summary of databases, programs and agencies that actively collect groundwater data, provides information on where the data is stored, and how it was used in this Basin Setting. A summary of these programs is provided in **Table 2-4** at the end of this section. The water quality monitoring network needs to be enhanced adding dedicated monitoring wells to track regional trends and to serve as a warning system for changes in water quality.

Irrigated Lands Regulatory Program

The Irrigated Lands Regulatory Program (ILRP) addresses discharge of wastes (e.g., sediments, pesticides, nitrates) from commercial irrigated lands. The goal of the ILRP is to protect surface water and groundwater and reduce impacts of irrigated agricultural discharges to waters of the State. In 1999, the California Legislature passed Senate Bill 390, which eliminated a blanket waiver for agricultural waste discharges. The Bill required the Regional Water Quality Control Board (RWQCB) to develop a program to regulate agricultural lands under the Porter-Cologne Water Quality Control Act. In 2003, the Central Valley Water Board adopted a conditional

Waiver of Waste Discharge Requirements (WDRs) to regulate agricultural discharges to surface waters. In September 2013, the RWQCB adopted the WDR governing the Tulare Lake Region, of which the Kaweah Subbasin is a part, that address discharges to both surface water and groundwater, thus requiring ILRP enrollment for all commercial irrigated agricultural operations.

Irrigated landowners can choose to comply with the WDRs individually or can join a coalition. Coalitions are governing agencies that assist members in complying with ILRP WDRs on a watershed level, thus potentially reducing/eliminating grower interaction with the RWQCB. Coalitions assess fees to cover their costs and RWQCB fees, prepare and implement mandatory regional water quality management and monitoring plans, and report the results of the monitoring efforts and the effectiveness of the plans.

A majority of the Kaweah Subbasin is within the Kaweah Basin Water Quality Association (KBWQA). One of the requirements under WDR was for the KBWQA to prepare a Groundwater Assessment Report (GAR), which is an analysis of the risks to groundwater from nitrates and pesticides as the primary constituents of concern (COCs) that may originate from irrigated agriculture within the coalition area. Both the vadose zone and aquifer have nitrates and pesticide in storage that are the result of past land use practices representing potential impacts that will continue to migrate over time.

Following results from the GAR, the KBWQA developed a Comprehensive Groundwater Quality Monitoring Plan (CGQMP) and Groundwater Trend Monitoring Plan (GTMP). These two works products will be the basis for the KBWQA's groundwater quality monitoring going forward. The KBWQA recently received a conditional approval from the RWQCB for these products, therefore no data is available at this time. In 2018, the first round of groundwater quality trend monitoring occurred. The usefulness of the data collected through the ILRP to the needs of the EKGSA SGMA compliance will be evaluated as data becomes available. The KBWQA will submit their data to the Groundwater Ambient Monitoring & Assessment (GAMA) Geotracker program when available.

Groundwater Ambient Monitoring & Assessment (GAMA) Program

The GAMA Program was created by the State Water Resources Control Board (SWRCB), in 2000. It was later expanded by the Groundwater Quality Monitoring Act of 2001 (AB 599). AB 599 required the SWRCB, to integrate existing monitoring programs and design new program elements as necessary, to monitor and assess groundwater quality. The GAMA Program is based on collaboration among agencies including the SWRCB, RWQCB, DWR, Department of Pesticide Regulations (DPR), USGS and USGS National Water Information System (NWIS), and Lawrence Livermore National Laboratory (LLNL). In addition to these state and federal agencies, local water agencies and well owners also participate in this program. The main goals of GAMA are to 1) improve statewide comprehensive groundwater monitoring, and 2) increase the availability to the general public of groundwater quality and contamination information. Monitoring projects in this program include:

- **Priority Basin Project** which provides a comprehensive groundwater quality assessment to help identify and understand the risks to groundwater. The project started assessing public system wells (deep groundwater resources) in 2002 and shifted focus to shallow aquifer assessments in 2012. The analysis sampled both public and domestic supply wells for deep and shallow aquifer assessments respectively. Since 2002 USGS, the technical lead, has performed baseline and trend assessments and sampled over 2,900 public and domestic water supply wells that represent 95% of the groundwater resources in California.
- **Domestic Well Project** began between 2002 and 2011, the GAMA Program sampled over 1,100 private wells in six California counties (Yuba, El Dorado, Tehama, Tulare, San Diego, and Monterey) for commonly detected chemicals. The voluntary participants received analytical test results and fact sheets, and the water quality data was included in the GAMA GeoTracker online database. This Project is currently on hiatus. Through this project, nitrate data including a stable isotopic analysis for 29 domestic wells within the Kaweah Subbasin were incorporated into the Basin Setting.

- **Technical Hydrogeologic and Data Support** has expanded to include several Divisions and Programs at the SWRCB and RWQCB, other state agencies, and non-governmental organizations. GAMA staff provides support for a number of activities, including:
    - Hydrogeologic analyses to evaluate drinking water sources
    - Development of geothermal well and water well standards
    - Technical support for state actions involving groundwater
    - Hydrogeologic analysis for desalination projects
    - Technical assistance for developing standard operating procedures for grant projects
    - Source water protection planning
    - Antidegradation in groundwater planning

GeoTracker and EnviroStor Databases

The SWRCB oversees the GeoTracker database. This database systems allows the SWRCB to house data related to sites that impact or have the potential to impact the groundwater. Records available on GeoTracker includes cleanup sites for Leaking Underground Storage Tank (LUST) Sites, Department of Defense Sites, and Cleanup Program Sites. Other records for various unregulated projects and permitted facilities includes Oil and Gas production, operating Permitted Underground Storage Tanks (USTs), and Land Disposal Sites.

GeoTracker is a public portal that can retrieve records and view data sets from multiple SWRCB programs and other agencies through Google maps GIS interface. This database is not only useful for the public, but also to help other agencies, such as the EKGSA, to monitor the progress of cases. It also provides a web application tool for secure reporting of lab data, field measurement data, documents, and reports.

The California Department of Toxic Substances Control (DTSC) oversees the EnviroStor database. This data management system tracks cleanup, permitting, enforcement, and investigation efforts at hazardous waste facilities and sites with known contamination or sites where further investigation is warranted by the DTSC. This database only provides reports, inspection activities and enforcement actions completed on or after 2009. Like the GeoTracker database, this is not only useful for the public, but other agencies may use it to monitor progress of ongoing cases. The primary difference between the two databases is that EnviroStor only houses records for cases that DTSC is the lead regulatory agency, whereas the GeoTracker database houses records to cases from various agencies at the State and local levels. For the Basin Setting, both databases were searched to identify and report on any contamination sites that may have impacts to groundwater water quality.

California State Drinking Water Information System (SDWIS)

All public drinking water systems (a system that has 15 or more service connections or regularly serves 25 individuals daily at least 60 days out of the year) are regulated by the DDW to demonstrate compliance with State and Federal drinking water standards through a rigorous monitoring and reporting program. Required monitoring for each well within each water system is uploaded to the DDW's database and subsequently available for the public through the SDWIS. In addition to providing compliance monitoring data for each regulated water system, other information such as monitoring frequency, basic facility descriptions, lead and copper sampling, violations and enforcement actions, and consumer confidence reports are also available.

All drinking water systems are required to collect samples, known as Title 22 constituents, on a given frequency depending on the constituent and regional groundwater vulnerability. Public water systems provide the most abundant source of data since the testing requirements are fairly frequent intervals. It is important to understand that this characterization is not intended to represent water supplied by purveyors because they may provide wellhead treatment to remove or reduce contamination. The following is a summary of the minimum sampling frequency for a public water supply well:

- General minerals, metals and organics (Synthetic Organic Chemicals and Volatile Organic Compounds) sampling is required every 3 years. If any organics are detected, sampling frequency must be increased to quarterly.
- Nitrate is required annually. If nitrate is ≥5 ppm, then sampling is required quarterly.
- If arsenic is ≥5 ppb, sampling should be increased to quarterly but is not always done.
- Radiologicals (gross alpha and uranium) are sampled one every 3 (when initial monitoring is ≥ ½ the MCL), 6 (when initial monitoring is ≤ ½ the MCL) or 9 (when initial monitoring is non-detect) years depending on historical results.

United States Geological Survey (USGS)

The USGS California Water Science Center (CWSC), provides California water data through data collection, processing, analysis, reporting, and archiving. Data include surface water, groundwater, spring sites, and atmospheric sites, with data often available in real-time via satellite telemetry. The CWSC groundwater database consists of records of wells, springs, test holes, tunnels, drains, and excavations. Available information includes groundwater level data, well depth, aquifer parameters, and more. Studies that were specifically used for the Basin Setting and groundwater characterization are:

- Status and Understanding of Groundwater Quality in the Two Southern San Joaquin Valley Study Units, 2005-2006: California GAMA Priority. Scientific Investigations Report 2011-5218. 2012.
- Environmental Setting of the San Joaquin-Tulare Basins, California. Water Resources Investigations Report 97-4205. 1998
- Groundwater Quality in the Shallow Aquifers of the Tulare, Kaweah, and Tule Groundwater Basins and Adjacent Highlands areas, Southern San Joaquin Valley, CA. USGS and SWRCB. Fact Sheet, 2017.
- Groundwater Quality in the Southeast San Joaquin Valley, California. USGS and SWRCB. June 2012.
- Groundwater Quality Data in the Southeast San Joaquin Valley, 2005-2006: Results from the California GAMA Program. Data Series 351. USGS and SWRCB. 2008.

Department of Pesticide Regulation (DPR)

The DPR Ground Water Protection Program evaluates and samples for pesticides to determine if they may contaminate groundwater, identifies areas sensitive to pesticide contamination and develops mitigation measures to prevent that movement. DPR obtains ground water sampling data from other public agencies, such as SDWIS, USGS and GAMA, and through its own sampling program. Sampling locations and constituents are determined by pesticides used in a region, and from review of pesticide detections reported by other agencies. Because of their sample selection methodology, DPR typically only collects one sample per well, they do not confirm positive detections with repeat sampling. Rather, their focus is on validating contamination through their research and sampling program. These data are reported annually along with the actions taken by DPR and the SWRCB to protect groundwater from contamination by agricultural pesticides. Annual reports are reviewed, and contaminant detections are identified in the groundwater quality characterization. In the Kaweah Subbasin, only legacy pesticides (dibromochloropropane and 1,2,3-trichloropropane) are detected in the public water system wells. No pesticides currently in use were identified.

Central Valley-Salinity Alternatives for Long-term Sustainability (CV-SALTS)

CV-SALTS is a collaborative stakeholder driven and managed program to develop sustainable salinity and nitrate management planning for the Central Valley. The program objective is intended to facilitate the salt and nitrate implementation strategies recommended in the Salt and Nitrate Management Plan (SNMP) developed in 2017. They are designed to address both legacy and ongoing salt and nitrate accumulation issues in surface and groundwater. The overarching management goals and priorities of the control are: 1) ensure safe drinking water supply; 2) achieve balanced salt and nitrate loading; and 3) implement long-term, managed restoration of impaired water bodies. The program is phased with the primary focus of early actions on nitrate impacts to groundwater drinking water supplies and established specific implementation activities. The Kaweah Subbasin is a Priority 1 basin for nitrate management. The nitrate control program schedule is set to begin in 2019, pending State Board adoption of the Salt and Nitrate Control Program basin plan.

CV-SALTS will enact a nitrate control program as part of the SNMP which requires forming a management zone as a regulatory option to comply with the requirements of the nitrate program. The management zones will consist of a defined management area to manage nitrates, ensure safe drinking water, and meet applicable water quality objectives. Local management plans will be created to implement the long-term goals of the nitrate control program. As programs are implemented, there will be versions of management areas to meet the objectives of their individual programs. While ILRP allows for compliance of their regulatory program through coalitions that cover a broad, non-contiguous area based on similar land use, SGMA and CV-SALTS will both require contiguous management areas/zones to be contiguous areas regardless of land use.

Both the ILRP and CV-SALTS programs involve permittees and local stakeholders working towards water management objectives set forth by the State. In this regard, collaborative efforts will likely be made to maximize the resources of each program and provide a more integrated approach to developing local solutions for groundwater management.

Table 2-4 Existing Groundwater Quality Monitoring Programs

Programs or Data Portals	Parameters	Frequency	Objectives	Notes
AB-3030 and SB-1938	Water levels are typically monitored annually An Ag Suitability analysis (limited suite of general minerals) monitoring frequency between annual to once every 3 years.	Semiannual to Annual		Monitoring is recommended as a part of groundwater management planning. Data availability is inconsistent between Districts.
ILRP	Annually: static water level, temperature, pH, electrical conductivity, nitrate as nitrogen, and dissolved oxygen. Once every five years, general minerals will be collected.	Annual Every 5 years	Monitor impacts of agricultural and fertilizer applications on first encountered groundwater	Sampling will begin in Fall 2018 with a limited number of wells sampled. The program will be expanded and may incorporate a shared sampling program with SGMA.
CV-SALTS	Sampling parameters required through WDR's: typically include monthly sodium, chloride, electrical conductivity, nitrogen species (N, NO_2, NO_3, NH_3), pH and other constituents of concern identified in the Report of Waste Discharge. A limited suite of general minerals is required quarterly from the source and annual from the wastewater.	Most constituents sampled monthly, quarterly general minerals from source water and annual general minerals from waste discharge Kaweah is a Priority 1 Basin, meaning that management strategies will be initiated in 2019.	To monitor degradation potential from wastewaters discharged to land application areas.	Water quality monitoring required by CV-SALTS is consistent with the Regional Water Boards existing requirements through their Waste Discharge Requirements process. It is unlikely that additional monitoring will be required. The initial phases of the program are strongly focused on identifying sources of salinity and reducing salinity and nitrogen species in wastewaters discharged to land. By 2030, the program is expected to implement projects to aid with salt and nitrate management in the Central Valley.
SDWIS	Database for all public water system wells and historical sample results. Data	Title 22 General Minerals and Metals every 3 years;	Demonstrate compliance with Drinking Water Standards through	An abundant source of data because of the required testing frequency and list of parameters.

Programs or Data Portals	Parameters	Frequency	Objectives	Notes
	available includes all Title 22 regulated constituents.	Nitrate as N annually, if ≥ 5 ppm, sampled quarterly; VOCs and SOCs sampled every 3 years; Uranium sampling depends on historical results, varies between 1 sample every 3 (when ≥ 10 pCi/L), 6 (when < 10 pCi/L) or 9 (no historical detection) years.	monitoring and reporting water quality data.	
GAMA. Collaboration with SWQCB, RWQCB, DWR, DPR, NWIS, LLNL	Constituents sampled vary by the Program Objectives. Typically, USGS is the technical lead in conducting the studies and reporting data.	The priority basin project performed baseline and trend assessments sampling over 2,900 public and domestic wells that represent 95% of the groundwater resources in CA. The Domestic Well Project sampled over 180 domestic wells in Tulare County: 29 Wells were within the Kaweah Subbasin.	Improve statewide comprehensive groundwater monitoring. Increase the availability to the general public of groundwater quality and contamination information.	USGS reports prepared for the Priority Basin Project were used to identify constituents of concern in the basin and confirm water quality trends prepared for groundwater characterization.
Geotracker and DTSC Envirostor	Many contaminants of concern, organic and inorganic.	Depends on program. Monthly, Semiannually, Annually, etc.	Records database for cleanup program sites, permitted waste dischargers,	Records available on GeoTracker includes cleanup sites for Leaking Underground Storage Tank (LUST) Sites, Department of Defense Sites, and Cleanup Program Sites. Other records for various unregulated projects and permitted facilities includes Irrigated Lands, Oil and Gas production, operating

Programs or Data Portals	Parameters	Frequency	Objectives	Notes
				Permitted Underground Storage Tanks (USTs), and Land Disposal Sites.
USGS California Water Science Center	Conducted Multiple Groundwater Quality Studies of the Kaweah Subbasin	Reports and fact sheet publications range from 1998 through 2017.	Special studies related to groundwater quality that provide comprehensive studies to characterize the basin.	Groundwater Quality in the Shallow Aquifer (2017). Status and Understanding (2012). Groundwater Quality in SESJ (2012). Groundwater Quality Data in the SESJ (2008). Environmental Setting (1998).
Department of Pesticide Regulation	Pesticides	Annual	DPR samples ground water to determine (1) whether pesticides with the potential to pollute ground water are present in ground water, (2) the extent and source of pesticide contamination, and (3) the effectiveness of regulatory mitigation measures.	https://www.cdpr.ca.gov/docs/emon/grndwtr/index.htm

2.3.3 Existing Land Subsidence Monitoring

Past, recent and potential future monitoring of land subsidence in the Kaweah Subbasin are summarized in **Table 2-5**. Much of the historical data does not cover the EKGSA area. Newer data sets (2015-2017) provide more coverage. The EKGSA will strive to keep these newer data sets active to avoid data gaps in the future. While land subsidence isn't believed to be a major concern in the EKGSA, it will be monitored to avoid Undesirable Results.

Table 2-5 Summary of Land Subsidence Monitoring in the Kaweah Subbasin

Category	Monitoring Entity(s)	Period of Record
Historic Monitoring	National Geodetic Survey of benchmarks (repeat level survey's)	1926-1970
Recent Monitoring	National Geodetic Survey of benchmarks (repeat level surveys and installation and measurement of extensometers), NASA including both InSAR and UAVSAR programs,	NGS – 1970 to Present, NASA – 2006 to 2017, (excluding 2011-2014)
Future Data Availability	National Geodetic Survey of benchmarks (repeat level surveys and installation and measurement of extensometers), NASA including both InSAR and UAVSAR programs, potentially new extensometers in the Kaweah Subbasin	2018 through present

2.3.4 Existing Stream Flow Monitoring

The most useful stream flow gauges monitored within the Subbasin are located outside the EKGSA. The closest water bodies regularly monitored are the Kaweah River, St. Johns River, and Yokohl Creek. The flow gauges are located in the Greater Kaweah GSA. Existing stream flow monitoring represents a data gap for the EKGSA to improve moving forward. Streams of interest for the EKGSA to improve monitoring data are: Cottonwood, Lewis, and Frazier Creeks.

2.4 Groundwater Conditions

Legal Requirements:
§354.16 Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes the following:

This chapter includes a description of the current and historical groundwater conditions within the EKGSA. This chapter includes best available historical and most recently available data to describe the groundwater trends, patterns, and current understanding sustainability indicators in the EKGSA. The sustainability indicators include groundwater levels, groundwater storage, groundwater quality, land subsidence, and interconnections between surface water and groundwater.

2.4.1 Current and Historical Groundwater Level Trends

Legal Requirements:
§354.16(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.

Current and historical groundwater level trends are provided below. This section provides an overview of groundwater conditions by describing both groundwater elevation maps and key well hydrographs.

The discussion on water level trends must include the context with regard to hydrologic variations in historical wet-dry cycles, referred to "water year type". Water levels vary in response to the cyclical nature of water supply and deficiency related to precipitation, surface water supplies and deliveries from the Kaweah River system. The Kaweah Subbasin consultant reviewed the record of rainfall recorded in Visalia from water year 1878 through 2017 in the Kaweah Subbasin Basin Setting (**Appendix 2-A**), more detailed discussion can be found in this document. For reference, **Figure 2-19** and **Table 2-6** are pulled into this GSP. The figure shows the departure from mean precipitation, which is the difference between precipitation in a specific year and the mean precipitation for the period. The figure and table emphasize the variable climactic cycles of the southern San Joaquin Valley, which consist of prolonged periods of modest drought punctuated by short wet periods.

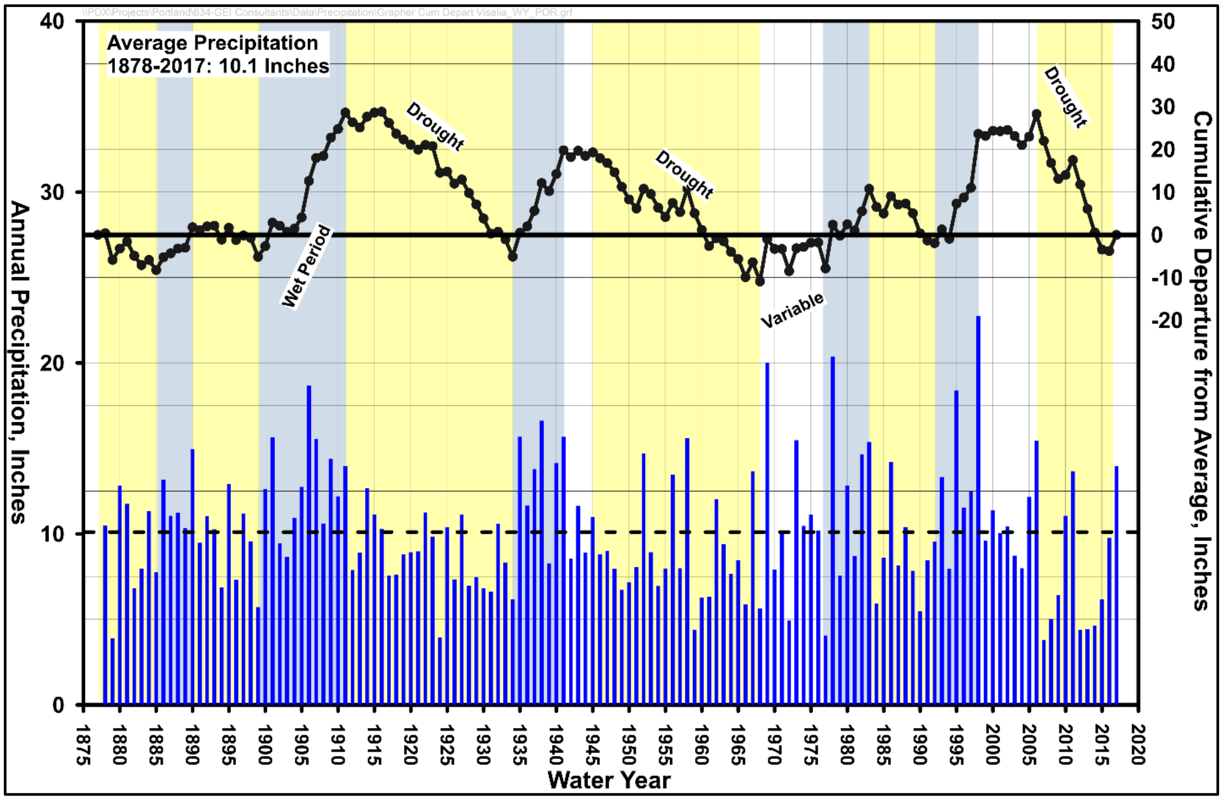

Figure 2-19 Cumulative Departure from Mean Precipitation - Visalia, CA

Table 2-6 Historic Hydrologic Conditions (Water Year Types)

Period (Water Years)	Hydrologic Condition	Duration (No. of Years)	Precipitation Deviation (Inches)	Deviation Rate (Inches/year)
1878 to 1885	Drought	8	- 6	- 0.7
1886 to 1890	Wet	5	10	2.0
1891 to 1899	Drought	9	7	- 0.8
1900 to 1911	Wet	12	34	2.8
1912 to 1934	Drought	23	- 34	- 1.5
1935 to 1941	Wet	7	25	3.6
1942 to 1945	Variable	4	4	- 0.1
1946 to 1968	Drought	23	- 30	- 1.3
1969 to 1977	Variable	9	3	0.3
1978 to 1983	Wet	5	19	3.1
1984 to 1993	Drought	8	-10	-1.0
1994 to 1998	Wet	5	22	4.5
1999 to 2006	Variable	8	5	0.6
2007 to 2016	Drought	10	32	- 3.2

Precipitation data from Visalia California NOAA gauge.
Precipitation Deviation is the cumulative departure from average precipitation for the period.
Deviation Rate provides a relative sense of the severity of the wet or dry periods.

The most recent drought (2007 – 2016) was the most extreme in recorded history, in particular the years 2012 through 2015 were exceptionally dry. This led to the unprecedented 0% Class I declarations in 2014 and 2015 for the Friant Division of the Central Valley Project (CVP). The lower precipitation totals and unavailability of CVP water led to water levels throughout the EKGSA to decline to the lowest levels on record since the 1960s. Some areas in the EKGSA experienced water level declines of as much as 100 feet.

It is important to note, that while much of the Subbasin experienced widespread water level declines, there are areas where water levels have experienced only very limited declines. Generally, along the Kaweah River near the foothills in the eastern portion of the Subbasin, some wells have experienced very minimal seasonal fluctuations. These wells are presumed to be both relatively shallow and benefit from almost continual recharge from the flow of the Kaweah and St. Johns Rivers.

2.4.1.1 Elevation and Flow Directions

Historical Conditions (1890 – 1962)

Groundwater elevations naturally experience periods of drawdown and recovery due to seasonal fluctuations, variation in precipitation patterns, and changes in surface water availability. This natural variability is impacted by anthropogenic causes, including groundwater pumping and the diversion of natural surface water features. Impacts of human activity on the groundwater supply of the EKGSA are evident from some of the earliest historical records. In 1890, Lindmore ID reported groundwater levels about 20 feet below the ground surface. By 1917, the beginnings of what would become a serious cone of depression was evident in vicinity of the City of Lindsay (USBR LID Land Class Report). The earliest records in Ivanhoe ID are from 1916, where groundwater levels were between 10 and 15 feet below the ground surface. By 1921 water levels had declined to more than 24 feet below ground surface (USBR IID Factual Report).

Maps of historical groundwater conditions in the EKGSA are presented in **Appendix 2-B**. The earliest map presented is from October of 1925. At that time, groundwater in the northern part of the EKGSA flowed steadily to the west, with water surface elevations (WSE) of at least 405 ft above sea level (ASL) in the east descending to 310-315 ft west of Ivanhoe ID. Groundwater beneath the southern part of the EKGSA flowed toward a depression called the Lindsay Cone, which had a WSE of 255 ft. The region was in the midst of a drought that began in 1912 and would not end for another 9 years.

Water surface elevation contours in 1939 show a pronounced increase in the severity of the Lindsay cone of depression. Its center had been pumped to 170 ft ASL. All groundwater south of CA 198 in the EKGSA flowed towards this depression, and its influence pulled water from beyond the borders of the EKGSA in the south and west. In the northern part of the EKGSA the groundwater levels held steady beneath surface water features (i.e. Cottonwood Creek) but retreated elsewhere, which resulted in a lowering of the WSE by as much as 40 ft across the Ivanhoe and Stone Corral IDs compared to their 1925 levels. The groundwater surface west of Ivanhoe ID had flattened somewhat at about 310 ft ASL.

Groundwater trends in Fall 1945 largely mirrored the Fall 1939 trends. Precipitation in the intervening 6 years had been variable. Groundwater levels in the north remained within about 10 ft of their 1939 levels. The Lindsay cone of depression worsened far beyond what the climate could account for, descending to less than 100 ft ASL at its center.

By 1952 (two figures – Spring and Fall) the Lindsay cone of depression had recovered somewhat from its mid-forties low. Spring 1952 WSE contours show that the center of the depression was at 140 ft ASL and had shifted more than two miles to the south. This rebound can be at least partially attributed to the completion of the FKC in 1951, especially given that the area had been in the midst of a drought since 1946. Fall contours from the same year continue this trend. Groundwater in the north deepened beneath Ivanhoe.

The influx of surface water made a significant difference in the character of the water table in the southern part of the EKGSA by the spring of 1962. A more natural westerly slope replaced the deep pit of the Lindsay Cone despite the continuing drought. Trends in the north continued much as they had before the FKC had been constructed. The overall gradient of the westerly flow steepened somewhat as the groundwater surface to the west of the EKGSA had dropped by about 20 to 30 feet. The mild depression beneath Ivanhoe ID migrated west for 1962. The WSE in the center of this depression dipped below 250 ft ASL.

Current Conditions (1981 – 2017)

Maps for 1981 until the end of the base period in 2017 were constructed using WSE data from the DWR's Water Data Library and from participating EKGSA districts, where applicable. Maps of current groundwater conditions in the EKGSA are presented in **Appendix 2-C**.

Groundwater levels rose across the EKGSA between 1962 and 1981. The groundwater depression beneath western Ivanhoe ID maintained its low at 240 ft ASL, but groundwater levels surrounding it on all sides rose between 20 to 40 feet. The groundwater surface in the south also bottomed out at 240 ft ASL in a mild depression situated between the Lindmore ID and the western border of the EKGSA. This depression does not appear to be related to the historical Lindsay cone – the groundwater surface where the center of the Lindsay Cone existed had risen to 300 ft above sea level, a 200 ft increase from 1945 levels.

Spring 1986 saw similar conditions to 1981. Minimum water surface levels in both the north and south rose on the order of 20 to 30 feet.

Spring of 1991 saw a reversal of the gains seen in the 1980s maps, due at least in part to a drought that began in 1984. WSEs fell by about 10 feet in the east and up to 40 feet in the west. The shape of the water surface retained much of its 1986 character.

Spring of 1996 maintained much of the shape of Spring 1991. Influx from the Tule and Kaweah rivers made their influence more pronounced in this year compared to a slight deepening of the water table in the interfan areas on the order of 10 ft.

A wet period between 1994 and 1998 saw groundwater somewhat replenished by spring of 1999, with groundwater across the EKGSA rising by 10-40 ft. These gains were more pronounced beneath major surface water features. The depression north-west of Ivanhoe ID roughly maintained its lateral extent but rose about 20 ft. Groundwater remained comparatively low beneath the EKGSA west of Lindmore despite rising 10-40ft.

Groundwater levels dropped across the EKGSA by 10 to 30 feet for Spring 2002. The depression north of Ivanhoe had increased in depth by 30 ft, dropping the WSE to 220 feet.

Spring of 2005 saw water levels in further retreat. The depression west of Ivanhoe ID connected to the declining WSE within the GKGSA. Water levels west of Lindmore ID dropped by 40 feet between 2002 and 2005.

The pattern of overall steady decline continued for Spring 2008, despite the lows in the west rebounding by nearly 20 ft. Groundwater in the central and eastern parts of the EKGSA declined on the order of 10 ft.

Spring 2011 saw similar water levels to Spring 2008. The impact of inflow beneath the Kaweah and Tule Rivers was more pronounced this year. The depression west of Ivanhoe became more cut off from the lower groundwater surface to the west, reaching a modest low of 230 ft ASL.

The impacts of prolonged drought in the region were making themselves known by Spring 2014. Groundwater across the EKGSA was in decline, on the order of 10 to 40 ft below their 2011 levels. Groundwater near the Kaweah River saw less of this impact, while the depression west of Lindmore declined up to 60 ft from 2011.

Spring 2017 is the last year of the base period. The impacts of the 2007-2016 drought are clearly evident across the EKGSA. While impacts on private domestic groundwater users are currently unquantified within the boundaries of the EKGSA, declines in groundwater levels throughout Tulare County during the drought led to over 1,300 private domestic wells reporting shortages or outages of water (CDWR 2018). West of the Lindmore ID groundwater reached a low of 80 ft ASL. This was a decline of 90 ft in three years. Groundwater levels across the Lindmore and Lindsay-Strathmore IDs fell by nearly 40-50 ft. Impacts in the Exeter ID were more subdued due to the proximity of the Kaweah River, but still saw declines of 20 to 30 ft from 2014. Ivanhoe ID saw declines between 15 to 20 ft. The non-districted area west of Ivanhoe experienced declines of up to 30 ft, forming a cone of depression. Groundwater across the Stone Corral ID declined by about 20 to 30 ft.

Comparing Current and Historical Conditions

When comparing current groundwater conditions with historical conditions, the impact of surface water supplies is very pronounced. In wet periods when surface water is more available, significant increases in the groundwater surface result. This is especially the case pre- and post-implementation of the CVP. **Figure 2-20** depicts the change in groundwater elevation between 1945 (pre-CVP deliveries) and present (2017). Nearly 70 years of CVP deliveries has reversed the Lindsay cone of depression and allowed for minimal groundwater elevation change in other regions of the EKGSA. The figure does also show significant declines in areas since 1945, these areas generally coincide with little to no surface water deliveries.

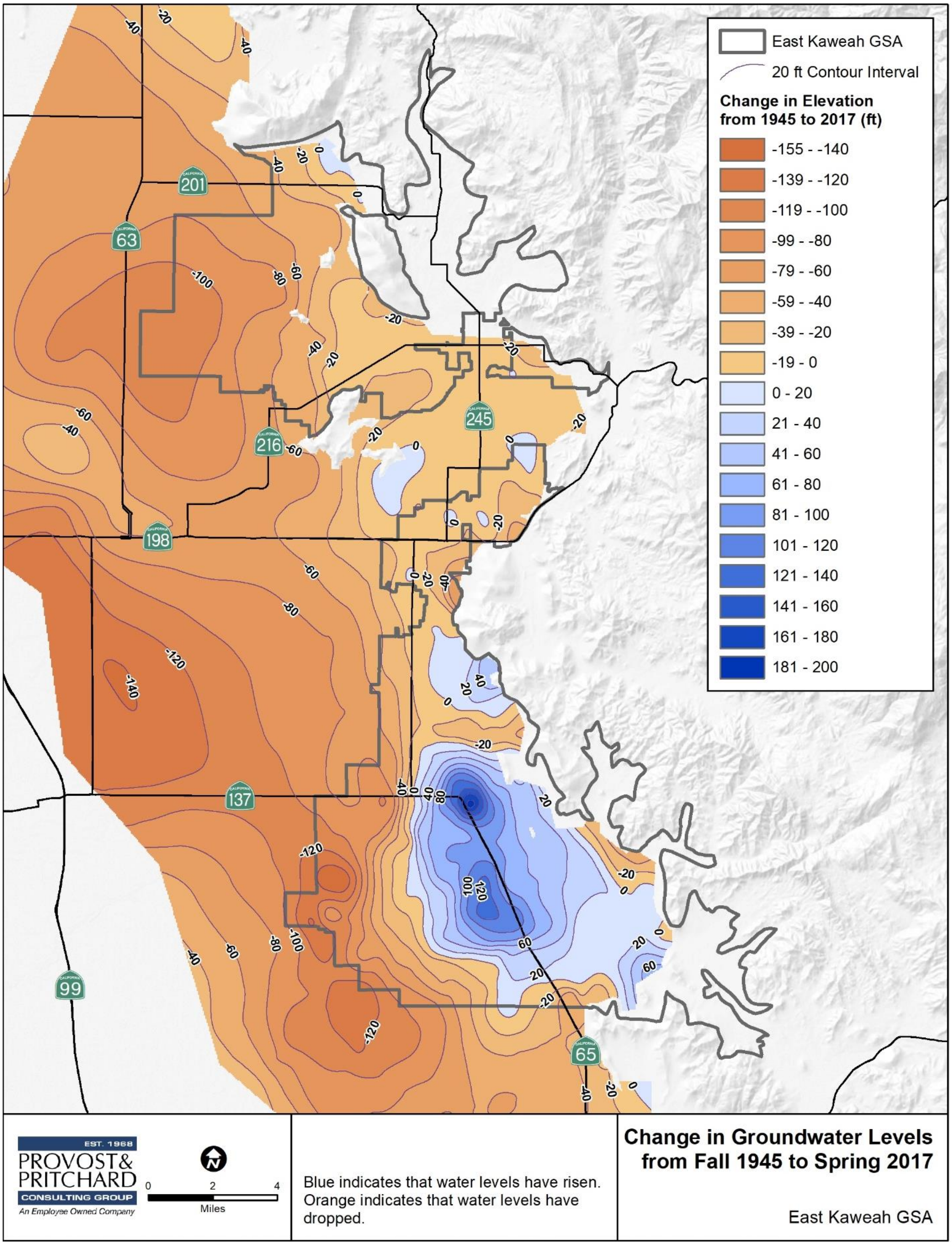

Figure 2-20 Groundwater Level Change from 1945 to 2017

2.4.1.2 Well Hydrographs

Hydrographs of individual wells in and around the EKGSA are presented in **Appendix 2-D**. **Figure 2-21** is a map showing locations of these wells. All groundwater well users and communities (such as Lindcove, Tonyville, Tooleville, etc.) in the EKGSA are susceptible to significant changes in groundwater levels, particularly those closer to the foothills on the east side, as the aquifer is shallower to bedrock. These hydrographs depict the span of time between 1981 and 2017. Hydrographs outside the borders of the EKGSA were included to establish boundary conditions. It is difficult to identify wells with records that are complete for the entire base period. The wells depicted often contain data gaps but represent the most complete information available at this time. The dataset used to create these hydrographs associates water levels with a season/year format (e.g. Spr1990) rather than with a specific date. For the purposes of plotting, spring levels were considered to have been taken on March 1, while fall levels were plotted on October 1. Nevertheless, these hydrographs are a useful tool for tracking water level patterns through time across the EKGSA.

Most wells across the area share a consistent pattern. Water levels rose or remained high throughout the early eighties. They declined in the late eighties and early nineties, largely due to drought conditions. Levels slowly rebounded throughout the nineties. Since Fall 2001 water levels have steadily fallen and remained in decline since, slightly rebounding in 2011 before plummeting through 2016 in response to the worst drought on record. The pattern closely mirrors annual hydrologic conditions. Rising groundwater levels coincide with and follow periods of above-average rainfall, while groundwater declines are clearly associated with periods of prolonged drought. There is a slight lag time evident between wet periods and when that water reaches the water table. The most prominent example of this is the water level increase associated with the 2010 water year. Water levels were on the rise by Spring 2011 (immediately following the wet season), but they continued to rise into Fall 2011. They were already on the decline again by Spring 2012, but the increase in the water levels between Spring 2011 and Fall 2011 is indicative of the lag associated with rainwater reaching the aquifer. It should be noted that this lag time is actually quite low compared to many places in the San Joaquin aquifers – the relatively shallow depth to water (DTW) and ready supply of recharge coming from the Sierra Nevada allow for relatively quick replenishment of the aquifer. In time spans where multiple years are consistently either wet or dry, fall levels are expected to be slightly lower than spring levels for the same year. These seasonal norms are evident on many of the hydrographs, independent of hydrologic conditions or location within the EKGSA. The exact magnitude of these seasonal fluctuations, however, varies by location.

Average DTW in the EKGSA was calculated from available hydrographs by year/season. **Figure 2-22** and **Figure 2-23** depicts the average DTW from 1981 through spring 2017 for the northern and southern EKGSA areas, respectively. The pool of hydrographs to pull from diminished in the last decade or so of the period of record. As a result, averages for more recent seasons were created with fewer data points than were used for earlier seasons. It is believed this due in part to some wells going dry and also due to changes in requirements for groundwater level monitoring (i.e. CASGEM). The average depth to water illustrates both seasonal trends and yearly conditions as discussed earlier. Fall levels are predictably lower than their spring counterparts, and averages in times of drought are typically lower than averages in times of plentiful precipitation. When taken by decade, these averages illustrate the deepening of the water table over time. In the eighties average DTW ranged from 27.4 ft to 52.7 ft, with an average depth for the decade of 37.7 ft. The nineties saw seasonal average DTW between 35.8 ft and 68.8 ft, with an average DTW of 52.4 ft. Average DTW for the 2000s was 53.7 ft, with seasonal averages spanning from 36.1 ft to 69.5 ft. The 2010s up to spring 2017 (the end of the study period) experienced average DTW of 79.5 ft. Average DTW in Fall 2015 reached 108.2 ft, the deepest average on record. Throughout the entire base period, the average DTW for the EKGSA was 54.7 ft. DTW for the fall averaged 58 ft, while the average for the spring was at 51.6 ft.

Hydrographs by Geomorphic Region

The following provides discussion on the hydrographs grouped by the geomorphic regions shown in **Figure 2-2**. Grouping in this fashion was done to relate wells with similar region and hydrogeology.

Cottonwood Creek Interfan – Hydrographs in the Stone Corral and Ivanhoe IDs are presented as representing the Cottonwood Creek Interfan Area. The hydrographs of this area are generally similar to one another. Periods of wet verses dry are clearly demarcated, though few wells are shown to have more than 50 feet of change across the nearly 40-year timescale, and even those that exceeded 50 feet only did so during the extended drought of the 2010s. Seasonal fluctuations are clear but rarely pronounced, being usually on the order of several feet and rarely exceeding 10 feet of change between seasons. Overall DTW varies according to proximity to surface water, with wells near Cottonwood Creek and the St. Johns River having consistently lower depth to water (between 15-50 feet, depending on drought conditions) than wells located in the western part of Ivanhoe (between 50-100 feet). Average depth to water during the base period was 54.7 ft.

Kaweah River Alluvial Fan – Hydrographs in Exeter ID north of the City of Exeter and wells located between the two main lobes of the EKGSA are presented representing the Kaweah Alluvial Fan. The temporal behavior of wells in this region vary according to proximity to the Kaweah River and Yokohl Creek. Wells located within about a mile of these waterbodies tend to maintain high groundwater levels regardless of annual hydrologic conditions. Seasonal water level fluctuations are likewise subdued, often on the order of one to three feet. This behavior is expected and demonstrates the gains due to stream seepage from which these wells benefit. Seasonal fluctuations are more obvious in wells further away from the waterbodies. Seasonal differences within a single year can exceed 20 feet, though less dramatic variation is also common, often within the same well. Even during severe drought, historically much of this area maintains DTW within 100 feet of the ground surface. Average DTW during the base period was 49.8 ft.

Lewis Creek Interfan – Hydrographs in Exeter ID wells south of the City of Exeter and wells in or near Lindmore and Lindsay-Strathmore IDs are presented as representing the Lewis Creek Interfan. Much (though not all) of this area receives surface water imports. Deliveries from the FKC have a marked impact on the water levels within the region. Many wells in the Lewis Creek Interfan Area have not experienced groundwater within 50 feet of the surface in the time since 1981. While pumping to the immediate west of the Lindmore ID is a concern, at least some of this DTW is indicative of the natural local low that can be expected of an interfan area between two major rivers. Seasonal fluctuations are usually mild, but consistent shifts of 10 feet are common in areas removed from surface water deliveries. The wells furthest west experienced dramatic seasonal shifts in the second half of the period. The hydrograph for well 20S26E16R001M shows seasonal fluctuations in excess of 70 feet. Wells 20S26E20J001M and 20S26E29N001M nearby show similar fluctuations. Average DTW for the Interfan during the base period was 64.2 ft.

Intermontane Valleys – This classification is included to showcase wells on the eastern border of the EKGSA with significant bedrock outcrop to their west. These wells are located in the small valleys interfingering with the mountain-front and are drilled into shallow alluvium veneering relatively shallow bedrock, with ready access to recharge coming from the mountain-front. They have consistently shallow DTW and low seasonal and hydrological deviation. Typical WSEs within these wells are consistently within 50 ft of the surface. Well 17S26E14L002M is nearly within the Valley proper and likely has deeper alluvium, less-direct recharge, and plentiful irrigation nearby. This well's hydrograph is more akin to wells in the Cottonwood Creek Interfan area as defined above, with greater overall DTW and increased variation between seasons of wet and dry. Average DTW for this grouping of wells was 26.9 ft based on the years with data. There are significant temporal data gaps for this region, during which time none or only one well provided data. Between fall of 2008 and fall of 2012 no data is recorded for any of these wells.

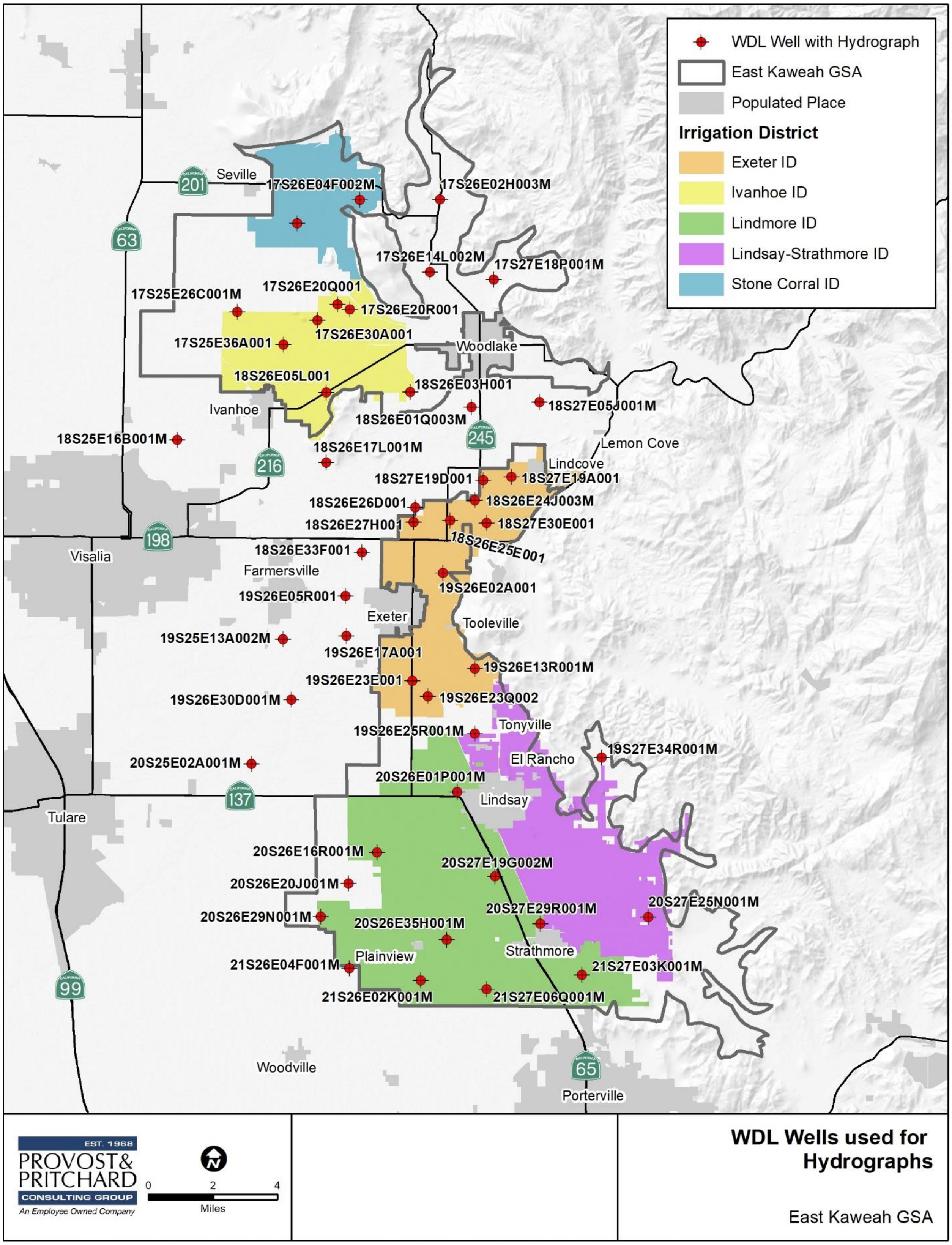

Figure 2-21 Well Hydrographs Location Map

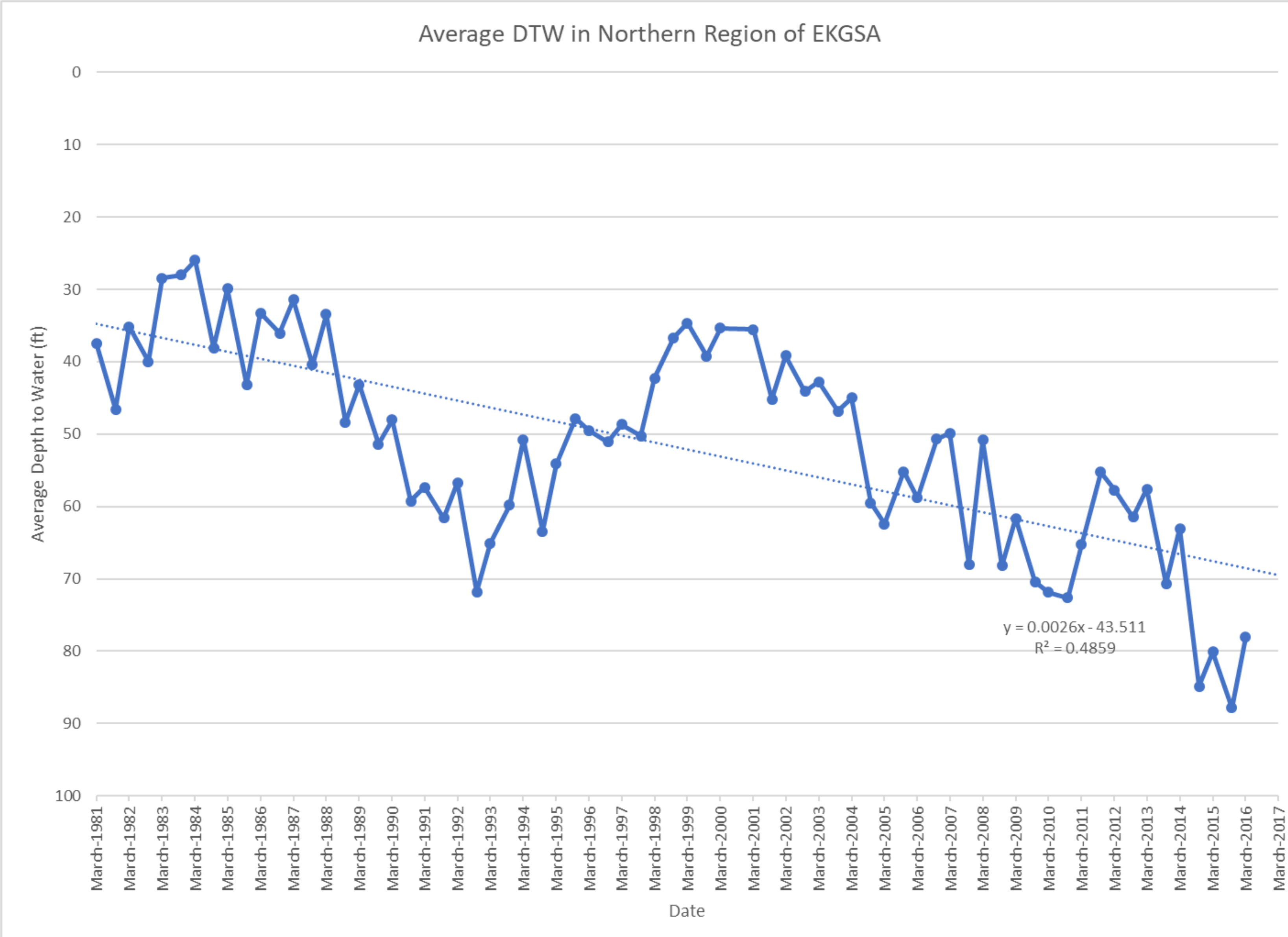

Figure 2-22 EKGSA Average Depth to Groundwater in the Northern Region

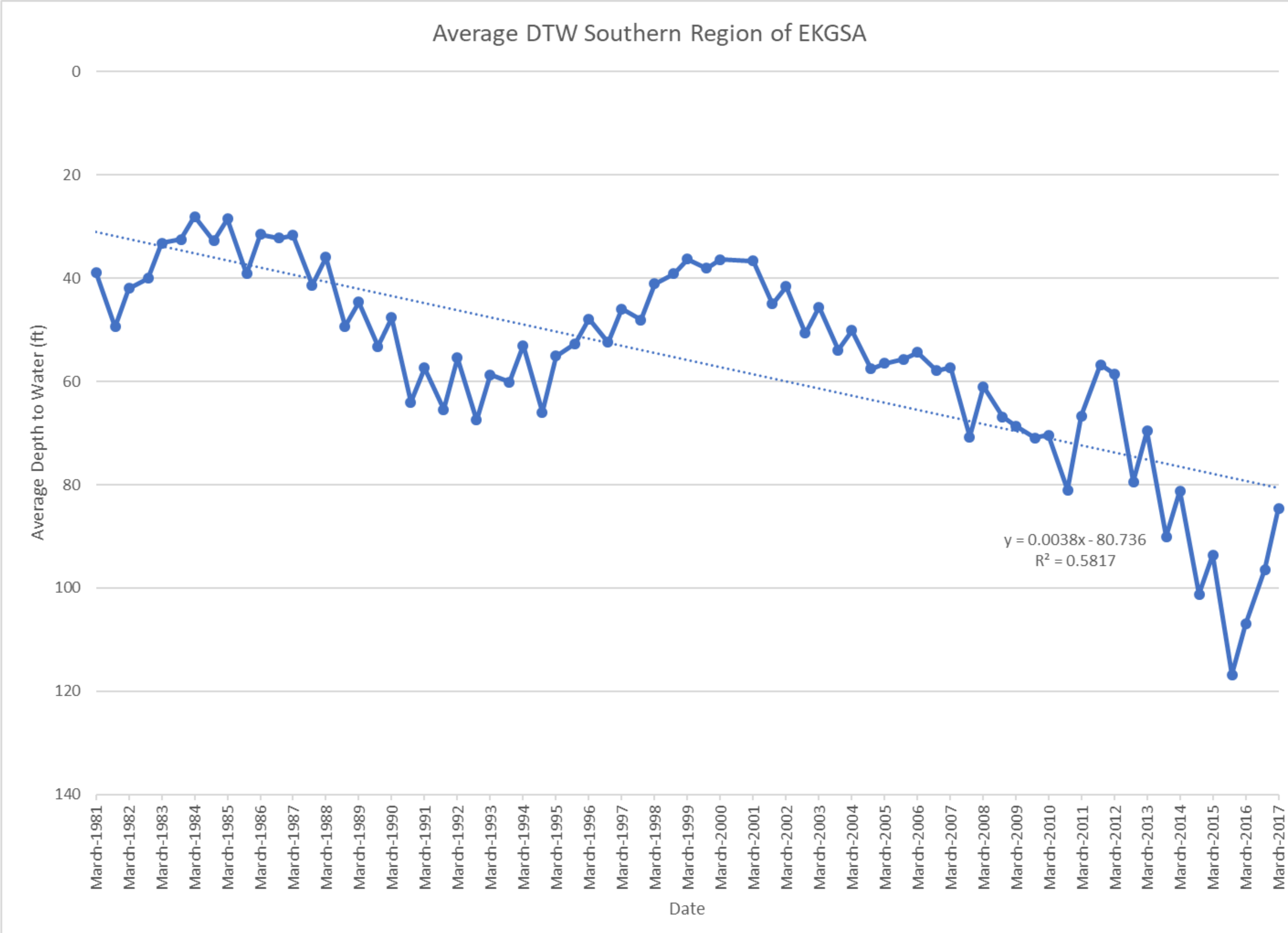

Figure 2-23 EKGSA Average Depth to Groundwater in the Southern Region

Well Depth:

Construction data for wells in the EKGSA was evaluated in a summarized format. Evaluating well logs confidently and accurately to match reports with the actual corresponding well in the field is difficult due to the current nature of the data sets available. This is a data gap that will be filled going forward. **Figure 2-24**, **Figure 2-25**, and **Figure 2-26** display the average completed well depths per section for agricultural, domestic, and public wells respectively. **Appendix 2-E** provides more figures for these three well types, including minimum and maximum completed depths and number of wells per section.

Wells in the vicinity of rivers and other natural conveyances tend to be completed at shallower depths than wells drilled elsewhere. Wells along the eastern side of the valley are commonly drilled to shallower depths than wells in the western reaches of the EKGSA. Deeper wells in the eastern parts of the EKGSA tap fractured-rock aquifers within the bedrock rather than the aquifers of the valley floor.

2.4.1.3 Lateral and Vertical Gradients

Lateral Gradients

Aquifers in the EKGSA are unconfined. Unconfined groundwater flow rates move in response to the slope of its surface and the permeability of the water-bearing materials. Flow rates are on the order of a several feet per day in higher permeable materials to only a few feet per year in low permeable materials. The gradients of the groundwater in the EKGSA are in the range between 6 and 40 vertical feet per mile, typically averaging around 20 feet per mile (0.003 feet per foot).

Vertical Gradients

Water levels in an unconfined aquifer system coincide with the top of the zone of saturation, where hydrostatic pressure is equal to atmospheric pressure. Seasonal water level variations in such systems are typically subdued. Groundwater conditions at specific locations vary from regional patterns due to localized hydrogeologic conditions and groundwater pumping.

2.4.1.4 Regional Patterns

The groundwater elevation contour maps provided for the current conditions range from Spring 1981 to Spring 2017 (see **Appendix 2-C**). Review of the contour maps indicate that the principal direction of groundwater flow is to the southwest in the unconfined aquifer within the Kaweah River alluvial fan and continental deposits. Subsurface inflow occurs from the Sierra Nevada Mountains to the east, Kings River system to the north, and the Tule River system to the south.

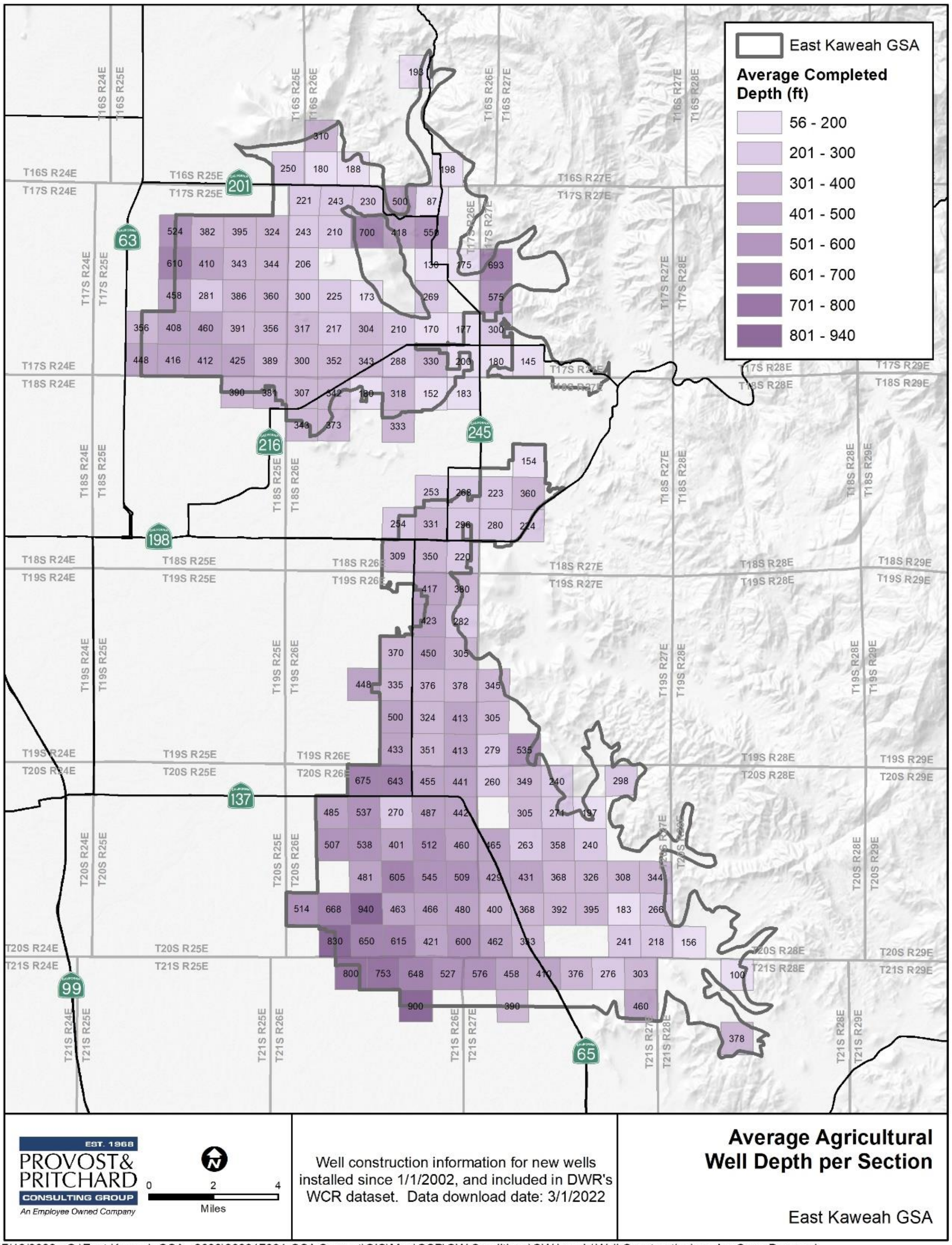

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Figure 2-24 Average Agricultural Well Depth

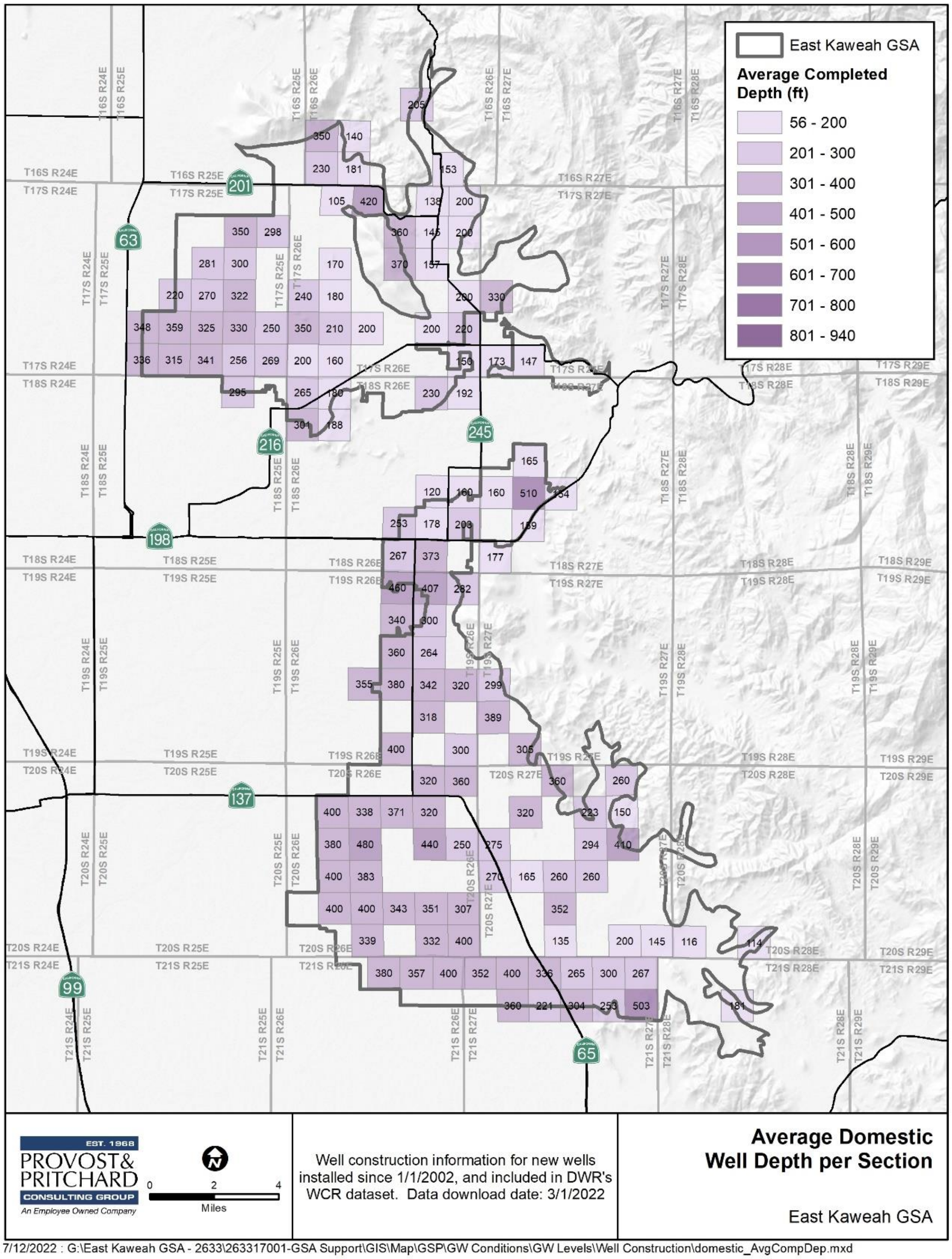

Figure 2-25 Average Domestic Well Depth

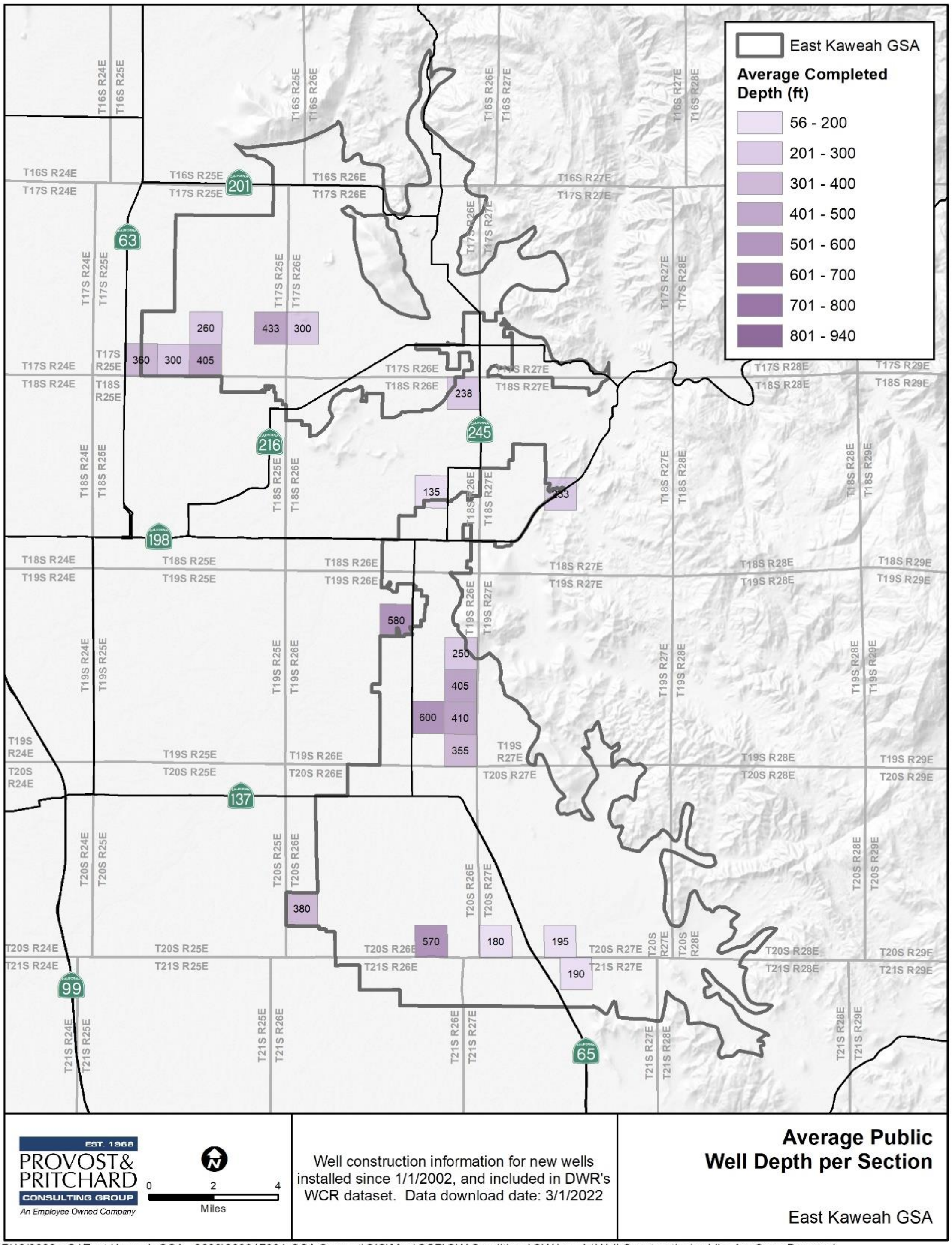

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Figure 2-26 Average Public Well Depth

2.4.2 Seawater Intrusion

Legal Requirements:
§354.16(c) Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.

Seawater intrusion is not an issue in the EKGSA, or the Kaweah Subbasin as a whole, because there is no coastal boundary. Seawater intrusion is an issue in coastal basins that may be induced by creating a landward gradient through lowering of the groundwater table.

2.4.3 Groundwater Quality

Legal Requirements:
§354.16(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.

The Kaweah Subbasin Basin Setting document in **Appendix 2-A** discusses in more detail the groundwater quality for the Kaweah Subbasin. Groundwater quality discussion specific to the EKGSA has been pulled into this GSP. The primary source of data referenced for this characterization was obtained from the SDWIS which collects sample results from all State regulated public water systems and Geotracker.

2.4.3.1 Bulletin 118 Overview

Groundwater in the oxidized older alluvium and younger alluvium is generally of the calcium bicarbonate type. In the unconsolidated deposits beneath the alluvial fans, groundwater is generally low in dissolved constituents. Where recharge is from the major streams, sodium constitutes less than 42% of the cations and TDS ranges from 100 to 270 mg/l. Sodium and bicarbonate are the principal ions in groundwater in the continental deposits and in reduced older alluvial deposits. Sodium accounts for more than 70 percent of the cations in the water from these deposits. TDS ranges from 100 to 500 mg/l. In the interfan areas, where recharge is from intermittent streams, dissolved constituents range from 270 to 650 mg/l and magnesium and chloride are major constituents (Croft & Gordon, 1968).

2.4.3.2 Data Sources and Zonal Delineation

For the purpose of establishing minimum thresholds and measurable objectives, hydrogeologic zones of similar characteristics are being delineated at the Subbasin level. The boundaries of these zones will likely be updated and modified regularly. These are presented in the Kaweah Subbasin Basin Setting document. The EKGSA is primarily located within Zones 7, 8, 9, and 10. A portion of the southern lobe extends into Zone 6.

There is a total of 47 public water systems in the Subbasin with data available in SDWIS. These systems are generally representative of the Subbasin as they're located throughout the area. Between all 47 active public water systems, 174 wells were evaluated. In addition to SDWIS, GeoTracker GAMA was searched to identify contaminant plumes, and the SWRCB's Human Right to Water Portal was searched to identify contaminants the are commonly violating drinking water standards. A limited amount of data was available for private domestic wells within the Subbasin. For now, the Subbasin is referring to the SWRCB's GAMA Domestic Well Project.

2.4.3.3 Overview of Groundwater Quality Conditions

While all regulated drinking water constituents were considered, findings from this evaluation show that the most common water quality issues within the EKGSA are: nitrate, arsenic, perchlorate, hexavalent chromium (Chromium VI), dibromochloropropane (DBCP), 1,2,3-trichloropropane (TCP), sodium, and chloride. This water quality discussion is divided by constituent to explain the drinking water standard, agricultural standard (if applicable), potential impacts to beneficial uses in the different regions of the Subbasin, and existing regulatory and monitoring programs dedicated to that constituent.

2.4.3.3.1 Arsenic

Chemical Properties

The following chemical properties are summarized from the SWRCB GAMA Program Groundwater Information sheet for arsenic. Naturally occurring in the environment, arsenic is a semi-metal element. The primary natural source of arsenic found in groundwater is from the weathering of arsenic-containing rocks. The solubility, mobility, and toxicity of arsenic are dependent upon its oxidation state and increase with increasing alkalinity and salinity. Arsenic mobility in groundwater is dependent on adsorption/desorption reactions and precipitation/dissolution reactions. During adsorption reactions, dissolved arsenic adheres to the surface of solid aquifer materials (i.e. clay layers). Desorption removes the arsenic from aquifer materials and releases it in the surround aquifer. Low-oxygen conditions, compression of clay layers, and/or an increase in pH about 8.5 can also displace arsenic from mineral surfaces into its aqueous form (Fendorf et al. 2018).

Arsenic is a known human carcinogen. Specifically, ingestion of arsenic in sufficient quantities can increase the risk of liver, bladder, kidney, lung, and skin cancer. When groundwater is the exposure medium, arsenic is quickly absorbed after ingestion, while dermal (skin) exposure results in a much smaller amount of arsenic entering the body. Ingestion of moderate to elevated arsenic levels (greater than 300 ug/L) may cause stomach and intestine irritation, nausea, vomiting, and diarrhea, abnormal heart rhythm, blood-vessel damage, and impaired nerve functioning. Consumption of large oral doses above 60,000 ug/L is fatal.

Sources and Spatial Distribution in the EKGSA

Based review of the DPR studies and the hydrogeology of the Kaweah Subbasin, the major source of arsenic in the groundwater appears to be naturally occurring from erosion of natural deposits. Data from public water systems shows that arsenic detections around 5-10 ppb are more prevalent in the western portion of the Subbasin, generally where the Corcoran clay is present. The Corcoran clay generally follows the boundary of hydrogeologic zone 4 and extends to the westerns portion of the Kaweah Subbasin. Based upon recorded in Geotracker data, **Appendix 2-F** further depict the spatial distribution of arsenic concentrations throughout the EKGSA throughout the base period (1997-2017).

Existing Regulatory Programs and Monitoring Efforts

Arsenic is a regulated chemical for drinking water sources with monitoring and compliance requirements designated by Title 22, §64431 overseen by the SWRCB Division of Drinking Water. Arsenic has a primary drinking water Maximum Contaminant Level (MCL) of 10 parts per billion (ppb) and an Agricultural Water Quality Goal of 100 ppb. In November 2008, the California MCL for arsenic was reduced to from 50 ppb to 10 pbb. At a minimum, public water systems are required by Title 22 §64432 to monitor for arsenic annually. More frequent monitoring is required if arsenic has been historically detected. Monitoring data from the public water systems is available via DDW's SDWIS database (Section 2.3.2). In addition to DDW regulation, monitoring, and oversight, data on arsenic concentrations is available via the GAMA Priority Basin Project on Geotracker. Arsenic will be monitored as a constituent of concern within the Kaweah Subbasin.

2.4.3.3.2 Dibromochloropropane (DBCP)

Chemical Properties

The following chemical properties are summarized from the GAMA Program Groundwater Information sheet for dibromochloropropane (DBCP). DBCP is a colorless organochlorine compound that was used as a soil fumigant to control nematodes in over 40 different crops. The chemical is highly persistent in the soil and can be easily mobilized and move into groundwater. Denser than water, once in an aquifer, free phase DBCP may sink to the bottom of the aquifer and persist for long periods of time.

In humans, DBCP ingestion can cause gastrointestinal distress and pulmonary edema. Even low exposures via contaminated groundwater consumption may cause sterility in men and other male reproductive effects, such as decreased sperm counts. There is also evidence that DBCP may have the potential to cause cancer with lifetime exposure at levels above the MCL.

Sources and Spatial Distribution in the EKGSA

DBCP is a manufactured chemical that does not occur naturally in the environment. Prior to 1979, DBCP was used extensively on grapes, tomatoes, cotton, and fruit trees throughout Fresno, San Bernardino, Stanislaus, and Tulare counties. Agricultural application of DBCP was banned in California in 1977.

Concentrations of DBCP above the MCL of 0.2 ppb have been detected in the EKGSA a total of seven times from 1997 to 2017 outside of the cities of Exeter, Lindsay, and Plainview. Given the diffuse use of DBCP on agricultural lands throughout Tulare County, DBCP MCL exceedances appear to be wide-spread and scattered throughout the EKGSA without a predictable contaminant plume pattern. In 2008, the Department of Public Health (transferred to State Water Board as DDW in July 2014) estimated the median half-life of DBCP in the Central Valley is 20 years. This is consistent with the data that has been evaluated for this Subbasin since the levels are generally decreasing. **Appendix 2-F** further depict the spatial distribution of DBCP concentrations throughout the EKGSA throughout the base period (1997-2017).

Existing Regulatory Programs and Monitoring

DBCP is a synthetic organic contaminant with a drinking water MCL of 0.2 ppb. There is no Agricultural Water Quality Goal. The drinking water MCL was set in 1989 and CCR Title 22 requires quarterly monitoring, compliance determinations, and treatment. All public water system monitoring data is available via the SDWIS database.

The SWRCB monitored for DBCP via their GAMA Priority Basin Project and Domestic Well Project. Both of these projects were one-time, assessment studies and not considered continuous monitoring programs. The Priority Basin Project examined the quality of groundwater resources primarily used for domestic drinking-water supplies. Samples taken from monitoring wells between 150 and 500 feet in depth were used in the study to represent the quality of the shallow aquifer. The Tulare Shallow Aquifer Study via the Priority Basin Project sampled 96 wells from November 2014 to April 2015. DBCP was present at concentrations above the MCL in about 1% of groundwater resources used for domestic drinking water (SWRCB 2017). The Tulare County Domestic Well Project was a voluntary monitoring program that tested volunteered domestic wells throughout the county in 2006. DBCP was detected in 27 wells within Tulare County with concentrations ranging from 0.01 to 1.63 ug/L. Eight wells had DBCP concentrations above the MCL of 0.2 ug/L. All monitoring data collected for both the Priority Basin and Domestic Well Project is publicly available via the GAMA Geotracker database.

The discovery of DBCP and other pesticide contamination in groundwater in the early 1980's lead to the passage of the Pesticide Contamination Prevention Act (PCPA) of 1985. The PCPA requires that the Department of Pesticide Regulation (DPR) obtain, report, and analyze the pesticide results for well sampling conducted by public agencies as well as create their own monitoring program to sample wells for the presence of agricultural pesticides (including DBCP). DBCP concentrations data can be accessed via GAMA Geotracker or by filing a public records request with DPR.

2.4.3.3.3 Hexavalent Chromium

Chemical Properties

The following chemical properties are summarized from the GAMA Program Groundwater Information sheet for hexavalent chromium. Hexavalent chromium (Chromium VI) is a metallic element found in natural deposits of ores containing other elements, mostly as chrome-iron ore. Under most conditions, natural chromium in the environment occurs as Chromium III. Under oxidizing conditions, alkaline pH range, and the presence of manganese dioxide, natural chromium may partially dissolve in groundwater as chromium IV.

Chromium VI is known to cause cancer in humans when ingested and can damage the lining of the throat. When consumed, Chromium VI can upset the gastrointestinal tract and damage the liver and kidneys.

Sources and Spatial Distribution in the EKGSA

Recent analyses have indicated that the Chromium VI in California groundwater occurs naturally in most locations throughout the state. Naturally occurring Chromium VI might be associated with serpentinite-containing rock and chromium containing geologic formations. In industrial areas, it can be introduced to the environment via the discharges of dye and paint pigments, wood preservatives, chrome-plating liquid wastes, and leaching from hazardous waste sites.

Chromium VI is not commonly found in concentrations greater than 10 ppb in the Kaweah Subbasin. During evaluation of historical chromium VI results, only one well exceeded 10 ppb. This well is located outside of the EKGSA and there does not appear to be a threat that Chromium VI contamination will be a large-scale issue in the EKGSA. However, due to its potential human health impacts, Chromium VI will still be monitored within the EKGSA. **Appendix 2-F** further depicts the spatial distribution of Chromium VI concentrations throughout the EKGSA throughout the base period (1997-2017).

Existing Regulatory Programs and Monitoring

There is no federal MCL for Chromium VI. In July 2014, California adopted a primary MCL of 10 ppb. However, as of September 2017, the MCL was withdrawn by the SWRCB based on a Superior Court of Sacramento County ruling. While DDW repeats the regulatory process for adopting the new MCL, the federal MCL of 50 ppb for total chromium applies as the drinking water standard. There is no Agricultural Water Quality Goal for Chromium VI.

In 2001, the California Department of Public Heath adopted a regulation that added Chromium VI to the list of unregulated chemicals for which monitoring is required (UCMR). The detection limit for the purposes of reporting (DLR) and the former California state notification level (NL) is 1 ug/L. Between 2001 and 2012, over 12,000 public drinking water systems reported hexavalent chromium concentrations. This data is available via the SDWIS database and public water systems' annual Consumer Confidence Reports.

2.4.3.3.4 Nitrate

Chemical Properties

The following chemical properties are summarized from the GAMA Program Groundwater Information sheet for nitrate. Nitrate (NO3), is produced in the atmosphere from nitrogen and occurs naturally in groundwater at concentrations typically below 2 mg/L (as N). Nitrate is naturally produced from nitrogen gas through biologic fixation and from organic nitrogen through mineralization. High concentrations of nitrate in groundwater are often associated with the use of fertilizers or animal/human waste. Nitrate is highly mobile in groundwater and once dissolved is difficult to remove.

High levels of nitrate in drinking water is considered a human health risk. Infants under six months of age have a greater risk of nitrate poisoning called methemoglobinemia ("blue baby" syndrome). Toxic effects occur when bacteria in the infant's stomach convert nitrate to the more toxic nitrite. Nitrite enters the bloodstream and it interferes with the body's ability to carry oxygen to body tissues. Pregnant women are also susceptible to methemoglobinemia. Further long-term exposure studies are required to determine a direct relationship between nitrate levels and cancer.

Sources and Spatial Distribution in the EKGSA

Known sources of nitrate include runoff and leaching from fertilizer use from commercial irrigated agriculture, animal waste from dairy operations, leaching from septic systems and sewage, and very small concentrations from erosion of natural deposits. Characterizing nitrate contamination in the Kaweah Subbasin includes identifying known and estimated sources of nitrate contamination, identifying public water system wells with nitrate concentrations above the MCL, and correlating the concentrations with land uses and water level trends.

Public water systems with high nitrate levels or increasing nitrate trends are prevalent throughout the Subbasin. According to Burton, Shelton, & Belitz (2012), most nitrate concentrations greater than 5 ppm were detected in the eastern part of the study units. In Hydrogeologic Zones 8, 9, 10 and portions of zone 7, nitrate tend to be higher than 5 ppm with increasing trends. As described in **Section 2.3.2**, the Kaweah Basin Water Quality Association (KBWQA) conducted a Groundwater Analysis Report (GAR) as part of the requirements of the Irrigated Lands Regulatory Program (ILRP). KBWQA findings report that nitrates appear to be the primary groundwater quality issue within the KBWQA boundary area (which covers a majority of the Kaweah Subbasin). High nitrate levels, many of which are already above the MCL, are located throughout the Kaweah Subbasin. Main locations with lower nitrate levels include near the footprint of the Kaweah River, southeast of the city of Visalia, and the foothill to mountain areas. **Appendix 2-F** further depicts the spatial distribution of nitrate concentrations throughout the EKGSA during the base period (1997-2017).

The historical and current predominate land use in the EKGSA is for commercial irrigated agriculture with some interspersed dairy farms. While Burton et. Al (2012) reports nitrate contaminations correlates to areas of agriculture classified as orchard and vineyard land uses, USGS finds that these regions also have medium to high density septic systems. Greater than 50 percent of the land use in hydrogeologic zones 7, 8 and 9 are orchards or vineyards. Septic-system density greater than the Subbasin median value of 5 septic systems in a 500-meter radius around each selected GAMA well occurred hydrogeologic zones 4-9, with very high density of 11.8 septic systems within 500 meters of the selected wells in zones 7, and 11.0 septic systems in zone 9. USGS data was used for this evaluation to develop a clearer understanding of potential sources of nitrate contamination. While previous reports point towards orchard and vineyard land uses, septic system density is an unquantified source of contamination. While the existence of septic systems does not necessarily mean that they are a contributing source of nitrate contamination within the aquifer. However, leaky, poorly maintained septic systems can be a serious source of localized nitrate contamination. It is currently unknown the amount of contamination associated with poorly maintained septic systems. This represents a data gap that the EKGSA and Subbasin will need to evaluate going forward. Data gathered by USGS (Report 2011-5218) was determined from housing characteristics data from the 1990 U.S. Census. The density of septic systems in each housing census block was calculated from the number of tanks and block area. To more precisely identify the nitrate sources, current data should be compiled and evaluated with proximity to domestic water wells. This effort is being made through the Disadvantaged Community Involvement Program is trying to identify septic system density and condition in the Tulare-Kern Funding Area.

Existing Regulatory Programs and Monitoring

Nitrate as Nitrogen (N) has an acute drinking water MCL of 10 parts per million (ppm). There is no Agricultural Water Quality Goal for nitrate. Title 22 §64432.1 requires public water systems to test for nitrate annually. For public systems that use groundwater as a source must sample quarterly for at least one year following any one sample in which the concentration is greater than or equal to 50 percent of the MCL. All results must be reported to DDW, communicated to water users via annual consumer confidence reports, and be publicly available via DDW's SDWIS database.

Discharges of nitrate into groundwater is regulated and monitored by the SWRCB and Regional Boards via the Irrigated Lands Regulatory Program, individually issued Waste Discharge Requirements (WDRs), and the Dairy Order. Food processing related wastewater and industrial wastewater are generally managed by individual facility waste discharge requirements. Within these permits, the Regional Board sets agronomic limits for land application of nitrate contaminated wastewater and mandates quarterly water quality reports.

The Waste Discharge Requirements for Growers within the Tulare Lake Basin that are Members of a Third-Party Group Order R5-2013-0120-07 (ILRP General Order) requires that growers submit annual nitrogen management summary reports that record the amount of nitrogen applied to their irrigated acreage and the amount of nitrogen removed by their commercial crop harvests. In addition, growers must submit farm evaluations detailing the protective practices they utilize on-farm to reduce nitrate percolation into the aquifer. The KBWQA also monitors for nitrate concentrations annually via the groundwater trend monitoring program mandated by the ILRP General Order. All data from the ILRP groundwater trend monitoring program is publicly available via Geotracker. The groundwater trend monitoring program is a more recent ILRP requirement and at this time only one year of data has been collected. In addition, the KBWQA is collaboratively working with other agricultural coalitions to develop mass-loading groundwater protection targets for nitrate.

The Reissued Waste Discharge Requirements General Order for Existing Milk Cow Dairies R5-2013-0122 (Dairy General Order) requires a variety of nitrate mitigation practices to minimize the amount of nitrate traveling into the groundwater aquifer. Requirements of the Dairy General Order include visual inspections, nutrient monitoring, monitoring of surface runoff, and groundwater monitoring. Dairy dischargers must also provide a waste management plan and nutrient management plan to the Regional Board. Similar to the ILRP, dairies must submit data annually on the ratio of total nitrogen applied to land application areas versus uptake by crop harvest and the estimated amount of total manure and process water generated by the facility.

2.4.3.3.5 Perchlorate

Chemical Properties

The following chemical properties are summarized from the GAMA Program Groundwater Information sheet for perchlorate (ClO4 -). Perchlorate is a naturally occurring and man-made anion that consists of one chlorine atom bonded to four oxygen atoms. Perchlorate is highly soluble and mobile in groundwater and resistant to degradation in the environment. Due to its low vapor pressure, perchlorate does not volatize from water or soil surfaces to the air and when released directly to the atmosphere it settles readily though wet or dry deposition.

In the body, perchlorate interferes with the uptake of iodine by the thyroid grants, causing disruption of thyroid hormone production. Inhibited thyroid function can results in hypothyroidism and cause thyroid tumors in rare cases. Pregnant women and their developing fetuses are the most sensitive to perchlorate contamination in drinking water. During the first and second trimesters of pregnancy, the fetal thyroid is not yet fully functional, so the mother's thyroid must be able to produce enough extra hormones to enable her baby's brain to develop properly. Women with critically low levels of iodine can miscarry, or their developing fetuses can suffer congenital hypothyroidism, which may stunt the fetus's physical growth and impede proper development of its central nervous system.

Sources and Spatial Distribution in the EKGSA

Perchlorate may occur naturally, particularly in arid regions such as the southwestern United States. In addition, perchlorate is reported to be present in some caliche formations in Chile that are used to produce nitrate fertilizers. Perchlorate originates as a contaminant in the environment from the release of solid salts of ammonium, potassium, or sodium perchlorate. The majority of perchlorate detections in groundwater (~90%) are associated with the manufacturing or testing of solid rockets fuels for the Department of Defense (DOD) or National Aeronautics and Space Administration (NASA). In addition to rocket fuels, perchlorate salts are also used in the manufacture of fireworks, matches, automotive air bag inflators, leather, rubber, and paint production.

From 1997 to 2017, 13 exceedances of the perchlorate MCL were recorded in the southern portion of the EKGSA around the cities of Lindsay and Strathmore. Current data is not indicative of a specific point source of the perchlorate pollution. **Appendix 2-F** further depict the spatial distribution of perchlorate concentrations throughout the EKGSA throughout the base period (1997-2017).

Existing Regulatory Programs and Monitoring

In January 2001, the Department of Health Services (now managed under the Division of Drinking Water), identified perchlorate as an unregulated chemical requiring monitoring under Title 22. At this time, public water systems began testing for perchlorate in their drinking water supplies. In 2004, the California Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA) adopted a public health goal (PHG) for perchlorate at 0.006 mg/L (6 ppb). Following statutory mandates, the perchlorate MCL was established at 6 ppb in October of 2007. In 2015, the OEHHA lowered the PHG from 6 ppb to 1 ppb, prompting review of the perchlorate MCL. Pending further review by the State Board, the MCL remains at 0.006 mg/L (ppb). Similar to previously discussed constituents, public water systems are required to test for and report data on perchlorate results. Title 22, Chapter 15, §64432.3, requires that all community and nontransient-noncommunity water systems collect two samples at each source in a year (at least five to seven months apart). For systems that have perchlorate detections, sampling must continue to occur on a quarterly basis. All sampling results are publicly available via the SDWIS database.

Perchlorate is also monitored for within the National Pollutant Discharge Elimination Systems (NPDES) with oversight managed by the State and Regional Boards. Any business that discharges waste into the waters of the state, must apply for an individual waste discharge permit (WDR) or be covered under a General Order. Currently, there are no registered point-source dischargers of perchlorate in the EKGSA.

2.4.3.3.6 1,2,3-Trichloropropane (TCP) Occurrence

Chemical Properties

The following chemical properties are summarized from the GAMA Program Groundwater Information sheet for 1,2,3-trichloropropane (TCP). TCP is a man-made chlorinated hydrocarbon. While only slightly soluble in water, TCP has a low soil sorption coefficient, resulting in easy migration from the soil into groundwater supplies. TCP is generally resistant to biodegradation, hydrolysis, oxidations, and reduction under naturally occurring conditions, making it highly persistent and mobile within the environment.

TCP has acute, chronic, and carcinogenic effects on human health. Acute contact with TCP can irritate and burn the skin, nose, throat, and lungs. It can impact concentration, memory, and muscle coordination. Long-term chronic exposure to TCP can cause liver and kidney damage, reduced body weight, and increased tumor risk. TCP causes cancer in animals and is recognized by the State of California as a human carcinogen.

Sources and Spatial Distribution in the EKGSA

Typically found at industrial or hazardous waste sites, TCP was introduced to California's groundwater as an impurity within DBCP fumigants manufactured by Shell Chemical Company and Dow Chemical Company. As discussed in **Section 2.4.3.3.2**, DBCP contaminated with TCP was extensively used throughout Tulare County as a nematicide. TCP has also been used in solvents in the past. There are no known point sources of TCP from industrial or hazardous waste sites in the EKGSA.

Three wells in the southern half of the EKGSA tested higher than the MCL between 2001-2018 with maximum recorded concentration 0.8 ug/L. Contamination within the EKGSA appears to be diffuse with no specific TCP contamination plume appearing. **Appendix 2-F** further depict the spatial distribution of TCP concentrations throughout the EKGSA throughout the base period (1997-2017).

Existing Regulatory Programs and Monitoring

TCP has a primary drinking water MCL of 5 parts per trillion (ppt). There is no Agricultural Water Quality Goal for TCP. As discussed in **Section 2.4.3.3.2** (DBCP), TCP is no longer permitted for agricultural use. Today, TCP is currently used as a chemical intermediate in the production of other chemicals, such as polysulfone liquid polymers and dichloropropene. Any TCP discharges from a point source is managed through the State's NPDES permit system. There are no permitted facilities discharging TCP in the EKGSA.

Large public water systems began sampling their wells for TCP using a low-level analytical method around 2003, as a requirement of the Unregulated Chemical Monitoring Rule (UCMR). From this data, DDW determined that the most impacted counties are Kern, Fresno, Tulare, Merced and Los Angeles. Based on detections of TCP in groundwater, EOHHA established a 0.0007 ug/L PHG in 2009. In July 2017, the SWRCB DDW adopted the current MCL for TCP at 0.005 ug/L. All water systems are required to test their wells quarterly beginning in January 2018. Only a few of the 47-public water system had data available in SDWIS at this time, the majority of detections were located in the central portion of the Subbasin. The data quantity available for TCP concentrations will continue to increase over time as given that monitoring regulations went into effect in 2018.

2.4.3.3.7 Tetrachloroethylene (PCE) / Contamination Plume Occurrence

Chemical Properties

The following chemical properties are summarized from the GAMA Program Groundwater Information sheet for tetrachloroethylene (PCE). PCE is a colorless, volatile, and nonflammable hydrocarbon. PCE forms a dense non-aqueous phase liquid (DNAPL) that is insoluble in water. In groundwater aquifers, the half-life degradation rate is estimated to be between 1-2 years but may be considerably longer under certain conditions.

PCE exposure has acute, chronic, and carcinogenic health impacts. Typically, acute exposure levels are experienced via exposure to PCE in the air at concentrations between 100-200 mg/L. Chronic exposure via drinking water over the MCL can cause adverse effects to the liver, kidneys, and central nervous system. Prolonged skin contact can cause irritation, dryness, and dermatitis. Scientific evidences show that PCE may cause cancer from prolonged exposure, even at levels below the MCL. The US EPA classifies PCE as a probable human carcinogen.

Sources and Spatial Distribution in the EKGSA

PCE is a manufactured chemical and does not have any known natural sources. Mainly used as a cleaning solvent in dry cleaning and textile processing. Sources of PCE in the EKGSA include discharges related to dry cleaning operations and metal degreasing processes. An evaluation of contamination plumes in the Subbasin was identified through the SWRCB – GeoTracker and DTSC – EnviroStor databases. There is a total of 21 sites identified within the Kaweah Subbasin, none of which are in the EKGSA. Fortunately, per the available reports, none of the sites listed have been determined to have an impact on the aquifer.

Contamination sites will continue to be monitored in the Subbasin to determine the extent of impact to the groundwater. In some instances, sites with shallow monitoring wells went dry due to the water table levels dropping and deeper monitoring wells had to be drilled to continue the investigations. At this time, there is not enough information to determine if the contaminants are sinking with the groundwater levels.

Existing Regulatory Programs and Monitoring

PCE is a volatile organic compound with a primary drinking water MCL of 5 ppb. There is no Agricultural Water Quality Goal for PCE. Public water systems utilizing groundwater sources must initially monitor for PCE during four consecutive quarterly sampling events. If PCE is detected in the groundwater, PCE testing must continue for each compliance period. All data collected by public water systems on PCE concentrations is available via the SDWIS database. California's Site Cleanup Program (SCP) regulates and oversees the investigation and cleanup of "non-federally owned" sites where recent or historical unauthorized releases of pollutants to the environment have occurred. The State and Regional Boards oversee the dischargers clean-up activities to ensure that dischargers provide adequate clean-up and abatement of the contamination. Within the EKGSA, there are no registered SCP sites for PCE. Any potential data for cleanup sites overseen by cities, counties, and health agencies is available via Geotracker. For sites under the jurisdiction of the California Department of Toxic Substances Control (DTSC), the DTSC database, Envirostor, provides data on water quality at cleanup sites.

2.4.3.3.8 Sodium and Chloride Occurrence

Chemical Properties

Sodium is the sixth most abundant element on Earth and is widely distributed in soils, plants, water, and foods. Most of the world has significant deposits of sodium-containing materials, most notably sodium chloride.

Sources and Spatial Distribution in the EKGSA

There are four salinity sources: agriculture, municipal, industrial, and natural. By agriculture, evaporation of irrigation water will remove water and leave salts behind. Plants may also naturally increase soil salinity as they uptake water and exclude the salts. Application of synthetic fertilizers and manure from confined animal facilities are also other means by agriculture. A municipal source is through the use of detergents, water softeners, and industrial processes. Wastewater discharged from Publicly Owned Treatment Works (POTWs) and septic systems can increase salinity levels. An industrial source is through processes such as cooling towers, power plants, food processors, and canning facilities. The last source is naturally from the groundwater, which contains naturally occurring salts from dissolving rocks and organic material.

There are not too many wells within the Kaweah Subbasin that have increasing or elevated sodium and chloride levels. However, there are areas of the EKGSA that have increasing or elevated sodium and chloride levels. Sodium and chloride levels are increasing and, in some cases, already over the Agricultural Water Quality Goal.

Existing Regulatory Programs and Monitoring

Based on drinking water standards, the recommended secondary maximum contaminant level (SMCL) for chloride is 250 ug/L (ppm) with an upper limit of 500 ug/L (ppm). There is no drinking water standard for sodium, however the Agricultural Water Quality Goal (AWQG) for sodium and chloride are 69 ppm and 106 ppm, respectively. The criteria identified are protective of various agricultural uses of water, including irrigation for various types of crops and stock watering. Due to the AWQG being more stringent than sodium and chloride's drinking water SMCL and the importance of irrigated lands within the EKGSA, the Agricultural Water Quality Goals for sodium and chloride will be used when evaluating water quality from agricultural wells.

2.4.4 Land Subsidence

Legal Requirements:
§354.16(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 best available information.

Inelastic (irrecoverable) land subsidence (subsidence) is a concern in some areas of active groundwater extraction as it may lead to increased flood risk in low lying areas; damage or collapse to well casings, canals and infrastructure; and permanent reduction in the storage capacity of the aquifer. Subsidence due to groundwater pumping in the Central Valley has been a burgeoning issue for decades (NASA Report). Subsidence is not a large concern within the EKGSA, since the 1950s there has not been significant subsidence in the area. However, the EKGSA has nearby neighbors that are experiencing impacts due to subsidence, such as areas near Corcoran (to the west) and the Tule Subbasin (to the south). InSAR data obtained from a NASA

UAVSR airborne platform indicates levels of subsidence in the Subbasin have increased since summer of 2014, which coincides with a significant drought period and the first of two years of unprecedented 0% CVP delivery.

2.4.4.1 Cause of Land Subsidence

There are several known processes that may contribute to land subsidence, such as the following: aquifer compaction from overdraft; hydro-compaction (shallow or near-surface subsidence) of moisture deficient deposits above the water table that are wetted for the first time since deposition; petroleum reservoir compaction due to oil and gas withdrawal; and subsidence caused by tectonic forces (Ireland et al., 1984).

Subsidence typically occurs in the fine-grained beds of the aquifers and in the aquitards due to the one-time release of water from the inelastic specific storage of clay layers through groundwater pumping. Clay particles are supported by water when they are deposited but long-term pumping depressurizes the clay. This depressurization allows for the permanent collapse and rearrangement of the structure, or matrix, of particles in fine-grained layers. Groundwater generally cannot re-enter the clay structure after it has collapsed. This condition represents a permanent loss of the water storage volume in fine-grained layers due to a reduction of porosity and specific storage in the clay layers. Although space within the overall aquifer is reduced by surface land subsidence and the thickness of the clay layers are reduced, this storage reduction does not substantially decrease usable storage for groundwater because the clay layers do not typically store significant amounts of recoverable, usable groundwater (LSCE, 2014). Nonetheless, this one-time release of water from compaction has been substantial in some areas of the San Joaquin Valley. Although the largest regional clay unit in and adjacent to the Kaweah Subbasin is the Corcoran Clay, a relatively insignificant volume of water is produced from it (Faunt, 2009), likely because it is thick and has low permeability (DWR, 2017).

2.4.4.2 Past Land Subsidence

Historical documentation of subsidence within the Central Valley relies on various types of data, including topographic mapping and ground surveys (including the remote sensing NASA JPL InSAR data), declining groundwater levels, borehole extensometers, and continuous GPS station data sets. Within the Subbasin, the National Geodetic Survey has documented subsidence up to 8 feet during the period from 1926 to 1970, generally on the western and southwestern ends of the Subbasin (Ireland et al., 1984). Groundwater overdraft is the primary driver for historical land subsidence in the Central Valley (Faunt et. al., 2009). USGS estimates about seventy five percent of historic land subsidence in the Central Valley occurred in the 1950s and 1960s during a period of extensive groundwater development (Galloway, et al., 1999). Greater rates of compaction are generally correlated with below normal water year indices, (critical, dry, or below normal) while subsidence rates were lower during high water year indices (wet, above normal).

2.4.4.3 Recent Land Subsidence

Recent subsidence studies of the Central Valley have utilized satellite-based, remote sensing data from the Interferometric Synthetic Aperture Radar (InSAR) and aircraft-based L-band SAR or Unmanned Aerial Vehicle Synthetic Aperture Radar (UAVSAR) programs, led by NASA and Jet Propulsion Laboratory (JPL), as well as other international researchers. These datasets provide a continuous estimate of subsidence over a large portion of the Subbasin. Additionally, subsidence in the Subbasin and in the Tule Subbasin (to the south) can also be observed at point locations through continuous GPS (CGPS) stations and other land surface monitoring stations. Most of these are not located within the EKGA, representing a data gap. These CGPS stations are monitored as a part of UNAVCO's Plate Boundary Observation (PBO), the California Real Time Network (CRTN) and California Spatial Reference Center (CSRC) of the Scripps Orbit and Permanent Array Center (SOPAC). Annual averages of CGPS or future extensometer data may permit a more meaningful comparison and/or calibration with InSAR data in the future.

Recent and historical subsidence data is summarized in **Table 2-7**. The data presented includes a summary of InSAR data published in a subsidence study commissioned by the California Water Foundation (LSCE, 2014) and by JPL (Farr et al., 2015 and 2016). The InSAR data was collected from a group of satellites (Japanese

PALSAR, Canadian Radarsat-2, and European Space Agency's (ESA) satellite-borne Sentinel-1A and -1B), from 2006 to 2017, however there is a data gap for the EKGSA prior to 2015 due to the limit of study and absence of satellite data collection data prior to the ESA Sentinel satellites in 2014 (Farr et. al., 2016).

According to the California Water Foundation study (LSCE, 2014), subsidence is an on-going problem that is leading to significant impairment of water deliveries from the FKC south of the Kaweah Subbasin. According to DWR (2014), the Kaweah Subbasin is at a high risk for future subsidence due to 1) a significant number of wells with water levels at or below historic lows; 2) a documented pattern of historical subsidence; and 3) current reports of subsidence. Moreover, the largest amount of subsidence is exhibited to the west, southwest, and south of Kaweah in adjacent Subbasins. The extent of future subsidence will be determined by the further decline in groundwater elevations and the length of time water levels remain at historic lows. Stable groundwater elevations may help limit the risk of future subsidence that occurs as a result of groundwater pumping.

2.4.4.4 Future Data Availability

According to USGS, the ESA's Sentinel satellites collect InSAR data at approximately weekly intervals and the data is made available for download and personal use. Likewise, post-processed CGPS data is continuously available for personal use. Although no extensometers are currently within the Kaweah Subbasin and there are a limited number of extensometers in adjacent basins. The EKGSA will try to rely on InSAR data going forward as it provides coverage for the EKGSA area.

2.4.4.5 Map of Subsidence Locations

Historical rates of subsidence across the Subbasin are presented in the Kaweah Subbasin Basin Setting Document in **Appendix 2-A**. This document also includes hydrographs for selected wells (generally western portion of the Subbasin) plotted against subsidence data for the purpose of comparison. Although reported levels of subsidence are strongly related to declines in groundwater elevations and the potentiometric surfaces in deeper aquifers, other major contributing factors are the presence of regional fine-grained stratigraphic units, such as the Corcoran Clay, and localized areas with thick, fine-grained layers. Due to the Kaweah Subbasin's disposition to the effects of subsidence, the locations of vital infrastructure shall be considered in the assessment of areas sensitive to the effects of land subsidence. For the EKGSA, the FKC is the vital structure.

Cumulative rates of recent subsidence (Spring 2015 through 2017) are presented in . This time period covers a significant drought, and there appears to be some correlation between land subsidence in recent years in response to an increased groundwater demand to offset the limited surface water supplies due to drought. This trend is magnified in areas outside the EKGSA and reasonably corresponds with other regional data sets[2]. It should be noted the 2015 through 2018 cumulative shows significant portions of the EKGSA as static to slight uplift indicating there is some elasticity in the area.

2.4.4.6 Measured Subsidence

The following tabulated data includes cumulative inches of subsidence within and/or near the EKGSA, and approximate annual rates for various data collection periods. Although the highest rates of subsidence occur outside of the EKGSA, particularly to the west and south; data shows there has been some subsidence within the area. It appears there is correlation with subsidence and both a decline in water levels and pumping from deeper levels. Annual subsidence rates vary spatially but have increased in magnitude during the recent drought conditions as a higher demand has been placed on groundwater to meet demands.

[2] The higher rate of "subsidence" in the Frazier Valley area in the southeastern portion of the EKGSA is associated with land development during the referenced period.

Table 2-7 Land Subsidence Data

Subbasin Area	Date Range	Cumulative Subsidence (inches)	Calculated Annual Rate of Subsidence (inches/year)	Source
Kaweah Subbasin	1926 - 1970	~0 - 96	0 – 2.2	Ireland, 1984. Topographic Maps and Leveling Data.
South of Porterville (just outside of Subbasin)	2007 - 2017	21.3	2.1	CGPS PBO (P056 just south of Subbasin). Data are averaged by water year 2007 to 2017
Kaweah Subbasin *(Highest values near Corcoran)*	2015 - 2017	0 – 26.7	0 – 13.4	InSAR. Downloaded from DWR SGMA Viewer.
Mile Post 88. FKC. between Lindsay and Strathmore	1945/1951 to 2017	~4.6	~0.07	USBR FKC Subsidence Monitoring Surveys. NGVD29 to NAVD88
Mile Post 92 FKC. South of Subbasin	1945/1951 to 2017	~6.7	~0.1	

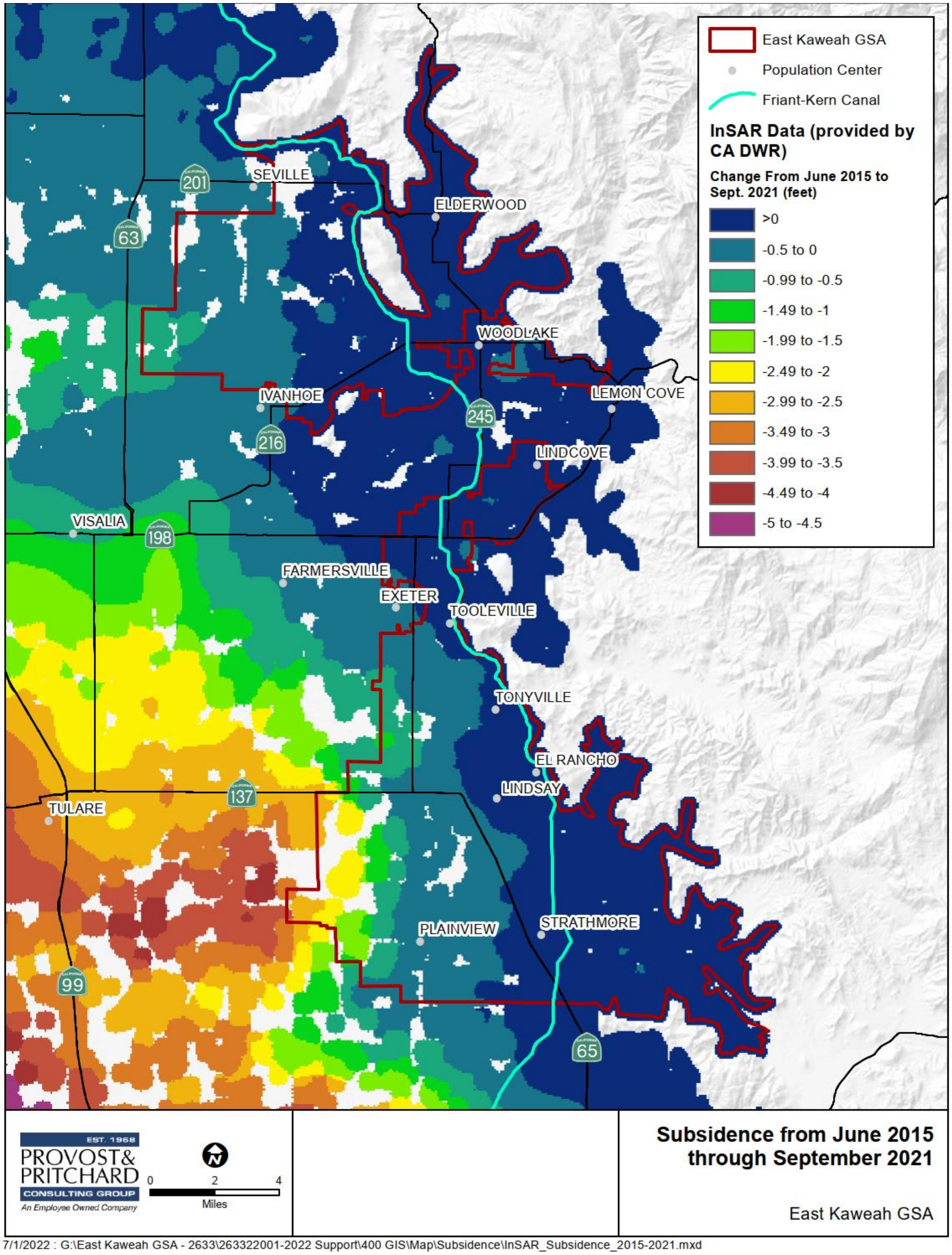


Figure 2-27 InSAR Subsidence Data for the EKGSA

2.4.5 Interconnected Surface Water Systems

Legal Requirements: **§354.16(f)** Identification of interconnected surface water systems within the basin and an estimate of the quantity and timing of depletions of those systems, utilizing data available from the Department, as specified in Section 353.2, or best available information.

Both the loss of streamflow to groundwater (losing streams) and the loss of groundwater to surface streams (gaining streams) are part of the natural hydrologic system. The direction of flow depends on the relative elevation of these inter-connected waters, and the rate of flow depends on the properties of the aquifer and the gradients of the water sources. Many surface water-groundwater systems reverse the flow direction seasonally in response to either groundwater extraction or significant groundwater recharge related to spring and early summer runoff.

An analysis of baseline conditions has been performed, which considered both local knowledge of natural streamflow within the Kaweah Subbasin system including timing and flow regimes (gaining and losing stretches) and gaged streamflow compared to groundwater-level information. Based on this, an estimate of streamflow contribution to the groundwater supply is included in the water budget for the planning base period.

Generally, the only available streamflow data is outside the EKGSA. Cottonwood, Lewis, and Frazier Creeks do not have gauges. However, monthly to semiannual groundwater-level measurements collected within the EKGSA support the understanding of the variability of the proximity and separation of the surface water from the groundwater in both wet and drought conditions. In general, the vast majority of the natural streams and manmade ditches throughout the EKGSA are considered losing channels throughout the year with no connectedness between the surface water and groundwater system. However, some upper reaches of the creeks near the foothills and the Kaweah River upstream of McKays Point are more likely to be relatively neutral to gaining stream reaches during times of year. Locations where interconnectivity was possible during the Spring of 2015 are shown in **Figure 2-28.**

2.4.6 Groundwater Dependent Ecosystems

Legal Requirements: **§354.16(g)** Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or best available information.

Where groundwater and surface water are separated by significant distances, as is the case with the majority of the EKGSA, the groundwater does not interact with the natural streams or manmade ditches, and therefore, no possibility exists for the presence of Groundwater Dependent Ecosystems (GDE). However, there are locations near the foothills of the Sierra Nevada where groundwater levels are closer to the surface.

Areas where groundwater is within 30 feet of the ground surface are primarily located along the Kaweah River (primarily in GKGSA), the Stone Corral ID area, and portions of Lewis Creek in the Lindsay-Strathmore ID area. **Figure 2-28** represents areas where groundwater elevations as of the Spring of 2015 were within 30 feet of the ground surface. **Figure 2-29** depicts a map of the EKGSA with 30-foot DTW contours for various water year types through the Base Period (1997-2017). This highlights potential areas that may be considered interconnected surface waters and/or GDE with further evaluation. Wetlands within these areas may be considered GDE, however additional study, data, and field verification are necessary. This data gap will be addressed as part of the Interconnected Surface Water Data Gap Work Plan (**Section 5.3.7**).

2.4.7 Conditions – January 1, 2015

Groundwater levels measured in the spring and fall of each year by the member agencies provide the data required to document groundwater conditions January 1, 2015. To document the groundwater conditions as of

January 1, 2015, data from the first round of groundwater level measurements that occurred after that date, which is generally Spring (March), are being utilized and are presented in **Figure 2-28**.

Review of groundwater level monitoring data indicate that water levels were at or near the lowest levels on record since the 1960s in the EKGSA. In 2015 the State was experiencing a severe drought, which led to high groundwater pumping. Additionally, the drought led to 0% Friant CVP allocations. Approximately 70% of the EKGSA area is receives surface water from the Friant CVP. Lack of delivery of this imported supply significantly impacted the EKGSA in 2015.

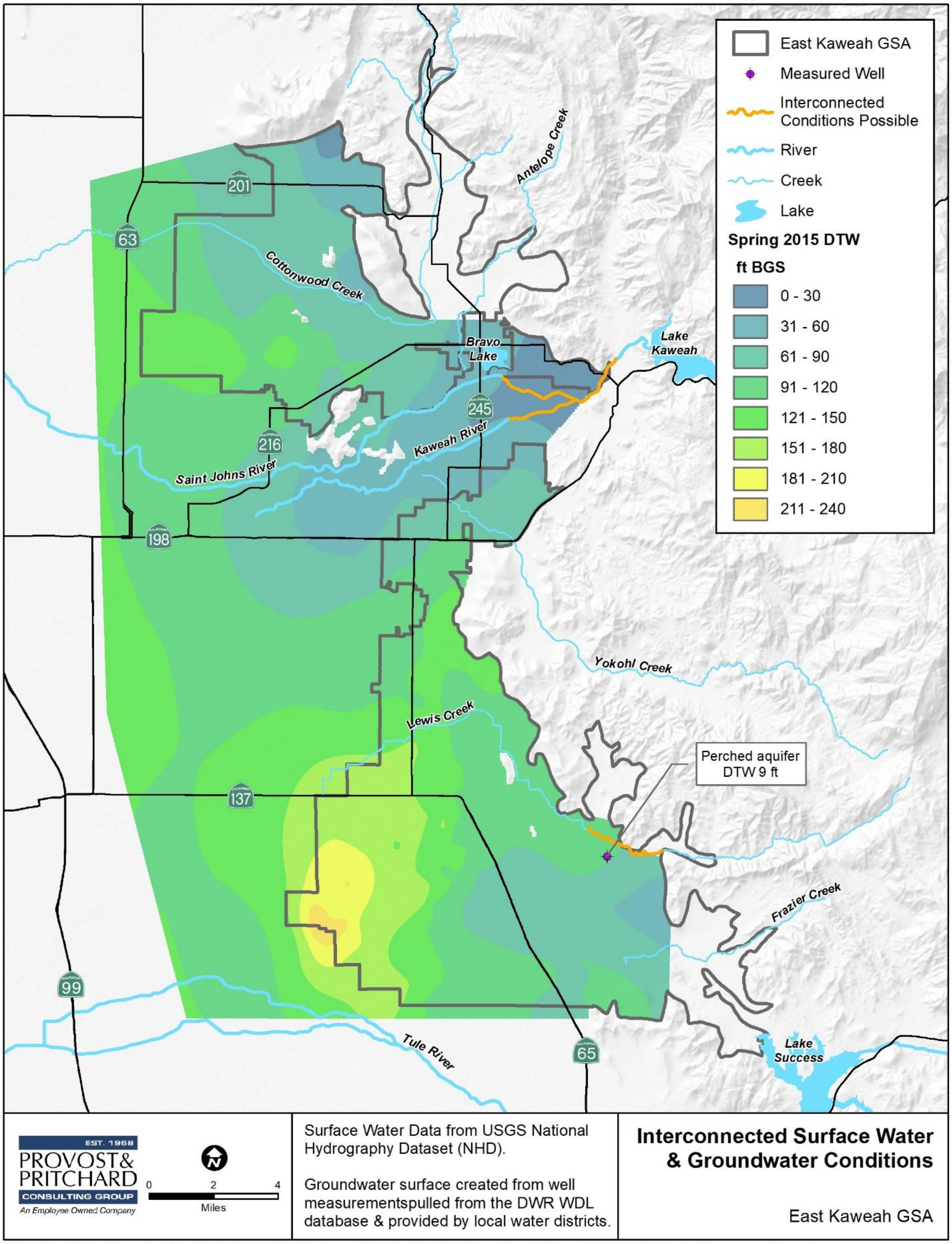


Figure 2-28 Potential Groundwater Dependent Ecosystems

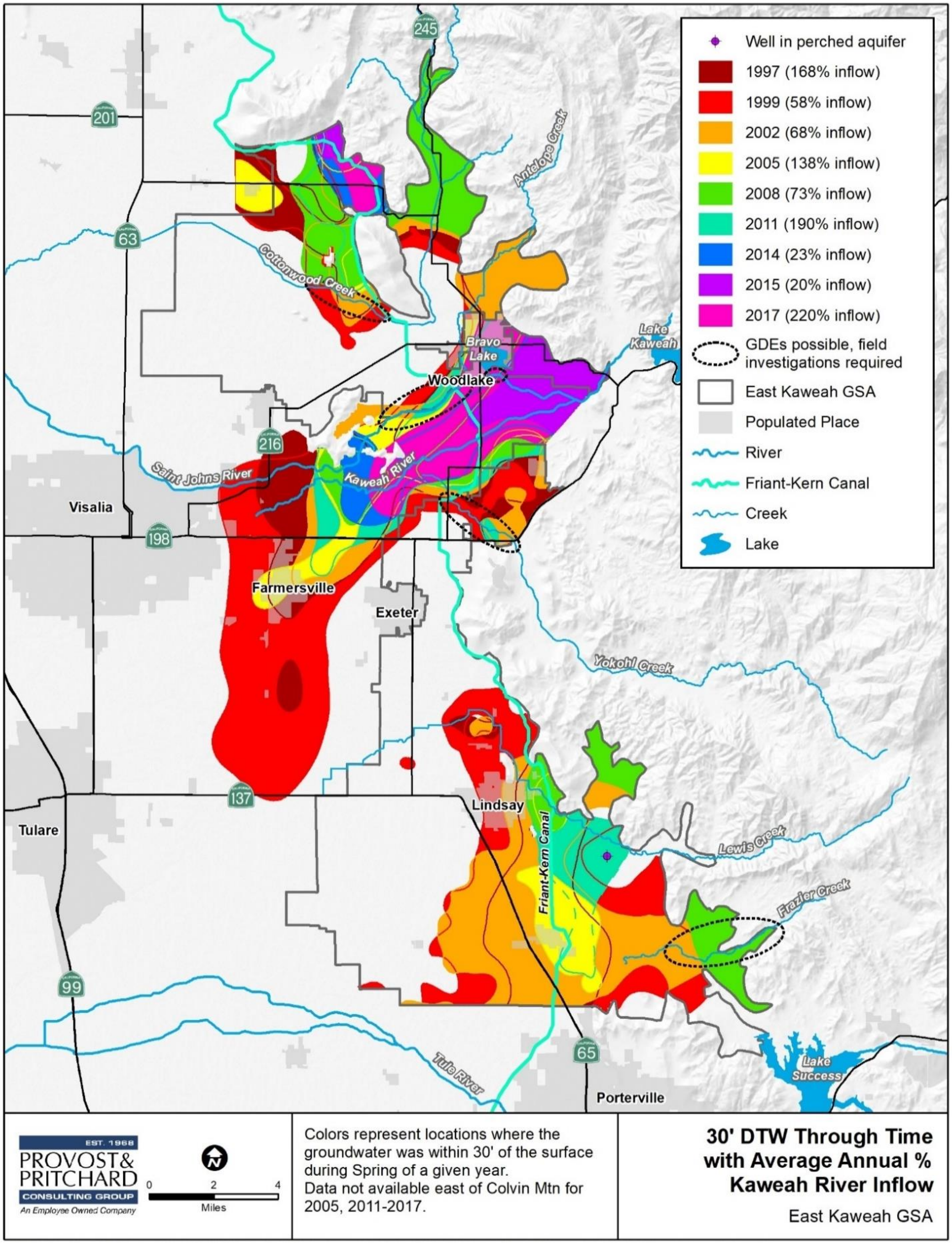


Figure 2-29 Potential GDE Analysis Areas through Select Base Period Groundwater Levels

2.5 Water Budget §354.18

Legal Requirements:
§354.18 (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.

The Kaweah Subbasin water budget was developed for the entire Subbasin using data between water years 1981 and 2017. A "water year" refers to the inclusive period from October 1 through the following September 30. The date of the water year is, by convention, named as the ending year, such that "water year 1981" begins on October 1, 1980 and ends on September 30, 1981. Components contributing to the inflow and outflow of surface and groundwater within the GSA were used to calculate the historical water balance. The Subbasin-wide water budget estimates uses "the best available information" to the quantity the surface and groundwater flow during each year in this 37-year period. The results are presented in the Kaweah Subbasin Basin Setting Document in **Appendix 2-A**.

This Water Budget Section for the EKGSA will focus on the Subbasin's approved planning period, using data between water years 1997 and 2017. This 21-year planning period includes a more robust data set for groundwater inflows and outflows, includes more current land uses and on-farm practices, and is more representative of surface water use in the Subbasin. This section of the GSP summarizes the available data from the period of record and the general methodology used for quantification of each of the water budget components into and out of the groundwater system. From the available data, the accumulated overdraft in the planning period is quantified and presented. The water budget components are summarized into water year totals, from which the annual change in groundwater storage is calculated. Finally, an estimate of the sustainable yield for the EKGSA's share of Subbasin is presented.

The water budget is simply a statement of the balance of total water gains and losses in groundwater. In very simple terms, the water budget is summarized by the following equation:

$$\text{Inflow} = \text{Outflow} (\pm) \text{ Change in Storage}$$

The water budget components in the EKGSA were calculated from a variety of compiled sources from Reclamation, DWR, USGS, and district-reported water use data. The water budget components used in the calculations for the EKGSA, and Subbasin as a whole, include the following:

Table 2-8. Water Budget Components

Inflow Components	Outflow Components
Subsurface inflow	Subsurface outflow
Percolation of Precipitation	Agricultural water demand and consumptive use
Streambed percolation and delivered water conveyance losses	Municipal and Industrial Pumping
Artificial recharge	Agricultural Pumping
Percolation of irrigation return water	Consumptive use by phreatophytes
Percolation of wastewater	Evaporative losses
	Exported water

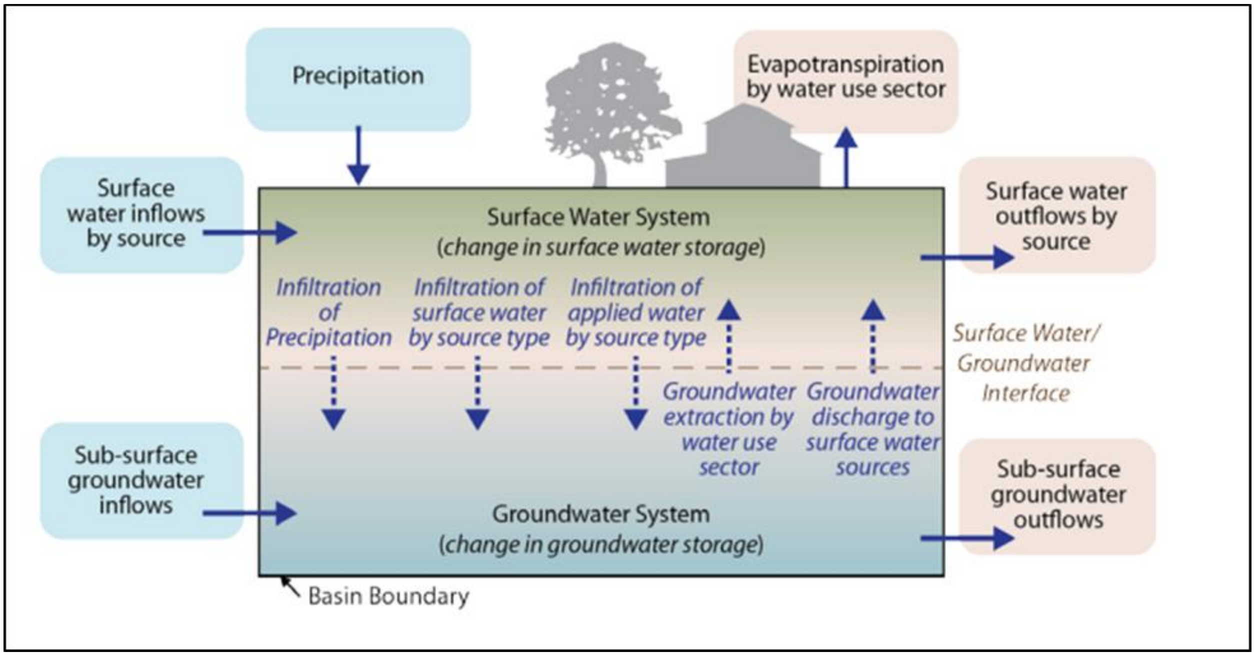


Figure 2-30 Water Budget Components

2.5.1 Numerical Model

Legal Requirements
§354.18 **(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.

A numerical groundwater model using MODFLOW was developed to support implementation of GSPs for all three GSAs in the Kaweah Subbasin. The model, known as the Kaweah Subbasin Hydrologic Model (KSHM), represents a new SGMA tool that includes complex hydrologic analyses in addition to groundwater flow.

The KSHM is based on an existing groundwater model developed by Fugro in 2005 that covers the KDWCD portion of the Kaweah Subbasin, which is approximately equal to 75 percent of the Subbasin area. This original numerical model was revised, expanded and updated to support the objectives of the GSPs in the Subbasin. The KSHM will be used to predict future groundwater conditions with and without proposed management actions in the GSAs and cumulatively for the entire Subbasin. Additional discussion on the model specifics, its principal elements, relationship to the historical and current water budgets, and the results of its use to develop the projected water budgets is provided in **Appendix 2-G**.

2.5.2 Current and Historical Water Budget

Legal Requirements:
§354.18

(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.

(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.

The current and historical water budget was created to quantify the inflow and outflow through the EKGSA, and Subbasin, based on records of historical hydrology, water supply availability, water demand, and land use. The data was collected for the 37-year beginning in water year 1981 and extends through water year 2017. This 37-year base period includes two wet-dry hydrologic cycles, variations in available surface water supply and changes to water demand patterns due to new cropping patterns and land uses. Since water supply and land use during this period has a great deal of climatic and hydrological variability the effects on the aquifer are believed to be representatively evaluated and quantified. The historical water budget was compiled for the three GSAs within the Subbasin to evaluate the historical availability and reliability of past surface water supply deliveries to gauge the aquifer response to water supply and demand trends by water year type. The data was collected, and water budget compiled in accordance with a coordination agreement between the three GSAs "to ensure that the three GSPs are developed and implemented utilizing the same data and methodologies, and that the elements of the GSPs necessary to achieve the sustainability goal for the basin are based upon consistent interpretations of the basin setting."

2.5.2.1 Base Period Selection

Water years for 1997 to 2017 have been selected for the water budget planning period since the range satisfies both the historical and current water budget requirements. This period covers the 10-year minimum and is sufficient to calibrate the tools and methods used in estimates and future water budget and aquifer response projections. The period for the water budget also includes "the most recently available information." Since the base period ends in 2017 it incorporates recent cultural conditions, including an unprecedented lack of imported surface water availability between 2012 and 2015. This four-year period set a new record for the driest four-year period of statewide precipitation. In 2013 many communities reported the lowest levels of rainfall on record and 2015 included the driest January on record statewide (2016 Drought Contingency Plan). Although the period between 2012 and 2015 included extreme dry-weather events the precipitation patterns for the years leading into the beginning of the base period have many similarities.

This period was selected by comparing the average Kaweah River runoff and precipitation for the period compared to the long-term averages for the period of record. The relation between runoff and precipitation during this period was also compared and displays a relatively robust correlation. The period of record for Kaweah River runoff dates back to 1904, and the period of record for precipitation dates back to 1876.

Records from the Visalia precipitation station were used for the analysis of the Kaweah Subbasin since this station has a long period of data, is centrally located within the Subbasin, and it gives the best estimate of the average rainfall across the Subbasin. Average rainfall at this station is 10.1 inches per year. The average annual precipitation for the 1997 to 2017 period is approximately 9.7 inches, or 96% of the long-term average, for a variance of approximately four percent for the 141-year historical record.

During the period of record between water years 1904 and 2017, the average annual runoff within the Kaweah River at Three Rivers was 426,569 acre-feet (AF), with a range from 90,114 AF (2015) to 1,360,000 AF (1983). The average annual runoff for the 1997 to 2017 period is approximately 431,900 AF, or 101% of the long-term average, for a variance of approximately one percent from 113-year historical record. Kaweah River runoff variations shown in **Figure 2-31**, shows the climactic variability by stacking subsequent years, such that upward trending portions (blue areas) represent wet periods and downward trending portions (yellow areas) represent drought periods. An analysis of the statistical relationship between the composite precipitation and river flow data sets is presented as **Figure 2-32**. The average composite precipitation and Kaweah River runoff during the reference period allows for the approximation of the long-term average (within several percent).

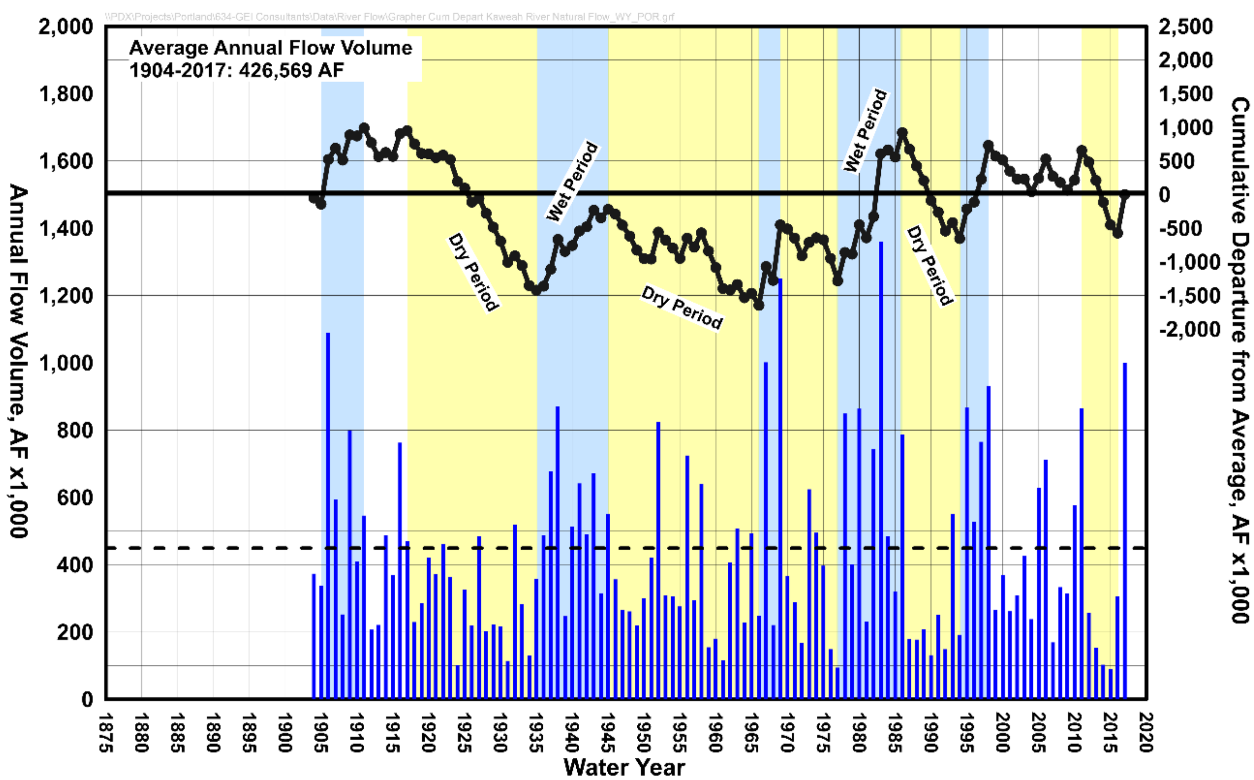


Figure 2-31 Cumulative Departure from Average Annual Flow

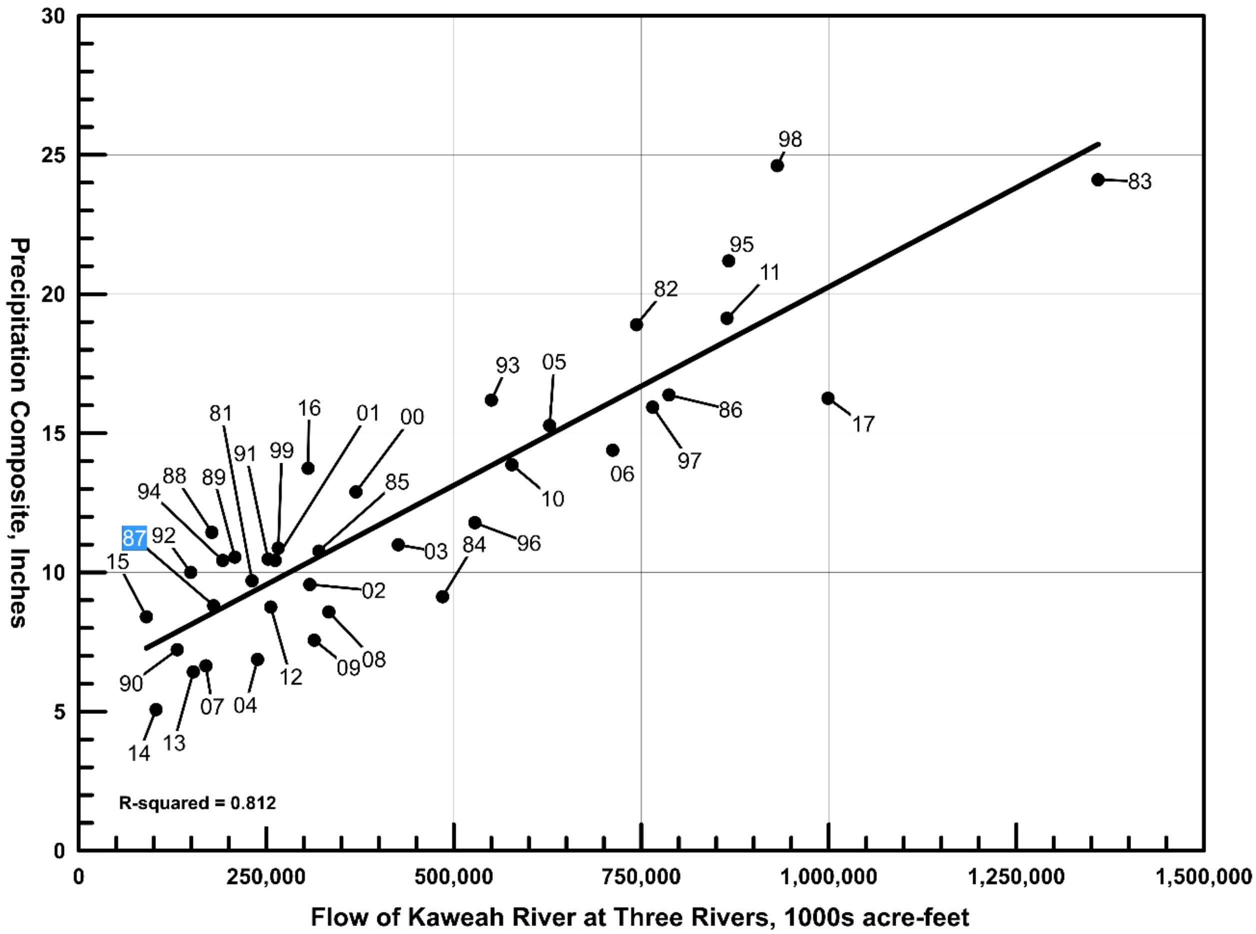


Figure 2-32 Kaweah River Runoff Versus Mean Precipitation

2.5.3 Quantification of Water Budget Components

Legal Requirements:
§354.18(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.
(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.

2.5.3.1 Surface Water

The two sources of surface water to the EKGSA are Kaweah River water and Friant Division CVP supplies. The Kaweah River is the primary source of local surface water throughout the Subbasin. However, the Wutchumna Water Company (WWC) is the primary entity in the EKGSA to take surface water from the Kaweah River. On average, the WWC diverts just over 67,000 AF per year (AFY) of Kaweah River water. Approximately one-third (23,300 AFY) of this total is delivered to WWC shareholders within the EKGSA boundary.

The Subbasin, and the EKGSA in particular, has been using supplemental surface water supplies for decades. In the early 1950s additional surface water supplies were made available to the region through contracts with Reclamation. These supplies have been brought into the region through the CVP's Friant-Kern Canal (FKC).

The EKGSA has eight long-term contractors for CVP supplies. On average, these contractors diverted approximately 84,500 AFY from the FKC for agricultural and municipal uses.

Deliveries of supplemental surface water supplies are necessary for agricultural water users to mitigate the undesirable results from overdraft. Historically, the region would receive surface water supplies at the contracted amount with Reclamation and there was enough water to prevent a decline in groundwater levels. For example, during the 1987 to 1992 drought, imported water was available without significant contract limitations, therefore, no significant water level declines were noted. However, beginning in the 2010s, long-term surface water allocations were reduced to comply with the terms of a settlement on the San Joaquin River Restoration Program. In the recent 2012 to 2015 drought, CVP contract deliveries were severely limited, such that in 2012 only 57% Class 1 water was delivered; in 2013 only 62% and in both 2014 and 2015, no contracted water was delivered. Corresponding to this unprecedented lack of surface water, groundwater levels declined to new record low levels.

On average, during the 1997 – 2017 period, a total of approximately 101,240 AFY of imported CVP and Kaweah River was diverted for use within the EKGSA. 98% of this total was delivered for agricultural irrigation. Gross irrigation demand is supplied by both surface and groundwater. There are several small creeks and with tributary waters that contribute to the EKGSA, however, these waterways lack gauges so their contribution to overall water use is not easily accounted for. The minor creeks and streams that flow into the EKGSA include: Cottonwood Creek, Lewis Creek, and Frazier Creek. Since it is difficult to estimate these seasonal flows in the absence of flow meters, the contributions of these waterways are captured in the estimations for Mountain Front recharge.

Surface Water Crop Delivery

Surface water is primarily applied to irrigated crops since agriculture uses a majority of the water resources in the EKGSA. The calculation for the volume of surface water delivered to fields for agricultural crop demands is described with the following equation adapted from previous methods (Fugro, 2007; 2016):

$$SW_C = HG_{DIV} + R_{DIV} + RW - TotDS_P - RB_{DIV} - S$$

Where:

SW_C	=	Surface water delivered to crops
HG_{DIV}	=	Headgate diversions
R_{DIV}	=	Riparian diversions
RW	=	Recycled water
$TotDS_P$	=	Total ditch system percolation
RB_{DIV}	=	Recharge basin diversions
S	=	Spills

The annual quantities of water associated with each of the components in the equation above are presented in the following sections with an emphasis placed on the relationship between surface water "loss" and aquifer inflow. The activities contributing to water system losses include riparian diversions, recycled water use, ditch system percolation, recharge basin diversions, and spills. Each of these factors as they relate to the EKGSA will be presented and discussed in the following paragraphs. Based on the calculation above, the total average volume of surface water delivered to crops in the EKGSA is just over 99,000 AFY. Total agricultural crop demand for the EKGSA is currently estimated at approximately 250,000 AFY. The surface water deliveries are used to offset groundwater pumping to meet the irrigated agriculture demand.

Headgate Diversions (HG_{DIV})

Headgate diversions refer to water diverted through headgates from a conveyance facility (i.e. FKC or Kaweah River). These diversions are the gross water diverted before accounting for losses and spills. From 1997-2017, the EKGSA diverted approximately 109,550 AFY of surface water through headgates.

Riparian Diversions *(R_{DIV})*

Riparian users are property owners with water rights adjacent to rivers, creeks and streams. All riparian diversions are all located within GKGSA; therefore, no riparian water is included in the EKGSA Water Budget.

Recycled Water (RW)

In the EKGSA, the City of Lindsay operates a wastewater treatment plant (WWTP) that treats City effluent and citrus processing wastewater. The City has been percolating recycled citrus processing wastewater from two nearby plants since 1985. The Regional Water Quality Control Board limits the quantity of applied effluent to 0.45 million gallons per day and the flow the land application site averaged 40 to 70 million gallons from 2009-2011 (RWQCB Waste Discharge Requirements Order R5-2012-0122). Effluent is mixed with irrigation water at a ratio of one-part wastewater to four parts well water then it is applied to the fields via flood irrigation. Crops grown with this treated effluent include alfalfa, wheat and corn. The overall quantity of recycled water used in the EKGSA per year is very small at approximately 170 AF/year.

Total Ditch System Percolation ($TotDS_P$)

The volume of the total ditch system percolation is the portion of water that percolates into the groundwater table through unlined ditches and canals before it is delivered on-farm for agricultural irrigation. There is only one such facility in the EKGSA, the Wutchumna Ditch operated by the WWC. From 1997 - 2017, the annual volume of surface water that percolates through this ditch is 8,835 AFY.

Recharge Basin Diversions (RB_{DIV})

Recharge basin diversions represent the quantity of delivered water that migrates to the water table from recharge basin percolation. While there are some tailwater basins located in some irrigation districts in the EKGSA, no recharge basin diversions are quantified at this time. Going forward this data will be more accurately quantified in EKGSA.

Spills (S)

In wet years when there is an abundance of surface water that exceeds crop demands, recharge basin capacities and conveyance system capacities. During these years surface water leaves the Subbasin in the form of surface water "spills." Spill points are typically located on the low spots of conveyance structures and generally occur on the west side of the Subbasin and not within the EKGSA. Within the EKGSA surface water can leave the boundary through the Wutchumna Ditch delivery to the Tulare ID Main Intake Canal and Frazier Creek into the Lower Tule River ID. Deliveries to Tulare ID are accounted for in the Mid-Kaweah GSA water budget. Due to lack of data and infrequency of occurrence, no spill is accounted for Frazier Creek spill to Lower Tule River ID.

Surface Water Delivered to Crops

Per the calculations for surface water deliveries, the average annual amount of surface water delivered to meet crop demand within the EKGSA is about 99,100 AFY over the 1997-2017 period. Documented deliveries varied over this base period and ranged from about 40,000 AFY (2015) to 148,000 AFY (1998). Approximately 98% of the total water diverted in the EKGSA is ultimately delivered for irrigation.

2.5.3.2 Inflows to the Groundwater System

This section quantifies the components of inflow to the groundwater system. The components include the following:

- Subsurface inflow
- Percolation of precipitation
- Streambed percolation in natural and man-made channels
- Artificial recharge

- Percolation of irrigation water
- Percolation of wastewater

Subsurface Inflow

Subsurface inflow is defined as the natural flow of water beneath the surface of the earth as part of the water cycle. Annual estimates were prepared to determine the subsurface flow for flow within the Subbasin between the three GSAs and the flow into and out of the Subbasin as a whole. These calculations were performed using the Darcy flow equation, that uses the input values of groundwater gradient and hydraulic conductivity to estimate the natural diffusion of groundwater over a period of time. The gradient was calculated for every year of the base period using the groundwater contour maps prepared for the Subbasin. Horizontal hydraulic conductivity values were used from the numerical groundwater model.

In this method, the rate of groundwater flow is expressed by the Darcy equation Q = PiA, where 'P' is the coefficient of aquifer permeability (horizontal hydraulic conductivity), 'i' is the average hydraulic gradient, and 'A' is the cross-sectional area of the saturated aquifer. Permeability data for the aquifers in the Kaweah Subbasin were discussed earlier in the Basin Setting. Hydraulic gradient data derived from annual water level contour maps developed for this GSP were analyzed on an annual basis over the base period. The cross-sectional areas of the aquifer thickness were estimated using GIS analysis along various lines, known as flux lines, throughout the Subbasin. A total of 23 groundwater flux lines were used to analyze subsurface flow into and out of different areas of the Subbasin. From these, annual magnitudes of subsurface flow were tallied. A map of these flux lines in available in the Kaweah Subbasin Basin Setting document in **Appendix 2-A**.

These subsurface flow calculations include an estimate of mountain-front recharge, which is the contribution of water from the mountains to recharge the aquifers in the adjacent basins. For the Kaweah Subbasin, this flow enters the Subbasin from the Sierra Nevada on the east. Based on several sources, mountain-front recharge is estimated to contribute an average of 52,000 AFY to the Kaweah Subbasin. A summary of the total annual subsurface inflow and outflow estimated for the EKGSA is presented in **Table 2-10**.

Percolation of Precipitation

The amount of rainfall that migrates through the subsurface geology and enters the water table depends on several factors, some of which include soil type and structure; density of vegetation; intensity, duration and quantity of precipitation; vertical soil permeability; and local topography. Rainfall will not deeply percolate until the initial soil moisture deficiency is exceeded. Typically, rainfall will not penetrate beyond the root zone of native vegetation since the quantity and duration of rainfall is insufficient to sustain deep percolation. In contrast, reported percolation of precipitation over irrigated lands is higher since the artificial application of water increases the seasonal soil moisture content and less annual rainfall is required to exceed the soil moisture deficiency. Once a storm fills the moisture deficiency within the root zone excess precipitation will travel downward and contribute to the groundwater reservoir.

Estimates for deep percolation of precipitation through the older data period from water years 1981 to 1999 were obtained using a method that relates the distribution of known crop types, rainfall patterns, reference evapotranspiration (ETo) rates from the California Irrigation Management Information System (CIMIS) and soil data. This data was paired with a monthly moisture model that contains data for immediate evaporation, effective rainfall, percolation of infiltrated rainfall, and percolation of runoff from rainfall. The model for the percolation of precipitation was developed from the relationship between land use parameters and precipitation records (Fugro West, 2007). For the period between 2000 and 2017, estimates of the percolation of precipitation were conducted by a more accurate alternate method that relies on a daily root zone water balance model and crop evapotranspiration (ET) obtained from a combination of remote sensing (satellite) images and computer simulations. The method utilizes Davids Engineering's "Normalized Difference Vegetation Index" (NDVI) analysis methods, which were applied to the entire Subbasin (Davids, 2018). More detail of the methodology is provided in the Kaweah Subbasin Basin Setting document in **Appendix 2-A**.

Percolation of precipitation on non-irrigated lands was estimated using published methods based on the distribution of annual precipitation with comparable parcel areas provided by Davids Engineering (Williamson et.al., 1989) Based on this method, approximately 8% of annual precipitation percolates into the groundwater each year. Estimates for the percolation of precipitation are presented in **Table 2-10**. These results show the average annual percolation of precipitation adds 23,200 AFY to the groundwater in the EKGSA.

Natural Channels

The EKGSA lacks reliable, long-standing stream gauges on the four major tributaries that flow into the area from the Sierra Nevada foothills. There is a single stream flow gauge on Yokohl Creek, while the other water bodies Cottonwood, Lewis, and Frazier Creeks do not have permanent gauges. In the absence of data, streambed percolation for the EKGSA was determined by an alternate method. The percolation from these creeks was assumed to be included in the mountain-front recharge accounted for in the Subsurface Flow. This is a data gap that will be further evaluated going forward. In addition to these creeks, a portion of the St. Johns River runs along the boundary between the EKGSA and GKGSA. It is assumed percolation over this stretch enters both the EKGSA and GKGSA. Per these estimates, the average annual natural percolation into the EKGSA is 2,000 AFY as shown in **Table 2-10**. Implementation of the Interconnected Surface Water Data Gap Work Plan will improve the understanding of percolation rates within the EKGSA (**Section 5.3.7**).

Ditches

The Wutchumna Ditch is the only open channel ditch within the EKGSA that delivers surface water. Estimates for the percolation of water from this ditch into the EKGSA are based on WWC data. The annual volume of surface water that percolates through this ditch is estimated at 8,835 AFY when accounting for losses associated with evaporation at Bravo Lake. The resulting value is a conservative estimate that will likely be further examined during implementation period.

Artificial Recharge

Artificial recharge basins are constructed in regions with permeable soils to capture surface water for percolation into the groundwater table. Recharge basin diversions represent the quantity of delivered water that migrates to the water table from recharge basin percolation. While there are some tailwater basins located in some irrigation districts in the EKGSA, no recharge basin diversions are quantified at this time. Going forward this data will be more appropriately quantified in EKGSA.

Percolation of Irrigation Return Water

Estimates for percolation of irrigation return water were developed using a database model as described by Davids Engineering (2013 and 2018) and are described in detail in the Kaweah Subbasin Basin Setting document in **Appendix 2-A**. This form of groundwater recharge is substantial, as the average percolation of irrigation return water is estimated at 42,700 AFY for the EKGSA.

Percolation of Wastewater

The City of Lindsay also owns and operates a wastewater treatment facility and has been diverting a portion of treated effluent for use in groundwater recharge since 1985. At this facility, wastewater is discharged to holding ponds for percolation, evaporation, or agricultural reuse. The annual sum of wastewater that percolates to groundwater within EKGSA are approximately 1,500 AFY.

2.5.3.3 Outflows from the Groundwater System

This section quantifies the components of outflow to the groundwater system. The components include the following:

- Subsurface outflow
- Agricultural groundwater pumping

- Municipal & Industrial (M&I) groundwater pumping
- Phreatophyte extraction
- Evaporation

Subsurface Outflow

Subsurface outflow is the flow of groundwater at depth that exceeds the downgradient boundary of a groundwater basin. In the case of the EKGSA, generally most subsurface outflow stays within the Kaweah Subbasin as the outflow moves into the GKGSA to the west. Other potential outflows can be to the northwest into the Kings Subbasin or to the south into the Tule Subbasin. Outflows into these other basins is largely dependent on water year type. During the planning period, an average of 13,000 AFY flowed out of the EKGSA each year. Subsurface outflow calculations were performed using the Darcy equation method described in the Subsurface Inflow section for every year of the base period.

Agricultural Water Demand and Consumptive Use

Irrigated agricultural lands are the principal component of water use within the EKGSA and Kaweah Subbasin as a whole. Similar to the analysis for percolation of precipitation and percolation of irrigation water, the calculations for the agricultural water demand were conducted using two different methods based on available information for the Subbasin during the data period. In the earlier portion of the data period (1981 to 1999), the agricultural water demand is principally based on periodic land surveys with some frequencies that are separated by as many as 10 years (Fugro West, 2007). These methods were updated with remote sensing methods that incorporate data from a total of 154 raw satellite images during the period from September 1998 through the end of water year 2017.

For the period between 2000 and 2017 clipped GIS files of the irrigated fields were input into the Davids Engineering database model (2018) and then queried from the full Subbasin irrigated fields table to return annual estimated gross applied irrigation water for all irrigated acres. Due to the significance of this water budget component a considerable amount of database model error checking was performed. The Davids Engineering database model also accounts for the agricultural land that has been converted to urban land use over time to yield more a more accurate estimate. The results of the gross applied irrigation water analyses for the EKGSA indicate approximately 250,000 AFY, from a combination of surface and groundwater sources, were delivered to the agricultural lands during the planning period between 1997 and 2017. Due to the reliance on land use surveys, estimated soil characteristics, estimated irrigation practices and efficiencies, remote sensing technologies, and necessary calibration checks, this water budget item will continue to be evaluated and updated through the implementation of the GSP.

Agricultural Pumping

Groundwater is primarily extracted for application to irrigated agriculture within the EKGSA, which accounts for approximately 98% of the total groundwater pumping.

The distribution of groundwater pumping was determined based on the spatial distribution of crops, water demand and annual surface water deliveries to individual appropriator/district service areas. Crop water demand was calculated using two different methods for the 37-year data period. The analysis for water years 1981 through 1999 used estimated crop water use from DWR land use surveys and irrigation efficiency factors (Fugro West, 2007). The analysis for water years 1999 through 2017 was based on Davids Engineering's method (2018) of using satellite data to calculate the normalized difference vegetation index (NDVI). A detailed spatial distribution of crop water demand is available from the NDVI analysis method.

The surface water supply in the EKGSA is from a combination of local Kaweah River and imported CVP supplies. Since the spatial distributions of surface water deliveries within each service area are unknown, it is assumed that surface water deliveries are distributed evenly across the irrigated fields within each service area.

The current extent of irrigated agriculture and distribution pattern among surface water appropriators was well established in the Kaweah Subbasin prior to the start of the 37-year Subbasin study period (Bookman-Edmonston, 1972 and Fugro West, 2007) so the appropriator service areas have remained virtually unchanged. Minor changes have occurred in the form of disjointed conversions of agricultural lands to urban developments (Davids Engineering, 2018) and land use changes in some service areas. These minor changes to the appropriator service areas are considered in the surface water delivery analysis.

To determine the distribution of groundwater pumping for irrigated agriculture, the surface water volumes distributed among the known-irrigated fields within each service area were subtracted from the spatially precise NDVI crop water demand dataset, according to the following equation:

$$AP = CD - SWc$$

where:

AP = Agricultural Pumping
CD = Agricultural Crop Demand
SWc = Surface Water Crop Delivery

The results of this calculation show, on average, a total of 151,000 AFY was pumped from the ground each year. These values range from a low of 84,000 AF in 1998, to a high of over 234,000 AF in 2014 during the recent drought and associated lack of imported surface water.

This analysis was performed for all years in the base period that are included in the water budget. As expected, the results of this analysis show a pattern of increased agricultural pumping during drought periods to compensate for a reduction in surface water deliveries to irrigated lands from both local and imported sources and a commensurate increase in crop water demand. Pronounced increases in agricultural pumping followed extended periods of drought, such as during the 2012 to 2015 period when imported water supplies were limited or non-existent.

Municipal and Industrial Pumping

A variety of methods were used to estimate municipal and industrial (M&I) pumping in the EKGSA and the Subbasin. The categories of water users included in this summarized component include:

- Urban
- Small public water system
- Rural domestic
- Golf course
- Dairy

The total estimate for M&I groundwater pumping within the EKGSA is the sum of the individual estimates for groundwater demand as presented in the following sections. Data and methodologies from the WRI reports (Fugro West, 2007; Fugro Consultants, 2016) and additional information compiled for the purpose of this study were used to estimate the M&I demand summary. Data was derived from metered municipal groundwater pumping records, demand estimates based on service connections and categories of facilities, population and dwelling unit density estimates, interviews with various industrial facility managers (nursery, food processing, and packing plants, etc.), and information provided by the County Agricultural Commissioner's Office and the Dairy Advisor.

Urban Demand

Urban demand in the EKGSA is the demand on groundwater that occurs in the larger communities of Lindsay and Strathmore, whom partially rely on groundwater to meet their demands. In most years, Strathmore utilizes its CVP supplies to meet demand. The City of Lindsay meets approximately 60% of their demand with surface water through the CVP. The remaining 40% is supplied by pumped groundwater. Through the 1997-2017 period urban demand (40% of the City of Lindsay demand) in the EKGSA averaged about 1,100 AFY.

Small Water Systems Pumping

Calculations for the annual water demand in small, regulated public water systems in the EKGSA were based on methodologies within the WRI reports (Fugro West, 2007; Fugro Consultants, 2016) and an analysis of the types of water systems in the area available from the County of Tulare Health and Human Services Agency. Water system listings provided the following information: facility identification/name, general location within respective counties, codes related to the approximate number of service connections for the facility, and a contact name and phone number for each facility. Examples of typical facility types are mutual water companies, schools, mobile home parks, county facilities (e.g. civic centers, road yards), motels, livestock sales yards, and miscellaneous industries such as nurseries, food processing facilities, packing houses, etc.

Approximately one-third of the groundwater pumped by small public water systems occurs in rural settings. Per previous studies, about 70% of this pumped groundwater is believed to return to the water table through septic system percolation (Dziegielewski and Kiefer, 2010). The overall use by small water systems is 485 AFY which is minimal in the context of the overall water use. However, the groundwater demand for small water systems increased each year, which is attributed to population changes within Tulare County.

Rural Domestic Pumping

Rural domestic water demand consists of the demand of residences not served by a municipal connection, mutual water company, or other small public water system. Rural residential units can be described as "ranchette" type homes of several acres in size with an average population of three per dwelling unit. Total water demand for such dwelling units is on the order of 2 acre-feet per year.

Unlike the small, public water system demand estimates that were indexed for population changes in Tulare County, the density of rural domestic dwellings has not changed significantly since 1981, other than a small portion of properties replaced by urban expansion. Similar to the rural small water system analysis above, 70% of the pumped rural domestic water is assumed to return to groundwater via septic system percolation and irrigation return flows (Dziegielewski and Kiefer, 2010). Aerial analysis of the EKGSA resulted in there being approximately 18.6 dwelling units per square mile in the areas outside urban and small water system centers. These areas cover roughly half of the EKGSA (90 square miles). This resulted in approximately 1,700 units whose total pumping is estimated at 3,400 AFY, of which 70% is returned to groundwater leaving a net average of 1,000 AF consumed by rural consumers each year.

Golf Course Pumping

There are no golf courses within the EKGSA boundary. Therefore, this pumping component is not included in the EKGSA water budget.

Dairy Pumping

Dairies and associated processing and distribution facilities utilize a significant amount of water. Estimates of net water consumed by dairy operations (farms) were based on cow census records kept by Tulare County and a per-cow based water use factor. Conversations with County personnel indicate the gross daily water use per cow is in the order of 125 gallons per day (gpd). Net water use (considering the recycled water used to irrigate adjacent agricultural lands) is approximately 75 gpd (Fugro West, 2007). This equates to approximately 0.084 AFY per cow. Current estimates of dairy cow population suggest there are approximately 4,400 cows within the EKGSA. The analysis results in a net average of 370 AFY of water is consumed and must be pumped to meet dairy demand in the EKGSA.

Total M&I Groundwater Pumping

The total M&I groundwater pumping estimate is the sum of the individual components described in the preceding paragraphs. For several of the M&I components, such as small water systems and rural domestic users, a portion of the pumped groundwater deep percolates and returns to the groundwater reservoir so adjustments are incorporated. Factoring in the percolation returns a remaining volume of 3,000 AFY of pumped groundwater was removed from the groundwater reservoir yearly during the 1997 – 2017 period.

Phreatophyte Extractions

Phreatophyte extractions are groundwater losses due to consumption by plants with deep root systems. Within the EKGA phreatophyte extractions were calculated using GIS clip analysis similar to the method used in the WRI analysis (Fugro West, 2007). The results of phreatophyte extraction analysis indicate this component constitutes a minor extraction from the groundwater reservoir of about 100 AFY.

2.5.3.4 Change in Groundwater Storage

Annual variations in the volumes of groundwater storage were calculated for each year of the base period. The changes in storage for the planning period from water year 1997 to 2017 were used to evaluate conditions of water supply surplus and deficiency, and in recognizing conditions of overdraft. **Table 2-10** presents the annual amounts of each water budget component for inflow and outflow within the EKGSA as computed by the use of the equation of hydrologic equilibrium (the "inventory method"). The results of the water budget show that the Kaweah Subbasin is in overdraft. The magnitude of the overdraft for the Kaweah Subbasin during the planning period averaged 77,600 AFY. As indicated in **Table 2-10**, the EKGSA accounted for an accumulated 590,000 AF of the water supply deficiency of over the 21-year period, or an average deficit of 28,000 AFY.

2.5.3.5 Safe Yield

The safe or perennial yield of a groundwater basin is typically defined as the volume of groundwater that can be pumped on a long-term average basis without producing undesirable results. Long-term withdrawals in excess of the safe yield is considered overdraft. While the definition of "undesirable results" mentioned in the definition have changed in recent years and are now codified in SGMA regulations, they are recognized to include not only the depletion of groundwater reserves, but also deterioration in water quality, unreasonable and uneconomic pumping lifts, creation of conflicts in water rights, land subsidence, and depletion of streamflow by induced infiltration (Freeze and Cherry, 1979). It should be recognized that the concepts of safe yield and overdraft imply conditions of water supply and use over a long-term period. Given the importance of the conjunctive use of both surface water and groundwater in the Subbasin, short-term water supply differences are satisfied by groundwater pumping, which in any given year, often exceed the safe yield of the Subbasin. The Subbasin, however, has a very large amount of groundwater storage that can be used as carryover storage during years when there is little natural recharge, and replaced in other years when pumping is reduced (when surface water is available or from various types of projects, including, artificial recharge).

There are several available methods to estimate the safe yield under the conditions of water supply and use that prevailed during the 37-year data period. Use of these methods requires acknowledgement of the inherent uncertainties in the estimates of recharge and discharge as well as the challenges associated with calculating the changes of groundwater in storage in the confined "pressure" area of the Subbasin. One of the methods assumes that the safe yield is equal to the long-term recharge. Although there are considerable assumptions used to estimate each component of inflow in the hydrologic equation, the data suggests the safe yield of the Subbasin is in the range of 720,000AFY.

The Kaweah Subbasin GSAs split this water in three types of water (Native, Foreign, and Salvaged) through an agreed-to methodology, known as the Water Accounting Framework (WAF), that assigns groundwater inflow components to each GSA. **Table 2-9** shows the components of groundwater inflow in the three types of water coordinated amongst the Kaweah Subbasin GSAs. This is the beginning of a potential groundwater allocation, but presently provides each GSA a groundwater supply for their region. Through this accounting, the EKGSA is allotted approximately 124,600 AFY, with the largest portion being the Native supply at nearly 97,000 AFY. This coordinated WAF is in the Coordination Agreement and also included in **Appendix 2-H**. Through this WAF accounting the sustainable Native yield for the Subbasin is approximately 364,000 AFY. Not included in this number is subsurface inflow from the surrounding subbasins which totals approximately 60,000 AFY. During GSP Implementation the Kaweah Subbasin intends to coordinate on this groundwater component with the neighboring subbasins.

It is the intent of the Kaweah Subbasin GSAs to continue to discuss water balances and groundwater conditions during the GSP implementation. The groundwater net inflow balances and hydrogeologic water budgets of each GSA region will be given due consideration in these future discussions. The current Subbasin WAF is a preliminary starting point from which to establish a future framework to assess GSA responsibilities in achieving the Subbasin Sustainability Goal and eliminating Undesirable Results by 2040. As additional data becomes available and water budget component are refined, the Subbasin and individual GSA water budgets will be periodically reevaluated, no less frequent than the five-year GSP assessments as submitted to DWR. Furthermore, in time the safe yield estimate will likely be superseded by forthcoming sustainable yield values for the basins, which will avoid undesirable results and achieve measurable objectives.

Table 2-9 WAF Components of Groundwater Inflow

Native:	**Inflows which all well owners have access to on a pro-rata basis**
•	Percolation from rainfall
•	Streambed percolation (natural channels) from the Kaweah River watershed sources
•	Agricultural land irrigation returns from pumped groundwater
•	Mountain-front recharge
Foreign:	**All imported water entering the Subbasin from non-local sources under contract by local agencies or by purchase/exchange agreements**
•	Streambed percolation from imported sources
•	Basin recharge from imported sources
•	Ditch percolation from imported sources
•	Agricultural land irrigation from imported sources
Salvaged:	**All local surface and groundwater supplies that are stored, treated, and otherwise managed by an appropriator/owner of the supply and associated water infrastructure systems**
•	Ditch percolation from previously appropriated Kaweah River sources
•	Additional ditch/field recharge from over-irrigation
•	Captured storm water returns
•	Wastewater treatment plant returns
•	Basin percolation from previously appropriated Kaweah River sources
•	Agricultural land irrigation returns from Kaweah River watershed sources

Table 2-10 EKGSA Water Budget Summary

Estimated Deep Percolation, Extractions and Change in Storage - East Kaweah GSA

Values in 1,000s af

Water Year	Rainfall		Components of Inflow						Components of Outflow								Total Inflow	Total Outflow	Change in Storage	Cumulative Change in Storage
									Groundwater Pumpage											
	Inches	% of Average	Subsurface Inflow	Wastewater Inflow	Steambed Percolation and Conveyance Losses	Percolation of Recharge Basins	Percolation of Irrigation Water	Percolation of Precipitation on Crop Land	M & I	Gross Applied Irrigation Water (Crop Water Demand)	Delivered Surface Water	*GW Pumping for Irrigated Agriculture*	*Total Net Extraction*	Extraction by Phreatophytes	Evaporative Losses	Subsurface Outflow			*Inventory Method*	*Inventory Method*
1997	12.5	124%	112.5	1.2	13.2	0.0	43.3	28.0	2.7	243.7	147.9	*95.8*	*98.5*	0.1	1.8	17.3	*198.2*	*117.7*	*80.5*	*80.5*
1998	22.8	226%	110.2	1.3	14.0	0.0	46.4	53.3	2.5	210.2	126.7	*83.5*	*86.1*	0.2	1.8	23.7	*225.2*	*111.8*	*113.4*	*193.9*
1999	9.6	95%	55.9	1.3	4.8	0.2	45.8	21.1	3.3	226.5	116.0	*110.8*	*114.1*	0.1	0.6	27.0	*129.1*	*141.7*	*-12.6*	*181.3*
2000	11.4	113%	62.7	1.3	9.9	0.3	48.3	26.3	3.0	252.4	117.6	*135.1*	*138.2*	0.1	1.4	29.9	*148.8*	*169.6*	*-20.8*	*160.5*
2001	10.1	100%	66.0	1.3	9.7	0.0	41.0	16.0	2.4	257.7	98.9	*158.8*	*161.2*	0.1	1.3	24.6	*133.9*	*187.3*	*-53.4*	*107.1*
2002	10.4	104%	48.4	1.4	9.5	0.4	43.2	17.7	3.5	265.4	107.7	*158.1*	*161.6*	0.1	1.3	25.7	*120.5*	*188.7*	*-68.2*	*39.0*
2003	8.7	87%	45.4	1.4	11.0	0.0	41.8	18.0	3.1	253.7	112.5	*141.2*	*144.3*	0.1	1.5	18.9	*117.6*	*164.8*	*-47.2*	*-8.3*
2004	8.0	79%	14.0	1.4	6.7	0.0	39.4	13.1	3.6	262.6	104.8	*157.8*	*161.4*	0.1	0.9	11.8	*74.6*	*174.2*	*-99.6*	*-107.9*
2005	12.2	121%	70.1	1.4	11.7	0.3	38.1	25.5	2.9	221.7	110.4	*111.6*	*114.5*	0.1	1.6	5.6	*147.1*	*121.9*	*25.2*	*-82.6*
2006	15.4	153%	87.5	1.5	21.5	0.0	43.6	34.2	3.1	236.1	112.8	*123.2*	*126.3*	0.1	3.3	11.1	*188.2*	*140.8*	*47.4*	*-35.2*
2007	3.8	38%	44.6	1.5	6.9	0.0	41.7	9.9	3.1	265.6	80.2	*185.5*	*188.6*	0.0	1.0	17.9	*104.5*	*207.6*	*-103.0*	*-138.2*
2008	5.0	50%	43.9	1.5	9.6	0.5	42.0	17.0	3.1	261.6	98.6	*163.5*	*166.7*	0.0	1.5	8.1	*114.5*	*176.3*	*-61.8*	*-200.0*
2009	6.4	64%	27.9	1.5	9.7	0.4	38.5	10.5	3.1	274.7	90.3	*184.8*	*187.9*	0.1	1.5	***-0.6***	*88.5*	*188.9*	*-100.3*	*-300.3*
2010	11.1	110%	74.0	1.6	16.8	0.1	42.9	23.4	3.4	245.3	110.7	*134.7*	*138.0*	0.1	2.5	10.0	*158.7*	*150.7*	*8.1*	*-292.3*
2011	13.7	135%	145.6	1.6	16.4	0.9	46.9	53.6	3.8	240.2	116.4	*125.4*	*129.2*	0.1	2.3	11.5	*265.1*	*143.2*	*121.9*	*-170.4*
2012	4.4	44%	43.8	1.6	10.1	0.0	42.7	15.6	2.8	262.6	79.8	*182.8*	*185.5*	0.0	1.4	12.4	*113.8*	*199.4*	*-85.5*	*-255.9*
2013	4.4	44%	41.0	1.6	5.4	0.0	41.2	9.0	2.7	274.9	82.1	*192.8*	*195.5*	0.0	0.7	9.4	*98.2*	*205.6*	*-107.4*	*-363.2*
2014	4.7	46%	1.9	1.6	10.1	0.0	43.2	7.0	2.5	282.7	48.4	*234.3*	*236.8*	0.0	1.7	5.9	*63.7*	*244.4*	*-180.7*	*-543.9*
2015	6.2	61%	25.4	1.6	4.2	0.0	39.6	13.3	2.4	256.5	40.2	*216.3*	*218.8*	0.1	0.6	0.5	*84.2*	*219.9*	*-135.7*	*-679.7*
2016	9.8	97%	53.8	1.6	9.2	0.2	39.5	30.5	2.6	226.1	76.9	*149.4*	*152.0*	0.1	1.3	***-3.1***	*134.7*	*150.4*	*-15.6*	*-695.3*
2017	14.0	139%	138.3	1.6	18.2	0.7	48.6	43.8	2.7	227.0	103.5	*124.1*	*126.8*	0.1	2.5	4.3	*251.3*	*133.8*	*117.5*	*-577.8*
Maximum	22.8	226%	145.6	1.6	21.5	0.9	48.6	53.6	3.8	282.7	147.9	234.3	236.8	0.2	3.3	29.9	265.1	244.4	121.9	
Minimum	3.8	38%	1.9	1.2	4.2	0.0	38.1	7.0	2.4	210.2	40.2	83.5	86.1	0.0	0.6	-3.1	63.7	111.8	-180.7	
Average	**9.7**	**97%**	**62.5**	**1.5**	**10.9**	**0.2**	**42.7**	**23.2**	**3.0**	**249.9**	**99.2**	**150.9**	**153.9**	**0.1**	**1.6**	**12.9**	**141.0**	**168.5**	**-27.5**	
% of Total			44%	1%	8%	0%	30%	16%	2%			90%		0.06%	0.93%	8%				
			100%						100%											

Italic = Calculation
= Component of Inflow
= Component of Outflow

2.5.4 Projected Water Budget

Legal Requirements:
§354.18

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

(3) Projected water budgets shall be used to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation, and to identify the uncertainties of these projected water budget components. The projected water budget shall utilize the following methodologies and assumptions to estimate future baseline conditions concerning hydrology, water demand and surface water supply availability or reliability over the planning and implementation horizon:

(A) Projected hydrology shall utilize 50 years of historical precipitation, evapotranspiration, and streamflow information as the baseline condition for estimating future hydrology. The projected hydrology information shall also be applied as the baseline condition used to evaluate future scenarios of hydrologic uncertainty associated with projections of climate change and sea level rise.

(B) Projected water demand shall utilize the most recent land use, evapotranspiration, and crop coefficient information as the baseline condition for estimating future water demand. The projected water demand information shall also be applied as the baseline condition used to evaluate future scenarios of water demand uncertainty associated with projected changes in local land use planning, population growth, and climate.

(C) Projected surface water supply shall utilize the most recent water supply information as the baseline condition for estimating future surface water supply. The projected surface water supply shall also be applied as the baseline condition used to evaluate future scenarios of surface water supply availability and reliability as a function of the historical surface water supply identified in Section 354.18(c)(2)(A), and the projected changes in local land use planning, population growth, and climate.

The projected water budget in the Kaweah Subbasin will be estimated by applying the numerical groundwater model to past and present trends. Alternative future water supply and demand scenarios will be developed in coordination with the three GSAs and input to the numerical groundwater model. This section describes the estimated impact of climate change on groundwater supply, surface water availability and projected water demands, and is based from the Kaweah Subbasin Basin Setting document in **Appendix 2-A**.

2.5.4.1 Climate Change Analysis and Results

SGMA requires local agencies developing and implementing GSPs to include water budgets that assess the current, historical, and projected water budgets for the basin, including the effects of climate change. Additional clarification is found in DWR's Water Budget and Modeling BMPs that describe the use of climate change data to compute projected water budgets and simulate related actions in groundwater/surface water models. DWR also provides SGMA Climate Change Data and published a guide for Climate Change Data Use During Groundwater Sustainability Plan Development (Guidance Document) as the primary source of technical guidance (DWR, 2018). The DWR-provided climate change data is based on the California Water Commission's Water Storage Investment Program (WSIP) climate change analysis results that use global climate models and radiative forcing scenarios recommended for hydrologic studies in California by the Climate Change Technical Advisory Group (CCTAG). Climate data from the recommended GCM models and scenarios have also been downscaled and aggregated to generate an ensemble time series of change factors which describe the projected change in precipitation and evapotranspiration values for climate conditions that are expected to prevail at mid-century and late-century, centered around 2030 and 2070, respectively. The DWR dataset also includes two additional simulation results for extreme climate scenarios under 2070 conditions. Use of the extreme scenarios which represent Drier/Extreme Warming (2070DEW) and Wetter/Moderate Warming (2070WMW) conditions in GSPs is optional.

This section describes the retrieval, processing, and analysis of DWR-provided climate change data to project the impact of climate change on precipitation, evapotranspiration, upstream inflow, and imported flows in the Kaweah Subbasin under future conditions between 2030 and 2070. The precipitation and evapotranspiration change projections are computed relative to a baseline period of 1981 to 2010 and are summarized for the EKGSA, GKGSA and MKGSA areas. Change projections for upstream inflow into Kaweah Lake and imported water from the FKC, are computed using a baseline period of 1981 to 2003. Representative periods were chosen from the baseline analysis period for the Basin Settings report, available concurrent climate projections, (calendar years 1915 to 2011) and derived hydrologic simulations (water years 1922 to 2011) from the SGMA Data Viewer.

2.5.4.1.1 Data Processing

The 2030 and 2070 precipitation and evapotranspiration (ET) data is available on 6 km resolution grids. The climate datasets have also been run through a soil moisture accounting model known as the Variable Infiltration Capacity (VIC) hydrology model and routed to the outlet of Subbasins defined by 8-digit Hydrologic Unit Codes (HUCs). The resulting downscaled hydrologic time series are available also on the SGMA Data Viewer hosted by DWR. Precipitation and ET data used in this analysis were downloaded from the SGMA Data Viewer for 69 climate grid cells covering the Kaweah Subbasin. Separate monthly time series of change factors were developed for each of the three Kaweah Subbasin GSAs by averaging grid cell values covering each GSA area. Monthly time series of change factors for inflow into Kaweah Lake and flow diversions from the FKC were similarly retrieved from the SGMA Data Viewer. Mean monthly and annual values were computed from the Subbasin time series to show projected patterns of change under 2030 and 2070 conditions.

2.5.4.1.2 Projected Changes in Evapotranspiration

Crops require more water to sustain growth in warmer climates, and this increased water requirement is characterized in climate models using the rate of evapotranspiration. Under 2030 conditions, all three GSAs in the Kaweah Subbasin are projected to experience annual water requirement increases of 3.2% from the baseline period. In 2030 the largest monthly changes will occur in winter and early summer and projected increases of 4.3% to 4.8% will occur in January and 3.8% to 4% will occur in June. Under 2070 conditions, annual evapotranspiration is projected to increase by 8.2% from the baseline period in all three GSA areas. Predictions for 2070 show the largest monthly changes will occur in December with projected increases of between 12.8% to 13.5%. Summer increases peak approximately 8% in May and June.

2.5.4.1.3 Projected Changes in Precipitation

The seasonal distribution of precipitation in the Kaweah Subbasin is projected to change. Decreases in precipitation are anticipated in early fall and late spring while an increase in rainfall is projected in winter and summer. Under 2030 conditions, the largest monthly changes will occur in May where there is a projected decrease of 14% while March and August will receive increases of approximately 9% and 10%, respectively. Under 2070 conditions, rainfall will decrease by up to 31% in May and the largest increases will occur in September (25%) and January (17%). Although the precipitation pattern is anticipated to change, all three GSA areas will experience minimal changes in total annual precipitation. Increases in annual precipitation for the EKGSA is projected at 0.4% from the baseline period in 2030. By 2070, small decreases in annual precipitation are projected with a change of 0.6% projected for the EKGSA.

2.5.4.1.4 Projected Changes in Full Natural Flow

The quantity of surface water that flows into Kaweah Lake, the main local water source, is projected to decrease. Under current climactic conditions Kaweah Lake receives 465 thousand acre-feet (TAF) in 2030; in 2070 this quantity is expected to decrease to 442 TAF. Similarly, peak flows are projected to decrease from monthly peaks of 102 TAF under current climate conditions to 82 TAF by 2030 followed by a minimal decline to 81 TAF under 2070 conditions. Additionally, significant changes in the seasonal timing of flows are expected. In 2030, the monthly inflows into the reservoir are projected to peak in May. By 2070, inflows are projected to occur earlier in the water year, with peak monthly inflows occurring in March.

2.5.4.1.5 Projected Changes in Imported Flow Diversions

Climate change can also impact the quantity and timing of imported water delivered to the Kaweah Subbasin from the CVP. The Friant Water Authority developed a technical memorandum that shows the impacts climate change and the San Joaquin River Restoration Program (SJRRP) have on water deliveries through the FKC. The analysis evaluated five different scenarios incorporating climate change and SJRRP implementation. The results indicate that relative to baseline conditions, the central tendency of water deliveries from the Friant system to the Kaweah Subbasin would decrease by 8.5% to 154.4 TAF under 2030 conditions and by 16.8% to 140.4 TAF under 2070 conditions. The two extreme climate conditions for 2070 would results in a 37.9% decrease to 104.7 TAF for the Drier/Extreme Warming Conditions and a 10.4% increase to 186.3 TAF for the Wetter/Moderate Warming Conditions, respectively. These projections suggest that the Subbasin needs to prepare for decreasing water deliveries from Friant in the 'Near-Future' and most scenarios in the 'Far-Future.'

2.5.4.2 Impacts of Climate Change Projections on Water Balance

Overall, total surface water supply in Kaweah Subbasin is projected to decrease from 672 TAF during baseline conditions to 625 TAF in 2030 and 603 TAF by 2070. Conversely, total water demand is projected to increase from 1,073 TAF under baseline conditions to 1,105 TAF in 2030 conditions and 1,155 TAF under 2070 conditions. The combined effect of these changes is that total water deficit in the Subbasin will increase from 401 TAF under baseline conditions to 480 TAF in 2030 conditions and 552 TAF by 2070 unless measures are implemented to increase supply and/or reduce demand.

2.5.4.3 Future Demand Estimates

Using the historical and current water budget, the total water demands within the Subbasin were estimated for the future demand period extending 50 years into the future through 2070. To predict total demand for this period, two components of demand were considered: extractions from the groundwater reservoir and agricultural and M&I pumping.

2.5.4.3.1 Future Agricultural Demand

In the base period, irrigated agriculture water demand averaged 1,055,700 AFY and was provided through a combination of surface water and groundwater for a wide variety of crops including almonds, alfalfa, citrus, cotton, grapes, olives, truck crops, walnuts, wheat and several others (Davids Engineering, 2018). Crop evapotranspiration (ET) was derived for each of these crops for each year during the recent period of 1999 to 2017, using trends in water use for each crop. During the period, total water demand related to almond farming increased by 14%, while total water demand to satisfy miscellaneous field crops has declined by 18%. Considering the trends for a total of 16 crop categories on a net basis, the average change in crop water ET demand has remained relatively unchanged after a modest increase each year from 1999 and 2017.

Crop water demand was 1,046,900 acre-feet in 2017 for the Subbasin. Future projection of crop demand to 2030 and 2070 indicates that agricultural demand will increase to 1,138,200 acre-feet in 2030 and 1,239,500 acre-feet in 2070, including projected climate change affects.

2.5.4.3.2 Future M&I and Other Demands

To estimate future M&I demands, which includes dairies, small water systems, rural domestic systems, golf courses, and nursery farms in addition to the main urban centers, 2015 Urban Water Management Plans for the Cities of Visalia (Cal Water, 2016) and the Tulare (City of Tulare, 2015) and California Department of Finance population projections (California Department of Finance, 2017) were utilized.

M&I and other demands in the Kaweah Subbasin were 76,400 acre-feet per year in 2015, which was primarily supplied through groundwater pumping. M&I and other demand is projected to increase to 126,421 AFY by 2030 and 186,455 AFY in 2070.

During the projected future period, water supply availability is projected to decrease approximately 10% in response to climate change and SJRRP implementation. During this same period demand for agricultural, M&I, and other demands is anticipated to increase approximately 26%. This gap will be filled through sustainable groundwater use. This sustainable yield will be established based on a set of measurable objectives evaluating the five present sustainability indicators throughout the Subbasin. Groundwater modeling will be used to estimate the sustainable yield through the use of initial thresholds and objectives.

2.6 Identification of Data Gaps

Legal Requirements:
§354.38(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.

Identification of data gaps will continue to be a work in progress. The principal data gaps are listed below, which are subject to revision during the course of completion of this GSP. The EKGSA is intending to fill these gaps during the next five years.

- Geological/hydrogeological information for all areas of the EKGSA.
    - The SkyTEM effort should assist in filling this data gap
    - New and/or better well logging for monitoring and production wells can also be informative in locations with little or no data
- Well construction information such as: depth of well, perforation intervals, casing diameter, and use
    - Strongly encourage the Kaweah Subbasin GSAs and Tulare County initiate a well canvas of the area to develop a better data set
    - Potential Drinking Well Observation Plan can assist with gathering well data for specific drinking water wells in the region
- Spatial extent and density of monitoring network
    - Improve water level monitoring in gap areas by construction of new wells
    - Improve water quality monitoring through increased monitoring
- Stream flow monitoring on Cottonwood, Yokohl, Lewis, and Frazier Creeks
    - Gauges are proposed to be constructed, especially for the creeks potentially to be used for recharge activities
    - Specific watershed studies for these creek watersheds can be performed to better inform the estimations of creek flows and seepage
- Consistent subsidence monitoring
    - Likely remedied with more consistent InSAR data
    - Specific infrastructure to be surveyed for subsidence impacts
- Presence of Interconnected Surface Water/GDE
    - Likely linked with the added stream flow monitoring
    - More consistent groundwater level monitoring in the intermontane valleys
    - Likely to perform more studies and field verification by qualified professionals
- Water Budget Components
    - Further development of subsurface inflows and outflows from the mountain front and neighboring subbasins
    - Improved understanding of surface water deliveries within district boundaries
    - Retention/Recharge basin data collection and tracking as more recharge is developed
    - Improved understanding of irrigation demand and method for crop and soil types within the Subbasin and EKGSA
    - Improved tracking of M&I demands

3 Sustainable Management Criteria

Legal Requirements:
§354.22 This Subarticle describes criteria by which an Agency defines conditions in its Plan that constitute sustainable groundwater management for the basin, including the process by which the Agency shall characterize undesirable results, and establish minimum thresholds and measurable objectives for each applicable sustainability indicator.

Sustainable groundwater management is defined by SGMA as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results. Thus, the avoidance of undesirable results, defined later in this chapter, is vital to the success of this GSP. The purpose of this chapter is to define various Sustainable Management Criteria (SMC) by setting a sustainability goal, defining and quantifying undesirable results, and by setting minimum thresholds and measurable objectives. A thorough understanding of the historical and current state of the basin is necessary to properly define SMCs, therefore, development of the criteria is dependent on basin information developed and presented in the hydrogeologic conceptual model, groundwater conditions, and water budget sections of the EKGSA GSP (**Chapter 2**).

3.1 Sustainability Goal

Legal Requirements:
§354.24 Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.

SGMA requires GSAs to establish, within their GSP, a sustainability goal applicable for the entire basin that culminates in the absence of undesirable results within 20 years. The Sustainability Goal and basis for SMC were coordinated across the Kaweah GSAs and included in Appendix 6 of the Coordination Agreement (attached hereto and incorporated in **Appendix 1-A**).
Consistent with the Coordination Agreement (**Appendix 1-A**), the broadly stated sustainability goal for the Kaweah Subbasin is for each GSA to manage groundwater resources to preserve the viability of existing agricultural enterprises of the region, domestic wells, and the smaller communities that provide much of their job base in the Subbasin, including the school districts serving these communities. The goal will also strive to fulfill the water needs of existing and amended county and city general plans that commit to continued economic and population growth within Tulare County and within portions of Kings County.

This goal statement complies with §354.24 of the Regulations. This Goal will be achieved by:

- The implementation of the EKGSA, GKGSA and MKGSA GSPs, each designed to identify phased implementation of measures (projects and management actions) targeted to ensure that the Kaweah Subbasin is managed to avoid undesirable results and achieve measurable objectives by 2040 or as may be otherwise extended by DWR.
- Collaboration with other agencies and entities to arrest chronic groundwater-level and groundwater storage declines, reduce or minimize land subsidence where significant and unreasonable, decelerate ongoing water quality degradation where feasible, and protect the local beneficial uses and users.

- Assessments at each interim milestone of implemented projects and management actions and their achievements towards avoiding undesirable results as defined herein.
- Continuance of projects and management actions implementation by the three GSAs as appropriate through the planning and implementation horizon to maintain this sustainability goal.

In order to achieve the goals outlined in the EKGSA's GSP, a combination of projects and management actions will be implemented over the course of the next 20 years. There is currently estimated 28,000 AF/year of overdraft associated with the EKGSA. Understanding that projects take time and funding to construct, interim goals for 5, 10, and 15 years were set to create a glide path for reaching the sustainability goal by 2040. This "glide path" will mitigate groundwater level depletion by 5, 25, and 55 percent respectively. As much of the overdraft as possible will be mitigated by projects to improve water supply, overdraft not eliminated through these projects will be addressed via management actions. All planned projects and management actions are discussed in more detail in the Projects and Management Actions Chapter (**Chapter 5**), including a general timeline for project implementation.

The key to demonstrating that the Kaweah Subbasin is meeting its sustainability goal is by avoiding undesirable results. Further discussed in the next section, significant and unreasonable groundwater level depletion is the obvious cause of chronic lowering of groundwater levels. Within the EKGSA, significant correlation has also been developed between the lowering of groundwater levels and the undesirable results of significant and unreasonable surface water depletion and reduction of aquifer storage. Given the strong correlation between groundwater levels and the required sustainability indicators, eliminating long-term overdraft is the main method for achieving the Kaweah Subbasin's sustainability goal. Minimum thresholds, quantifiable values that represents the groundwater conditions at a representative monitoring site, were determined based on measured data from within the Agency's boundaries and will be discussed later in this chapter.

3.2 Sustainability Indicators

3.2.1 Sustainability Indicators Present in the Basin

Sustainability indicators are the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, become undesirable results. Within the Kaweah Subbasin, five sustainability indicators are present in the basin:

1. *Chronic lowering of groundwater levels resulting in a significant and unreasonable depletion of supply.*
2. *Significant and unreasonable reduction of groundwater storage.*
3. *Significant and unreasonable degraded water quality.*
4. *Significant and unreasonable land subsidence.*
5. *Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of surface water.*

For each of the five sustainability indicators applicable to the EKGSA, representative undesirable results, minimum thresholds, and measurable objectives are presented in later sections of this chapter.

3.2.2 Sustainability Indicators Not Present in the Basin

Legal Requirements:
§354.26 (d) An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.

Seawater intrusion can play an important role in groundwater quality for areas near the coast. However, the Kaweah Subbasin is located over 100 miles from the California Central Coast and no historical data to date has demonstrated any seawater intrusion impacts.

3.3 Management Areas

Legal Requirements:
§354.20. Management Areas
(a) Each Agency may define one or more management areas within a basin if the Agency has determined that creation of management areas will facilitate implementation of the Plan. Management areas may define different minimum thresholds and be operated to different measurable objectives than the basin at large, provided that undesirable results are defined consistently throughout the basin. (b) A basin that includes one or more management areas shall describe the following in the Plan: (1) The reason for the creation of each management area. (2) The minimum thresholds and measurable objectives established for each management area, and an explanation of the rationale for selecting those values, if different from the basin at large. (3) The level of monitoring and analysis appropriate for each management area. (4) An explanation of how the management area can operate under different minimum thresholds and measurable objectives without causing undesirable results outside the management area, if applicable. 19 (c) If a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information required by this Subarticle sufficient to describe conditions in those areas. Note: Authority cited: Section 10733.2, Water Code. Reference: Sections 10733.2 and 10733.4, Water Code.

3.3.1 Management Areas Rationale

To facilitate implementation of this GSP, it was necessary to look at both the political boundaries already in place and the natural hydrogeologic patterns present in the Subbasin and the EKGSA in particular. Historical boundaries of the member irrigation districts were used to separate the EKGSA into management areas. The district boundaries formed a helpful foundation for GSP implementation due to their status as longstanding public agencies in the community, their near-daily interaction with a majority of the heavily impacted EKGSA denizens, involvement with the GSP development process, ability to leverage surface water imports, and their critical role in future partnerships within the EKGSA on projects and management actions to achieve sustainability by 2040. The larger "urban" areas (City of Lindsay and Strathmore PUD) were grouped into nearby irrigation districts (Lindmore and Lindsay-Strathmore, respectively). The large non-districted areas in the primary intercardinal directions of the EKGSA made logical targets to also form their own management areas. These "non-districted area" management areas are within no other jurisdictional boundary other than Tulare County. These non-district areas will likely have oversight by both Tulare County and the EKGSA. This effectively divided the EKGSA into nine management areas. It is believed that forming these management areas based on existing jurisdictional boundaries will allow for effective implementation of EKGSA projects and management actions by leaning upon the existing governance structure of the irrigation districts. In addition, delineation based upon irrigation district service areas simplifies the water budget accounting for each management area as imported surface water supplies are allocated to the irrigation district responsible for its importation. For more information on imported surface water and its impacts on the water balance of the EKGSA, see **Chapter 2**. The management area boundaries are not intended to be restrictive of landowner's ability to transfer groundwater, should an allocation and transfer market be established, as groundwater is an overlying landowner right and not the management area.

3.3.1.1 Threshold Regions

The EKGSA recognizes that groundwater behavior is unlikely to mirror the pre-conceived political boundaries of irrigation districts. Therefore, to adequately account for differences in hydrogeologic behavior and pumping rates while forming minimum thresholds and measurable objectives, the EKGSA was further subdivided into threshold regions. The threshold regions were intended to group water supply wells that would experience similar impacts by accounting for management areas, groundwater elevations, base of aquifer, aquifer type, beneficial use type, land use, and similar completed well depths.

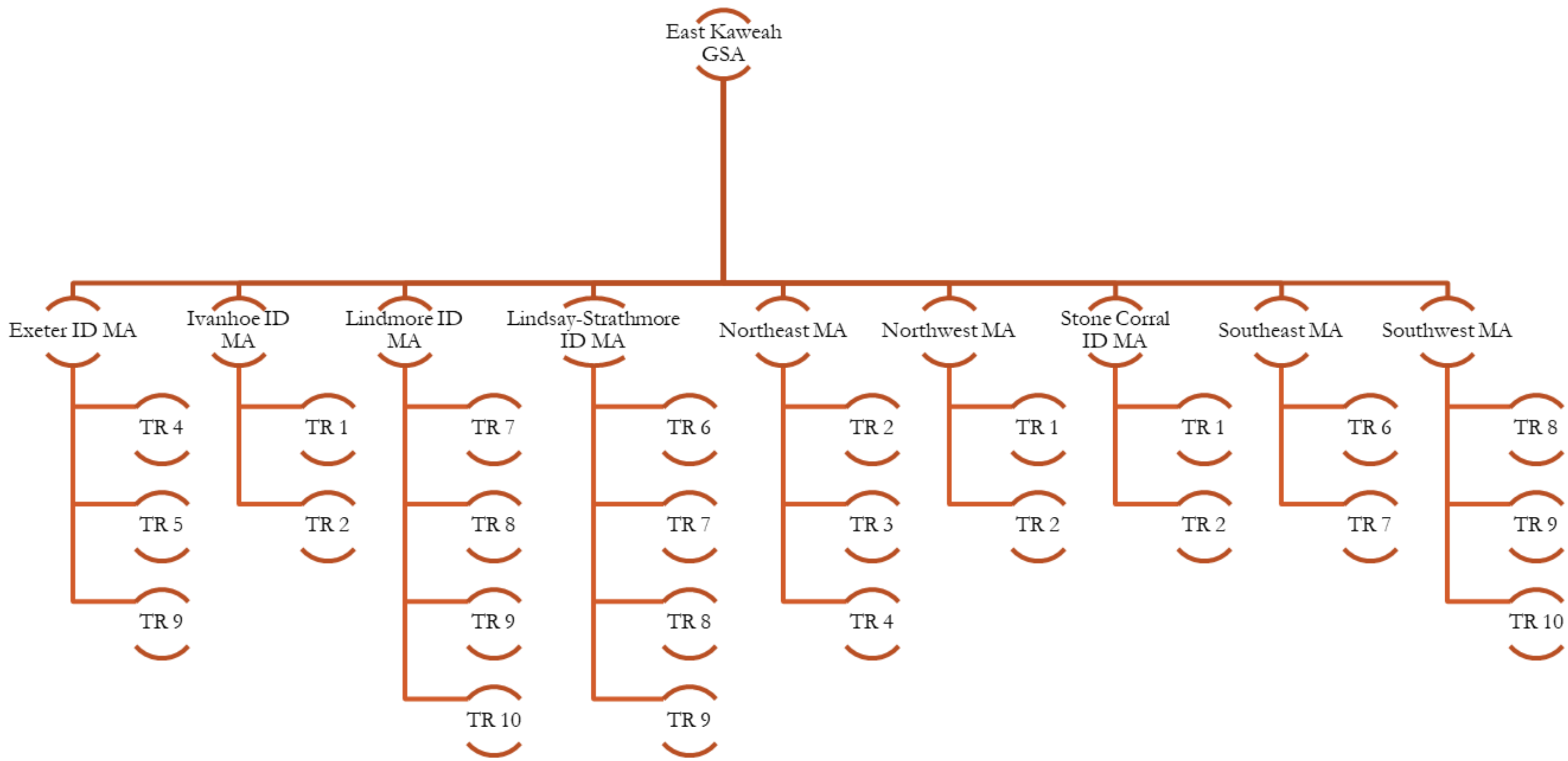
The analysis of well construction data from the Water Data Library (WDL) and local irrigation districts, was critical to the development of threshold regions. The raw well construction information dataset was filtered to include more recent well drilling, to increase the likelihood that the well would still be in use. In addition, only wells classified as agricultural, domestic, and/or public wells were included in the dataset. Using this methodology, construction details for each well were available, making it possible to better estimate at what water surface elevation a well may potentially go dry, and how much water would remain in the well at any particular depth. It allowed for analyses not only of what percentage of wells would be dry in total, but also what percentage of each type (i.e. agricultural, domestic, or public) of well would be dry within each region.

Threshold regions are composed of smaller geographic Township/Range/Section (TRS) units. TRS units are grouped based on Well Construction Reports (WCR) information. Publicly available well construction information is notoriously difficult to match to its corresponding well, and WCRs do not always contain accurate information regarding the coordinates of the well drilled or any information about the well's identifying codes. The database of all WCR information from which the well construction information used to prepare this GSP was derived can only place a well accurately within its TRS. Therefore, TRS became the highest resolution available to the output dataset and sections were grouped together if the historic rate of decline trend analysis matched other trend analysis results in that threshold region. For example, the sections where the 2040 well trend analysis had landed in the 301-400 ft ASL range were all grouped together to form one threshold region.

Finally, threshold regions were subdivided to account for which side of the Kaweah River the sections fell on, either to the north or south of the River. For example, Threshold Regions 1 & 9 both fall in the 101-200 ft ASL range. Region 1 is north of the Kaweah River while Region 9 is to the south, and so they were divided into their own regions. Region 4 - River is an exception to this rule, as it was specifically designed to capture the conditions in the upper part of the Kaweah alluvial fan. Initial threshold regions were further subdivided into their geomorphic province. This was done on the premise that groundwater in the alluvial fan, where there is ready influence from the Kaweah River, would behave differently than the groundwater in the interfan areas. This led to the differentiation between Regions 5 & 9 despite the regions being south of the Kaweah River and touching one another.

Incorporating the geographic location of threshold regions across the jurisdictional boundaries of the management areas allows for a comprehensive geologic and political lens to view minimum threshold and measurable objective tracking. In total, each overlying management area contains two to four threshold regions, **Figure 3-1** and **Figure 3-2** demonstrate which threshold regions fall within each management area.

Figure 3-1 Organization Chart of EKGSA Management Areas and Overlapping Threshold Regions



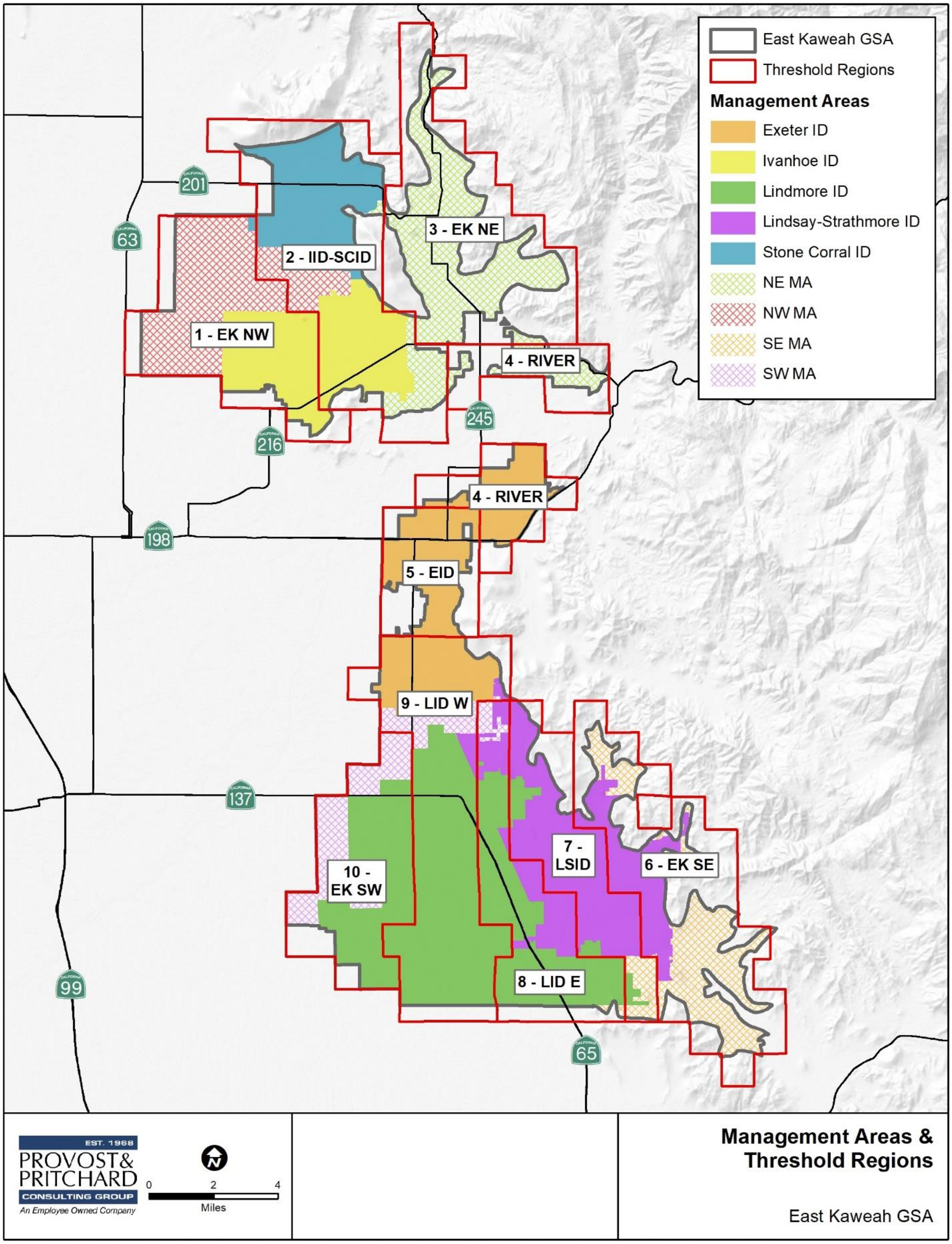


Figure 3-2 Map of EKGSA Management Areas and Overlapping Threshold Regions

3.3.2 Management Area Descriptions

3.3.2.1 Exeter ID Management Area

The Exeter ID Management Area primarily covers the existing area of the Exeter ID. The EKGSA will work closely with Exeter ID to implement projects and management actions within the District's jurisdiction. Formed in 1937, the district was formed to act as a civil and agricultural leader in the community that has the authorized and legal organization in place to consider the water needs of the Exeter area. Exeter ID also has the ability to negotiate and enter into contracts with the federal government for surface water supplies from the Central Valley Project (CVP). The District provides surface water to agricultural operations only. The District does not currently, nor has it historically, supplied water for municipal or industrial purposes. In addition to the agricultural land holdings, the communities of Lindcove, Yokohl, Rocky Hill, and Tooleville are located within the management area's boundary. These communities do not receive surface water deliveries from Exeter ID, but instead benefit from the in-lieu recharge provided by Exeter ID to agricultural acreage in close proximity to their communities.

Exeter ID Management Area is located within the Yokohl Creek portion of the Kaweah River Alluvial Fan and contains a mixture of older and younger alluvium soils (**Figure 3-3** and **Figure 3-4**). Surface water bodies of significance within the management area include two miles of the ephemeral Yokohl Creek in the northern portion and approximately eight miles of the Friant-Kern Canal (FKC). At this time, no significant groundwater dependent ecosystems have been identified along the ephemeral Yokohl Creek (**Figure 3-9**) in this management area. The Exeter ID Management Area's overlying land area encompasses hydrogeologic threshold regions four, five, and nine. Threshold region four primarily consists of wells whose water surface elevation (WSE) minimum threshold (MT) fall within the 301-400 feet WSE range. Per the same analysis, threshold region five's wells have MT within the 201-300 feet WSE range. Wells located within threshold region nine have MT that fall within the 101-200 feet WSE.

3.3.2.2 Ivanhoe ID Management Area

The Ivanhoe ID Management Area primarily corresponds with the existing service area of the Ivanhoe ID. The EKGSA will work closely with Ivanhoe ID to implement projects and management actions within the District's jurisdiction. Ivanhoe ID holds surface water rights to the Kaweah River and contracts with the federal government for CVP surface water supplies from the FKC.

The Ivanhoe ID Management Area is generally located between the St. Johns River to the south and Cottonwood Creek to the north. Approximately 90% of the District is situated on an old alluvial plain characterized by gently rolling terrain and strongly developed soils (**Figure 3-3** and **Figure 3-4**). The remainder of the District consists of small areas of foothill lands, recent stream deposits adjoining Cottonwood Creek, and adobe clay soils on the smooth valley plain near the foothills. At this time, no significant groundwater dependent ecosystems have been identified within the Ivanhoe ID Management Area (**Figure 3-9**). The Ivanhoe ID Management Area's overlying land area encompasses the hydrogeologic threshold regions one and two. Threshold region one consists of wells whose MTs fall within the 101-200 feet WSE range and threshold region two consists of wells whose MTs fall within the 201-300 feet WSE range.

3.3.2.3 Lindmore ID Management Area

The Lindmore ID Management Area primarily corresponds with the existing service area of the Lindmore ID, but also includes the City of Lindsay. The EKGSA will work closely with Lindmore ID and the City of Lindsay to implement projects and management actions within the management area. Lindmore ID organized for the purpose of securing a supplemental water supply from the Friant Division CVP in response to rapid expansion in the amount of irrigated agriculture. The City of Lindsay is also a Contractor for CVP supplies to meet its municipal demand. The City of Lindsay was included with Lindmore ID due to their proximity and location of some City wells being within the Lindmore ID boundary. The community of Plainview is also within this management area as it is located within the Lindmore ID boundary. Plainview does not receive surface water but will benefit from surface water deliveries within Lindmore ID maintaining groundwater levels.

The Lindmore ID Management Area lies at the base of the western foothills of the Sierra Nevada and extends from two miles north of Lindsay, southward to roughly 1 ½ miles south of Strathmore, a total distance of about nine miles. Running from east to west, the district is approximately 10 miles wide. Composed primarily of low alluvial plains and fans, this management area contains a mixture of both older and young alluvium soils (**Figure 3-3** and **Figure 3-4**). At this time, no significant groundwater dependent ecosystems have been identified within the Lindmore ID Management Area (**Figure 3-9**). Lindmore ID Management Area spans threshold regions seven, eight, nine, and ten. Threshold region seven primarily consists of wells whose MTs fall in the 301-400 feet WSE range. Wells located within threshold region eight, nine, and ten have MTs that fall in the 201-300 feet, 101-200 feet, and 1-100 feet WSE ranges, respectively.

3.3.2.4 Lindsay-Strathmore ID Management Area

The Lindsay-Strathmore ID Management Area covers the existing service area of the Lindsay-Strathmore ID and includes the communities of Strathmore and Tonyville. The EKGSA will work closely with Lindsay-Strathmore ID to implement projects and management actions within the management area. The District receives surface water supplies via the CVP and Kaweah River water through stock in the Wutchumna Water Company. The community of Strathmore, through Strathmore Public Utility District (PUD), also receives water through the CVP for its municipal demand. Strathmore and Tonyville were included with Lindsay-Strathmore ID due to connections each have with Lindsay-Strathmore ID where it be sharing a turnout on the FKC or Lindsay-Strathmore ID supplying water to the community.

The Lindsay-Strathmore ID Management Area overlays a combination of dissected upland, low alluvial plains, and Sierra Nevada geomorphology, and, depending on the location in the management area, geologic units vary between continental deposits, older alluvium, younger alluvium, and metamorphic rocks (**Figure 3-3** and **Figure 3-4**). Natural vegetation and wetlands along portions of Lewis Creek in threshold regions six and seven have the potential to be identified as groundwater dependent ecosystems (**Figure 3-9**). However, the elevated groundwater surface along portions of Lewis Creek are likely due to a perched surface that is more dependent on the surface and subsurface flows from the Sierra Nevada and independent of the pumping activities in the remainder of the aquifer. More information on this portion are to be gained through the Interconnected Surface Water Data Gap Work Plan (**Section 5.3.7**).

Threshold regions six, seven, eight, and nine fall within the boundaries of the Lindsay-Strathmore ID management area. Wells in threshold region six have MTs in the 401-500 feet range. Threshold region seven wells have MTs in the 301-400 feet WSE range and threshold region eight wells have MTs in the 201-300 feet WSE range.

3.3.2.5 Northeast Management Area

The Northeast Management Area is composed primarily of non-districted areas located in the northeastern portion of the EKGSA. For the most part, this area does not receive surface water supply and relies primarily on groundwater pumping for any water needs. The Wutchumna Water Company and Sentinel Butte Mutual Water Company have service areas within this management area and deliver Kaweah River surface supplies to company stockholders. No irrigation district has oversight of the Northeast Management Area; therefore, the EKGSA in conjunction with Tulare County will likely provide oversight of this management area.

The Northeast Management Area is predominately located in the Cottonwood Creek Interfan area of the EKGSA but has highly diverse geologic units consisting of continental deposits, older and younger alluvium, diorite and granodiorite, gabbro, and metamorphic rocks (**Figure 3-3** and **Figure 3-4**). Potential groundwater dependent ecosystems exist along the Kaweah River in this management area (**Figure 3-9**).

The Northeast Management Area is primarily comprised of threshold region three but has some areas extending into threshold region two. Threshold region three wells have MTs in the 301-400 feet WSE range, while threshold region two wells have MTs in the 201-300 feet WSE range.

3.3.2.6 Northwest Management Area

Similar to the Northeast Management Area, the Northwest Management Area is composed primarily of non-districted areas. Located in the Cottonwood Creek Interfan Area, the Northwest Management Area is composed primarily of older alluvium deposits, with some young alluvium deposits in the northern region of the management area (**Figure 3-3** and **Figure 3-4**). No natural vegetation and wetlands have been identified as groundwater dependent ecosystems within the management area (**Figure 3-9**). The Management Area encompasses threshold regions one and two. Threshold region one wells have MTs in the 101-200 feet WSE range and threshold region two wells have MTs in the 201-300 feet WSE range.

3.3.2.7 Stone Corral ID Management Area

The Stone Corral ID Management Area makes up the vast majority of the Stone Corral ID. The EKGSA will work closely with Stone Corral ID to implement projects and management actions within the management area. The District organized for the purpose of contracting for CVP surface supplies and for the construction of a distribution systems by the federal government. Stone Corral ID services agricultural demand and does not provide any municipal water deliveries.

The Stone Corral ID Management Area is situated on the ridge between the Kaweah and Kings River alluvial fans with dissected uplands dominating the geomorphology in the northeastern section of the management area. The area's geologic units range from continental deposits, to older and younger alluvium (**Figure 3-3** and **Figure 3-4**). At this time, no groundwater dependent ecosystems have been identified within the Stone Corral ID Management Area (**Figure 3-9**). The Stone Corral ID Management Area is almost entirely within threshold regions two, with a very small portion extending into threshold region one. Threshold region two wells have MTs within the 201-300 feet WSE range.

3.3.2.8 Southeast Management Area

The Southeast Management area is composed primarily of non-districted areas in the southeastern portion of the EKGSA. Consisting of the southeast border areas of the EKGSA, the management area encompasses portions of the Sierra Nevada, dissected uplands, and low alluvial plains. The geologic units in the management area consists of continental deposits, older and younger alluvium, diorite and granodiorite, gabbro, and metamorphic rocks (**Figure 3-3** and **Figure 3-4**). The Southeast Management Area contains significant potential for groundwater dependent ecosystems along Lewis and Frazier Creeks (**Figure 3-9**). However, these primarily occur higher in the foothills prior to influence of pumping. The Southeast Management Area contains threshold regions six and seven. Threshold region six wells have MTs within the 401-500 feet range. Threshold region seven towels have MTs within the 301-400 feet WSE range.

3.3.2.9 Southwest Management Area

The Southwest Management Area includes non-districted areas west of Lindmore ID and includes the Lewis Creek Water District located between Lindmore and Exeter IDs. Lying on the Lewis Creek Interfan Area, the management area is mostly composed of older and younger alluvium deposits (**Figure 3-3** and **Figure 3-4**). No groundwater dependent ecosystems have been identified in this management area (**Figure 3-9**). The Southwest Management Area encompasses threshold regions eight, nine, and ten, which contain wells whose MTs fall within the 201-300 feet, 101-200 feet, and 1-100 feet WSE ranges, respectively.

3.3.3 Monitoring and Analysis

> The level of monitoring and analysis appropriate for each management area. (4) An explanation of how the management area can operate under different minimum thresholds and measurable objectives without causing undesirable results outside the management area, if applicable. 19 (c) If a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information required by this Subarticle sufficient to describe conditions in those areas. Note: Authority cited: Section 10733.2, Water Code. Reference: Sections 10733.2 and 10733.4, Water Code.

As discussed previously, management areas were designed based upon historical political boundaries. To fairly assess the level of monitoring and analysis required for each management area, the EKGSA was further broken into threshold regions. As described in **Section 3.3.1**, the threshold regions were determined by grouping wells that would experience similar impacts by accounting for GSP management areas, groundwater elevations, base of aquifer, aquifer type, beneficial user type, land use, and similar completed well depths. Specifically, MTs and measurable objectives (MO) were set in a holistic manner that evaluated the potential impacts of each region's MTs on the whole basin's beneficial uses and users. By determining MTs based upon groundwater level's direct impacts to beneficial users and uses, the EKGSA captures the intricate relationships between threshold regions while setting minimum thresholds and measurable objectives.

Each threshold region will conduct a baseline amount of monitoring and analysis as set forth in the Monitoring Network Chapter (**Chapter 4**). If, based upon collected data, there is determined to be a need for different and/or additional monitoring and analysis for a sustainability indicator in a specific threshold region, that will be communicated in the required annual or five-year updates to this GSP.

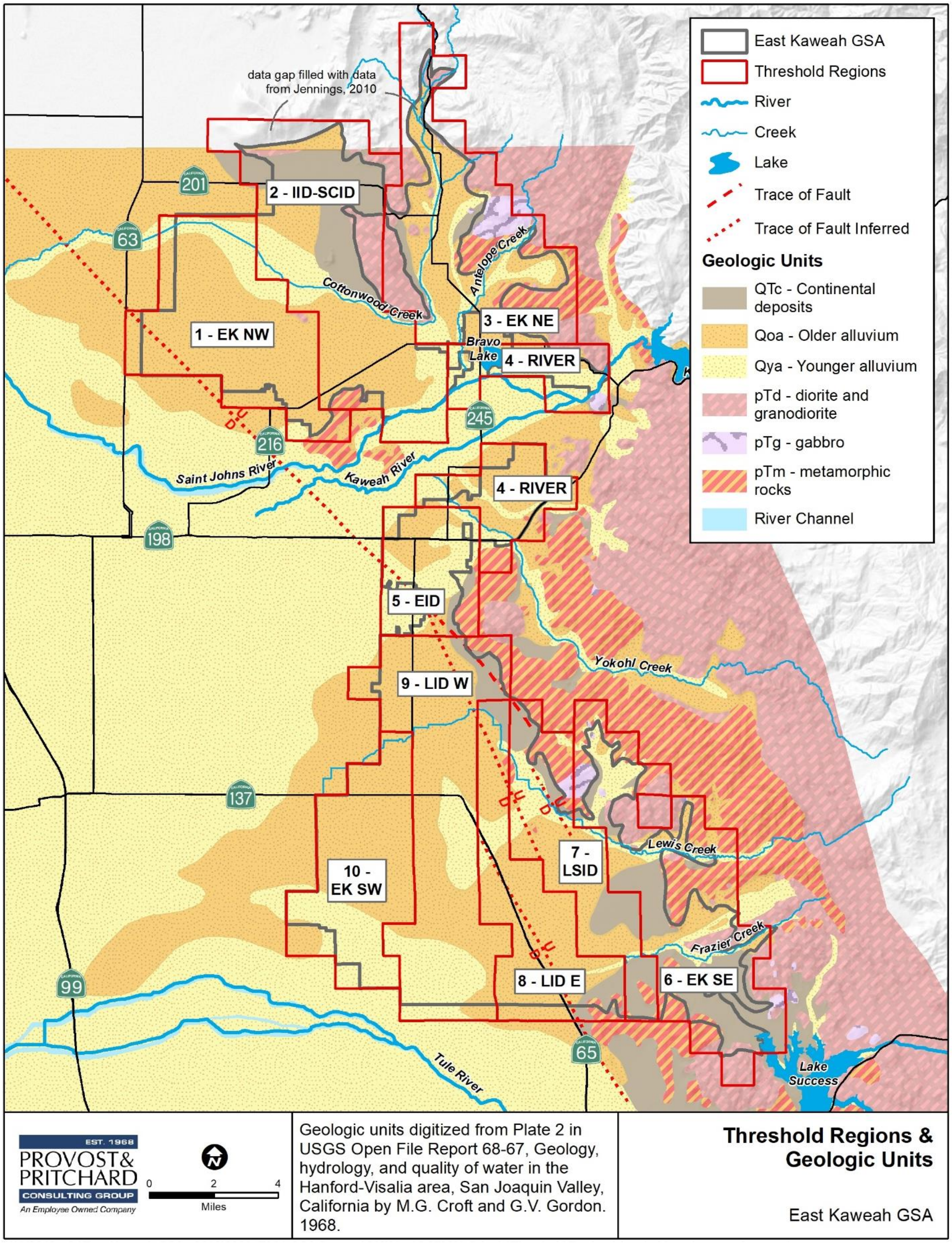


Figure 3-3 EKGSA Threshold Regions and Geologic Units

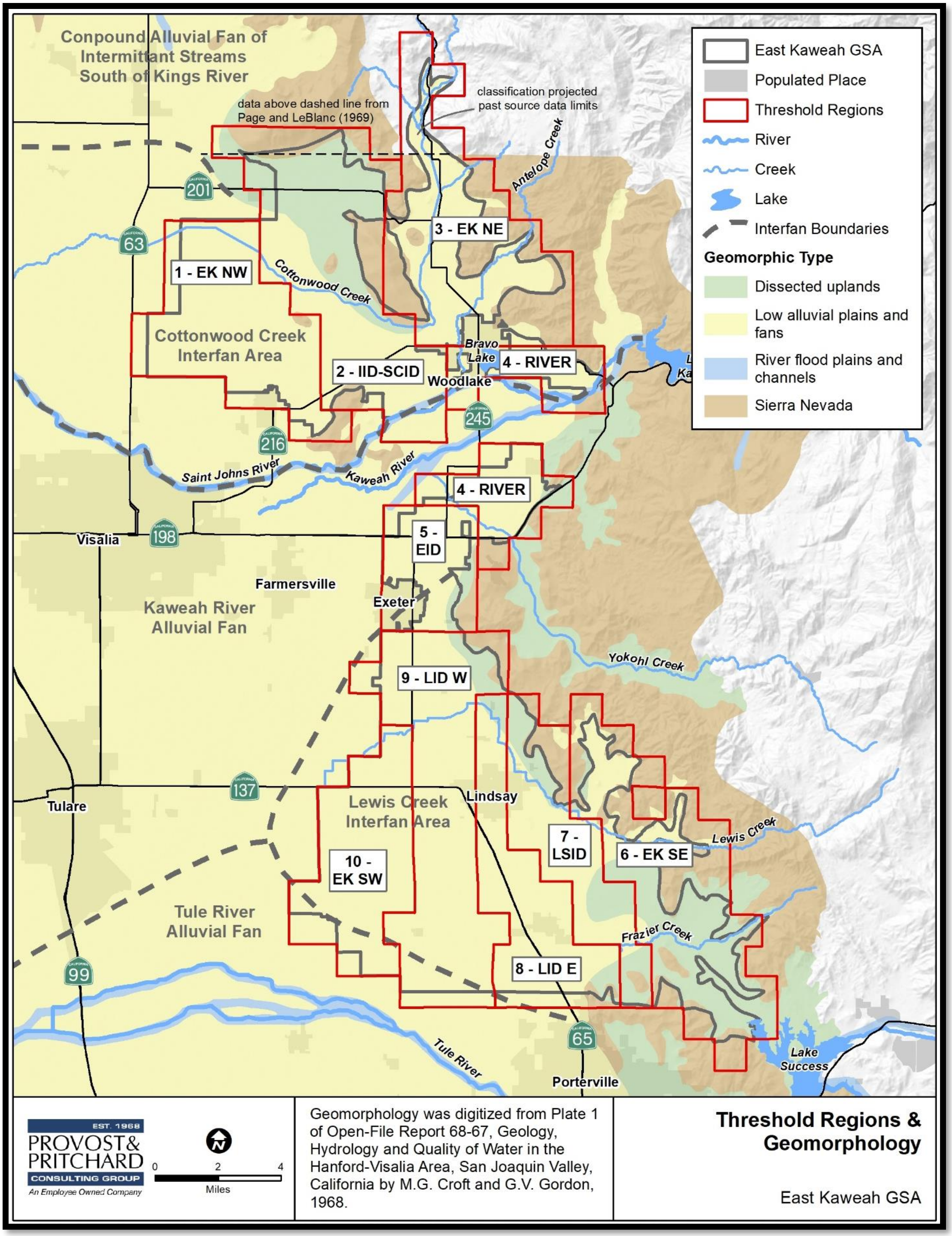


Figure 3-4 EKGSA Threshold Regions and Geomorphology

3.4 Undesirable Results, Minimum Thresholds, and Measurable Objectives by Sustainability Indicator

Legal Requirements:
§354.26 (a) Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.

This Section provides location-specific sustainable management criteria (SMC) for five of the six sustainability indicators, including establishing undesirable results (URs), MTs, and MOs with integrated interim milestones. This section builds from the Kaweah Subbasin's sustainability goal described in **Section 3.1** and is consistent with Appendix 6 of the Coordination Agreement (**Appendix 1-A**).

The goal of SGMA is to achieve sustainable management of groundwater basins. To meet this goal, the EKGSA has set undesirable results, minimum thresholds, and measurable objectives to provide quantitative support of the EKGSA's ability to reach sustainability by 2040. Demonstration of the absence of undesirable results supports a determination that the Subbasin is operating within its sustainable yield and, thus, that the sustainability goal has been achieved. However, the occurrence of one of more undesirable results within the initial 20-year implementation period does not by itself, indicate that the Subbasin is not being managed sustainably.

The EKGSA carefully considered and determined the conditions at which each of the five applicable sustainability indicators become significant and unreasonable. Undesirable results are considered to occur when any of the five sustainability indicators present in the Subbasin have exceeded minimum thresholds by a significant and unreasonable manner. All undesirable result descriptions presented in this chapter are consistent with those presented within the Kaweah Subbasin Coordination Agreement (**Appendix 1-A**). Further sections of this chapter enumerate the data and rationale used as justification for determining "significant and unreasonable" undesirable result conditions for each specific sustainability indicator and provide the following rationales, as required by §354.26:

- Investigation of the cause of groundwater conditions that will lead, or has led, to undesirable results impacting beneficial uses and users in the subbasin;
- Criteria used to define when and where the effects of groundwater conditions cause undesirable results;
- Quantification of undesirable results via localized minimum threshold exceedances; and,
- Description of the potential effects of the undesirable result on beneficial uses or users.

In general, undesirable results for each sustainability indicator were determined using a lengthy, data informed, Subbasin-wide coordinated, and stakeholder-inclusive progress. Specifically, the EKGSA Technical Advisory Committee (TAC), Subbasin working group, and Board of Directors (Board) carefully considered when the five sustainability indicators applicable to the EKGSA would reach levels that were "significant and unreasonable" based upon the quantitative data presented in the Basin Setting and Water Budget (**Chapter 2**) and additional investigative analysis on impacts to beneficial users and uses . The Board, in combination with stakeholder input and TAC expert advice, ultimately determined undesirable results based upon the relative levels that would have a significant and unreasonable negative impact not only impact communities with the Kaweah Subbasin, historical and biological quality of life, but would also severely threaten regional agricultural economy and impact the world's food chain supply.

In addition to the qualitative description for each undesirable result, each undesirable result must also be substantiated using a quantitative minimum threshold. A minimum threshold is a quantitative value that represents the groundwater conditions at a representative monitoring site that, when exceeded individually or in combination with minimum thresholds at other monitoring sites, may cause an undesirable result(s) in the basin. When setting the minimum threshold for each sustainability indicator, the relevant beneficial uses and users of groundwater were considered. In addition, EKGSA minimum thresholds were set at levels that do not impede adjacent GSAs or subbasins from meeting their minimum thresholds or sustainability goals.

Based upon the hydrogeologic and institutional boundaries present, the EKGSA developed unique MTs for each of the sustainability indicators for each of the threshold regions as described in the previous sections. In total, the EKGSA consists of nine management areas, further sub-divided into ten threshold regions that exhibit unique hydrogeologic behavior (**Figure 3-2**).

For each minimum threshold, the following components will be presented in each indicators' relevant section:

(1) *The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the Basin Setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the Basin Setting.*
(2) *The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the EKGSA has determined that conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.*
(3) *How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.*
(4) *How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.*
(5) *How state, federal, or local standards relate to the relevant sustainability indicator. If a minimum threshold differs from other regulatory standards, the EKGSA will explain the nature and basis for the difference.*
(6) *How each minimum threshold will be quantitatively measured, consistent with monitoring network requirements.*
(7) *In all management zones within the EKGSA, there is a significant correlation between groundwater levels and aquifer storage. The EKGSA proposes to utilize groundwater levels as a proxy metric for aquifer storage. For land subsidence, the EKGSA will use a rate of land subsidence related to critical infrastructure (Friant-Kern Canal). Interconnected surface water will be evaluated using a rate of surface water depletion in interconnected channels. The EKGSA will use constituents of concern concentration measurements as the quantitative metric to determine minimum threshold exceedances for water quality.*
(8) *Each of the sustainability indicators must be monitored to watch for minimum threshold exceedances. However, based on the strong relationship between groundwater levels and changes in aquifer storage, land subsidence, and, and potentially, depletions of interconnected surface water, whichever indicator is the most sensitive to groundwater level reduction will be the limiting minimum threshold in that threshold region. Given the specific hydrogeology of the EKGSA and limited data for interconnected surface water depletions, groundwater levels have been determined at this time to be the most sensitive to possible minimum threshold exceedances and therefore, causing undesirable results. In general, based on currently known information, groundwater level minimum thresholds are the most sensitive to exceedances and would be triggered prior to undesirable results being experienced due to surface water depletions, aquifer storage reductions, or increasing levels of land subsidence. In addition to monitoring groundwater levels, water quality, interconnected surface water depletion rates, and land subsidence minimum thresholds will be monitored separately.*

Measurable objectives are quantitative goals that reflect the desired groundwater conditions and allow the EKGSA to achieve the sustainability goal within 20 years. Measurable objectives were set so that there is a reasonable margin of operational flexibility between the minimum threshold and measurable objective that provides accommodation for droughts, climate change, conjunctive use operations, and other groundwater management activities. Interim milestones for the EKGSA implementation timeline were designed to allow the EKGSA to make progress over time toward the sustainability goal and are presented for each sustainability indicator. Consistent with the Coordination Agreement (**Appendix 1-A**), A summary of the undesirable results, minimum thresholds, measurable objective, and interim milestone for each sustainability indicator is presented in **Table 3-1**.

Table 3-1 Sustainable Management Criteria Overview for the EKGSA

Sustainability Indicator	GW Elevation	GW Storage	SW-GW Connection	GW Quality	Land Subsidence
Undesirable Result	Unreasonable lowering of groundwater levels resulting in significant impacts to supply wells	Unreasonable reduction in groundwater storage	Unreasonable depletion of interconnected surface waterways, where present	Unreasonable long-term changes of water quality concentrations from baseline conditions to significantly impact users of groundwater	Loss of the functionality of a structure or a facility to the point that, due to subsidence, the structure or facility cannot reasonably operate without either significant repair or replacement
Measurement Methodology	Groundwater Levels	Groundwater Levels (Proxy)	Surface water depletion rate	Sampling for 3 COCs at Ag wells in Monitoring Network; Utilize public system Title 22 quality monitoring	Annual survey of set Mile Posts along the FKC and InSAR data when available and Plainview well point
Minimum Threshold	The most protective groundwater level in a threshold region based on the protective level of at least the 90th percentile of all beneficial uses and users without allowing a greater rate of the historical groundwater decline experienced between 1997-2017	The most protective groundwater level in a threshold region based on the protective level of at least the 90th percentile of all beneficial uses and users without allowing a greater rate of the historical groundwater decline experienced between 1997-2017	More than 50% losses in interconnected surface waterways when water is present	No long-term (10-yr. running average) increase in concentration beyond recognized Ag or Urban standards for those wells under the threshold. For those wells over the recognized Ag or Urban standards, no long-term increases by 20% in concentration	9.5" of subsidence in a year and cumulative (relate to no more than 10% capacity reduction in current capacity of the FKC)
Measurable Objective	Spring 2017 groundwater levels	Spring 2017 groundwater levels	Equal to or less than 30% losses in interconnected surface waterways when water is present	No unreasonable increase in concentration caused by groundwater pumping and recharge efforts	No subsidence throughout the GSA
Interim Milestones	Proportionate to % of overdraft to be corrected in 5-year intervals through implementation period	Proportionate to % of overdraft to be corrected in 5-year intervals through implementation period	Proportionate to % of depletion rate to be corrected in 5-year intervals through implementation period	No change from current Objective (re-evaluate at the 5-year milestone pending data collection)	No change from current Objective

3.4.1 Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage

3.4.1.1 Undesirable Results

Legal Requirements:
§354.26 (b) The description of undesirable results shall include the following:

(1) The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.

(2) The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.

(3) Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.

Groundwater elevations shall serve as the sustainability indicator and metric for chronic lowering of groundwater levels, and by proxy, reductions in groundwater storage.

Consistent with Appendix 6 of the Coordination Agreement (**Appendix 1-A**), with respect to groundwater level declines (as well as groundwater storage by proxy), undesirable results occur when one third of the representative monitoring sites in all three GSA jurisdictions exceed their respective minimum threshold water level elevations. Should this occur, a determination shall be made of the then-current GSA water budgets and resulting indications on net reduction in storage. Similar determinations shall be made of adjacent GSA water budgets in neighboring subbasins to ascertain the causes for the occurrence of the undesirable result.

The Kaweah GSAs recognize that water levels will continue to decline until the overdraft within and surrounding the Subbasin has been corrected. It is also recognized that during this time, the water level may decline below the depth of some wells within the Subbasin. Well construction has varied over the years and wells have been constructed at varying depths, and the construction depth and perforation intervals are not known for all wells in the Subbasin at this time. Some wells, even recently constructed wells, may have been poorly constructed or constructed too shallow for long-term operation. SGMA does not require GSAs to maintain current water levels or prevent any wells from going dry. Rather, GSAs are required to stabilize and correct groundwater decline. The EKGSA does not view an individual well going dry as an undesirable result. Consistent with Appendix 6 of the Coordination Agreement, in giving due consideration to the beneficial users and uses of groundwater within the GSA, EKGSA set minimum thresholds to protect greater than the 90th percentile of all beneficial uses and users without allowing a greater rate of groundwater decline than the historical decline experienced between 1997-2017. In addition, EKGSA has committed to developing and implementing a mitigation program (**Section 5.3.8**) for wells that may be impacted prior to minimum thresholds exceedances.

3.4.1.1.1 Criteria to Define

Prior to defining any undesirable results in the Subbasin, the Subbasin GSAs reviewed the understanding of the Basin Setting, inventoried existing monitoring programs and available data, assessed beneficial users and uses, and actively engaged with interested parties. The reviewed information and stakeholder input were used by the EKGSA TAC, Subbasin working group, and EKGSA Board to determine when the conditions at which each of the sustainability indicators applicable to the EKGSA may become significant and unreasonable.

The terms "significant and unreasonable" are not defined by SGMA, and are left to GSAs to define within their GSPs. The process to define "significant and unreasonable" began with stakeholder and landowner discussions. Section 6.4.2 of Appendix 6 of the Kaweah Subbasin Coordination Agreement (**Appendix 1-A**) discusses the criteria for defining undesirable results in the Kaweah Subbasin. Consistent with the Coordination Agreement, an undesirable result would be when a significant and unreasonable subset of existing and active wells are dewatered, which is believed to occur when one-third of the Representative Monitoring Sites (RMS) reach or exceed their respective Minimum Threshold (MT) groundwater elevation.

In the view of the Kaweah Subbasin GSAs and its stakeholders, the following impacts from lowering groundwater levels are viewed as "significant and unreasonable" as they would directly impact the viability of beneficial uses/users to meet their reasonable water demands through groundwater:

- *Inability of the groundwater aquifer to recover in periods of average/above average precipitation following multi-year drought periods*
- *Dewatering of a subset of existing wells below the bottom of the well*
- *Substantial increase in costs for pumping groundwater, well development, well construction, etc. that impact the economic viability of the area*
- *Adverse effects on health and safety*
- *Interfere with other sustainability indicators*

Consistent with the Coordination Agreement (**Appendix 1-A**), the GSAs within the Kaweah Subbasin have determined that undesirable results for groundwater levels may be significant and unreasonable when there is a reduction in the long-term viability of domestic, agricultural, or municipal uses over the planning and implementation horizon of the Subbasin GSPs.

3.4.1.1.2 Causes of Groundwater Conditions that Could Lead to Undesirable Results

As described in Section 6.4.2 of Appendix 6 of the Coordination Agreement (**Appendix 1-A)**, the primary cause of groundwater conditions that would lead to chronic lowering of groundwater levels is groundwater pumping in excess of natural and artificial recharge, a transition to permanent crops and development of large dairies hardening water demand in all years, and reduction in imported supplies from Millerton Lake to be delivered outside the Kaweah Subbasin. The restriction of imported supplies due to climate and other factors.

Pumping beneath the EKGSA directly influences sustainability indicators through the lowering of groundwater levels. Pumping beneath neighboring GSAs also influences groundwater levels beneath the EKGSA. With the EKGSA being at the head of the Subbasin, groundwater will continue to flow down gradient and, in particular, towards depressions if pumping is not adequately curtailed, regardless of measures taken in the EKGSA to diminish overdraft.

3.4.1.1.3 Potential Impacts on Beneficial Uses and Users of Groundwater

Section 6.4.4 of Appendix 6 of the Kaweah Subbasin Coordination Agreement (**Appendix 1A**) discusses the potential impacts on beneficial uses and users in the Kaweah Subbasin. Potential impacts to wells associated with groundwater level declines in the transition period between 2020 and 2040 were evaluated through an analysis of well completed depths. Potential effects of lowered groundwater levels on the various beneficial uses of groundwater in the Kaweah Subbasin are as follows:

Agricultural – Potential effects to agricultural beneficial uses and users from lowered groundwater levels include financial impacts to lower pumps, repair/replace wells, and increased pumping costs. Analysis of well depths that could be affected by lowering groundwater levels to the minimum thresholds.

Domestic – Some domestic uses and users of groundwater may be impacted by continued lowering of groundwater levels during the transition period from January 2020 to December 2040. Analysis of well depths that could be affected by lowering groundwater levels to the minimum thresholds has been completed. Lowering groundwater levels below the total depth of shallow domestic wells could lead to added costs to haul in water supplies, tie into other available supplies, consolidation with existing water service providers, or requiring other form of mitigation.

Industrial & Municipal – Potential effects to industrial beneficial uses and users from lowered groundwater levels include financial impacts to lower pumps, repair/replace wells, and increased pumping costs. Analysis of well depths that could be affected by lowering groundwater levels to the minimum thresholds has been completed.

Additionally, a significant portion of the eastern area of the EKGSA has shallow depth to bedrock and the availability of supply above the bedrock could be diminished such that productive wells could not be constructed if water levels are not stabilized above these levels. Long-term reductions in aquifer storage reduces the resilience of the Subbasin to withstand drought periods and reduced surface water imports.

To address potential effects on agricultural, domestic and industrial beneficial uses and ensure access to water until the Subbasin reaches a sustainable groundwater level condition, each GSA will adopt a Mitigation Program or Programs consistent with the framework described further in the next section. EKGSA proposed Mitigation Program is located in **Section 5.3.8.2**. Because of this mitigation, the resulting impacts as described above during the implementation period are not considered significant and unreasonable.

3.4.1.2 Minimum Thresholds

Legal Requirements:
§354.28 (a) Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26.

(d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.

(e) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators.

3.4.1.2.1 Description of Minimum Thresholds

Chronic lowering of groundwater level MTs were developed to protect relevant and applicable beneficial uses and users of groundwater in the Subbasin. Beneficial users of groundwater are domestic pumpers, disadvantaged communities, small water systems (2 to 14 connections), municipal water systems (>14 connections), and agricultural pumpers. Understanding the types of users and their access to groundwater was the first step taken to inform what the GSAs and their stakeholder groups consider significant and unreasonable impacts to those users.

As displayed in **Figure 3-5**, chronic lowering of groundwater level MTs were set to protect greater than the 90th percentile of all beneficial uses and users (Method 1) without allowing a greater rate of decline than the historical groundwater decline experienced between 1997-2017 (Method 2). General descriptions of the methodologies are provided below and a detailed description of the approach and methodology for setting minimum thresholds is available in **Appendix 3-A**. Ultimately, groundwater level MTs were established for each of the EKGSA's 10 threshold regions based upon a protective level that does not exceed the historic rate of decline from 1997-2017 for wells within each threshold region (**Table 3-2**), as those levels were more protective than the 90th percentile of beneficial uses are users. All EKGSA representative monitoring sites within a threshold region are assigned the same MT groundwater elevations.

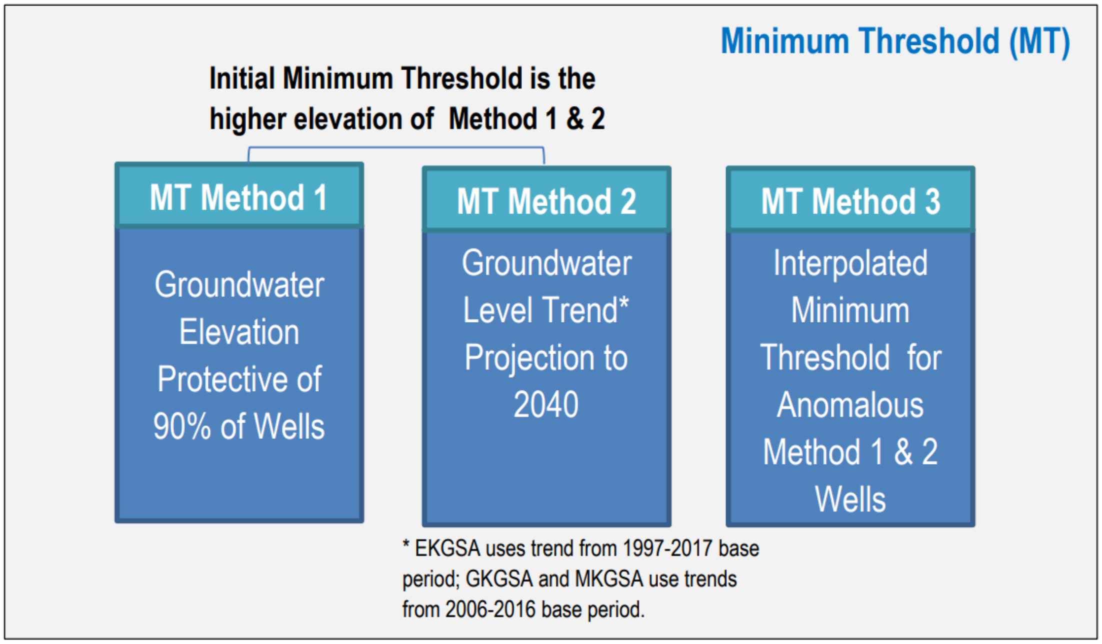


Figure 3-5 Chronic Lowering of Groundwater Levels Minimum Threshold Methodologies

Method 1 – Protective Elevations for Greater than the 90th Percentile for All Beneficial Uses and Users

Since wells are how beneficial users access groundwater, method 1 used to develop sustainable management criteria is based on water supply well completed depths. The depth of wells across the Subbasin varies by depth to groundwater and beneficial user type. Completed well depth statistics inform significant and unreasonable groundwater levels, with the minimum thresholds being based on protecting greater than the 90th percentile of beneficial uses and users ("90th percentile protection level"). Data used to determine a 90th percentile protection level include:

- *Completed depths, screen depths, and locations of wells installed since January 1, 2002, and included in DWR's WCR. Only wells drilled since 2002 are used for analysis to filter out wells that may have been abandoned or no longer represent typical modern well depths. Data download date was March 1, 2022.*
- *Historical groundwater elevation data from DWR's California Statewide Groundwater Elevation Monitoring Program, SGMA Portal Monitoring Network Module, and individual water agencies.*
- *Maps of current and historical groundwater elevation contours.*

The WCR dataset does not contain a complete accurate dataset, however, it is the best public source of data available. Approximately one-third of the wells drilled from 2002 onward did not have well completion depths and could not be used in the analysis. For purposes of well depth analyses, we assumed the available wells with depth data are typical of depths in the areas. Additional details on Methodology 1 are provided in **Appendix 3-A**.

Method 2 – Historic Rate of Decline Groundwater Trend (1997-2017)

Using hydrographs, the 90% well protection levels were also compared to the rate of groundwater depletion over the historical 21-year base period (1997-2017) to ensure the EKGSA did not revert to or exceed the undesirable condition of the groundwater basin prior to the 1950's when the construction of the Central Valley Project brought in surface water supplies. In cases where projected groundwater levels set at the 90th percentile protective level would exceed the undesirable groundwater levels experienced in the EKGSA prior to Central Valley Project surface water imports, or were not sufficiently protective of aquifer storage capacity, MTs were increased to be more protective of beneficial users by ensuring the MTs do not exceed the historic base period depletion rate. In EKGSA's eastern threshold regions, some initial MT elevations were also increased due to the shallow depth to the bottom of the aquifer.

Hydrograph Development Methodology and Data Sources

Utilizing the groundwater level data provided by the WDL and local irrigation districts, individual hydrographs were plotted using an R programming language script. For each well, historical groundwater level measurements were plotted alongside indicators for minimum thresholds, interim milestones, and measurable objectives. The hydrograph's primary and secondary axes were aligned so that WSE and DTW could be shown on the same chart. The hydrographs used for the historic rate of decline analysis are presented in **Appendix 3-B**.

Data from the WDL was used to develop the hydrographs. Utilizing the WDL dataset provided an expanded spatial distribution in comparison to the CASGEM dataset. The WDL draft includes the CASGEM wells and supplements them with other wells that had been sampled in the EKGSA for an extended time frame. The WDL is an important resource; however, many of the wells the districts were responsible for monitoring ceased to be updated in the State's system beginning in 2011. Though the data was no longer updated in the WDL, the districts were still monitoring some of these wells.

Historic Rate of Decline Methodology

Each hydrograph's historic rate of decline was projected out to 2040 in Excel. The predicted water levels were exported to ArcGIS. These projections were used to create a groundwater surface in ArcGIS via the interpolation method *spline with barriers*. *Spline with barriers* was chosen as the interpolation type due to its ability to account for the many prominent bedrock outcrops present within the EKGSA. This method forces water levels in the resulting surface to flow around impermeable features in the landscape rather than allowing water levels to flow through them. The surface created from the projected wells was evaluated for rationality and accuracy before being refined through further well exclusion.

3.4.1.2.2 Relationship to other Sustainability Indicators

Legal Requirements:
§354.26 b (2) The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.

The following provides an explanation of the relationship between the water level minimum thresholds and the other sustainability indicators and how the EKGSA determined that the minimum thresholds will avoid undesirable results for each Indicator:

- ***Depletion of surface water interconnections*** *occurs when there is direct influence between groundwater and surface water. High groundwater levels may seep into the streambed (a gaining reach) or water in the stream may directly provide recharge to the aquifer (a losing reach). Surface water and groundwater are not determined to interact if there are significant distances between groundwater and surface water. Surface water may continue to infiltrate and contribute to groundwater quantities, but this trip through the vadose zone acts as a barrier between the two bodies. They are not directly interacting and are therefore no longer interconnected. While there is potential that groundwater levels directly impact surface water depletions, there is currently not enough data to use groundwater levels as a proxy metric. Instead, EKGSA plans to implement an Interconnected Surface Water Work Plan (as described in* ***Section 5.3.7****) to fill critical data gaps and develop tools to better understand local ISW and groundwater level interactions.*
- ***Groundwater storage*** *is the measure of how much groundwater is stored within the aquifer. Therefore, more groundwater storage will be available to the aquifer during periods with higher groundwater levels than to the same aquifer*

when groundwater levels are lower. The strength of this relationship varies according to the depth to the base of the aquifer. An equal volume of groundwater lost by an area with a very shallow depth to the base of the aquifer and an area with a very great depth to the base of the aquifer will have vastly different consequences for beneficial users. The remaining amount of storage within the aquifer was a limiting factor in several of the eastern threshold regions that have a shallower aquifer due to presence of bedrock. This limitation was incorporated into the setting of groundwater level minimum thresholds.

- ***Groundwater Quality*** *in the EKGSA has not been directly correlated with groundwater levels at this time (**Appendix 3-C**). This relationship will continue to be assessed by the EKGSA as additional data is made available.*
- ***Land subsidence*** *is typically directly impacted by lowering of groundwater levels, if occurring within a susceptible soil layer (i.e. clay layer). Through review of available subsidence data, the EKGSA has not experienced significant subsidence within its boundary, which also limits the impact and correlation that the lowering of groundwater levels has on land subsidence. Instead, the EKGSA is setting a separate minimum threshold for land subsidence based on significant and unreasonable impacts on the viability of critical infrastructure (Friant-Kern Canal).*

3.4.1.2.3 Selection of Minimum Thresholds to Avoid Undesirable Results

Consistent with Appendix 6 of the Coordination Agreement (**Appendix 1-A),** the GSAs within the Kaweah Subbasin have determined that undesirable results for groundwater levels may be significant and unreasonable when there is a reduction in the long-term viability of domestic, agricultural, or municipal uses over the planning and implementation horizon of the Subbasin GSPs. Subbasin-wide loss of industrial, municipal, and domestic well pumping capacity occurs due to lowering groundwater levels.

As described in **Section 3.4.1.2.1**, groundwater levels minimum thresholds were set at the most protective groundwater level in a threshold region based on groundwater levels protective of greater than the 90th percentile of all beneficial uses and users (Method 1) without allowing a rate of groundwater decline greater than the historical decline experienced between 1997-2017 (Method 2). Ultimately, groundwater level minimum thresholds were established for each of the EKGSA's 10 threshold regions based upon a protective level that does not exceed the historic rate of decline from 1997-2017 for wells within each threshold region, as those levels were more protective than the 90% well protection level (**Table 3-2**). Therefore, the minimum thresholds are also protective of greater than the 90th percentile of all beneficial uses and users within the EKGSA and avoid reduction in the long-term viability of domestic, agricultural, and domestic well pumping capacity. For beneficial users and uses that may be impacted by the set minimum thresholds, **Section 5.3.8.2** outlines a Mitigation Program to mitigate impacts to well pumping capacity.

3.4.1.2.4 Impact of Minimum Thresholds on Water Uses and Users

The MTs for groundwater levels and, by proxy, aquifer storage were determined for each threshold region after lengthy consideration of the potential impacts on stakeholders within the EKGSA. The minimum thresholds and mitigation program (**Section 5.3.8.2**) have been established based on the groundwater level that was protective of the 90th percentile of all beneficial uses and users while not allowing a greater rate of decline over water years 2020 to 2040 than experienced between 1997-2017 and ensure enough storage to maintain water deliveries during at least a 5-year drought. The interim milestones and MOs have been determined based on the plan to correct the existing overdraft with an incremental approach intended to result in stabilized groundwater levels by 2040. **Appendix 3-D** provides an analysis of the set minimum thresholds impacts on beneficial users, including the estimated number of wells that may go dry if MTs are hit or exceeded. **Appendix 3-A** and **Appendix 3-D** also address data quality, inconsistencies, and uncertainties. The EKGSA intends to bolster the well data set for future analyses by partnering with the Kaweah Subbasin GSAs and County of Tulare to develop a more complete well canvass of the area, and developing a Drinking Water Well Monitoring Program (**Section 5.3.8**) to monitor and evaluate potential impacts to drinking water wells. Overall, the MTs have been established to allow for continued beneficial use within the EKGSA and provide improved long-term certainty of groundwater levels and corresponding supply.

3.4.1.2.5 Minimum Thresholds in Relation to Adjacent Basins

The Kaweah Subbasin has met with their neighboring subbasins and GSAs outside of the Kaweah Basin to discuss the process for modeling and setting thresholds and potential impacts. Most criteria and numeric setting were not final during these meetings. However, it is understood amongst all parties that MT elevations along the boundaries will need to be coordinated during implementation once focus shifts from finalizing the GSP documents. The EKGSA will evaluate and coordinate the potential differences between boundary thresholds and work to coordinate needed resolutions and clarifications in the future.

3.4.1.2.6 Measurement of Minimum Thresholds

Groundwater levels and groundwater storage MTs will be quantitatively measured using groundwater level measurements collected twice per year, to represent seasonal high and low groundwater conditions. The monitoring wells will be used by the EKGSA, described in the Monitoring Network Chapter (**Chapter 4**), to collect representative measurements to characterize the groundwater table. Groundwater level measurements will demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and/or surface water features. These measurements will also be used to estimate annual change in groundwater storage. Wells near potential interconnected surface water will be monitored to characterize the spatial and temporal changes to evaluate potential depletions of surface water caused by groundwater extractions, as described in the Interconnected Surface Water Work Plan (as described in **Section 5.3.7**).

3.4.1.2.7 Minimum Threshold Relationship to Federal, State, or Local Standards

There are currently no state, federal, or local regulatory standards applicable to groundwater levels. This GSP will become the basis for local regulatory standards.

3.4.1.2.8 Individual Minimum Thresholds by Threshold Region

The groundwater level minimum thresholds were established for each of the EKGSA threshold regions (**Figure 3-2**) and are summarized in the following table. For comparison, 2015 groundwater surface elevation (WSE) and depth to water (DTW) are included. **Appendix 3-A** lists the minimum thresholds for each representative monitoring site.

Table 3-2 Groundwater Level Minimum Thresholds

Threshold Region Name	Threshold Region Number	Minimum Threshold Water Surface Elevation (ft.)	Depth to Water (ft.)	2015 WSE (ft.)	2015 DTW (ft.)
EKGSA NW	1	185	169	246	108
IID-SCID	2	292	102	325	68
EKGSA NE	3	394*	81*	430*	45*
River	4	365	76	392	49
Exeter ID	5	244	162	309	97
EKGSA SE	6	429*	89*	413*	105*
LSID	7	312	123	337	98
Lindmore - East	8	235	164	307	92
Lindmore - West	9	145	218	241	122
EKGSA SW	10	75	269	163	182

*Regions with data gaps. Values estimated based on current data available.

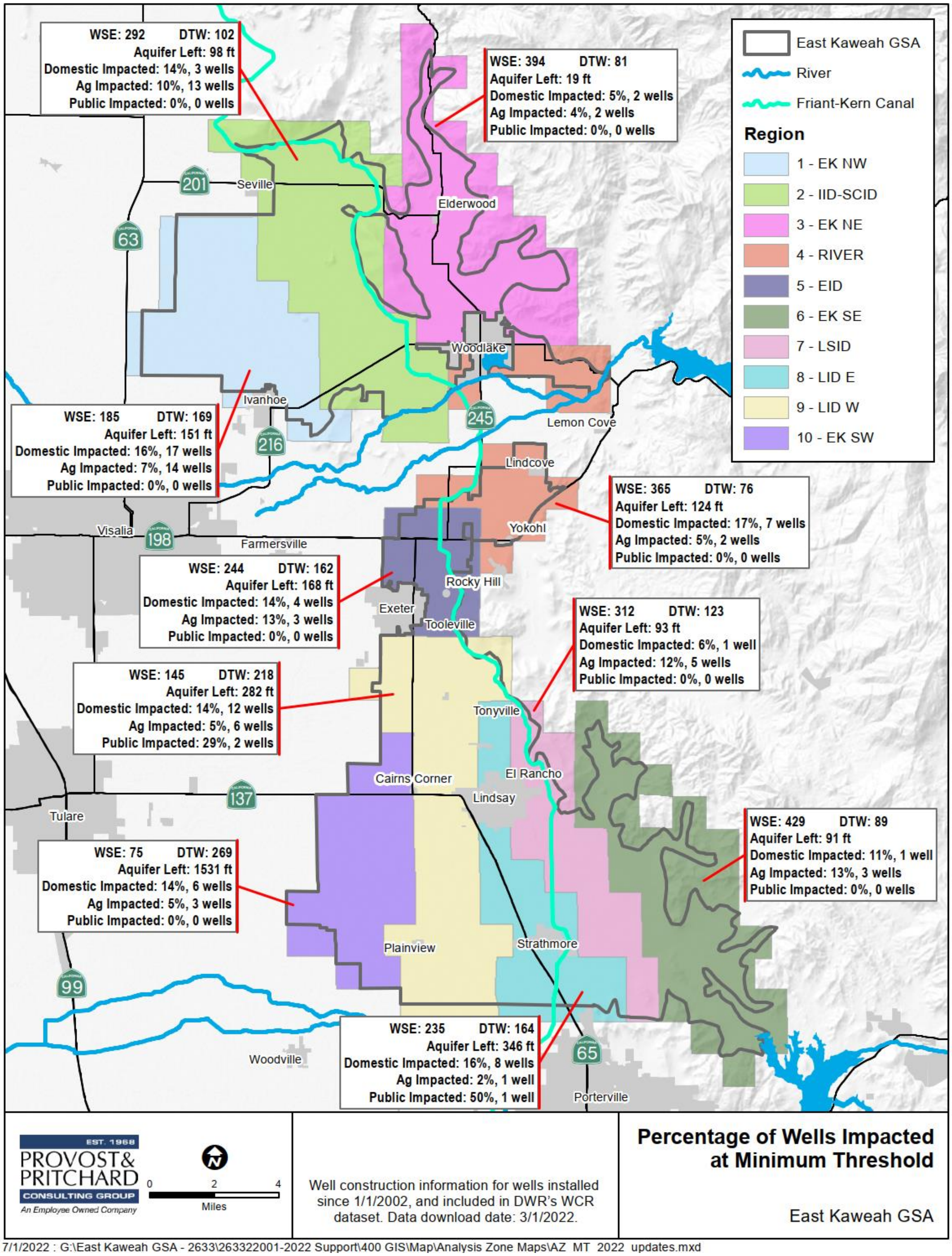


Figure 3-6 Groundwater Minimum Threshold and Well Impacts by Threshold Region

*Dataset to develop Figure 3-5 is described in Section 3.4.1.2.1.

3.4.1.3 Measurable Objectives

Legal Requirements:

§354.30 (a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.

(b) Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.

(c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.

(d) An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.

(e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.

(f) Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.

Table 3-3. Groundwater Level Measurable Objectives

Threshold Region	Water Surface Elevation (ft.)	Depth to Water (ft.)	2015 WSE (ft.)	2015 DTW (ft.)
EKGSA NW	227	127	246	108
IID-SCID	326	68	325	68
EKGSA NE	440*	35*	430*	45*
River	397	44	392	49
Exeter ID	303	103	309	97
EKGSA SE	441*	77*	413*	105*
LSID	357	78	337	98
Lindmore - East	300	99	307	92
Lindmore - West	229	134	241	122
EKGSA SW	160	184	163	182

**Regions with data gaps. Values estimated based on current data available.*

MOs are established at groundwater elevations higher than MTs to provide operational flexibility and reflect the GSAs' desired groundwater conditions in 2040. The margin of operational flexibility accounts for droughts, climate change, conjunctive use operations, other groundwater management activities, and data uncertainty. the All Kaweah GSAs are managing their groundwater to meet the MO in 2040. The EKGSA MOs are based on Spring 2017 groundwater levels. Spring 2017 was a wet year that followed the 2012-2016 drought.

The analysis evaluating the WCR data set for the minimum thresholds was performed at the measurable objective elevations. With the data gaps previously described in mind, a preliminary analysis of wells going dry was performed by comparing well depth elevations and the proposed MOs in each threshold region. Results from this analysis vary by threshold region and are summarized in **Figure 3-7**. Across the EKGSA approximately 0.3% of all wells may go dry at the proposed measurable objectives. Evaluating by well type, 0.2% of the domestic wells may go dry, while 0.4% of the agricultural wells and no public wells may go dry.

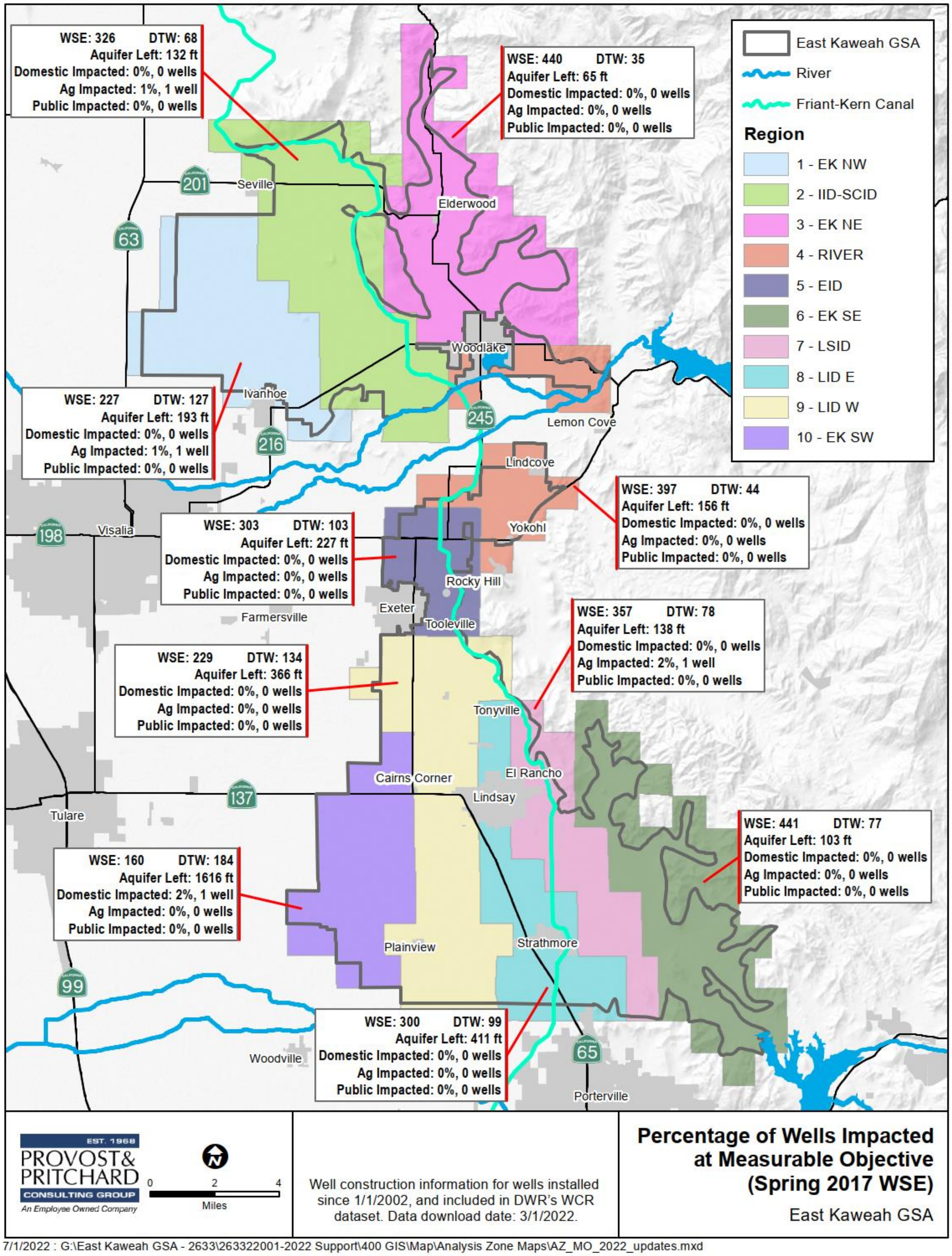


Figure 3-7 Groundwater Measurable Objective and Well Impacts by Threshold Region

*Dataset to develop Figure 3-6 is described in Section 3.4.1.2.1.

A margin of operational flexibility, or margin of safety, allows for variation in groundwater levels due to seasonal, annual and/or drought variations, and also takes into consideration levels of uncertainty. Drought years may cause pumping to increase, but wet years may provide enough opportunity for surface water recharge to offset drought years. This operational flexibility is the difference in groundwater levels between the measurable objective and minimum threshold and is depicted in **Table 3-4**.

Table 3-4 Margin of Operational Flexibility by Threshold Region

Threshold Region	2040 MT (ft.)	2040 MO (ft.)	Operational Flexibility (ft)
EKGSA NW	185	227	42
IID-SCID	292	326	34
EKGSA NE	394	440	46
River	365	397	32
Exeter	244	303	59
EKGSA SE	429	441	12
LSID	312	357	45
Lindmore - East	235	300	65
Lindmore - West	145	229	84
EKGSA SW	75	160	85

3.4.1.3.1 *Path to Achieve Measurable Objective*

The EKGSA and Kaweah Subbasin will implement projects and management actions to correct the declining groundwater levels and reach sustainability. The EKGSA-specific projects and potential management actions are described in **Chapter 5**. Implementation timeline and approximate costs are discussed in **Chapter 5.3.8.1.1**. The interim milestones for water level correction are unique to each threshold region but follow the same incremental mitigation rate for correction of 5%, 25%, 55%, 100% by 2025, 2030, 2035, and 2040, respectively. Measurable objective water levels have been determined based from the estimated overdraft correction timeline proposed within the EKGSA. **Table 3-5** summarizes the interim milestones by threshold region and **Figure 3-8** and depicts graphically using the EKGSA Northwest threshold region as an example.

Table 3-5 Groundwater Level Interim Milestones by Threshold Region

Threshold Region	Minimum Threshold (ft.)	2020 WSE (ft.)	5% Correction		25% Correction		55% Correction		100% Correction	
			2025 Δ (ft.)	2025 WSE (ft.)	2030 Δ (ft.)	2030 WSE (ft.)	2035 Δ (ft.)	2035 WSE (ft.)	2040 Δ (ft.)	2040 WSE (ft.)
EKGSA NW	185	222	-7	214	-1	214	3	217	10	227
IID-SCID	292	322	-6	316	-1	315	3	318	8	326
EKGSA NE	394	434	-8	426	-1	425	4	429	11	440
River	365	393	-6	387	-1	386	4	390	7	397
Exeter	244	295	-10	285	-1	284	5	289	14	303
EKGSA SE	429	439	-2	437	0	437	1	438	3	441
LSID	312	351	-8	344	-1	343	4	347	10	357
Lindmore - East	235	292	-11	281	-1	280	5	285	15	300
Lindmore - West	145	218	-14	204	-1	203	7	209	20	229
EKGSA SW	75	149	-14	135	-1	133	7	140	20	160

**Measurements are rounded to the nearest foot*

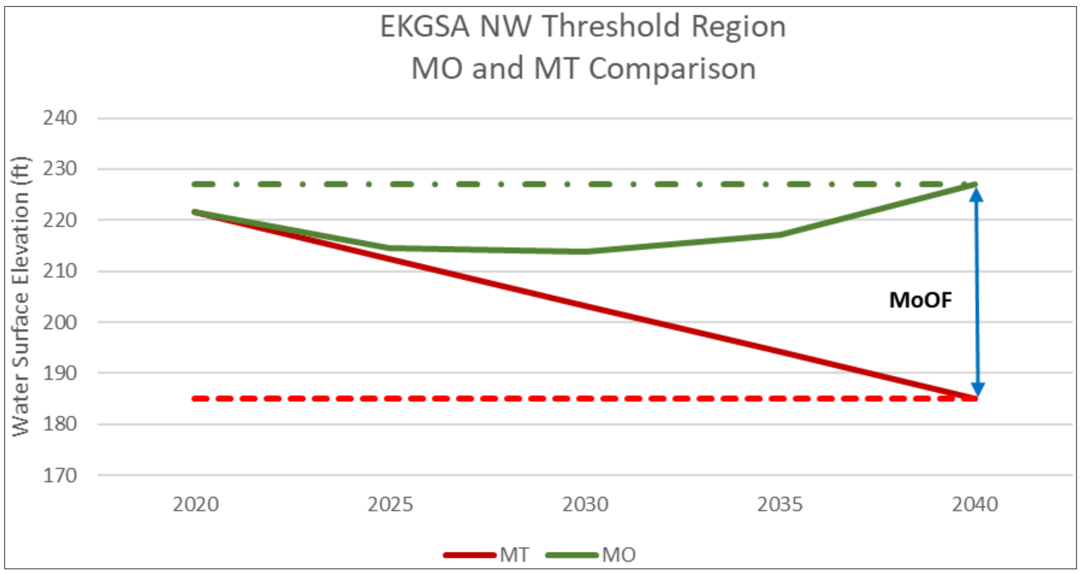


Figure 3-8 Example MO vs. MT Groundwater Level Comparison

3.4.2 Interconnected Surface Water

The EKGSA has identified interconnected surface water as a data gap and therefore does not have the data or a full understanding to establish definitive and scientifically defensible sustainable management criteria for this sustainability indicator. The EKGSA has committed to performing a Work Plan to fill these data gaps, as described in **Section 5.3.7** and Appendix 6 of the Coordination Agreement **(Appendix 1-A)**. The Work Plan will be performing further investigations and filling of data gaps to better understand this sustainability indicator and, ahead of the 2025 GSP update, refine the preliminary SMC described below.

3.4.2.1 Undesirable Results

3.4.2.1.1 Criteria to Define

Section 6.8 of Appendix 6 of the Kaweah Subbasin Coordination Agreement (**Appendix 1-A**) discusses the undesirable result (UR) for interconnected surface waters in the Kaweah Subbasin. The Kaweah Subbasin (East Kaweah and Greater Kaweah GSAs specifically) are implementing a work plan that is intended to provide a clearer definition of where potentially interconnected surface waters are located and to what extent adverse impacts related to groundwater pumping are present and can be defined and quantified. Consistent with the Coordination Agreement (**Appendix 1-A**) the current primary criteria and metric for defining and quantifying adverse impacts and URs will be the estimated percentage of losses within potentially interconnected channels, measured as a rate or volume of depletion of surface water, until the work plan provides more information. Increased channel losses reduce the amount of surface water that can be delivered throughout the Kaweah Subbasin. Delivery of surface water is a critically important part of sustainably managing the Kaweah Subbasin, thus impacts that reduce the ability to deliver surface water can become significant and unreasonable and ultimately lead to an undesirable result.

3.4.2.1.2 Causes of Groundwater Conditions that Could Lead to Undesirable Results

Section 6.8.1 of Appendix 6 of the Kaweah Subbasin Coordination Agreement (**Appendix 1-A**) discusses the causes of groundwater conditions that could lead to significant and unreasonable depletions of interconnected surface waters in the Kaweah Subbasin. URs associated with interconnected surface waters are understood to be caused by several factors. Some of these factors may include groundwater pumping, drier hydrology, and changes within the upper watershed, or some combination of those factors. Within the Kaweah Subbasin, there are currently significant data gaps related to understanding the potential locations of interconnected surface waters and their nexus to depletions caused by groundwater pumping. More information is intended to be developed and shared through a work plan being coordinated and implemented by the East and Greater Kaweah GSAs. The preliminary schedule for the work plan is discussed in **Section 5.3.7**. Pending data gathered and/or timing of such data, there may be shifts or re-ordering of phases/tasks to better adapt and facilitate completion.

3.4.2.1.3 Potential Impacts on Beneficial Uses and Users

Section 6.8.3 of Appendix 6 of the Kaweah Subbasin Coordination Agreement (**Appendix 1-A**) discusses the impacts on beneficial users and uses in relation to interconnected surface water in the Kaweah Subbasin. Currently identified potential beneficial uses/users related to interconnected surface water within the EKGSA are surface water users, riparian and/or groundwater dependent ecosystems, and water rights holders. As more data becomes available, the Work Plan may add or subtract to these uses/users in whole or part of the reaches of the selected waterways. The potential effects of depletions to interconnected surface water, when approaching or exceeding minimum thresholds and thus becoming an undesirable result include:

- *Increased losses in interconnected surface waterways used for surface water conveyance, reducing water supply reliability and volumes.*
- *Negatively and significantly impacting the health of riparian and/or groundwater dependent ecosystems.*
- *Violating laws and doctrines governing California's surface water rights.*

3.4.2.2 Minimum Thresholds

3.4.2.2.1 Description of Minimum Threshold

Depletion of surface water interconnections occurs when there is direct influence between groundwater and surface water. High groundwater levels may seep into the streambed (a gaining reach) or water in the stream may directly provide recharge to the aquifer (a losing reach). Surface water and groundwater are not determined to interact if there are significant distances between groundwater and surface water (disconnected reach). Surface water may continue to infiltrate and contribute to groundwater quantities, but the vadose zone acts as a barrier disconnecting the two bodies. Under these circumstances, surface waterbodies and the groundwater aquifer are not directly interacting and are no longer considered interconnected.

The potential, if any, groundwater dependent ecosystems and waterways to be evaluated for interconnectivity in the Work Plan are shown in **Figure 3-9** and **Figure 3-10**, respectively. The reaches selected are based on evaluating the spatial extents of the 30' DTW contour for Spring 2015 and Spring 2017 or where there is no groundwater level data. These two Spring seasons represent the driest and wettest water years since SGMA has been enacted and are used for understanding the potential extents and fluctuations along reaches to be studied through the Work Plan. These 30' DTW contours were not intended to imply conclusive locations of interconnected surface water at this time. Additionally, within the study area of Lewis Creek, there are portions that will need to be evaluated related to a perched water surface area that, at this time, appears to be independent of groundwater pumping and more linked to subsurface flow from the Sierra Nevada range to the east.

For the preliminary sustainable management criteria for the interconnected surface water sustainability indicator, the EKGSA has opted to evaluate based on channel losses, measured in a rate or volume of surface water depletion, in the selected surface waterways. Increased channel losses reduce the amount of surface water that can be delivered throughout the Kaweah Subbasin. Delivery of surface water is a critically important part of sustainably managing the Kaweah Subbasin, thus impacts that reduce the ability to deliver surface water can become significant and unreasonable and ultimately lead to an undesirable result.

The Work Plan intends to establish better criteria to define undesirable results either as an individual sustainability indicator or in relation with other indicators such as groundwater-level declines. As with all sustainability indicators, continued observations of conditions in the future and not less frequently than at each five-year GSP assessments, the EKGSA, in conjunction with the other Kaweah GSAs, will evaluate whether criteria should be changed.

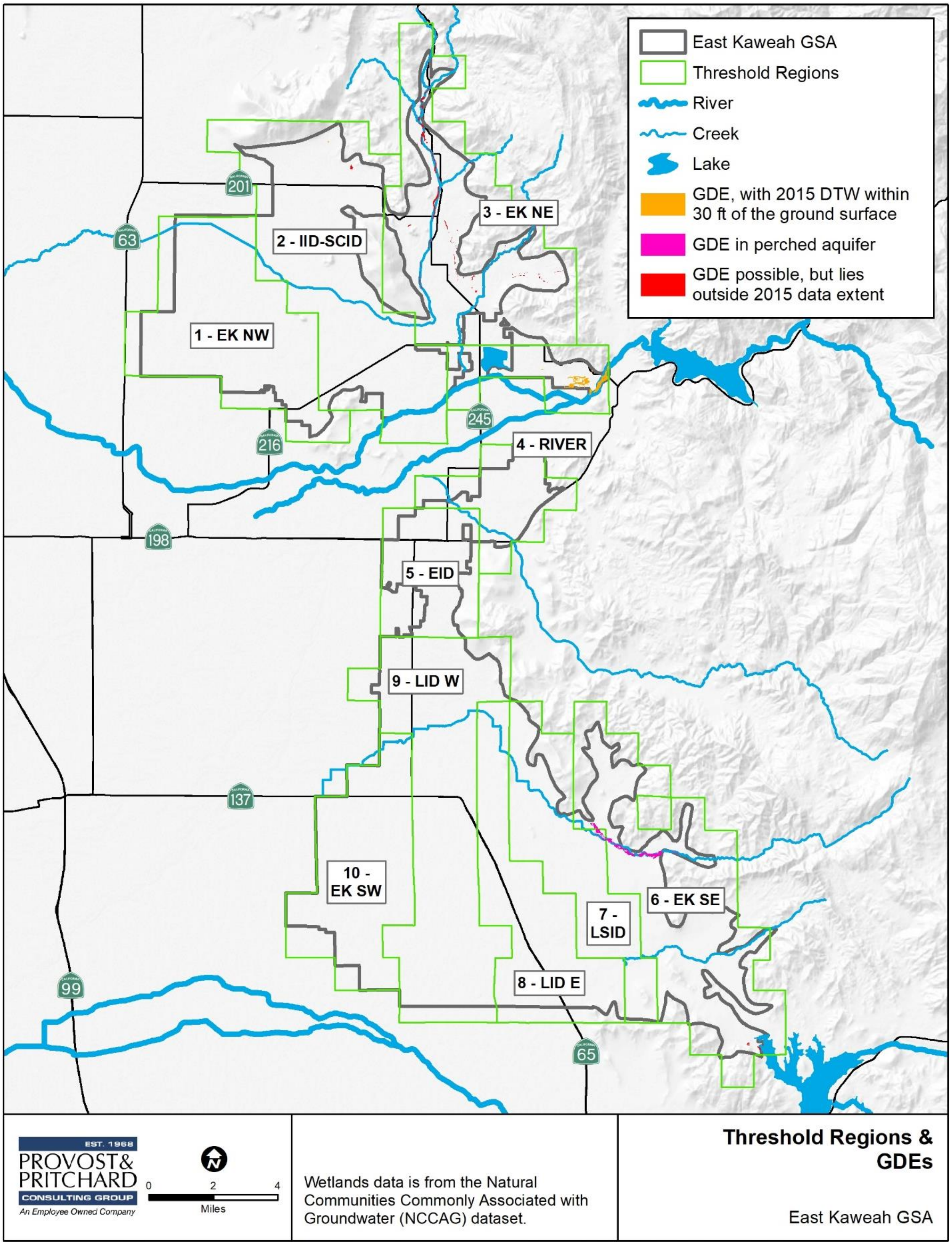


Figure 3-9 EKGSA Threshold Regions and Potential Groundwater Dependent Ecosystems

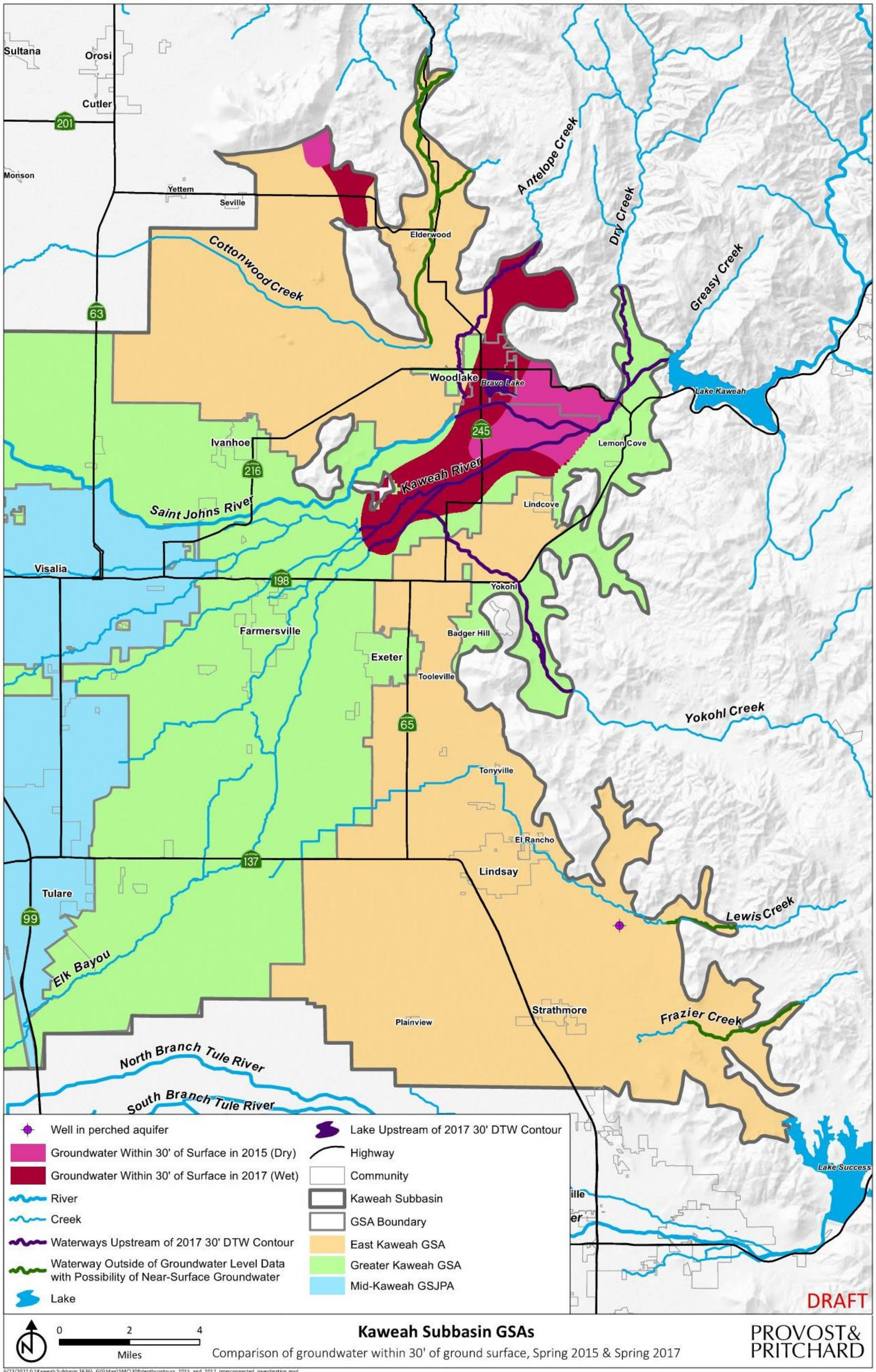


Figure 3-10. Selected Kaweah Subbasin Surface Waterways for Work Plan

3.4.2.2.2 Relationship for each Sustainability Indicator

The EKGSA has identified interconnected surface water as a data gap and therefore does not have enough data to establish relationships between other sustainability indicators.

3.4.2.2.3 Selection of Minimum Thresholds to Avoid Undesirable Results

The potential effects of depletions to interconnected surface water, when approaching or exceeding MTs and thus becoming an UR, are increased losses experienced by surface water users and rights holders and loss of potential riparian or groundwater dependent ecosystems. The EKGSA is initially setting MTs for interconnected surface waters based on the limited local experience of surface water purveyors in the area who have operated these waterways for decades, however to the extent channel losses have been caused by groundwater pumping is not understood. Based on this experience, typical losses in these channels have varied annually and seasonally but have been on the order of 30% of the flows in the channels. In dry periods these losses have increased. Losing half of the surface water supply may be considered significant and unreasonable given the importance of surface water supplies in the Kaweah Subbasin. Thus, the EKGSA has set starting MT for interconnected surface waters based on 50% loss of the respective waterway's flow, data permitting. In instances with little or no data, the 25-Year Storm capacity for the respective waterways is based on the 1970 Tulare county Flood Master Plan. Many of the waterways with little or no data are ephemeral in nature and take significant storms and/or wetter periods to generate surface water flow. Historic local hydrology suggests that approximately one out of four years are wetter hydrology, which guided the selection of the use of 25-Year Storm data. **Table 3-6** summarizes the estimated rates for the potentially interconnected portions of the surface waterway in the EKGSA. The rates are in cubic feet per second per linear foot of channel (CFS/LF).

3.4.2.2.4 Impact of Minimum Thresholds on Water Uses and Users

Fifty percent channel loss negatively impacts surface water users and water rights holders' ability to receive and beneficially use critical and limited surface water supplies in the Kaweah Subbasin. Riparian/groundwater dependent ecosystem health may also be impacted at 50% channel loss.

3.4.2.2.5 Measurement of Minimum Thresholds

Losses will be measured along potentially interconnected portions of the Kaweah River, Antelope Creek, Yokohl Creek, Cottonwood Creek, Lewis Creek, and Frazier Creek in units of cubic feet per second per linear foot of channel (CFS/LF). Measurement methods and techniques will be further explored as a part of the Work Plan but could include direct measurement of streamflow or analytical and numerical models.

3.4.2.2.6 Minimum Thresholds for Threshold Regions

The MT established by the EKGSA are applied to each individual waterway rather than a threshold region. The EKGSA will assess the need for further development of specific threshold regions respective of individual waterways as the Work Plan is implemented.

3.4.2.3 Measurable Objectives

3.4.2.3.1 Description of Measurable Objective

Similar to the approach used in setting MTs for interconnected surface waters, the EKGSA is leaning on limited local experience in setting the MOs for interconnected surface waters. From this experience, the understanding is that typical losses are on the order of 30% of the flows in the channels. The EKGSA is unaware of significant and unreasonable impacts or URs at this loss rate or whether groundwater pumping is impacting this rate. Thus, the EKGSA has set starting MO for interconnected surface waters based on 30% loss of the respective waterway's flow, data permitting. In instances with little or no data, the 25-Year Storm capacity for the respective waterways is based on the 1970 Tulare county Flood Master Plan. **Table 3-6** summarizes the estimated rates for the potentially interconnected portions of the surface waterway in the EKGSA in CFS/LF.

3.4.2.3.2 Margin of Safety for Measurable Objective

The current margin of safety between the measurable objective (30% channel losses) and minimum threshold (50% channel losses) is 20% channel losses (CFS/LF). The margin of safety will continue to be refined alongside other sustainable management criteria as the EKGSA implements the Work Plan.

3.4.2.3.3 Path to Achieve Measurable Objective

Interim Milestones for ISWs are set as a 5% reduction from the MT rate (50% losses in a channel) to the MO (30% losses in a channel) with each 5-year GSP update. Thus, the Interim Milestones would translate to 45% channel loss in 2025, 40% channel loss in 2030, 35% channel loss in 2035, and meeting the MO of 30% at the 2040 sustainability target. Interim Milestones, like other SMC related to interconnected surface water will be updated and refined through the proposed Work Plan and better understanding of the potential locations and extent ground groundwater pumping is causing depletions.

Table 3-6 Preliminary MT and MO for Interconnected Surface Waters

Water Body	Flow (CFS)	Channel Capacity[1]	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Kaweah River	Max	N/A	1,221	2,061	2,594	4,540	3,735	3,281	3,100	3,662	4,481	4,506	2,362	1,705
	Min		0	0	0	0	0	0	0	7	51	53	13	0
	Avg		611	1,031	1,297	2,270	1,868	1,641	1,550	1,834	2,266	2,280	1,188	853
	50% MT		**305**	**515**	**649**	**1,135**	**934**	**820**	**775**	**917**	**1,133**	**1,140**	**594**	**426**
	30% MO		**183**	**309**	**389**	**681**	**560**	**492**	**465**	**550**	**680**	**684**	**356**	**256**
Antelope Creek	Max													
	Min	1,340	Not enough flow data records to quantify by month											
	Avg													
	50% MT	**670**												
	30% MO	**402**												
Yokohl Creek	Max													
	Min	3,960	Not enough flow data records to quantify by month											
	Avg													
	50% MT	**1,980**												
	30% MO	**1,188**												
Cottonwood Creek	Max													
	Min	6,170	Not enough flow data records to quantify by month											
	Avg													
	50% MT	**3,085**												
	30% MO	**1,851**												
Lewis Creek	Max													
	Min	1,850	Not enough flow data records to quantify by month											
	Avg													
	50% MT	**925**												
	30% MO	**555**												
Frazier Creek	Max													
	Min	1,010	Not enough flow data records to quantify by month											
	Avg													
	50% MT	**505**												
	30% MO	**303**												

1 In instances where no flow data is available, the flow based upon the 1970 Tulare County Flood Control Master Plan was used for 25-Year Storm. Where data is available, monthly flow data based on flow measurement records from Water Years 1981-2021

3.4.3 Degraded Water Quality

3.4.3.1 Undesirable Results

Section 6.7 of Appendix 6 of the Kaweah Subbasin Coordination Agreement (**Appendix 1-A**) discusses the undesirable result for degraded water quality in the Kaweah Subbasin. Consistent with the Coordination Agreement, an undesirable result may be significant and unreasonable if groundwater quality is adversely impacted by groundwater pumping and recharge projects and these impacts result in groundwater no longer being generally suitable for agricultural irrigation and/or domestic use.

3.4.3.1.1 Criteria to Define

Section 6.7.2 of Appendix 6 of the Kaweah Subbasin Coordination Agreement (**Appendix 1-A**) discusses the criteria used to define the undesirable result for degraded water quality in the Kaweah Subbasin. As described in the Coordination Agreement, an undesirable result will occur should one-third of all Subbasin designated water quality monitoring sites exhibit a minimum threshold exceedance, and those exceedances are all associated with GSA actions.

Consistent with the Coordination Agreement, groundwater quality degradation will be evaluated relative to established maximum contaminant levels (MCL) or other agricultural constituents of concern set by applicable regulatory agencies. The metrics for degraded water quality shall be measured by MCL compliance or by other constituent content measurements where appropriate. In regions where agriculture represents the dominant use of groundwater, Agricultural Water Quality Objectives (WQO) will serve as the metric as opposed to drinking water MCLs within public water supply jurisdictions. An exceedance of any of the MCL or Agricultural WQO as defined herein at any representative monitoring sites will trigger a management action within the applicable Management Area or GSA, subject to determination that the exceedance was caused by actions of the GSA. MCLs and Agricultural WQO are listed in **Table 3-7**.

California's Porter-Cologne Water Quality Control Act (Porter-Cologne) is the overarching legislation determining the state standards applied to water quality within the boundaries of the EKGSA. Porter-Cologne extends the responsibilities of the federal Clean Water Act (CWA) from surface water to also include protecting groundwater quality. Implementation and compliance with the federal CWA and Porter-Cologne within California is maintained by the State and Regional Water Quality Control Boards. Each of California's nine regional water quality control boards must formulate and adopt basin plans for all areas of its region. Basin plans must conform with statewide policy set by the legislature and SWRCB (State Board 2015). Basin plans consists of designated beneficial uses to be protected, water quality objectives to protect those uses, and program implementation needed for achieving the objectives (California Water Code §13050(j)).

In the Kaweah Subbasin, the "Water Quality Control Plan for the Tulare Lake Basin" (Basin Plan), contains the administrative policies and procedures for protecting the surface and groundwater quality in the Tulare Lake Basin and its implementation is overseen by the Central Valley Regional Water Quality Control Board (Regional Board). Basin plans are adopted and amended by Regional Boards under a structured process involving full public participation and state environmental review. Basin plans and amendments must be approved by the State Water Board, Office of Administrative Law, and, if applicable, the U.S. Environmental Protection Agency. Due to the comprehensive scientific studies and stakeholder input used to develop, and the rigorous regulatory process required to approve the Basin Plan, the Kaweah Subbasin is leaning on this, and other agencies directed with water quality regulation, for assisting in defining "significant and unreasonable" water quality degradation.

Only water quality factors related to "actions, conditions, or circumstances resulting from human activities" are subject to the authority of the State or Regional Boards (CVWRCB 2015). Once beneficial uses have been determined for the basin, requisite water quality objectives are set to protect the beneficial use. Objectives can be revised through the basin plan amendment process and are achieved primarily through the adoption of waste discharge requirements (including federal NPDES permits) and enforcement orders. In the Kaweah Subbasin, Detailed Analysis Unit (DAU) 242, several beneficial uses for groundwater have been identified in the Basin Plan. However, due to the size of DAUs, the listed beneficial uses may not exist throughout the entire DAU. Through stakeholder discussions and anecdotes, it became clear that the primary beneficial uses of groundwater that are realized within the EKGSA are AGR and MUN. Thus, minimum threshold criteria focus on protecting these beneficial uses, which are described as:

- *Agricultural Supply (AGR) – Uses of water for farming, horticulture, or ranching, including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.*
- *Municipal and Domestic Supply (MUN) – Uses of water for community, military, or individual water supply systems, including, but not limited to, drinking water supply.*

3.4.3.1.2 Causes of Groundwater Conditions that Could Lead to Undesirable Results

Section 6.7.1 of Appendix 6 of the Kaweah Subbasin Coordination Agreement (**Appendix 1-A**) discusses the causes leading to an undesirable result for degraded water quality in the Kaweah Subbasin. URs associated with water quality degradation can result from pumping localities and rates, as well as other induced effects by implementation of a GSP, such that known plumes and contaminant migration could threaten production well quality. Well production depths too may draw out contaminated groundwater, both from naturally occurring and man-made constituents which, if MCLs are exceeded, may engender URs. Declining groundwater levels may or may not be a cause, depending on location. In areas where shallow groundwater can threaten the health of certain agricultural crops, rising water levels may be of concern as well.

3.4.3.1.3 Potential Impacts on Beneficial Uses and Users

Section 6.7.3 of Appendix 6 of the Kaweah Subbasin Coordination Agreement (**Appendix 1-A**) discusses the potential impacts of degraded water quality on beneficial users and uses in the Kaweah Subbasin. The potential effects of degraded water quality from migrating plumes or other induced effects of GSA actions include those upon municipal, small community and domestic well sites rendered unfit for potable supplies and associated uses, and/or the costs to treat groundwater supplies at the well head or point of use so that they are compliant with state and federal regulations. Potential effects also include those upon irrigated agricultural industries, as certain mineral constituents and salt build-up can impact field productivity and crop yields.

3.4.3.2 Minimum Thresholds

3.4.3.2.1 Description of Minimum Thresholds

Unlike groundwater storage and surface water depletion, no statistically significant correlation has been found between groundwater levels and water quality in the EKGSA (**Appendix 3-C**). Therefore, groundwater levels are not to be used as a proxy for determining water quality minimum thresholds. Instead, the EKGSA evaluated individual constituents of concern (COC) and, when available, historical water quality data indicated the potential for that contaminant to negatively impact the municipal and agricultural uses in the area. The compiled COC list was formed using the recorded water quality data over the 1997-2017 base period from the State Water Board's GAMA GeoTracker database (GeoTracker). The GeoTracker database includes the following datasets:

- *Department of Pesticide Regulation (DPR);*
- *Department of Water Resources (DWR);*

- *Groundwater Ambient Monitoring Assessment (GAMA) domestic wells, special study sites, and priority basin projects;*
- *State Water Board regulated monitoring wells, including:*
    - *Irrigated Lands Regulatory Program (ILRP);*
    - *Dairy Order;*
- *Public Water System Wells; and,*
- *National Water Information System (NWIS).*

In addition to GeoTracker data, the EKGSA also investigated data presented by the CV-SALTS surveillance and monitoring program pilot studies. The EKGSA also discussed the COC list with its stakeholders to ensure quality concerns from different parties were met.

Well monitoring data from Geotracker, and other sources, is currently not available at a granular enough level to allow for the mapping of specific contaminant plumes. Given these data gaps, the current level of water quality monitoring for the identified COCs needs to be enhanced by a network to track regional trends and to serve as a warning system for changes in water quality. More details on the EKGSA's monitoring network is provided in **Chapter 4**.

Table 3-7. Constituents of Concern for the EKGSA with Respective Minimum Threshold

Constituent	Threshold Level		Threshold Type	Municipal Minimum Threshold	Agricultural Minimum Threshold
1,2,3-Trichloropropane (1,2,3 TCP)	*0.005 ug/L*	*5 ppt*	*Primary MCL*	*X*	
1,2-Dibromo-3-chloropropane (DBCP)	*0.2 ug/L*	*0.2 ppb*	*Primary MCL*	*X*	
Arsenic	*10 ug/L*	*10 ppb*	*Primary MCL*	*X*	
Chloride	*500 mg/L*	*500 ppm*	*Action Level*	*X*	
	106 mg/L	106 ppm	*Agricultural Water Quality Goal*		*X*
Hexavalent Chromium	*20 ug/L***	*20 ppb*	*Health-Based Screening Level**	*X*	
Nitrate (as N)	*10 mg/L*	*10 ppm*	*Primary MCL*	*X*	
Perchlorate	*6 ug/L*	*6 ppb*	*Primary MCL*	*X*	
Sodium	*50 mg/L*	*50 ppm*	*Action Level*	*X*	
	69 mg/L	69 ppm	*Agricultural Water Quality Goal*		*X*
Total Dissolved Solids (TDS)	*1000 mg/L*	*1000 ppm*	*Secondary MCL*	*X*	*X*

**In 2014, the SWRCB established an MCL for hexavalent chromium at 10 ug/L. Due to lawsuits, the MCL was withdrawn by the SWRCB in 2017. Until an MCL is legally established, the previous Health-Based Screening Level will be used as the applicable threshold. A health-based screening level is a non-enforceable water-quality benchmark used to supplement MCLs and may indicate a potential human-health concern. (USGS 2018).*
***Until a revised MCL is adopted by the SWRCB, the total chromium MCL (20 ug/L) will be used as the drinking water standard for enforcement of the Safe Drinking Water Quality Requirements.*

The EKGSA emphasizes that the development and monitoring schedule of the aforementioned water quality COC list will be an iterative process. Over time, COCs that were historically a cause for concern within the basin may dissipate, while other COCs may emerge. The SWRCB continually updates applicable drinking water MCLs to address emerging contaminants of concern via a scientific, peer-reviewed process. In addition, agricultural commodity groups and the UC Cooperative Extension frequently publish research regarding the agronomic impacts of water quality. The EKGSA plans to annually assess, based on updates to data and research made publicly available, the applicability of the COC list and add or remove COCs as needed to sufficiently protect beneficial uses in the area.

Minimum Threshold

The EKGSA minimum threshold for groundwater quality will be based on a 10-year running average for COCs at a monitoring location. Minimum thresholds will breakdown to two categories, as follows:

- *For wells with 10-year average COC concentrations less than the recognized standard, no increase in concentration beyond the standard*
- *For wells with 10-year average COC concentrations greater than the recognized standard, no increases beyond 20% to the initial average concentration at GSP implementation*

It should be noted that COC concentrations in the range of 75% to 125% of the recognized standard may have challenges in evaluating statistical trends as the allowable error from laboratory analyses may influence the percentage. COC with small recognized limits are especially susceptible.

These COC concentrations will be with respect to the beneficial use the groundwater well supplies. Thus, public drinking wells will be subject to the municipal minimum threshold standard, and irrigation wells will be subject to the agricultural minimum threshold standards. A compiled list of COCs relevant to the EKGSA and their respective threshold levels is presented in **Table 3-7**.

The EKGSA recognizes that improving groundwater quality is a critical issue for long-term sustainability. However, unlike other sustainability indicators, groundwater quality management is already a part of a large, robust regulatory structure in place under the authority of the State Water Board. Through the data collection for developing this GSP, there are historical groundwater exceedances for the identified COCs predating January 1, 2015. See the Basin Setting in **Chapter 2** (and **Appendix 2-E**) for historical water quality information. However, §10727.2(b)(4) expressly states that a GSP, "may, but is not required to, address undesirable results that occurred before, and have not been corrected by, January 1, 2015." The EKGSA does not intend to take over regulatory roles assigned to other entities. Rather than duplicate these efforts, the EKGSA proposes to collaborate with other groundwater quality agencies and programs, when feasible, to sustain groundwater quality better than minimum thresholds. The EKGSA will also work to implement groundwater projects and management activities that support improved water quality while bringing the aquifer to a sustainable level.

3.4.3.2.2 Relationship for each Sustainability Indicator

As demonstrated in **Appendix 3-C**, water quality is uniquely independent from the other sustainability indicators within the EKGSA. At this time, given the data available, there does not appear to be a relationship between water quality and the other sustainability indicators in the Subbasin. Declining water levels, which relate directly with a reduction of groundwater storage, can potentially lead to increased concentrations of COC for those that reside in larger proportions in deeper aquifer zones. Conversely, rising water levels, which relate directly with an increase in groundwater storage, can also lead to increased concentrations of some COC that may reside in unsaturated soils at shallower depths. Groundwater quality cannot be used to predict responses of other sustainability indicators, and there is not a strong correlation by indicators that can potentially affect water quality such as change in groundwater levels and storage. Therefore, groundwater quality minimum thresholds should be established separately from other indicators.

3.4.3.2.3 Selection of Minimum Thresholds to Avoid Undesirable Results

Under SGMA, GSAs were given limited powers related to the groundwater quality sustainable indicator. For this reason, the EKGSA will be leaning on and collaborating with regulatory agencies tasked with establishing water quality standards and resolving quality issues. Thus, setting groundwater quality minimum thresholds was based on established standards aimed at protecting beneficial uses and users. The EKGSA views water that exceeds the established standards for the designated beneficial use is an undesirable result.

3.4.3.2.4 Impact of Minimum Thresholds on Water Uses and Users

The minimum thresholds have been set consistent with recognized water quality standards with respect to the water uses and users of groundwater at a given well. Minimum thresholds for drinking water supply wells lean on the recognized standards that are intended to be protective of human health (i.e. MCLs and Title 22). Minimum thresholds for irrigation supply wells lean on standards that are intended to be protective of agricultural crop health. Maintaining concentrations below these levels and leaning on agencies with the authority to solve quality issues, beneficial uses and users should be protected within the EKGSA.

3.4.3.2.5 Measurement of Minimum Thresholds

Measurement of water quality for evaluation against minimum thresholds will occur in two ways. For public wells supplying drinking water, the quality data is made public. The EKGSA will evaluate the regularly collected data for specific municipal COCs and their 10-year running average concentration, trend over time, and relation to its recognized water quality standard. Water quality for agricultural COCs will be collected through the representative agricultural wells in the monitoring network. Sampling will occur concurrent with groundwater level monitoring (Spring and Fall) to evaluate the COC 10-year running average concentrations, trend over time, and relation to its recognized water quality standard. As data is collected for both municipal and agricultural COCs, the minimum threshold trends and percentages can be evaluated and changed, if deemed appropriate by the EKGSA and its stakeholders.

In addition, while the preparation of this GSP was exempt from the California Environmental Quality Act (CEQA) requirements, projects implemented by the GSA under this GSP that “require the construction of a facility” are not exempt from CEQA. During CEQA compliance for a project requiring the construction of a facility (recharge pond, additional surface water conveyance, etc.), the EKGSA will investigate potential negative impacts on water quality resulting directly from the project on the aquifer prior to construction.

3.4.3.2.6 Minimum Thresholds for Management Areas and Threshold Regions

The minimum thresholds established by the EKGSA are specific to the beneficial use at a well. Therefore, the same minimum threshold parameters for water quality will be applied throughout the entire EKGSA. During implementation if additional data indicates special areas of concern, this policy decision can be reassessed.

3.4.3.3 Measurable Objectives

3.4.3.3.1 Description of Measurable Objective

The measurable objective for groundwater quality in the EKGSA is to have no unreasonable increase in concentration caused by groundwater pumping and recharge efforts. This objective will likely be evaluated on a case-by-case basis. The reason for the objective being “no unreasonable increase” is there may be instances where an increased concentration for short period is acceptable. For example, a recharge basin may cause a spike in concentrations in groundwater quality initially as constituents are carried through the soil profile. However, over the long-term, recharging with high quality surface water will improve groundwater quality. An example would be to have a well that has consistently been increasing to 9 mg/L Nitrate as N. Through implementation of a recharge basin up-gradient of this well, the concentrations have begun to plateau and/or improve (i.e. concentration drops to 6 mg/L). This would be viewed as achieving the Measurable Objective as no unreasonable increase occurred and/or improvement occurred.

3.4.3.3.2 Margin of Safety for Measurable Objective

The EKGSA will establish policy where it will begin to take action as monitoring of the groundwater quality concentration averages shows increase towards recognized quality standards. Action will begin if a COC concentration 10-year average reaches 80% of the recognized standard. If a COC concentration has not yet reached 80% of the recognized standard, but a statistically significant rapid rate of degradation towards the recognized standard exists, that may also trigger first action steps. If the action steps are triggered, the first step will be to initiate an evaluation of potential causes and sources of the concentration increase. When a cause is known, projects, management actions, and appropriate education and outreach can be implemented to resolve an issue. Based upon the data presented in the source analysis, appropriate examples of follow-up management actions or projects may include, but are not limited to, reassessing pumping allocations, exploring alternative placement of recharge areas, water treatment projects, notification and outreach with impacted stakeholders, and/or conferring with the appropriate state or local agency to confirm a plan exists to address the water quality problem of concern. Beginning to act when concentrations are at 80% is common amongst other groundwater quality agencies (i.e. CV-SALTS), and the EKGSA is proposing to adopt this practice.

3.4.3.3.3 Path to Achieve Measurable Objective

The EKGSA and Kaweah Subbasin will be looking to partner with agencies tasked with mitigating water quality issues. Partnering with these entities is believed to allow the Subbasin to achieve sustainable management of the groundwater aquifer that is void of all undesirable results. Additionally, with the planned increase in groundwater recharge with high quality water sources (Friant CVP and/or Local Kaweah River supplies), groundwater quality is anticipated to improve during the implementation period.

3.4.4 Land Subsidence

3.4.4.1 Undesirable Results

Section 6.6 of Appendix 6 of the Kaweah Subbasin Coordination Agreement (**Appendix 1-A**) discusses the UR for land subsidence in the Kaweah Subbasin. Land subsidence may be considered significant and unreasonable if there is a loss of a functionality of a structure or a facility to the point that, due to subsidence, the structure or facility cannot reasonably operate without either significant repair or replacement. The Kaweah Subbasin GSAs understand that impacts from subsidence have been occurring in the Kaweah Subbasin for many years. However, while some infrastructure has been impacted (well column collapse or capacity reduction), other facilities have not experienced those negative impacts, and why some have versus others not is still very difficult to understand. Shallow wells are generally not viewed as being at risk of subsidence impacts. The Kaweah Subbasin GSAs have attempted to consider all local infrastructure, land uses and groundwater users relative to current and potential subsidence impacts and develop a view of groundwater conditions that would avoid undesirable results in the Subbasin.

3.4.4.1.1 Criteria to Define

Section 6.6.2 of Appendix 6 of the Kaweah Subbasin Coordination Agreement (**Appendix 1-A**) discusses the criteria to define undesirable results associated with land subsidence in the Kaweah Subbasin.

As stated in the Coordination Agreement, the Kaweah Subbasin GSAs understand that the Friant-Kern Canal is a facility of statewide importance (critical infrastructure) that delivers San Joaquin River surface water to parties in the Kaweah Subbasin and beyond. For that reason, the Kaweah Subbasin GSAs also view that an UR would occur if the capacity of the Friant-Kern Canal was significantly impacted by subsidence. The Kaweah Subbasin GSAs understands there are local facilities (flood control channels, delivery channels, roadways, etc.) that are important infrastructure for all landowners across the Kaweah Subbasin. For that reason, the Kaweah Subbasin GSAs view that an UR would occur if these facilities are significantly impacted by subsidence.
Based on the discussions with stakeholders and landowners, there have been no known undesirable results within the EKGSA. Water conveyance structures tend to be the most sensitive to subsidence. However, damage to roads, railways, bridges, pipelines, buildings, and wells can also occur. The EKGSA assessed critical

infrastructure within the EKGSA that could be negatively impacted by significant subsidence. At this time, the EKGSA and its stakeholders have identified the Friant-Kern Canal (FKC) as the critical infrastructure within the EKGSA that could be negatively impacted by subsidence.

Also consistent with Section 6.6.2 of Appendix 6 of the Coordination Agreement, subsidence representative monitoring sites (RMS) will be monitored for ground surface elevation annually. The primary criteria for evaluation will be the reduction in land surface elevation, total amount of subsidence, and areal extent of such changes. There will be two methods of identifying an undesirable result for the Subbasin. The most critical to the EKGSA is the area along the Friant-Kern Canal. For the proximity around the Friant-Kern Canal (one-mile band on either side), if any of the subsidence RMS reach an MT in that band are reached, that will be viewed as an UR. Beyond the area of influence to the Friant-Kern Canal alignment, when one-third of the subbasin RMSs exceed their respective MTs, that will be viewed as an UR.

For many of the listed infrastructure, subsidence is only a problem when it is differential in nature i.e., elevation shifts across the areal extent of infrastructure deemed of high importance. For example, subsidence linearly along a major highway is manageable if gradual in its occurrence. In contrast, localized subsidence traversing across a highway, if sizable, would cause major cracking of the pavement surface and become a significant hazard to travelers. If an exceedance of a MT at a monitoring site occurs, the applicable GSA will reach out to the County, cities, water districts, and others both public and private, and inquire as to any infrastructure that has been damaged which may require a corrective course of action if deemed necessary. A broad areal extent of land subsidence thus may not be of major concern, with the exception of the associated loss of aquifer system water storage capacity.

3.4.4.1.2 Causes of Groundwater Conditions that Could Lead to Undesirable Results

Section 6.6.1 of Appendix 6 of the Kaweah Subbasin Coordination Agreement (**Appendix 1-A**) discusses the causes leading to URs associated with land subsidence in the Kaweah Subbasin. There are many factors involved ranging from the geological make-up in areas of the Subbasin, deep aquifer pumping (typically moving westerly in the Subbasin), and declining water levels leading to deeper drilling.

Currently, subsidence in the EKGSA has not impacted the capacity of the FKC within the EKGSA boundary; however, chokepoints in the canal have been formed in neighboring GSAs due to land subsidence. These chokepoints cause reduced capacity of the FKC and limit the amount of surface water that can be delivered to Contractors.

3.4.4.1.3 Potential Impacts on Beneficial Uses and Users

The Kaweah Subbasin GSAs have attempted to consider all local infrastructure, land uses and groundwater users relative to current and potential subsidence impacts and develop a view of groundwater conditions (MT elevations) that would avoid Undesirable Results in the Subbasin. Again, the Kaweah Subbasin GSAs view that stabilized groundwater levels as critical to the future success of dealing with subsidence. As groundwater pumping is reduced across the Subbasin, groundwater level declines will diminish, and fewer wells will be drilled deeper which will reduce the development of subsidence across the Subbasin.

Within the EKGSA, the beneficial uses and users are most impacted by decreased capacity in the FKC. Considered by many users to be the "lifeblood" of the EKGSA, maintaining integrity of the FKC will protect most beneficial users within the area. Although current data does not indicate a high likelihood within the EKGSA, beneficial users could also be impacted if subsidence caused damage to wells by collapsing casings.

3.4.4.2 Minimum Thresholds

3.4.4.2.1 Description of Minimum Threshold

Very few subsidence monuments are located within the EKGSA prior to 2020. Two subsidence monuments are located in the northern half of the GSA. One of these is by the FKC south of Colvin Mountain, while the other is located just east of Mud Spring Gap. Two monuments are located along Highway 198 in the Exeter ID.

DWR created a review of historical subsidence in the Valley entitled *Estimated Subsidence in the San Joaquin Valley between 1949 – 2005, most recently updated in April 2019*. This dataset only extends into the westernmost reaches of the EKGSA. All EKGSA subsidence indicated by the dataset was in the lowest vertical displacement group, with zero to five feet of elevation lost. Over the time period, this equates to approximately 1 inch per year at the most. Based on the mild rates of subsidence, DWR did not choose to extend the dataset any further to the east.

DWR also reports InSAR subsidence data annually, showing the vertical displacement accrued since 2015. The change from 2015 to 2021 is the most recent set to be published and is presented in **Figure 3-11**. According to this data set, the vast majority of the EKGSA has experienced less than 0.5 feet (6 inches) of change in elevation range during those years, indicating either no subsidence or slight uplift. A small portion in the southwestern portion of the EKGSA west of Lindmore ID has experienced approximately 2.0 to 2.5 feet of subsidence over the time period. The small area of the EKGSA seeing higher subsidence rates may be consequence of actions outside of the EKGSA boundary.

The Kaweah Subbasin went through an iterative process examining total subsidence MTs ranging from currently understood significant impacts to the estimated worst-case scenario link to groundwater levels equilibrating at their MT levels. More detail on the Subbasin-wide subsidence analysis is included in **Appendix 3-E**. The three-step process followed in **Appendix 3-E** held to total subsidence on the east side, around the Friant-Kern Canal, at the amount estimated to be significant and unreasonable. The allowable total subsidence MT then gradually increased going west across the Subbasin taking into account data and recent experience. The total subsidence for the EKGSA is more restrictive to protect the Friant-Kern Canal, which is anticipated to be more protective of the other land uses in the EKGSA. The subsidence MT was guided by not allowing more than a 10% capacity reduction in the current capacity of the FKC. Using the maximum amount of capacity loss and the engineering specifications of the FKC, it was estimated that 9.5" of subsidence cumulative (or in one year) could result in up to a 10% capacity loss in the FKC. Therefore, the MT for land subsidence was set at no more than 9.5" of land subsidence in a year to protect the FKC (**Table 3-8**). Additionally, since subsidence is tied to critical infrastructure capacity, the maximum cumulative subsidence for the implementation period is also set at 9.5" since that quantity relates to the 10% capacity reduction.

Table 3-8 Minimum Threshold for Land Subsidence

Minimum Threshold Parameter	Minimum Threshold Quantity
Annual Land Subsidence Rate	9.5 inches in a year; focus along the FKC
Maximum Cumulative Land Subsidence	9.5 inches

The above description of the relationship of MT around the Friant-Kern Canal and westward is shown graphically in **Figure 3-12**. The preliminary figure of total subsidence MT is intended to show the coordination across the Kaweah Subbasin that shows protection of the Friant-Kern Canal between the EKGSA and GKGSA. This figure then intends to depict the current understanding and relationship for increasing subsidence MT towards the west that has been deemed to be protective the various land surface uses within the Kaweah Subbasin topping out at the coordinated nine feet maximum subsidence MT.

3.4.4.2.2 Relationship for each Sustainability Indicator

Table 3-9 Subsidence's Relationship with Each Sustainability Indicator

Indicator	Relationship to Land Subsidence
Water Level	Land subsidence does not impact water levels, rather groundwater levels impact land subsidence. Land subsidence occurs due to a decline in water levels from confined groundwater pumping. It is assumed that the neighboring GSA's will reduce pumping to some extent from the confined aquifer to become sustainable. The reduction in confined groundwater pumping would lead to water levels stabilizing because of the water level sustainable management criteria, that would lead to land subsidence stabilizing.
Storage Change	There is loss of storage when inelastic land subsidence occurs.
Groundwater Quality	No current nexus to land subsidence.
Interconnected Surface Water	No current nexus to land subsidence.

3.4.4.2.3 Selection of Minimum Thresholds to Avoid Undesirable Results

Consistent with Appendix 6 of the Coordination Agreement (**Appendix 1-A**), land subsidence may be considered significant and unreasonable if there is a loss of a functionality of a structure or a facility to the point that, due to subsidence, the structure or facility cannot reasonably operate without either significant repair or replacement. When considering the EKGSA specific subsidence impacts on land surface uses, the FKC was determined to be critical infrastructure of statewide importance. Therefore, minimum thresholds were set at rates that would not result in more than a 10% capacity loss in the FKC. This rate is also protective of other critical infrastructure within the GSA.

3.4.4.2.4 Impact of Minimum Thresholds on Water Uses and Users

At the minimum threshold, the impact on water uses and water users would likely be significant. Many within the EKGSA rely on surface water from the FKC, therefore, if the capacity of the FKC is restricted, the EKGSA will be impacted. If the land subsidence monitoring shows subsidence in the area that may impact the FKC, the EKGSA will assess the area and address accordingly. Since there are no known issues with subsidence historically within the EKGSA, it is not anticipated that land subsidence will cause issues with the minimum threshold criteria, particularly as groundwater levels are sustained.

Other beneficial users can be impacted by subsidence by impacts to infrastructure such as roads, bridges, foundations, pipelines, and well casings. At this time the EKGSA has not deemed impacts to these facilities as critical or sensitive to subsidence as the FKC. However, to monitor potential impacts to well casings, a subsidence monitoring point will be established at a well in Plainview. This point will monitor potential impacts in an area of the EKGSA that may be more susceptible to subsidence, based on recent InSAR mapping (**Figure 3-11**). The EKGSA will evaluate if subsidence may be causing water supply well impacts. If negative impacts to water supply wells due to subsidence occur, wells could potentially qualify for mitigation (**Section 5.3.8**).

3.4.4.2.5 Measurement of Minimum Thresholds

The rate and extent of land subsidence will be measured annually via a survey of set mile posts along the FKC and at one of the Plainview well points. InSAR data will be utilized as a backstop when available.

3.4.4.2.6 Minimum Thresholds for Threshold Regions

Given the EKGSA's focus for land subsidence is the impact on critical infrastructure, the minimum threshold is set independent of the established EKGSA threshold regions.

3.4.4.3 Measurable Objectives

3.4.4.3.1 Description of Measurable Objective

The measurable objective for the land subsidence sustainability indicator in the EKGSA is to have no subsidence impacts to CVP deliveries via the FKC.

3.4.4.3.2 Margin of Safety for Measurable Objective

Over a year, there is a 9.5" inch margin of safety that allows for at most a 10% decrease in the FKC capacity. Based upon study of the current FKC capacity, a 10% decrease in the FKC capacity is believed to be an allowable maximum impact based upon the historical rates of subsidence in other basins the FKC traverses.

3.4.4.3.3 Path to Achieve Measurable Objective

To date there is no evidence of impacts to the FKC's capacity related to subsidence within the EKGSA. Therefore, there is no need to develop milestones as the measurable objective is to maintain current conditions that are protective of the integrity of the FKC.

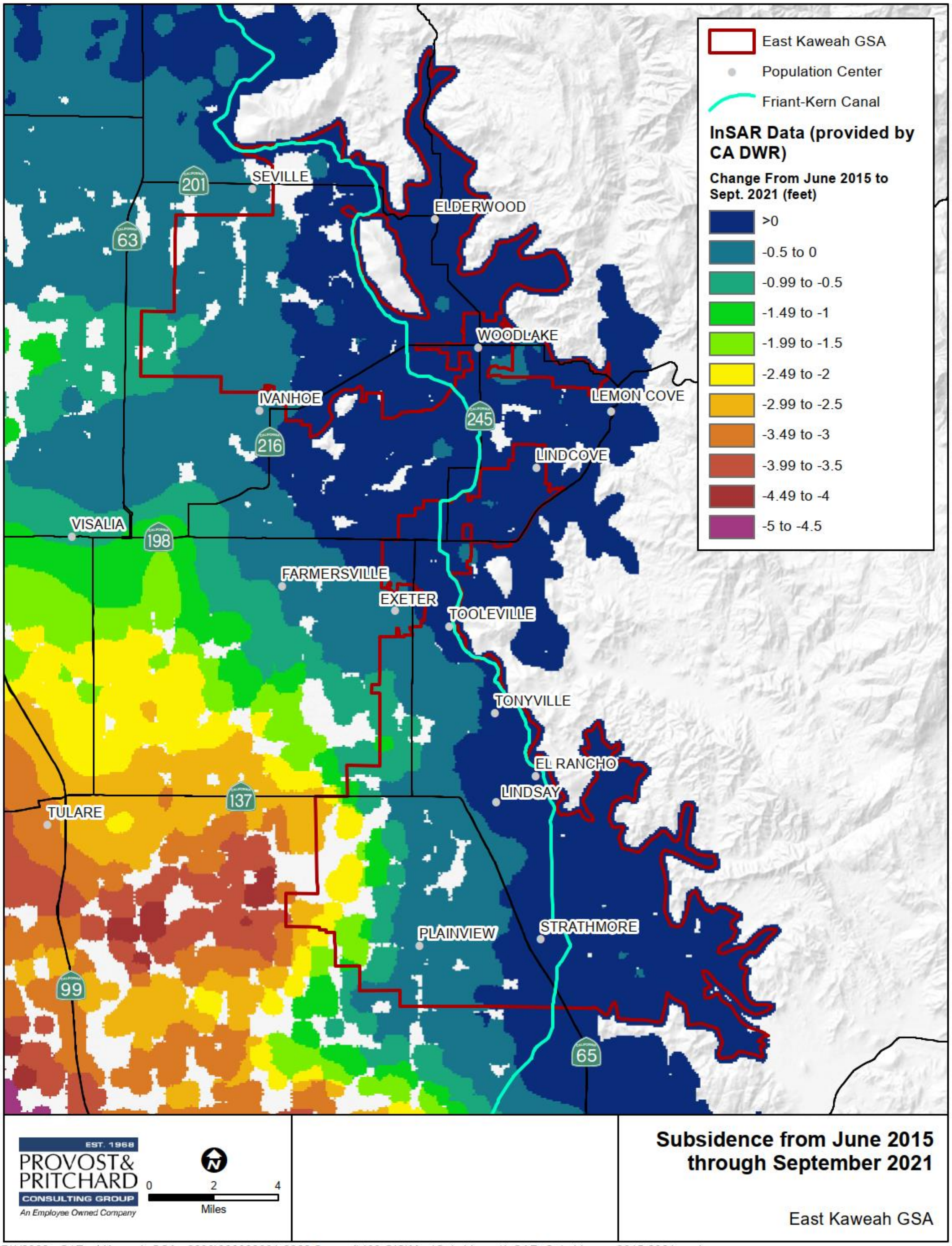


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Figure 3-11 Subsidence NASA InSAR Data from 2015 to 2021 for the EKGSA

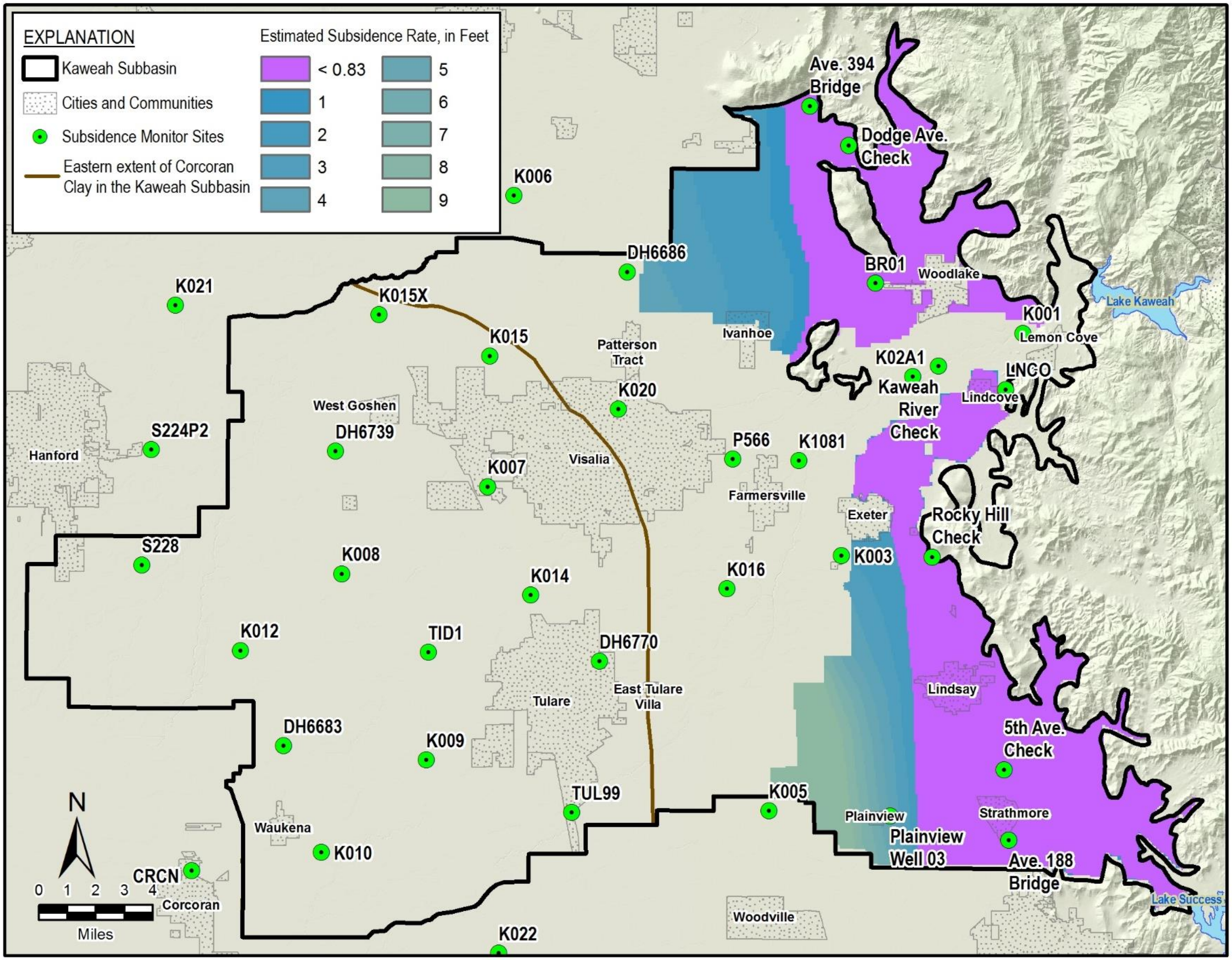


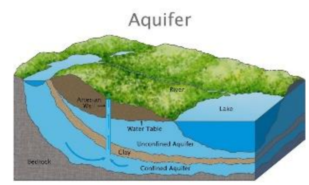
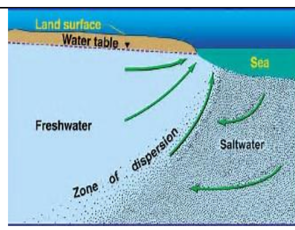
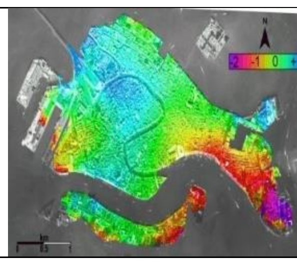
Figure 3-12 Preliminary Total Subsidence MT Gradation for the EKGSA

4 Monitoring Network

Legal Requirements:
§354.32 This Subarticle describes the monitoring network that shall be developed for each basin, including monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network shall promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.

Monitoring is a fundamental component of a groundwater management program. It is the method by which progress towards reaching measurable objectives and the goal of groundwater sustainability is ascertained. **Table 4-1** includes the sustainability indicators required for compliance with SGMA monitoring and reporting requirements. In areas where the current monitoring network does not meet SGMA objectives, this chapter discusses the current proposed monitoring network(s) and will identify current data gaps and propose measures to address these gaps in the future.

Table 4-1 Sustainable Indicator Monitoring

Groundwater Levels: Monitoring of static groundwater levels each spring and fall.		**Groundwater Storage:** Estimated annual change in groundwater storage based on groundwater levels.	
Seawater Intrusion: Intrusion of seawater into local aquifers. <u>This is not applicable to the EKGSA.</u>		**Water Quality:** Monitoring for water quality degradation that could impact available groundwater supplies.	
Land Subsidence: Surface land subsidence caused by groundwater withdrawals.		**Depletion of Interconnected Surface Water:** Loss of permanent connections between surface water and groundwater.	

4.1 Introduction

Legal Requirements:
§354.34(a) Each Agency shall develop a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan Implementation.

This chapter describes the existing and developing monitoring networks in the East Kaweah Groundwater Sustainability Agency (EKGSA) that will collect data to determine short-term, seasonal, and long-term trends in groundwater conditions and related surface conditions. The data collected from the monitoring networks will provide necessary information to support the implementation of this Groundwater Sustainability Plan (GSP), evaluate the effectiveness of this GSP, and serve as a guide for decision making by the EKGSA management.

4.1.1 Monitoring Network Objectives

Legal Requirements:
§354.34(b) Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:

1) *Demonstrate progress toward achieving measurable objectives described in the Plan.*
2) *Monitor impacts to the beneficial uses or users of groundwater*
3) *Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.*
4) *Quantify annual changes in water budget components.*

The objectives of the various monitoring programs include the following:

1. *Establish a baseline for future monitoring;*
2. *Provide warning of potential future problems;*
3. *Use data gathered to generate information for water resources evaluation;*
4. *Help to quantify annual changes in water budget components;*
5. *Develop meaningful long-term trends in groundwater characteristics;*
6. *Provide comparable data from various places in the EKGSA Area;*
7. *Demonstrate progress toward achieving measurable objectives described in the GSP;*
8. *Monitor changes in groundwater conditions relative to minimum thresholds;*
9. *Monitor impacts to the beneficial uses or users of groundwater.*

The requirements for monitoring the groundwater levels will initially be fulfilled by utilizing existing monitoring programs and data from public wells. Throughout the Subbasin there are several programs that currently monitor and report groundwater levels to DWR on a semiannual basis. The EKGSA will use these established monitoring points as the framework for the monitoring network and expand and improve upon it through implementation of the GSP. Whenever possible water quality will be monitored in conjunction with water level monitoring, in effort to develop a more robust groundwater quality data set. Where groundwater level monitoring is to occur in private wells, the EKGSA plans to seek landowner approval to use the wells in the monitoring network for water quality monitoring. The subsidence monitoring network will utilize available existing data sets and points in addition to adding several monitoring locations on key infrastructure within the EKGSA, primarily the Friant-Kern Canal (FKC) and a Plainview well.

4.1.2 Sustainability Indicator Monitoring Networks

Legal Requirements
§354.34(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:
[§354.34(c)(1) through §354.34(c)(6) are individually listed below]
§354.34(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.

The following sections (4.2 through 4.7) include descriptions of the monitoring networks within the EKGSA that will be utilized to meet criteria for the five sustainability indicators present: groundwater levels, groundwater storage, water quality, land subsidence, and depletion of interconnected surface water. The adequacy of the monitoring network is discussed for each sustainability indicator, as well as the quantitative values for the minimum thresholds, measurable objectives, and interim milestones. The sections also include a review of each monitoring network for site selection, monitoring frequency and density, identification of data gaps, and the current plans to fill data gaps. This information will be reviewed and evaluated during each five-year assessment.

When evaluating the adequacy of the monitoring network, three general types of data gaps will be considered:

1. *Temporal: A temporal data gap indicates that there is an insufficient frequency of monitoring. For instance, data may only be available for a well only in the Fall since it is rarely idle in the Spring. In addition, a privately owned well may have sporadic access due to locked security fencing, roaming dogs, change in ownership, etc.*
2. *Spatial: Spatial data gaps occur when there is an insufficient number or density of monitoring sites in a specific area.*
3. *Quality: Data may be available but be of poor or questionable accuracy. Poor data can lead to incorrect assumptions or biases, creating more inaccuracies than if no data had been collected at all. The data may not appear consistent with other data in the area, or with past readings at the monitoring site. The monitoring site may not meet all the desired criteria to provide reliable data, such as having information on perforation depth, etc.*

Improving the monitoring network(s) will aim to follow the Data Quality Objective (DQO) process that follows the U.S. EPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006). The DQO process is also outlined in the DWR's Best Management Practices for Monitoring Networks (2016a) and Monitoring Protocols (2016b). Leaning on this DQO process intends to help to ensure a repeatable and robust approach to collecting data with a specific goal in mind.

4.2 Seawater Intrusion

Legal Requirements:
§354.34(c)(3) Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.

The EKGSA is separated from the ocean by California's Coast Ranges, ~320-600 vertical feet, and ~120 miles (as the crow flies). Barring unprecedented tectonic upheaval, seawater intrusion is not an issue of particular concern in the Kaweah Sub-basin or EKGSA. In addition, there are no saline water lakes in or near the EKGSA. As a result, seawater intrusion is not discussed hereafter in this chapter as allowed by §354.34(j). Saline water intrusion from up-coning of deep saline groundwater is also not likely a problem given the typical depths to bedrock in the EKGSA, however TDS and other salts will be monitored as part of general water quality monitoring.

4.3 Groundwater Levels

Legal Requirements:
§354.34(c)(1) Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:

- ***A.*** *A sufficient density of monitor wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.*
- ***B.*** *Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.*

§354.34(h) The 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

4.3.1 Monitoring Network Description

Groundwater-level monitoring has been carried out for most of the past century. Existing groundwater wells with long monitoring histories make the best targets for continued monitoring. These wells are rare, and when they exist, their usefulness is often degraded by poor data quality. Most wells have incomplete temporal histories and lack consistent measurements for consecutive years throughout their operational lives. There is no recourse for historic temporal data gaps, but the temporal quality of future measurements in these wells can be ensured. Many existing wells do not have well logs or records with other construction information. Data containing the depth and perforation intervals is required according to SGMA guidelines. Matching a well to a construction log is a time-consuming process that is not guaranteed to be accurate and requires field verification. All existing wells in the monitoring network currently meet the SGMA guidelines for aquifer specificity as they are screened across a single water-bearing unit as there is only one aquifer underlying the EKGSA. Among the current records, data inconsistencies may arise due the fact that most of the historical well data is not derived from dedicated monitoring wells. Records may come from wells used for production; therefore, groundwater level measurements may be skewed by the frequency and timing of water level readings. For example, if water level readings were taken right after the well was pumped groundwater levels will appear to be much lower than if the aquifer was given appropriate time for recovery. Additionally, water level records may also be misrepresented if wells in the vicinity of the monitoring well underwent pumping activity that had an effect of the analyzed well. There is no way to pinpoint or correct historical data for this degree of uncertainty, so it further contributes to the degree of error associated with using available data. Future measurements will be extrapolated from a monitoring network with dedicated wells. The EKGSA will attempt to drill new monitoring wells in locations minimally affected by pumping, however, this is an aspect that cannot be directly controlled.

Existing monitoring networks and well information in or around the EKGSA that will be used to initially meet the monitoring criteria within the EKGSA include:

- Irrigation District wells: The EKGSA is made up of several irrigation districts that are Contractors with the Central Valley Project (CVP) of the Friant Division. These districts are: Stone Corral ID, Ivanhoe ID, Exeter ID, Lindmore ID, and Lindsay-Strathmore ID. As required per the CVP contracts, each of these districts maintain a network of wells monitored for groundwater levels. These networks were initially established in the 1950's and have been measuring groundwater levels in the spring and fall. This information has been used to map past spring and fall water elevations, depths to water, and changes in groundwater levels.
- CASGEM wells: DWR documents groundwater levels recorded by local agencies and reports them through the CASGEM program. The program was created by SBx7-6, Groundwater Monitoring, a part of the 2009 Comprehensive Water Package. The CASGEM system relies on records from deep wells within irrigation districts and municipalities since it does not currently own any dedicated monitoring wells. For the EKGSA area, most if not all, the CASGEM wells align with the Irrigation District wells. Thus, there is a good history to build from. Wherever available, this system takes readings

from wells and collects groundwater level data semi-annually in the spring and fall for reporting to DWR. The CASGEM network is proposed to be backbone of the initial groundwater level monitoring network when SGMA Implementation begins in 2020. Presently, the CASGEM network alone does not provide enough spatial density. Other well sources are proposed to bolster the network initially.

- Municipal wells: Municipalities within and surrounding the EKGSA include the cities of Woodlake, Exeter, Lindsay, Strathmore, Porterville, Ivanhoe, and Seville. Exeter and Porterville, both of which are located just outside the EKGSA, are the only cities that provide water to more than 3,000 municipal connections so they are required to conduct long-term resource planning to ensure there is an adequate water supply available to meet the community's existing and future water needs. These plans assess the reliability of water sources in a 20-year time frame and plans are updated every five years to ensure water resources are properly monitored. The remaining cities of Lindsay, Strathmore, Ivanhoe, and Seville currently do not fall under the regulatory requirements for creating plans outlining sustainable future water resources. The intent of the EKGSA is to utilize these public data sets when evaluating groundwater conditions.
- Public Water System Wells: Records from water wells in a few small public water systems in the portion of the EKGSA are anticipated to be used as part of the monitoring network. Water systems of interest in the EKGSA include Plainview, Tonyville, and Tooleville.
- Kaweah Delta Water Conservation District (KDWCD): The KDWCD spans some area within and adjacent to the EKGSA. KDWCD compiles semi-annual reports with data from its member agencies in addition to Kings County Water District and Tulare ID. Since 2002 the KDWCD has conducted an extensive monitoring program that takes groundwater level measurements in the spring and fall. Annual reports compare the reported levels to the levels obtained in the previous year.
- Private wells: In several parts of the EKGSA there are gaps in the current monitoring well coverage, therefore, records from private wells may be used to initially satisfy the monitoring network needs. Use of these wells would require landowners to execute agreements with the EKGSA to allow access and conduct and oversee the monitoring. This process is anticipated to be time intensive, so this option is not the most preferred method.
- Wells in adjacent GSAs: Groundwater level data from adjoining areas will likely be collected through data sharing agreements to help provide better interpret GSA boundary flow conditions (long term agreements still need to be prepared to collect/share data with other Subbasins/GSAs). Wells within the GKGSA, Kings River East GSA, Lower Tule River ID, and Eastern Tule GSA will aid in evaluating boundary conditions between the Kaweah and Kings Sub-basins and the Kaweah and Tule Sub-basins.

Figure 4-1 shows the proposed locations for the initial groundwater level monitoring network for the EGKSA, and the different types of wells to be utilized. The two wells notated with stars in the northern portion of the EKGSA are proposed dedicated monitoring wells that are anticipated to receive Technical Support Services (TSS) assistance through DWR. The seven locations notated with large circles are locations with data gaps. The EKGSA will aim to obtain data from these regions (within half a mile) through agreement on private wells or through drilling dedicated monitoring wells during the first year(s) of implementation. It is understood that over the course of implementation the EKGSA will gradually convert the entire Monitoring Network to dedicated monitoring wells.

Table 4-2 provides information on these monitoring points in a tabular format. This table sorts the monitoring locations by the ten threshold regions previously established in in **Chapter 3**. Each well contains data for the location, site type, monitoring frequency, monitored undesirable results, and groundwater level minimum thresholds and measurable objectives. At this time the EKGSA will monitor approximately seventy wells on a semi-annual or quarterly basis both inside and outside of the EKGSA boundary. Nine subsidence monitoring stations within the EKGSA boundary will be surveyed annually to monitor land subsidence.

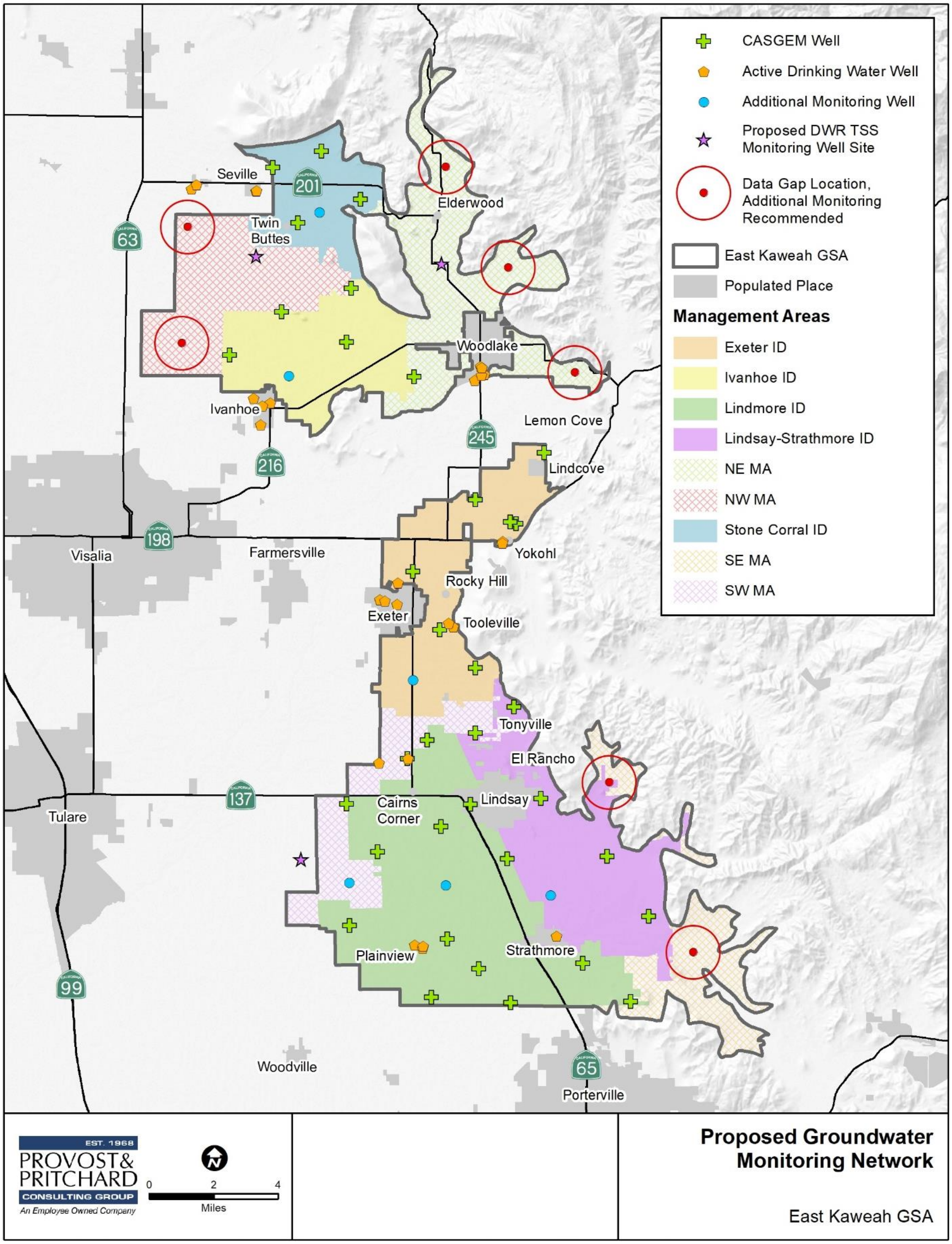


Figure 4-1: Initial Groundwater Monitoring Network

Table 4-2 Proposed Monitoring Network Information

TR	Latitude	Longitude	Site Type	Frequency	URs Monitored	Groundwater MT (DTW ft.)	Groundwater MO (DTW ft.)
1 - EK NW	36.4281	-119.2092	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	169	127
1 - EK NW	36.4086	-119.2381	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	169	127
1 - EK NW	36.3992	-119.2051	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	169	127
1 - EK NW	36.385905	-119.219633	Drinking Water Monitoring Well	Quarterly	GW Quality	169	127
1 - EK NW	36.389279	-119.224619	Drinking Water Monitoring Well	Quarterly	GW Quality	169	127
1 - EK NW	36.387249	-119.215311	Drinking Water Monitoring Well	Quarterly	GW Quality	169	127
2 - IID-SCID	36.493	-119.2142	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	102	68
2 - IID-SCID	36.5005	-119.187	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	102	68
2 - IID-SCID	36.4788	-119.1653	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	102	68
2 - IID-SCID	36.4682	-119.2001	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	102	68
2 - IID-SCID	36.4388	-119.1703	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	102	68
2 - IID-SCID	36.4146	-119.1728	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	102	68
2 - IID-SCID	36.399028	-119.135194	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	102	68
2 - IID-SCID	36.504083	-119.181382	Subsidence Survey Site	Annual	Subsidence	102	68
2 - IID-SCID	36.414025	-119.139866	Subsidence Monument	Annual	Subsidence	102	68
2 - IID-SCID	36.483936	-119.156678	Subsidence Survey Site	Annual	Subsidence	102	68
2 - IID-SCID	36.453177	-119.223455	Proposed Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	102	68
2 - IID-SCID	36.472965	-119.18822	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	102	68
3 - EK NE	36.449941	-119.120187	Proposed Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	81	35
4 - RIVER	36.3438	-119.1012	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	76	44
4 - RIVER	36.3649	-119.0628	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	76	44
4 - RIVER	36.333	-119.0784	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	76	44
4 - RIVER	36.3338	-119.0817	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	76	44
4 - RIVER	36.403201	-119.097777	Drinking Water Monitoring Well	Quarterly	GW Quality	76	44
4 - RIVER	36.4038	-119.098318	Drinking Water Monitoring Well	Quarterly	GW Quality	76	44
4 - RIVER	36.399822	-119.097991	Drinking Water Monitoring Well	Quarterly	GW Quality	76	44
4 - RIVER	36.400218	-119.096258	Drinking Water Monitoring Well	Quarterly	GW Quality	76	44
4 - RIVER	36.397603	-119.101521	Drinking Water Monitoring Well	Quarterly	GW Quality	76	44
4 - RIVER	36.325077	-119.085966	Drinking Water Monitoring Well	Quarterly	GW Quality	76	44
4 - RIVER	36.324287	-119.086025	Drinking Water Monitoring Well	Quarterly	GW Quality	76	44
5 - EID	36.3115	-119.135806	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	162	103
5 - EID	36.2853	-119.1209	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	162	103
5 - EID	36.325278	-119.106389	Subsidence Monument	Annual	Subsidence	162	103
5 - EID	36.311321	-119.135088	Subsidence Monument	Annual	Subsidence	162	103
5 - EID	36.296749	-119.144649	Drinking Water Monitoring Well	Quarterly	GW Quality	162	103
5 - EID	36.298267	-119.151426	Drinking Water Monitoring Well	Quarterly	GW Quality	162	103
5 - EID	36.306361	-119.144192	Drinking Water Monitoring Well	Quarterly	GW Quality	162	103
5 - EID	36.286649	-119.113386	Drinking Water Monitoring Well	Quarterly	GW Quality	162	103
5 - EID	36.288174	-119.115877	Drinking Water Monitoring Well	Quarterly	GW Quality	162	103
6 - EK SE	36.1833	-119.0278	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	89	77

TR	Latitude	Longitude	Site Type	Frequency	URs Monitored	Groundwater MT (DTW ft.)	Groundwater MO (DTW ft.)
6 - EK SE	36.1564	-119.0048	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	89	77
7 - LSID	36.2506	-119.0795	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	123	78
7 - LSID	36.2094	-119.0645	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	123	78
7 - LSID	36.1181	-119.0148	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	123	78
8 - LID E	36.1822	-119.0831	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	164	99
8 - LID E	36.1353	-119.0412	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	164	99
8 - LID E	36.1175	-119.0812	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	164	99
8 - LID E	36.1666	-119.058459	Subsidence Survey Site	Annual	Subsidence	164	99
8 - LID E	36.130819	-119.05574	Subsidence Survey Site	Annual	Subsidence	164	99
8 - LID E	36.165789	-119.059314	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	164	99
8 - LID E	36.147461	-119.055979	Drinking Water Monitoring Well	Quarterly	GW Quality	164	99
9 - LID W	36.2681	-119.1009	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	218	134
9 - LID W	36.2389	-119.1009	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	218	134
9 - LID W	36.2356	-119.1278	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	218	134
9 - LID W	36.1967	-119.1201	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	218	134
9 - LID W	36.2068	-119.1038	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	218	134
9 - LID W	36.1461	-119.1165	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	218	134
9 - LID W	36.12	-119.1253	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	218	134
9 - LID W	36.1328	-119.099	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	218	134
9 - LID W	36.2625	-119.1356	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	218	134
9 - LID W	36.1703	-119.1173	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	218	134
9 - LID W	36.142014	-119.130089	Drinking Water Monitoring Well	Quarterly	GW Quality	218	134
9 - LID W	36.143557	-119.134656	Drinking Water Monitoring Well	Quarterly	GW Quality	218	134
9 - LID W	36.142964	-119.130025	Drinking Water Monitoring Well, Subsidence Survey Site	Quarterly, Annual	GW Quality, Subsidence	218	134
9 - LID W	36.274669	-119.103826	Subsidence Survey Site	Annual	Subsidence	218	134
10 - EK SW	36.2273	-119.1386	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	269	184
10 - EK SW	36.2069	-119.1723	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	269	184
10 - EK SW	36.1853	-119.1551	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	269	184
10 - EK SW	36.1522	-119.1706	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	269	184
10 - EK SW	36.1714	-119.1709	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	269	184
10 - EK SW	36.227331	-119.138548	Drinking Water Monitoring Well	Quarterly	GW Quality	269	184
Outside EK	36.298705	-119.154153	Drinking Water Monitoring Well	Quarterly	GW Quality	N/A	N/A
Outside EK	36.225396	-119.154484	Drinking Water Monitoring Well	Quarterly	GW Quality	N/A	N/A
Outside EK	36.377371	-119.220542	Drinking Water Monitoring Well	Quarterly	GW Quality	N/A	N/A
Outside EK	36.37186	-119.100079	Subsidence Survey Site	Annual	Subsidence	N/A	N/A
Outside EK	36.482602	-119.223352	Drinking Water Monitoring Well	Quarterly	GW Quality	N/A	N/A
Outside EK	36.482413	-119.223388	Drinking Water Monitoring Well	Quarterly	GW Quality	N/A	N/A
Outside EK	36.483424	-119.259406	Drinking Water Monitoring Well	Quarterly	GW Quality	N/A	N/A
Outside EK	36.485176	-119.25665	Drinking Water Monitoring Well	Quarterly	GW Quality	N/A	N/A

4.3.2 Quantitative Values

Legal Requirements:
§354.34(g)(3) For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.

Threshold values are presented and discussed in **Chapter 3**. This includes details surrounding minimum threshold, measurable objective, and interim milestones.

4.3.3 Review and Evaluation of Monitoring Network

Legal Requirements:
§354.38(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

The monitoring network will be assessed and reviewed for adherence to SGMA requirements at the end of each five-year period, with the first period beginning in 2020 and concluding in 2025. As the monitoring network currently stands there are a few data gaps that may affect the interim monitoring of the overall sustainability goal of the basin, however, these will be addressed within the first five years of monitoring.

4.3.3.1 Monitoring Frequency and Density

Legal Requirements:
§354.34(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:

1) *Amount of current and projected groundwater use.*
2) *Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.*
3) *Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.*
4) *Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.*

Estimates for well densities necessary to adequately track monitoring objectives are in the CASGEM Groundwater Elevation Monitoring Guidelines (DWR, 2010). The CASGEM guidelines and Monitoring Network BMP reference the Hopkins (1984) approach which incorporates a relative well density based on the degree of groundwater used within a given area. The densities range from 1 well per 100 square miles to 1 well per 25 square miles based on the quantity of groundwater pumped. A minimum density of 1 well per 25 square miles is recommended for basins using over 100,000 AF of groundwater per year.

Groundwater use in the EKGSA currently exceeds 100,000 AF/year. As a result, a minimum well density of 1 well per 25 square miles will be used. For this evaluation, well density is tracked per 36-square mile Township, resulting in about 1.5 wells required per Township. A more conservative value of 2 wells per Township was adopted thereby improving upon the minimum density recommendation. Well densities in and around concentrated pumping areas and cities will be up to 4 wells per Township, whereas areas that have little to no pumping may have as few as 1 well per Township. The densest spatial distribution requirements require 10 wells per 100 square miles. With a total area of 183.3 square miles, the EKGSA would require 18 wells to meet the most stringent monitoring well network requirements.

As depicted in **Figure 4-1**, 35 CASGEM wells are located within the EKGSA. Quantitatively this is nearly double the required density, however, the placement of the CASGEM wells alone is not sufficient to provide an adequate monitoring network, especially for lands that lie outside of the irrigation districts within the

EKGSA. Furthermore, not all of these existing wells meet the criteria to be considered 'High Quality Monitoring Points'. High quality data is derived from wells that are deep enough to track seasonal fluctuations, have reliable access each spring and fall, and have information on the well depth and perforation intervals. In many cases the construction information (well depth and perforation intervals) are not known for the proposed Monitoring Network Wells. Due to the fact available information suggests the EKGSA overlies a single aquifer system, proposed wells that do not meet these guidelines will still be maintained in the monitoring network since they can still provide useful information about the behavior of the aquifer. Construction details (i.e. total depth and perforation intervals) from existing wells may be determined by video-surveying in the future. Obtaining existing well details is preferential since it would strengthen the status of existing monitoring wells that already have established histories. Eventually the GSA will own and/or oversee a monitoring network of wells of the correct specified density, however, the network of CASGEM wells will be used and expanded upon until this network is established.

Groundwater levels will be monitored at a minimum of twice each year in the Spring (likely March) and Fall (likely October). Spring measurements generally capture the recovery of the groundwater levels after an extended period of minimal agricultural irrigation demand, assuming normal rainfall. Fall measurements show a period after peak irrigation and other summertime urban demands have ceased, thereby yielding the cumulative impacts on the groundwater basin before any natural recovery has taken place.

4.3.3.2 Site Selection

Legal Requirements:
§354.34(g) Each Plan shall describe the following information about the monitoring network:
(1) Scientific rationale for the monitoring site selection process.

The rationale for including an existing well, or adding a new well, into the groundwater level monitoring network includes the following:

- *The monitoring point contributes to meeting the minimum density necessary within the EKGSA.*
- *The monitoring point contributes to the minimum density of wells in a township/range.*
- *The monitoring point has performed adequately to provide information for annual reporting, groundwater contour maps, and estimation of storage change. A prolonged period of record is important to compare interpretations of historical data to future interpretations.*
- *Construction information for the well, including total completed depth and the perforated interval(s), is known.*
- *Access to the well is unrestricted and/or permission to access the monitoring point can be obtained.*
- *Dedicated monitoring wells are preferable to production wells, where feasible.*

4.3.3.3 Identification of Data Gaps

Legal Requirements:
§354.38(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.
§354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:
1) *The location and reason for data gaps in the monitoring network.*
2) *Local issues and circumstances that limit or prevent monitoring*

Existing groundwater-level monitoring has provided data to prepare groundwater contour maps and identify groundwater level trends over the decades. The existing monitoring system relies heavily on the member irrigation districts, but this only provides data for a portion of the EKGSA. To better represent hydraulic gradient and flow direction within the EKGSA, about seven wells should be strategically placed for regular monitoring in the EKGSA. **Figure 4-1** shows the approximate locations where additional monitoring wells are believed to be useful in accomplishing this goal and meeting the monitoring well density requirements set forth