

East Kaweah GSA

# Groundwater Sustainability Plan 2022 Revision

Submitted ~~January 2020~~ July 2022

Prepared for:  
East Kaweah Groundwater Sustainability Agency  
Tulare County

Prepared by:  
Provost & Pritchard Consulting Group  
400 E. Main Street, Suite 300, Visalia, CA 93291

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**Report Prepared for:**

**East Kaweah Groundwater Sustainability Agency**

PO Box 908  
Lindsay, CA 93247

**Contact:**

Mike Hagman, Executive Director  
(559) 562-2534

**Report Prepared by:**

**Provost & Pritchard Consulting Group**

Matthew Klinchuch, PE Project Manager  
Trilby Barton, Outreach Coordinator  
Abigail Bullard, GIT  
Morgan Campbell  
T Jeffcoach, PE  
Jordan Muell, EIT  
Shay Overton, PG, CHG  
Kimberly Sobin, EIT  
Linda Sloan, PG, CHG  
Jason Thomas, GIS  
Amy Wilson, Associate Planner

**Contact:**

Matthew Klinchuch  
(559) 636-1166



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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
<a href="#">CV-SALTS</a>	<a href="#">Central Valley Salinity Alternatives for Long-Term Sustainability</a>
CWC	California Water Code
DAC	Disadvantaged Communities
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

Acronyms & Abbreviations  
East Kaweah GSA

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GA	Groundwater Allocation
GEI	GEI Consultants, Inc.
GKGSAA	Greater Kaweah Groundwater Sustainability Agency
GMT	Groundwater Marketing/Trading
GP	Groundwater Pumping Restrictions
GSA	Groundwater Sustainability 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 Hydrologic Model
LID	Lindmore Irrigation District
LSID	Lindsay-Strathmore Irrigation District
LU	Land Use
MCL	Maximum Contaminant Level
MGD	million gallons per day
MKGSAA	Mid-Kaweah Groundwater Sustainability Agency
<u>MO</u>	<u>measurable objective</u>
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
<u>SAFER</u>	<u>Safe and Affordable Funding for Equity and Resilience</u>
SB	Senate Bill
SCID	Stone Corral Irrigation District
SDAC	severely disadvantaged communities
SDWA	Safe Drinking Water Act

Acronyms & Abbreviations  
East Kaweah GSA

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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 (EKGSAs) is a joint powers authority ~~agency~~ 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 EKGSAs 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 EKGSAs 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 EKGSAs ~~will be looking to work~~ 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 \(SMCs\). EKGSAs was given 180 days to address the identified deficiencies. This revised EKGSAs 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 EKGSAs 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.

EKGSAs covers approximately 117,300 acres. Beneficial users within the plan area were identified ~~with~~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 EKGSAs boundary, based on information available from the Well Completion Report (WCR) database. In the EKGSAs 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**. 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

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, GK GSA and MK GSA 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.
- Application of the Kaweah Subbasin Hydrologic Model (KSHM) – incorporating the initial selection of projects and management actions by the Subbasin GSAs – and its simulation output is summarized in the Subbasin Coordination Agreement to help explain how the sustainability goal is to be achieved within 20 years of GSP implementation.
- 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.

~~The Kaweah Subbasin's sustainability goal is for each GSA to manage groundwater resources to preserve the viability of existing agricultural enterprises of the region, domestic wells, and 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 portions of Kings County. The sustainability goal was derived from Basin Settings, Kaweah Subbasin Hydrologic Model (KSHM), historical and current groundwater conditions, and the water budget. This goal will be achieved via combined implementation of EKGSA, CKGSA, and MKGSA GSPs. Specifically, all GSPs are designed to identify phased implementation of projects and management actions to reduce long term groundwater overdraft.~~

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*

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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 using the 2040 minimum threshold groundwater level projections~~ 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. ~~The threshold region delineation process focused on combining areas mimicking similar hydrogeologic behavior (corroborated by historical data) in response to climate and pumping regime experienced during the base period (1997–2017).~~ ~~By determining m~~ Minimum thresholds were then developed to be protective of based from projecting hydrogeologic data over the base period on protecting at least 90% of all completed water supply well depths in each threshold region. ~~In cases where projected groundwater levels set at the 90% well 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~~ The EKGSA also intended to capture the intricate nuances of relationships between threshold regions 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** 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.

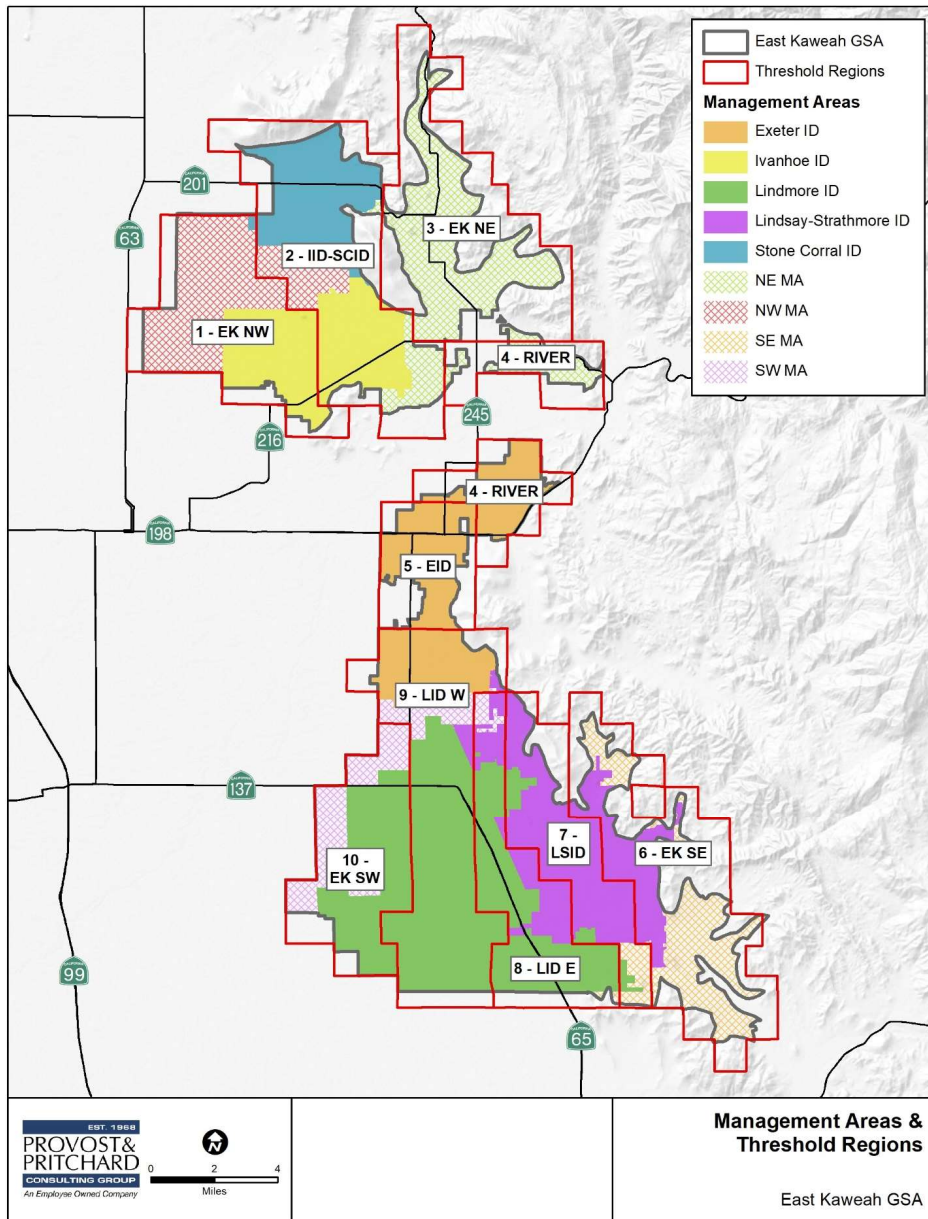


Figure ES-1 Map of EKGSA Management Areas and Overlapping Threshold Regions

### 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, 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 quantitative 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](#).

Table ES-1. Sustainable management criteria overview for the EK GSA

<u>Sustainability Indicator</u>	<u>GW Elevation</u>	<u>GW Storage</u>	<u>SW-GW Connection</u>	<u>GW Quality</u>	<u>Land Subsidence</u>
<u>Undesirable Result</u>	<u>Unreasonable lowering of groundwater levels resulting in significant impacts to supply wells</u>	<u>Unreasonable reduction in groundwater storage</u>	<u>Unreasonable depletion of interconnected surface waterways, where present</u>	<u>Unreasonable long-term changes of water quality concentrations from baseline conditions to significantly impact users of groundwater</u>	<u>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</u>
<u>Measurement Methodology</u>	<u>Groundwater Levels</u>	<u>Groundwater Levels (Proxy)</u>	<u>Surface water depletion rate</u>	<u>Sampling for 3 COCs at Ag wells in Monitoring Network; Utilize public system Title 22 quality monitoring</u>	<u>Annual survey of set Mile Posts along the FKC and InSAR data when available and Plainview well point</u>
<u>Minimum Threshold</u>	<u>The most protective groundwater level in a threshold region based on a level protective of at least the 90<sup>th</sup> percentile of all water supply wells and not allowing higher rates of historical groundwater decline experienced between 1997-2017</u>	<u>The most protective groundwater level in a threshold region based on a level protective of at least the 90<sup>th</sup> percentile of all water supply wells and not allowing higher rates of historical groundwater decline experienced between 1997-2017</u>	<u>More than 50% losses in interconnected surface waterways when water is present</u>	<u>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</u>	<u>9.5" of subsidence in a year and cumulative (relate to no more than 10% capacity reduction in current capacity of the FKC)</u>
<u>Measurable Objective</u>	<u>Spring 2017 groundwater levels</u>	<u>Spring 2017 groundwater levels</u>	<u>Equal to or less than 30% losses in interconnected surface waterways when water is present</u>	<u>No unreasonable increase in concentration caused by groundwater pumping and recharge efforts</u>	<u>No subsidence throughout the GSA</u>
<u>Interim Milestones</u>	<u>Proportionate to % of overdraft to be corrected in 5-year intervals through implementation period</u>	<u>Proportionate to % of overdraft to be corrected in 5-year intervals through implementation period</u>	<u>Proportionate to % of overdraft to be corrected in 5-year intervals through implementation period</u>	<u>No change from current Objective (re-evaluate at the 5-year milestone pending data collection)</u>	<u>No change from current objective</u>
<u>Sustainability Indicator</u>	<u>GW Elevation</u>	<u>GW Storage</u>	<u>SW-GW Connection</u>	<u>GW Quality</u>	<u>Land Subsidence</u>

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<b>Undesirable Result</b>	Unreasonable lowering of groundwater levels resulting in significant impacts to supply	Unreasonable reduction in groundwater storage	Unreasonable depletion of interconnected surface water and groundwater, where present	Unreasonable long-term changes of water quality concentrations from baseline conditions to significantly impact users of groundwater	Unreasonable impacts to critical infrastructure (i.e. Friant-Kern Canal)
<b>Measurement Methodology</b>	Groundwater Levels	Groundwater Levels (Proxy)	Groundwater Levels (Proxy)	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
<b>Minimum Threshold</b>	2040 Projected GW elevation based on the baseline (1997-2017) trend analysis of GW levels at wells throughout the GSA (10-Threshold Regions)	2040 Projected GW elevation based on the baseline (1997-2017) trend analysis of GW levels at wells throughout the GSA (10-Threshold Regions)	2040 Projected GW elevation based on the baseline (1997-2017) trend analysis of GW levels at wells throughout the GSA (10-Threshold Regions)	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)
<b>Measurable Objective</b>	Spring 2017	Spring 2017	Spring 2017	No unreasonable increase in concentration caused by groundwater pumping and recharge efforts.	No subsidence/impacts to CVP deliveries along the FKC related to groundwater pumping within the EK GSA
<b>Interim Milestones</b>	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 overdraft 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 ~~and interconnected surface water~~ 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](#).

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
Percblorate	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](#) 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

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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.



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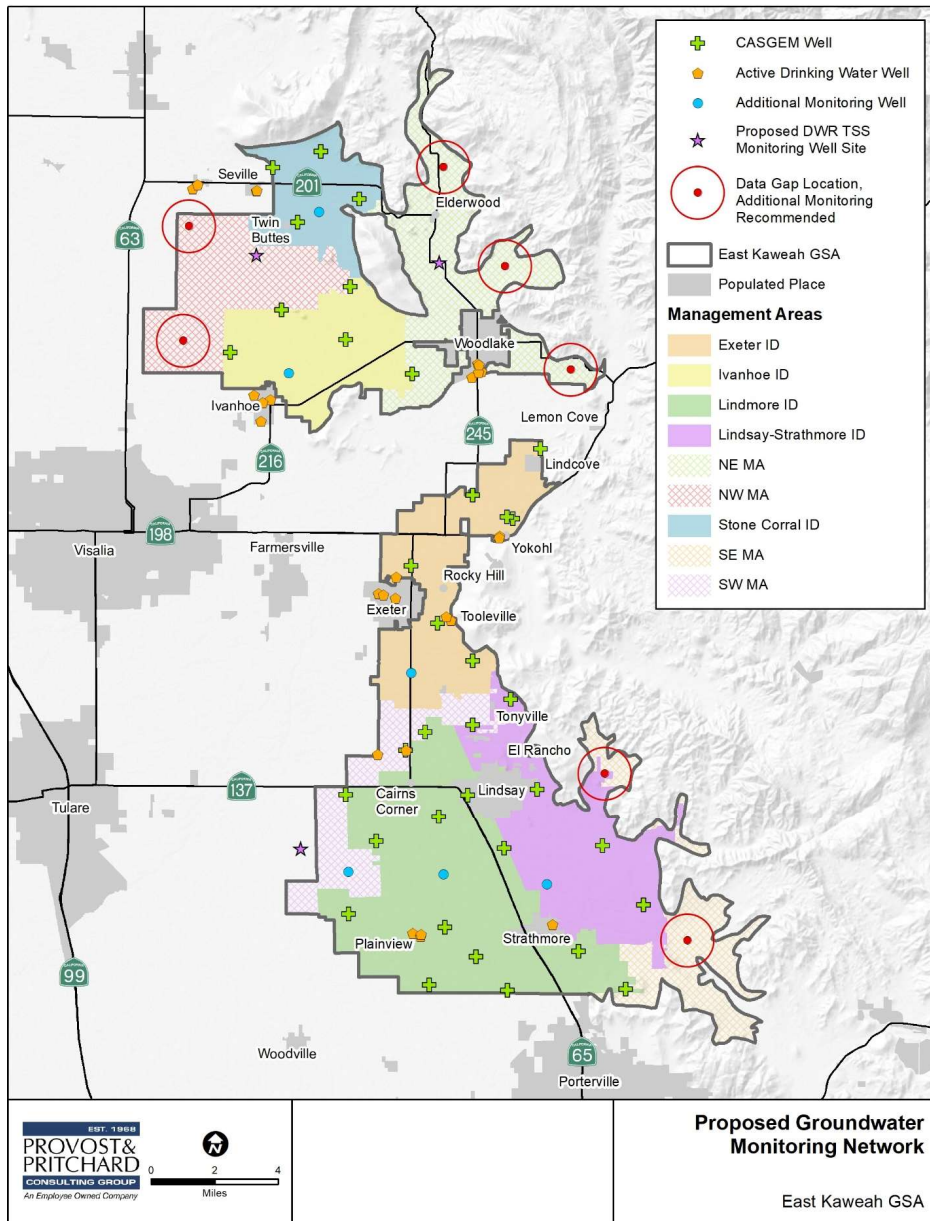


Figure ES-2 Initial EKGSA Groundwater Monitoring Network

## 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** 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** represents the estimated glide path to sustainability for the EKGSA, shown as cumulative mitigation.

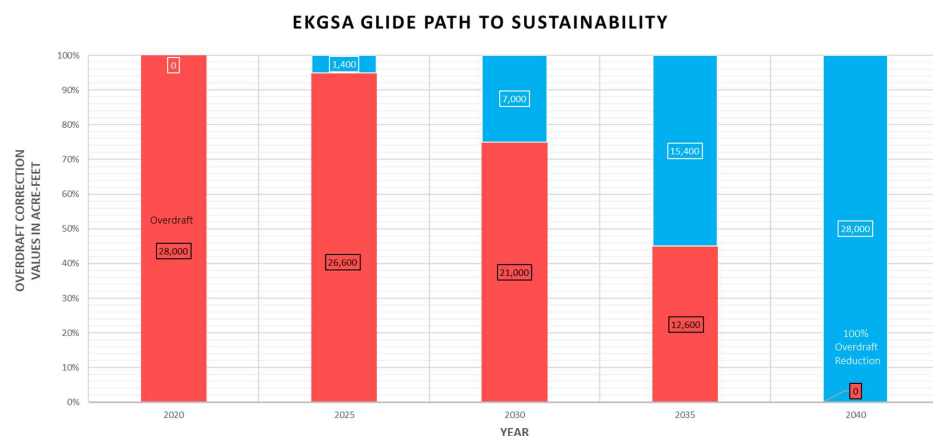


Figure ES-3 EKGSA Glide Path to Sustainability

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 ongoing 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](http://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 [and Montgomery and Associates \(M&A\) and Provost & Pritchard for coordinated revisions across the Coordination Agreement and Groundwater Sustainability Plans \(GSP\) revisions](#). The EKGSA has additionally contracted with Provost & Pritchard for the preparation of ~~its this~~ [Groundwater Sustainability Plan \(GSP\)](#). 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 Subbasin 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 [address how it 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 disciplines and interests, committee members were appointed via application process which identified

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### East Kaweah GSA

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 and 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.

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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 <sup>1</sup> ).
Management Actions/Programs	The EKGSA will implement various management polices to manage, monitor, and correct overdraft conditions <a href="#">and fill data gaps</a> to reach sustainability	<del>\$880,000</del> ~\$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)

<sup>1</sup> 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

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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.

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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%
<b>No deficiencies on water deliveries 1978-1989</b>			
1977	25%	0%	22%

\*UcS indicates Uncontrolled Season

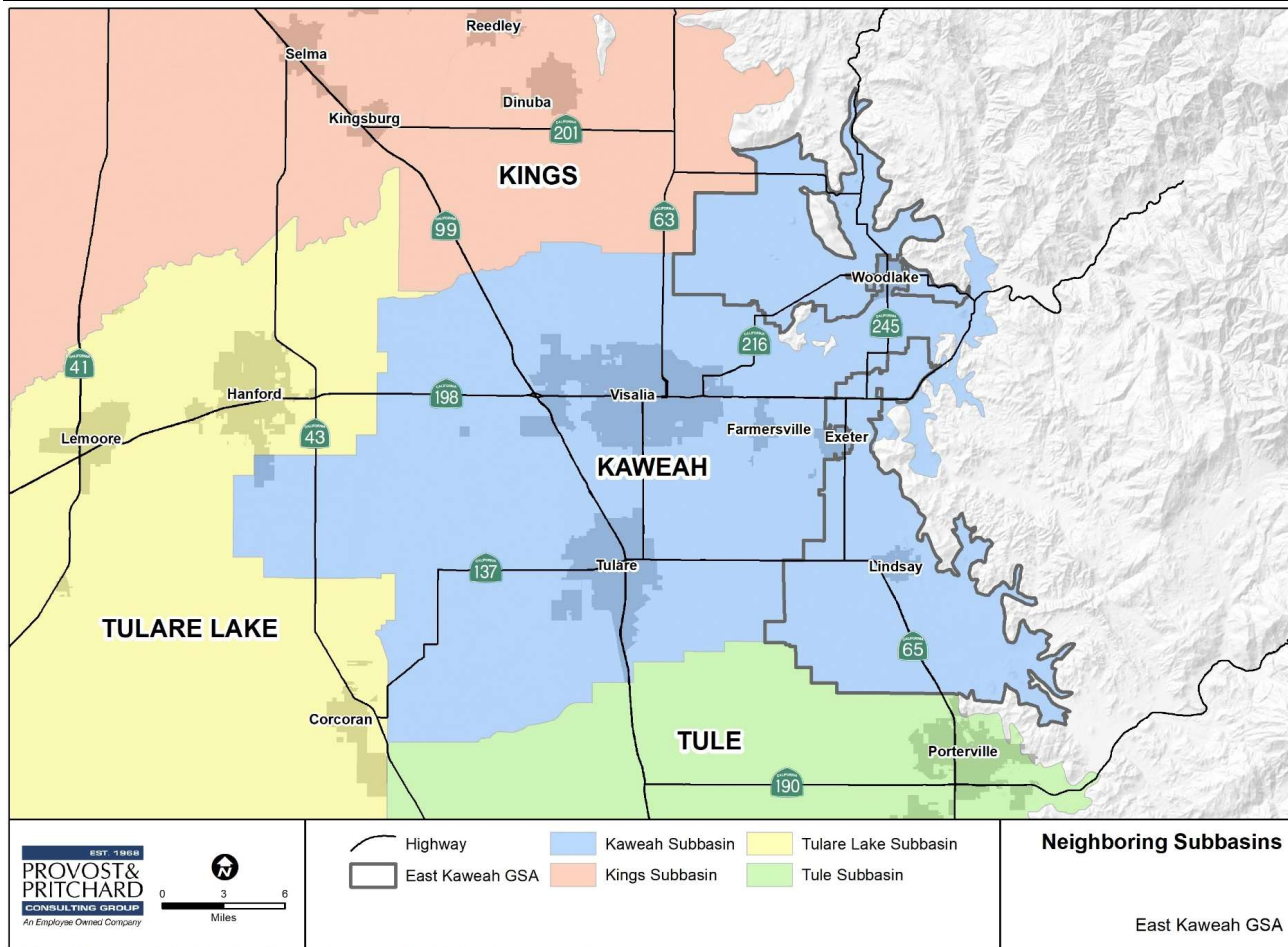


Figure 1-1 Groundwater Subbasins

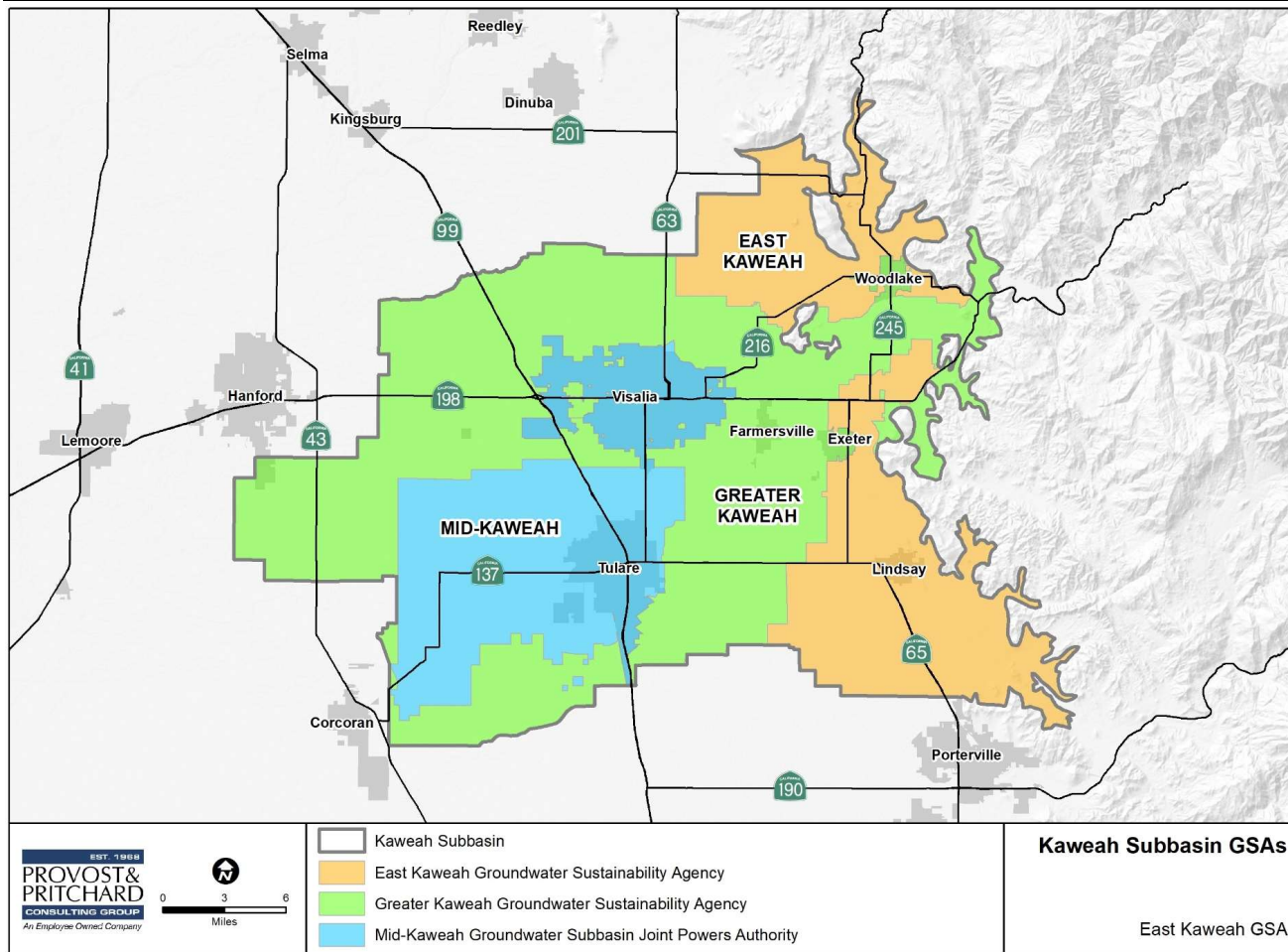


Figure 1-2 Groundwater Sustainability Agencies

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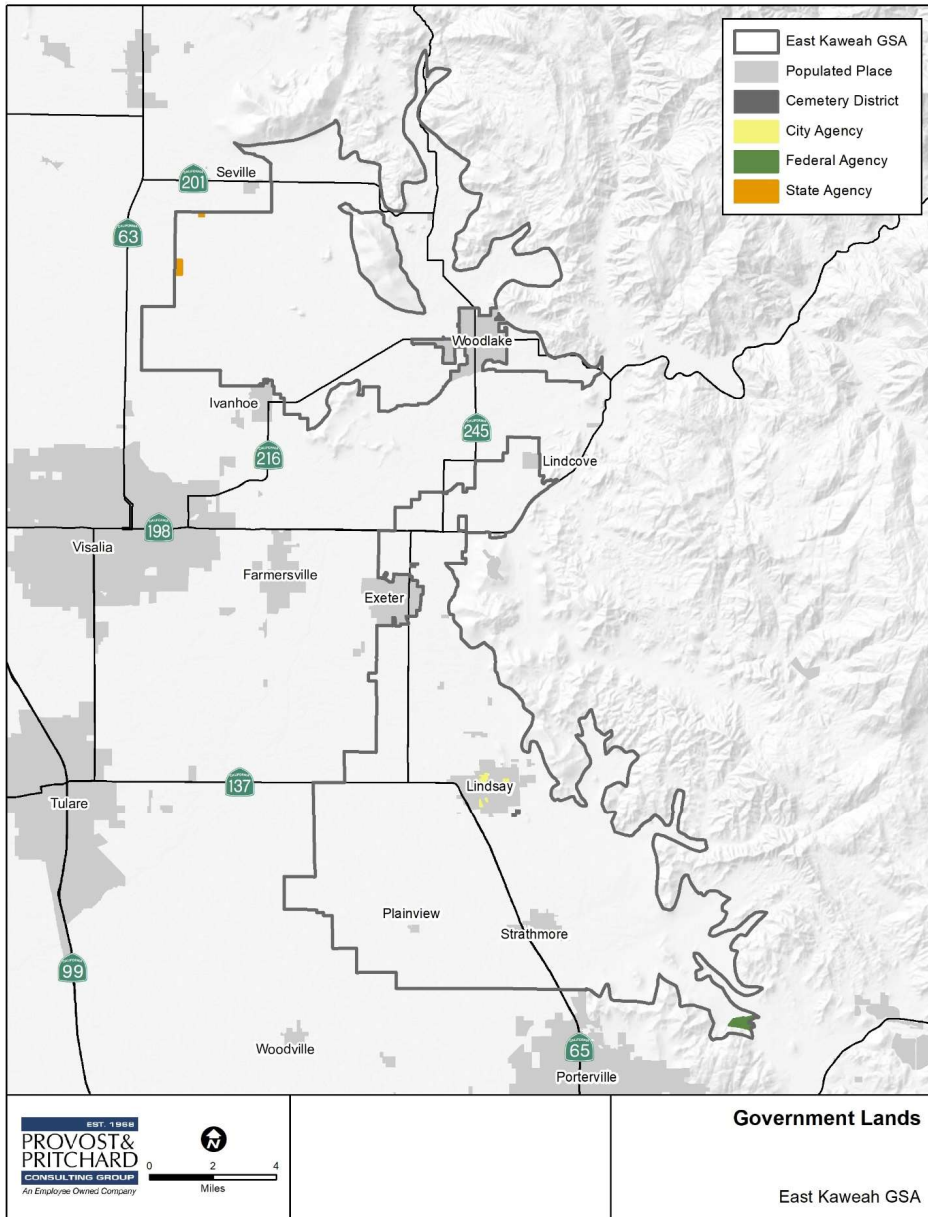


Figure 1-3 Government Lands



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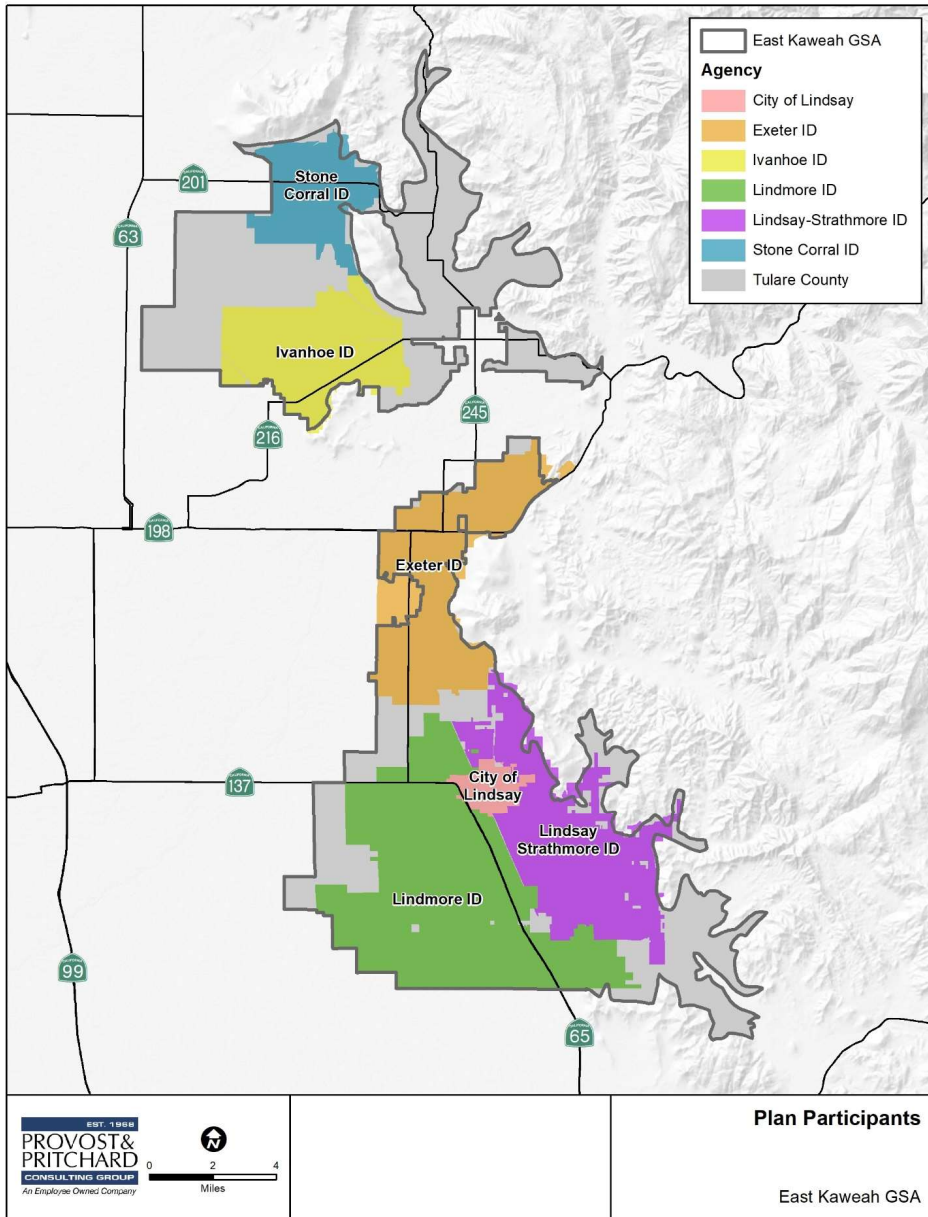


Figure 1-4 EKGSA Plan Participants

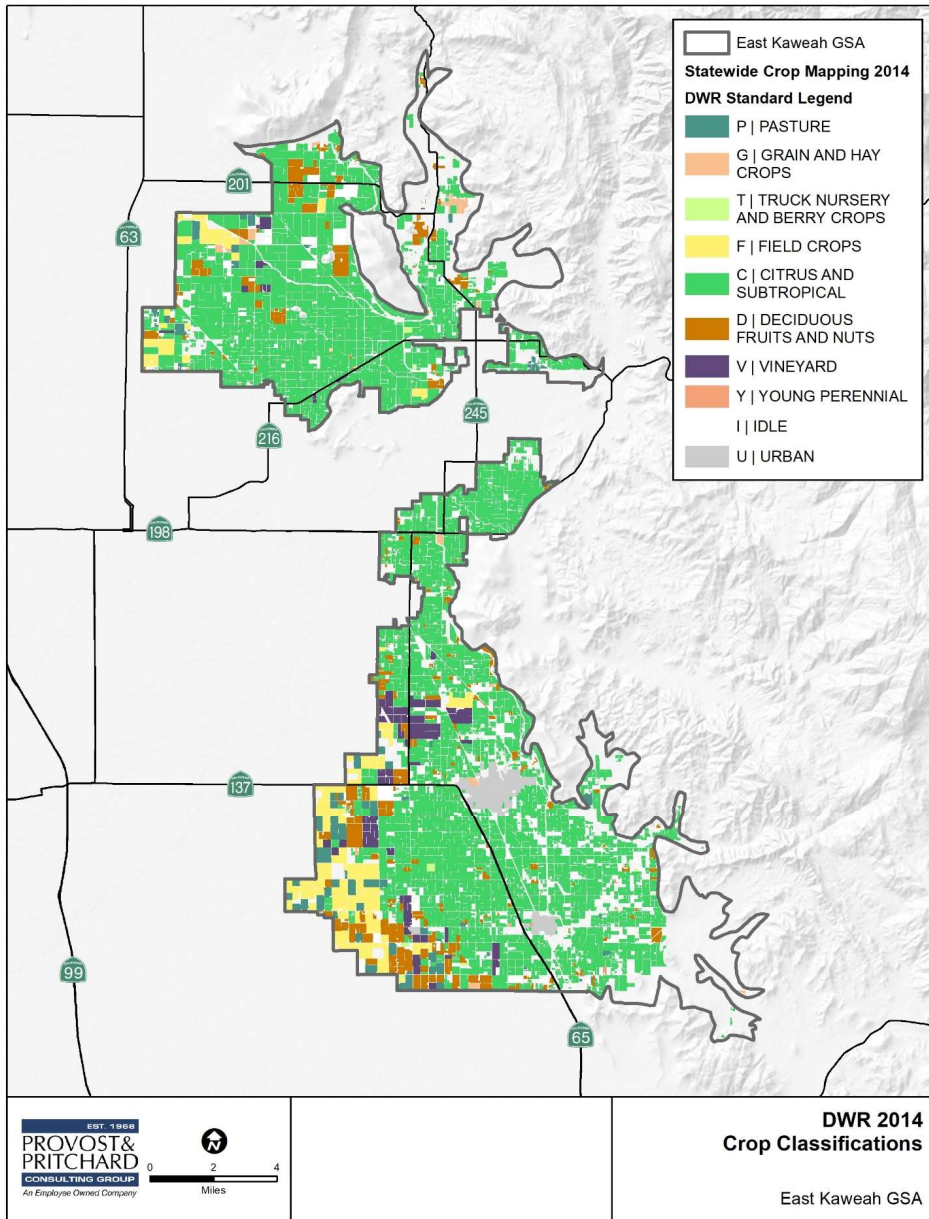


Figure 1-5 EKGSA Land Use

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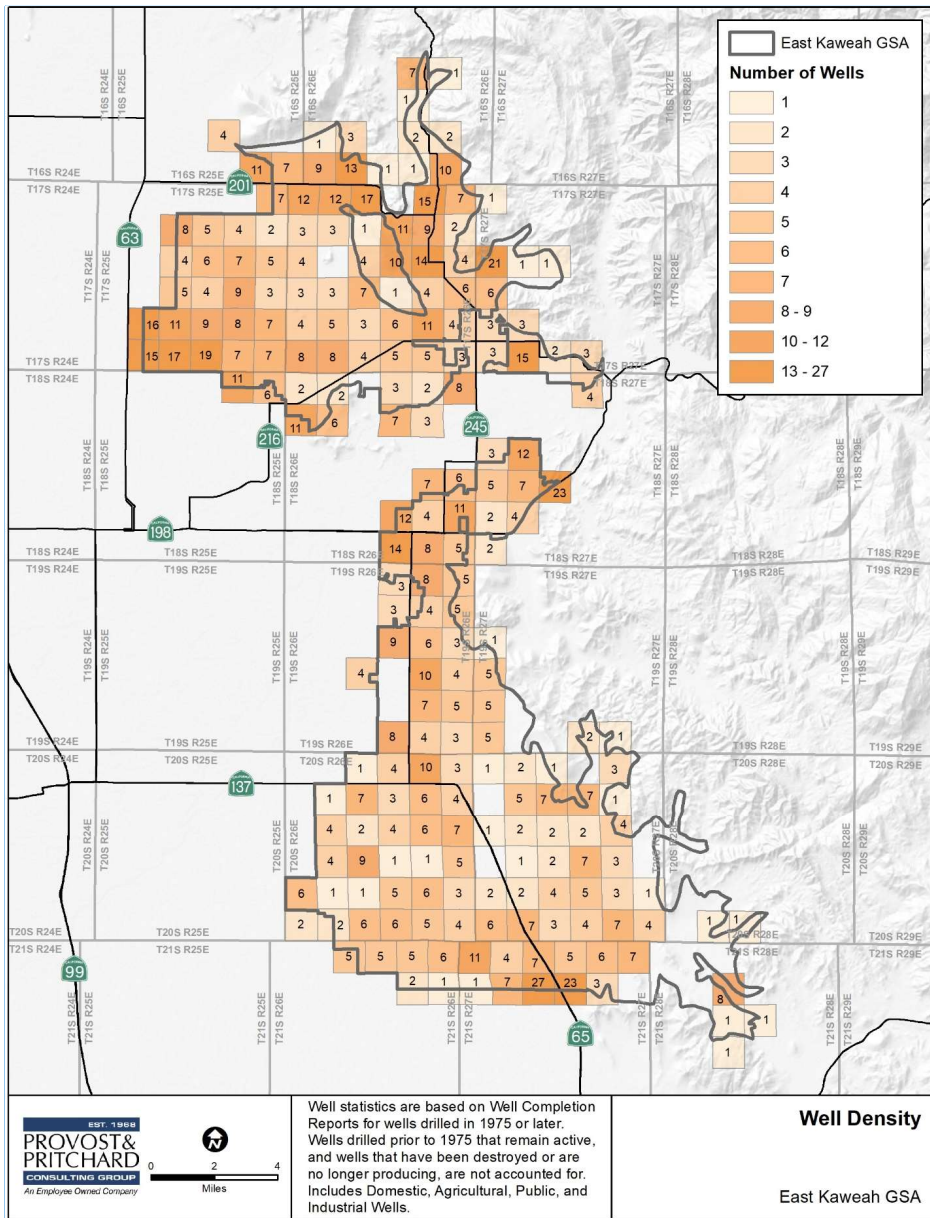


Figure 1-6 Well Density

Commented [MC1]: Pending GIS updates

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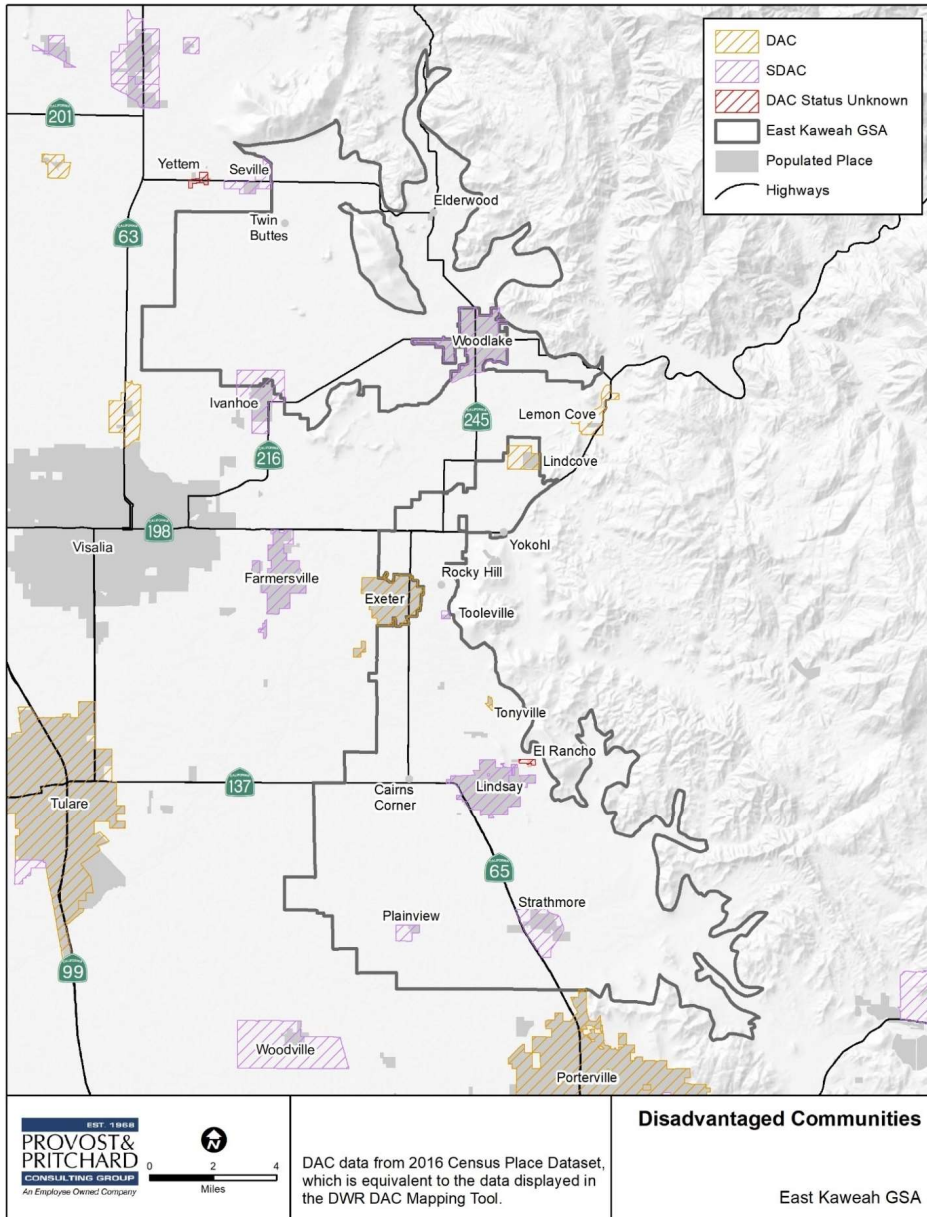


Figure 1-7 S/DAC in the EKGSA

### 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.

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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
<b>WATER SUPPLY</b>	
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
<b>WATER SUPPLY</b>	
PFS-2.5	New Systems or Individual Wells
<b>WATER QUALITY</b>	
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 uses 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/DW\\_SAP\\_document.pdf](http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/Documents/DWSAPGuidance/DW_SAP_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 Wutchurna 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

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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 Well Observation Program with review and input from drinking water users and representatives. The intent of this program would be to evaluate conditions of drinking water wells, investigate potential impacts, and distribute information to drinking well users within the EKGSA. This program will be useful in further development of a Drinking Water Well Protection Program that may be developed through management action implementation of this GSP.

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).

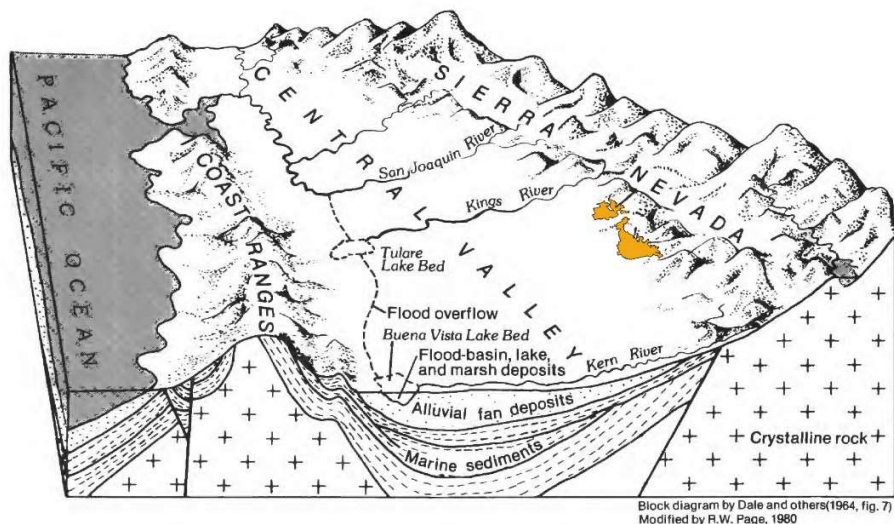


Figure 2-1 Isometric Block Diagram of the Central San Joaquin Valley

### 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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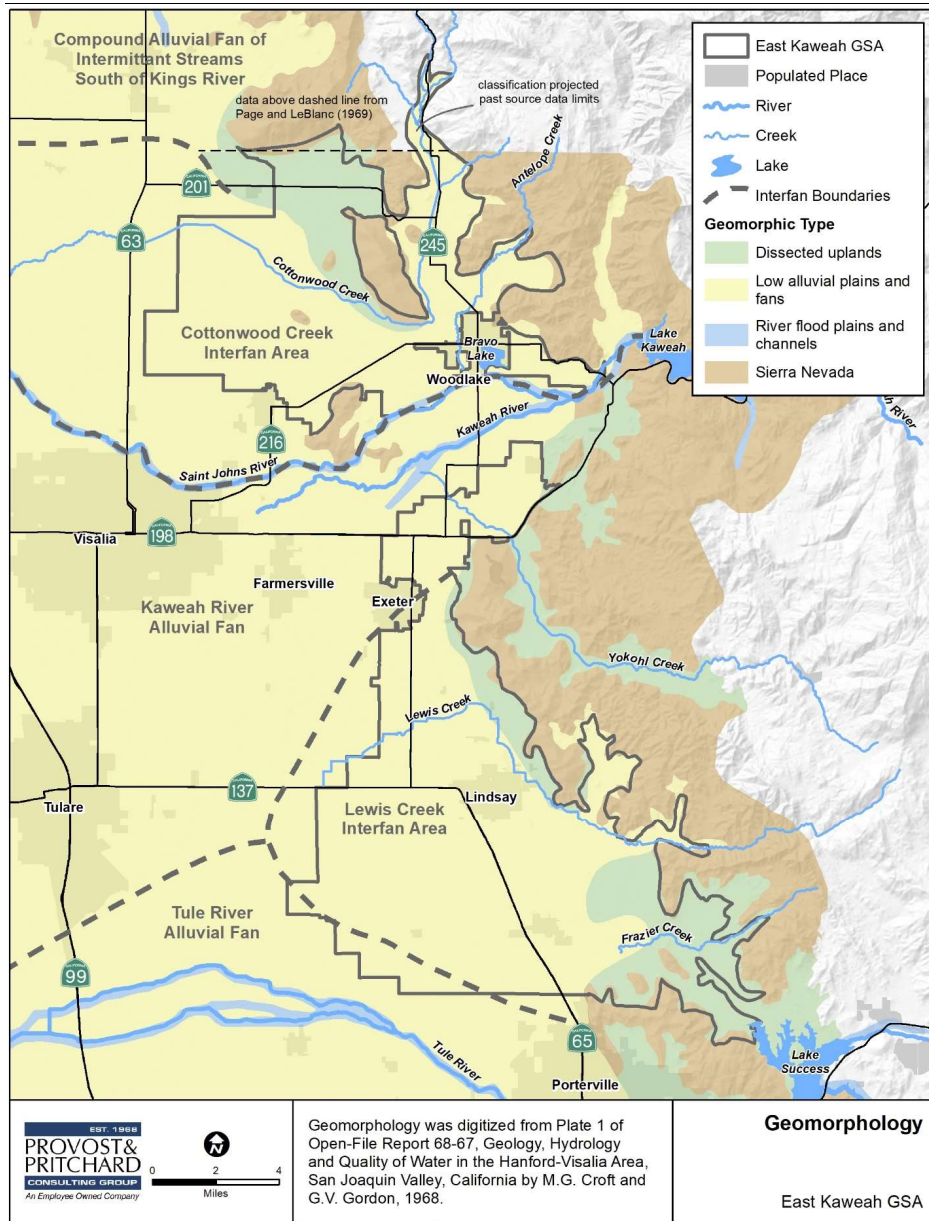


Figure 2-2 Geomorphic Features

Chapter Two: Basin Setting  
East Kaweah GSA

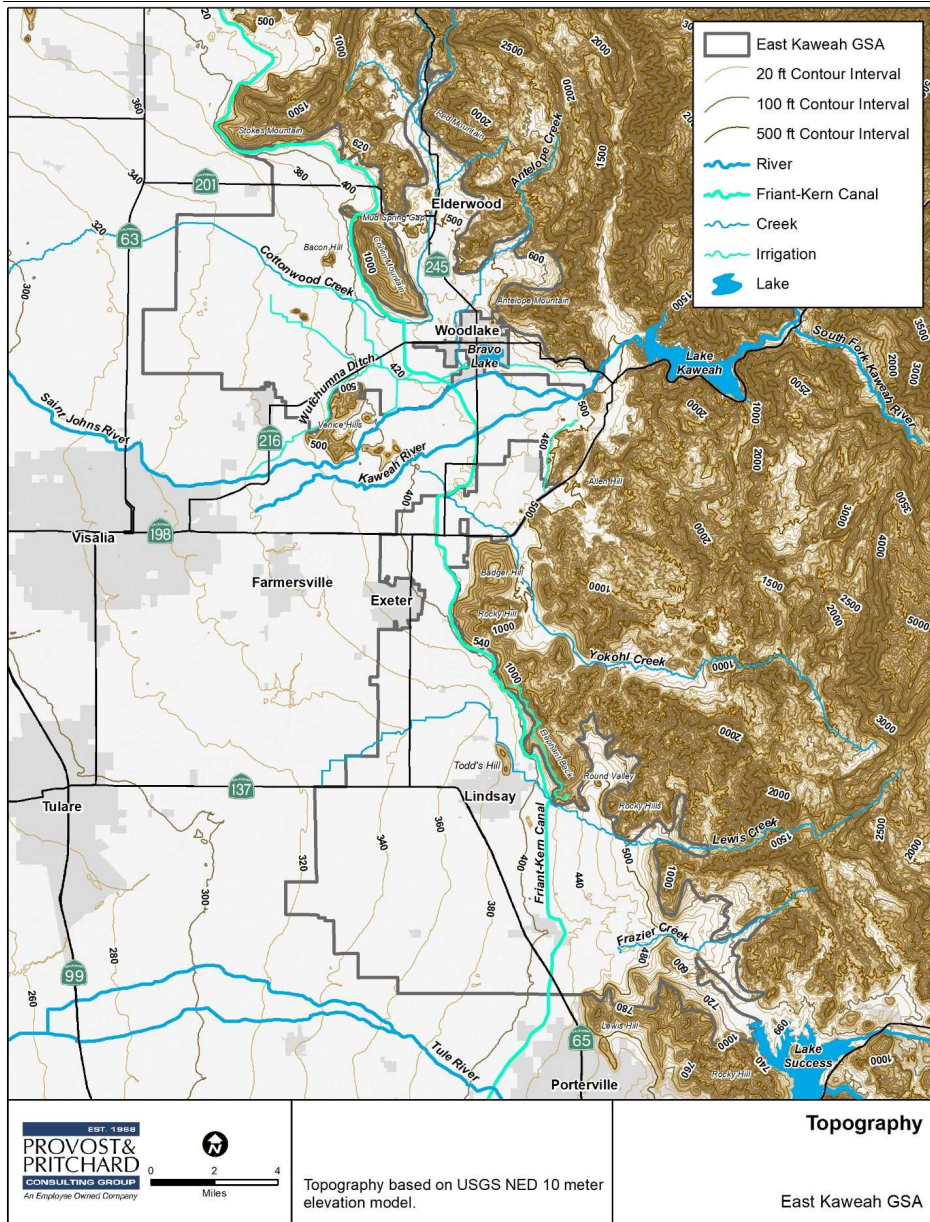


Figure 2-3 Topography



### 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	<b>Flood basin deposits (0 to 100 ft thick)</b> – 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. <b>River deposits (0 to 100 ft thick)</b> – 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.
Tertiary and Quaternary	<b>Lacustrine and marsh deposits (up to 3,600± ft thick)</b> – 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. <b>Continental rocks and deposits (15,000± ft thick)</b> – 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.	Principal confining unit (modified E Clay)
		Undifferentiated lower water-bearing zone; semiconfined to confined. Extends to base of freshwater which is variable.
Tertiary	<b>Marine rocks and deposits</b> – 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	<b>Crystalline basement rocks</b> – 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 – (QTI):** 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 (QTI), 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

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### East Kaweah GSA

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

## Chapter Two: Basin Setting

### East Kaweah GSA

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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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East Kaweah GSA

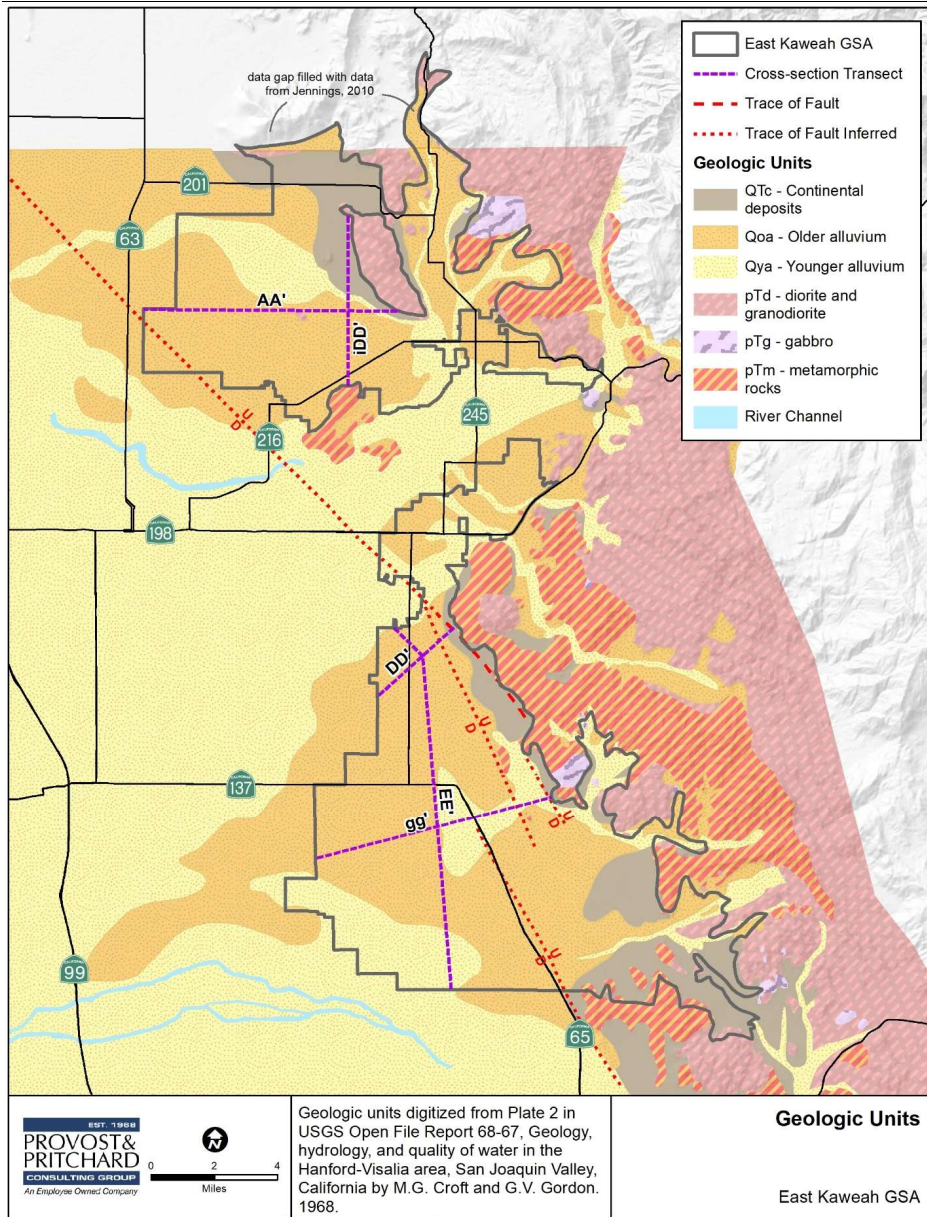


Figure 2-4 Geologic Units and Cross-Section Locations

### 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

## Chapter Two: Basin Setting East Kaweah GSA

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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.

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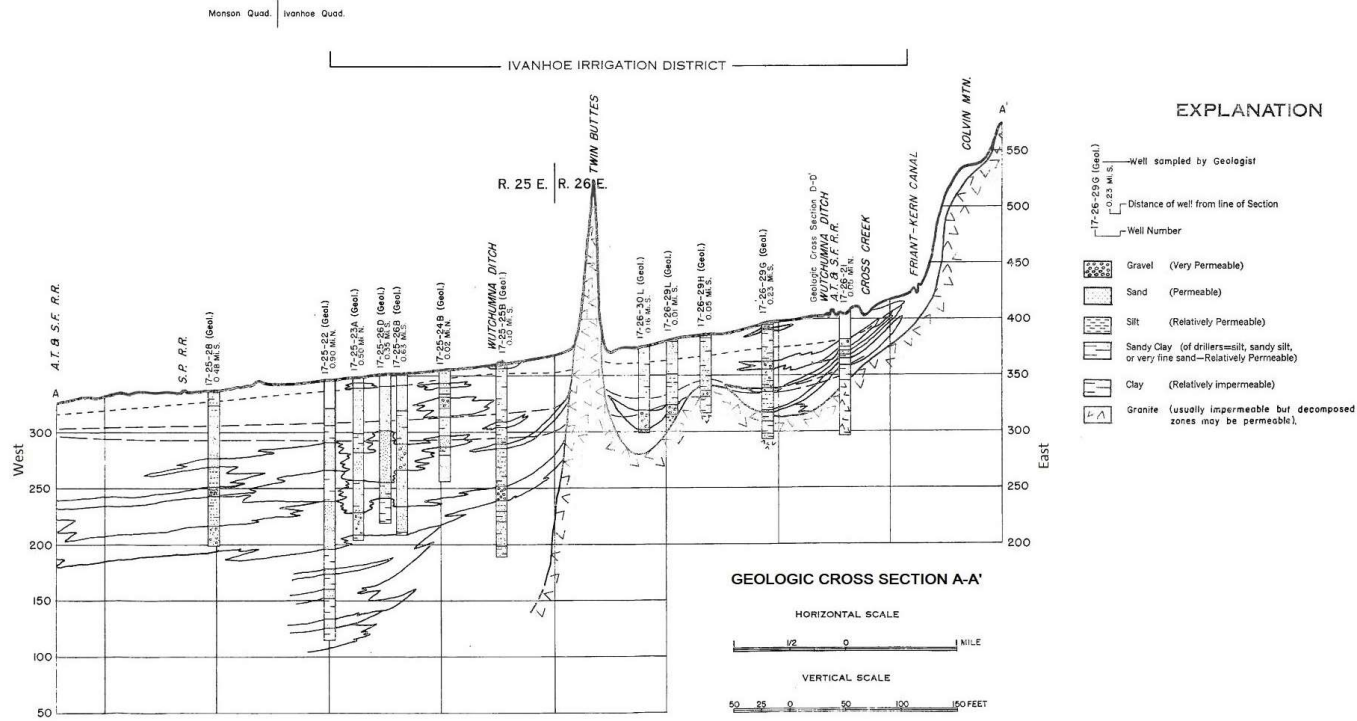


Figure 2-5 Regional Cross-Section AA', modified from Ivanhoe USBR Technical Report (1949)



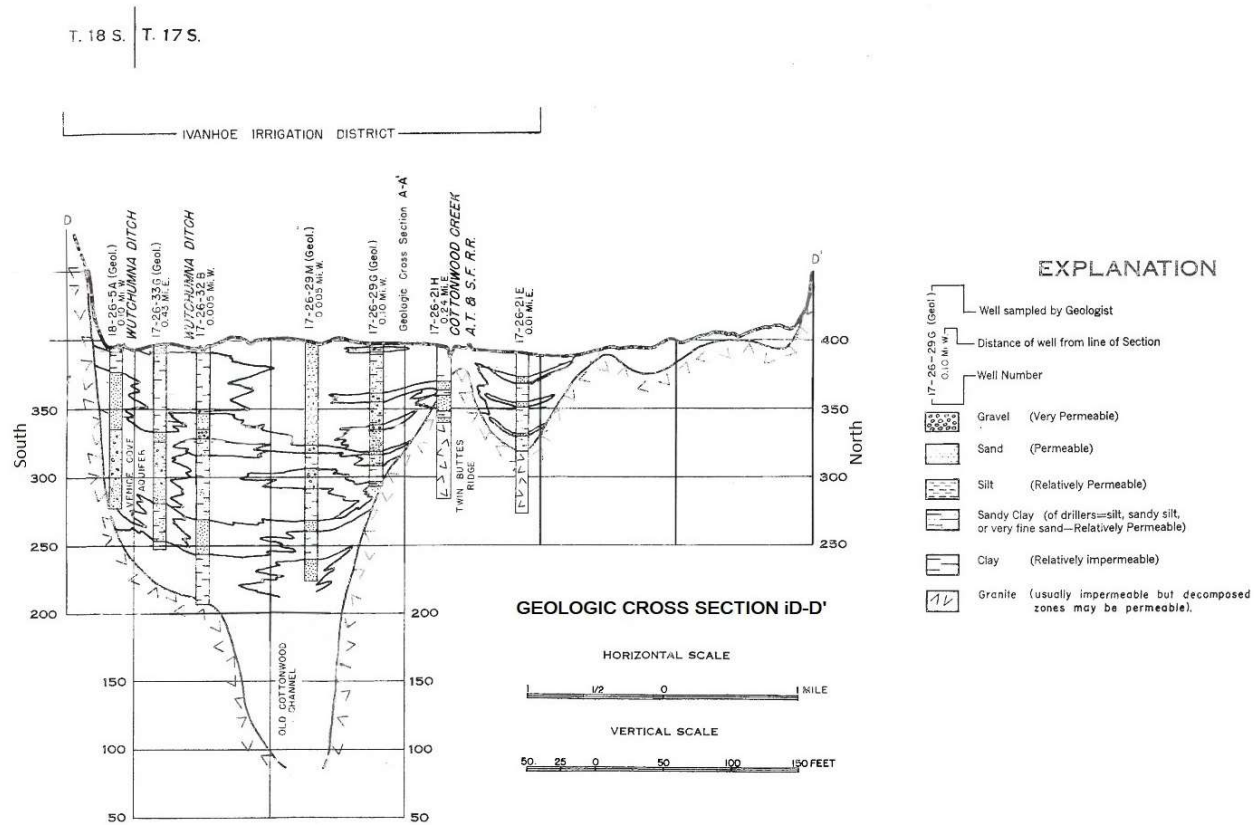


Figure 2-6 Regional Cross-Section iDD', modified from Ivanhoe USBR Technical Report (1949)

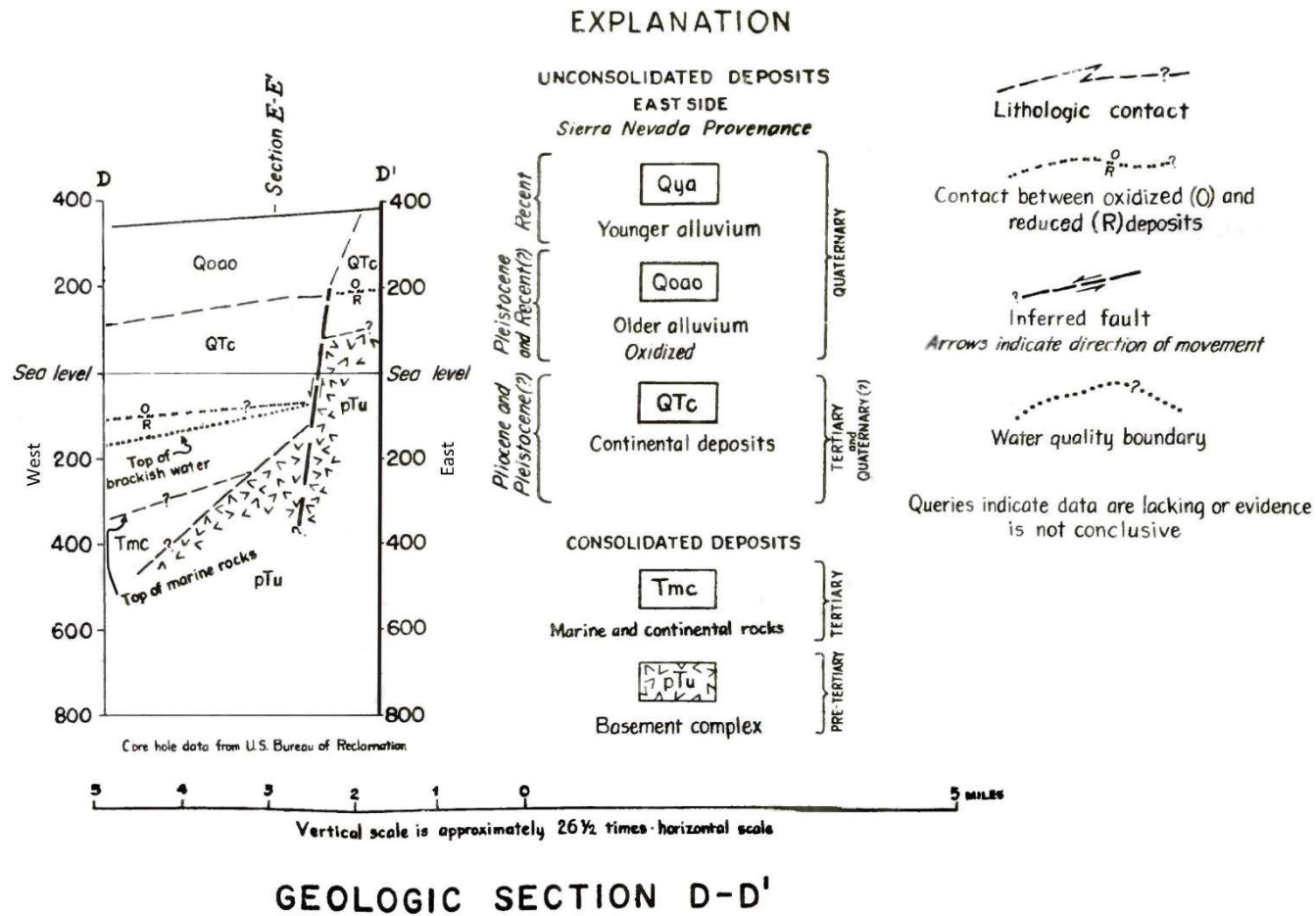


Figure 2-7 Regional Cross-Section DD', modified from Croft & Gordon (1968)

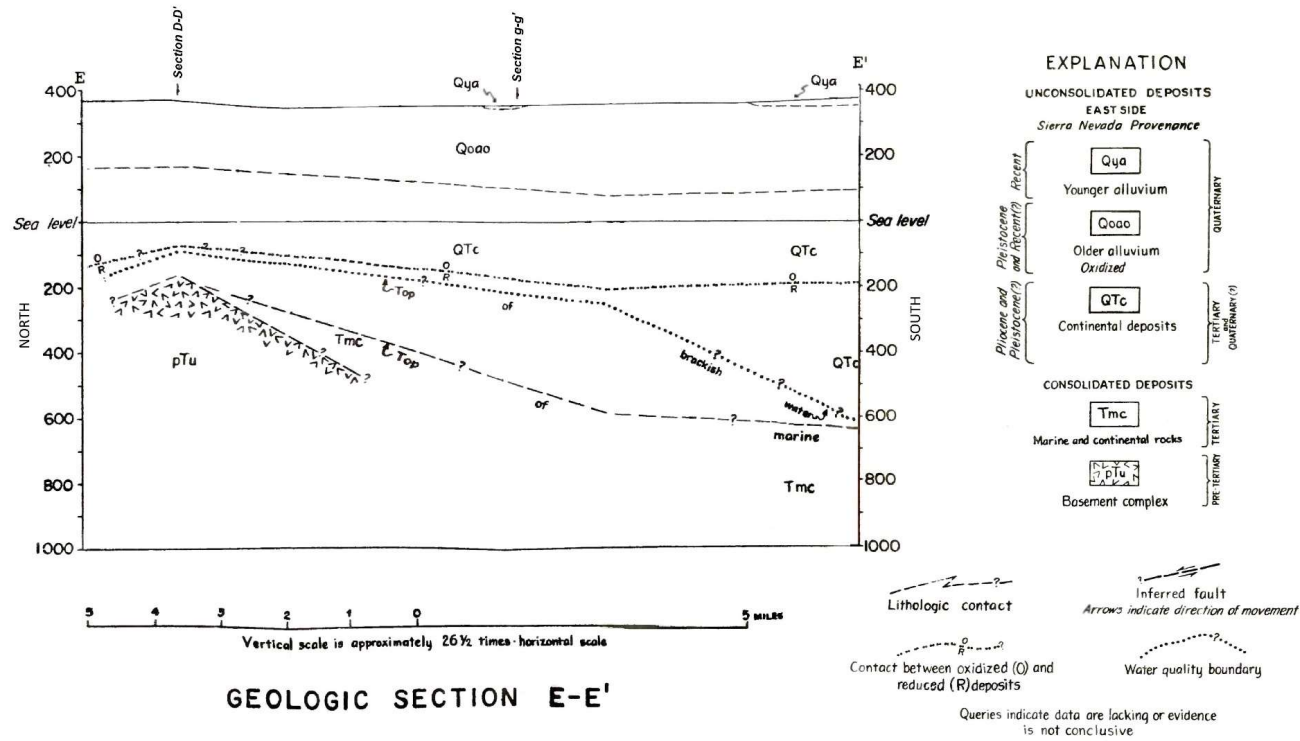


Figure 2-8 Regional Cross-Section EE', modified from Croft & Gordon (1968)

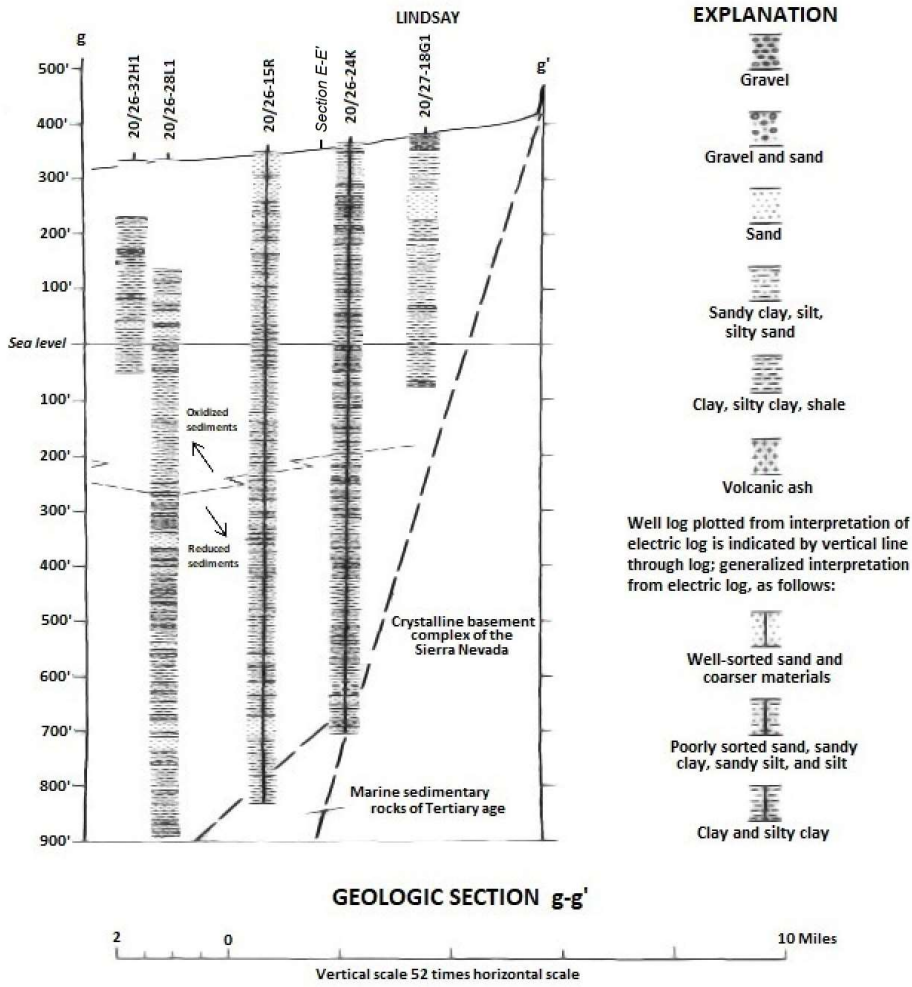


Figure 2-9 Regional Cross-Section gg', modified from Davis et al. (1959)

### 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.

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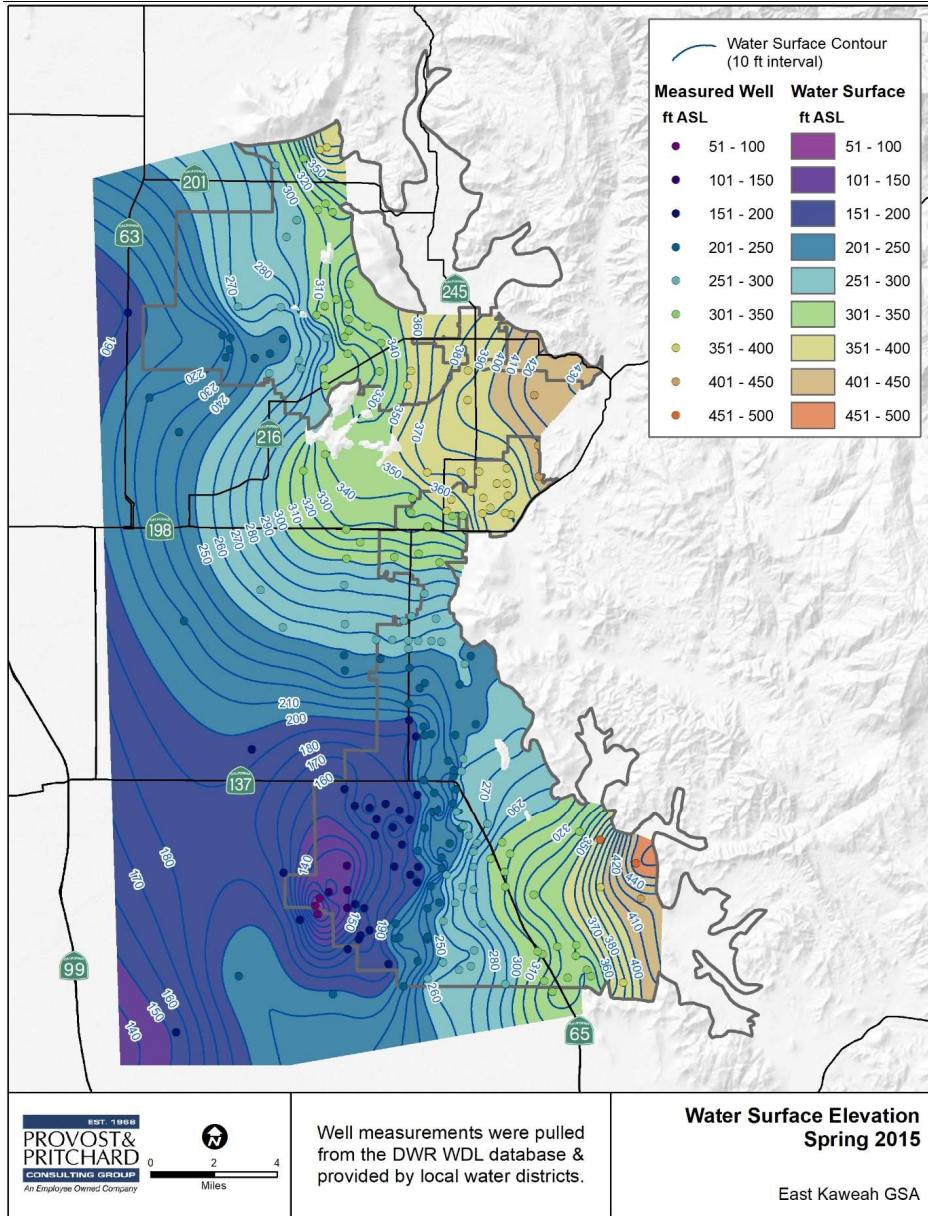


Figure 2-10 Generalized Groundwater Contour Map, Spring 2015

Chapter Two: Basin Setting  
East Kaweah GSA

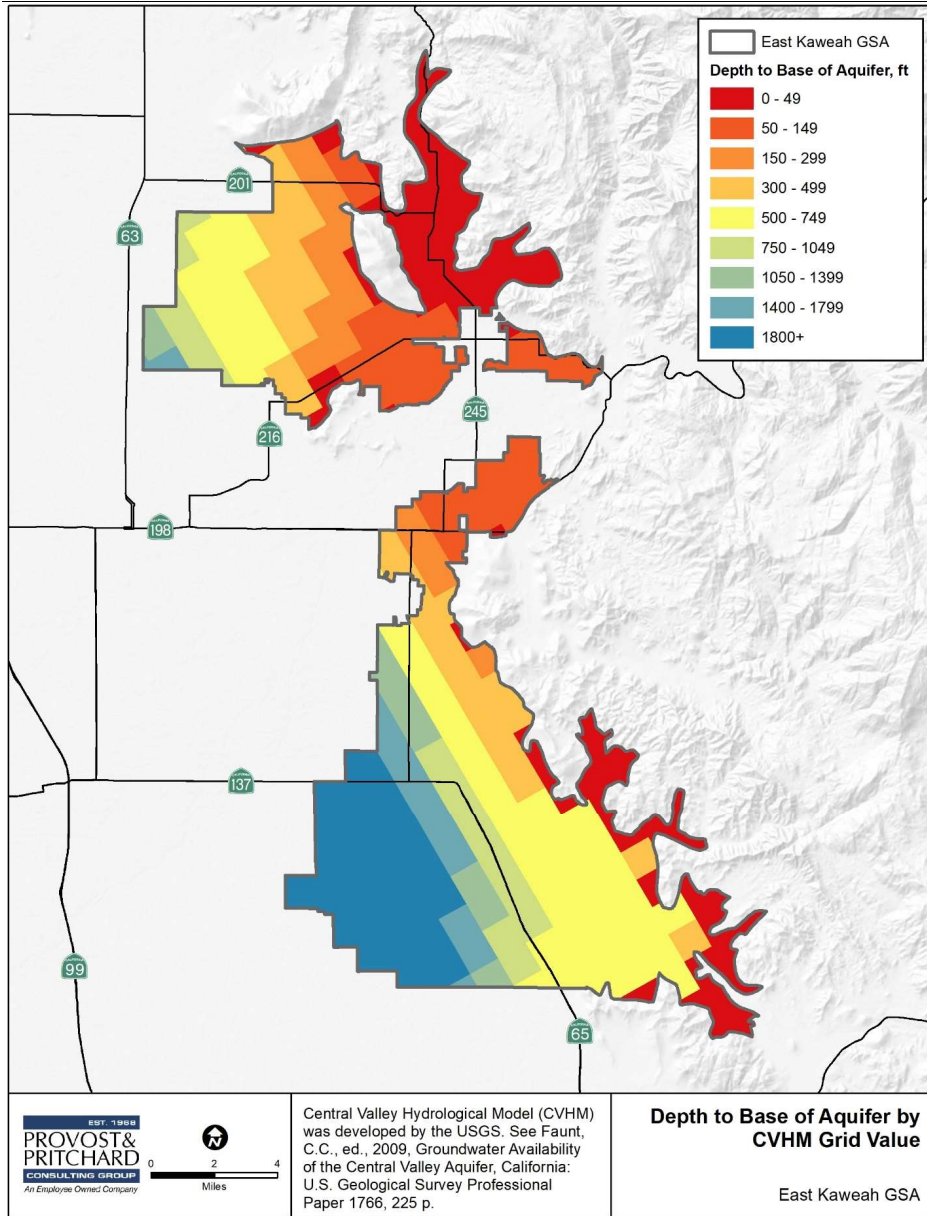


Figure 2-11 Base of Aquifer

## 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



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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.

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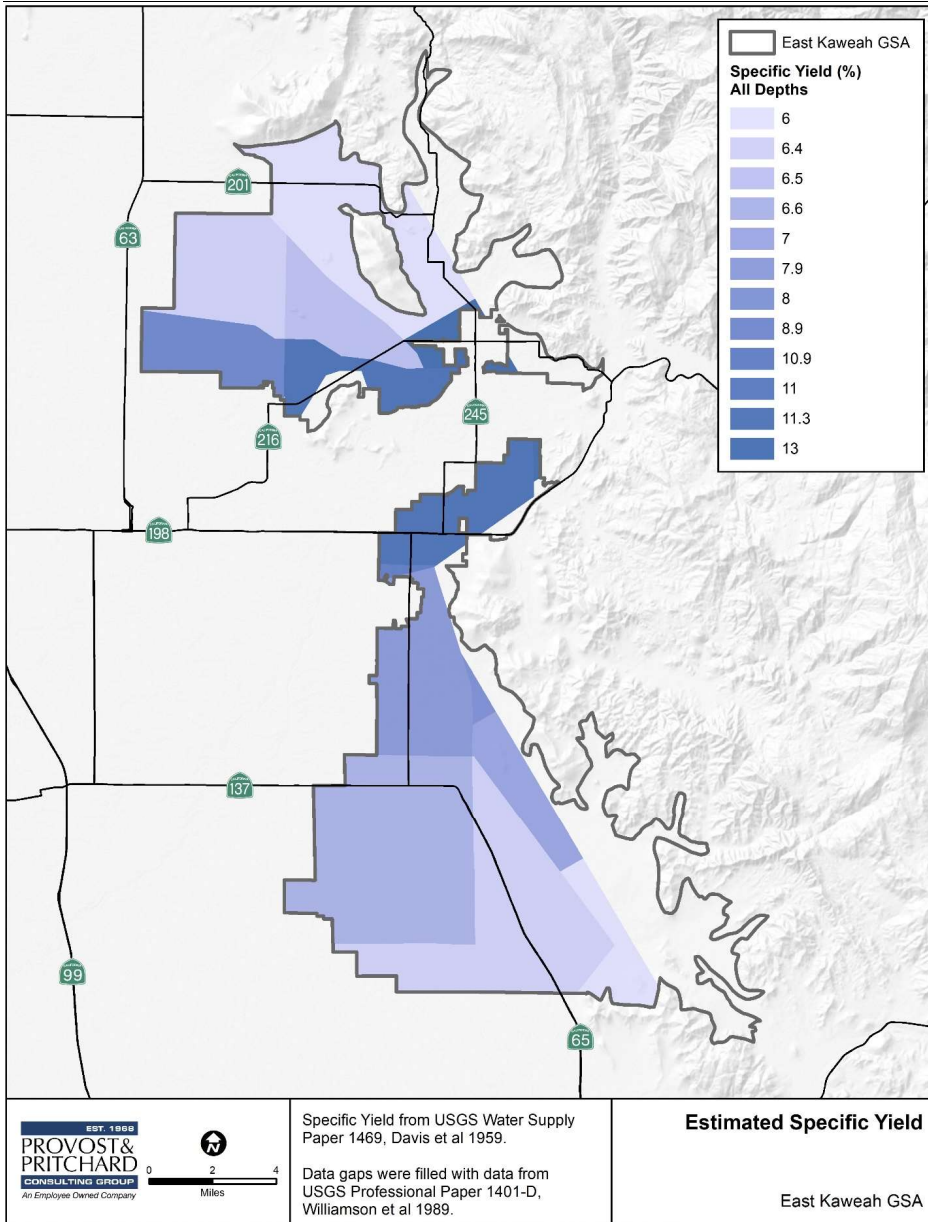


Figure 2-12 Estimated Specific Yields

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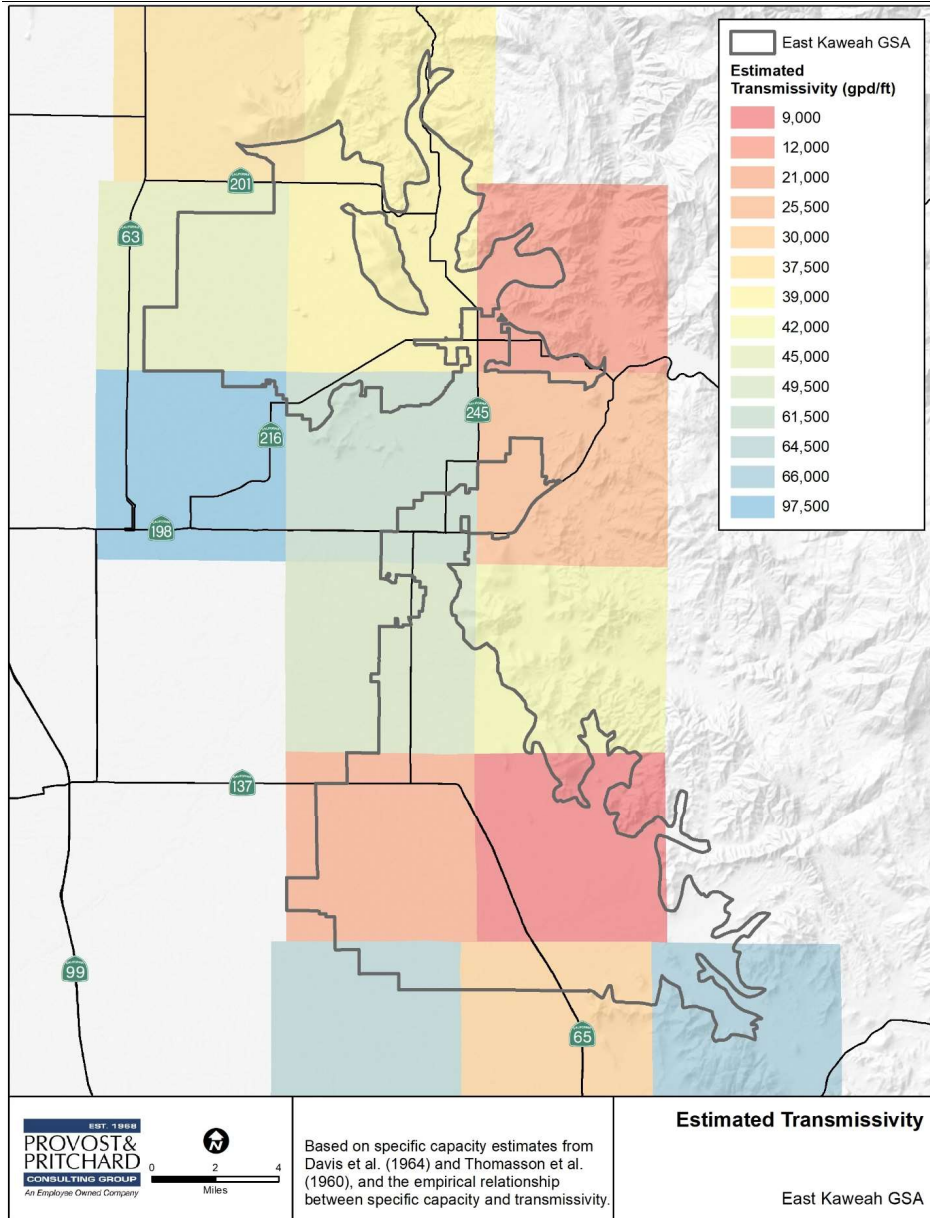


Figure 2-13 Estimated Transmissivity

### 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.

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### 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 through 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 \(Section 5.3.7\).](#)

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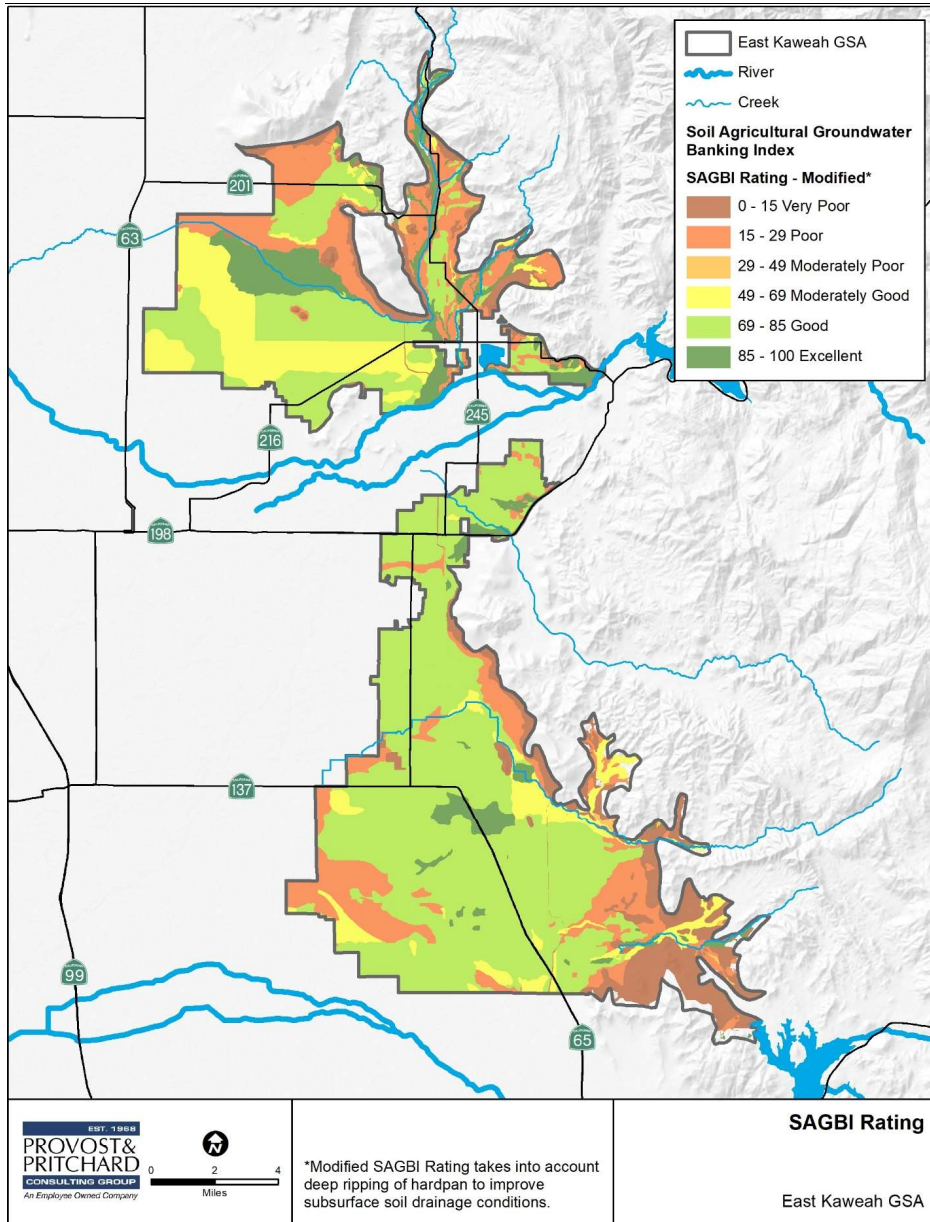


Figure 2-14 Modified Soil Agricultural Groundwater Banking Index (SAGBI) Rating

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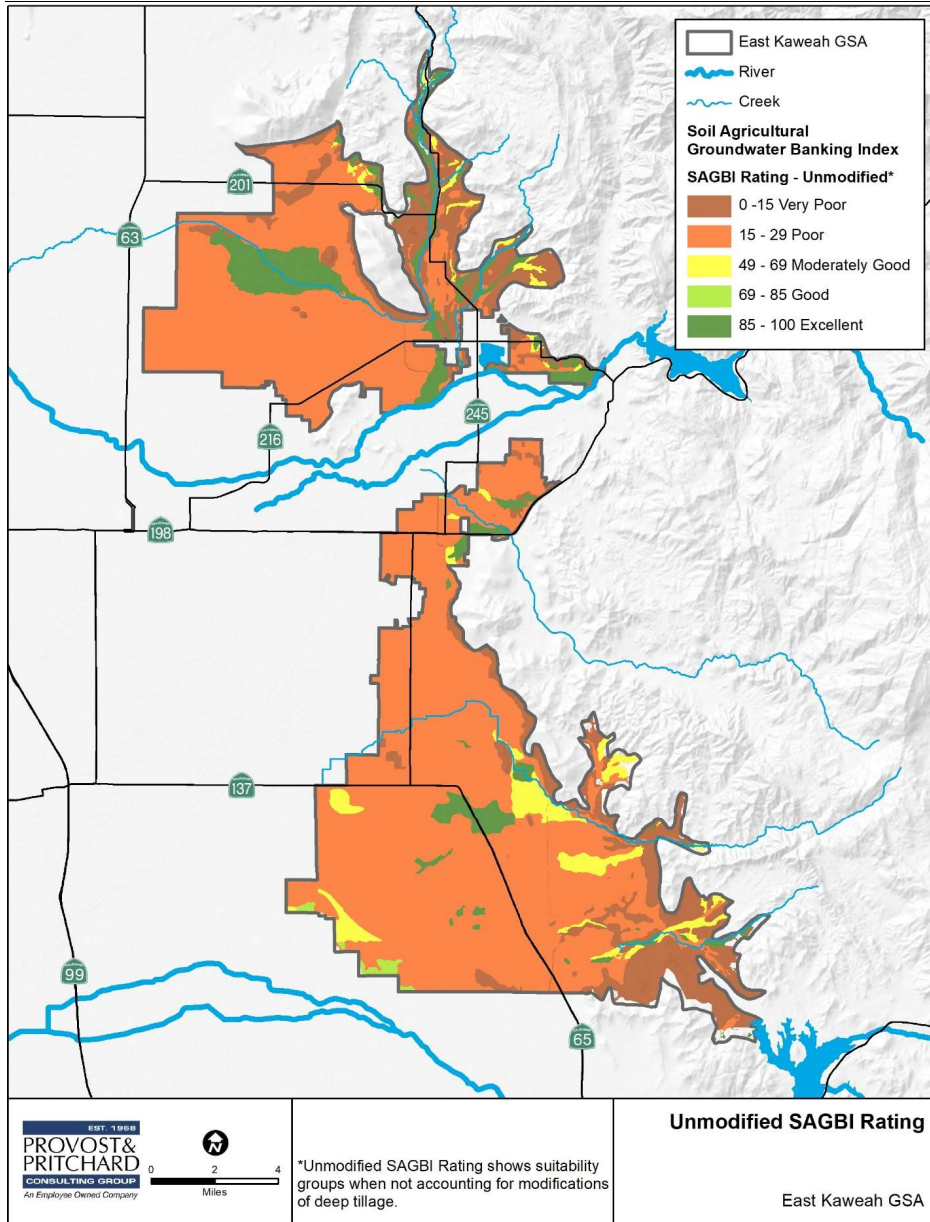


Figure 2-15 Unmodified Soil Agricultural Groundwater Banking Index (SAGBI) Rating



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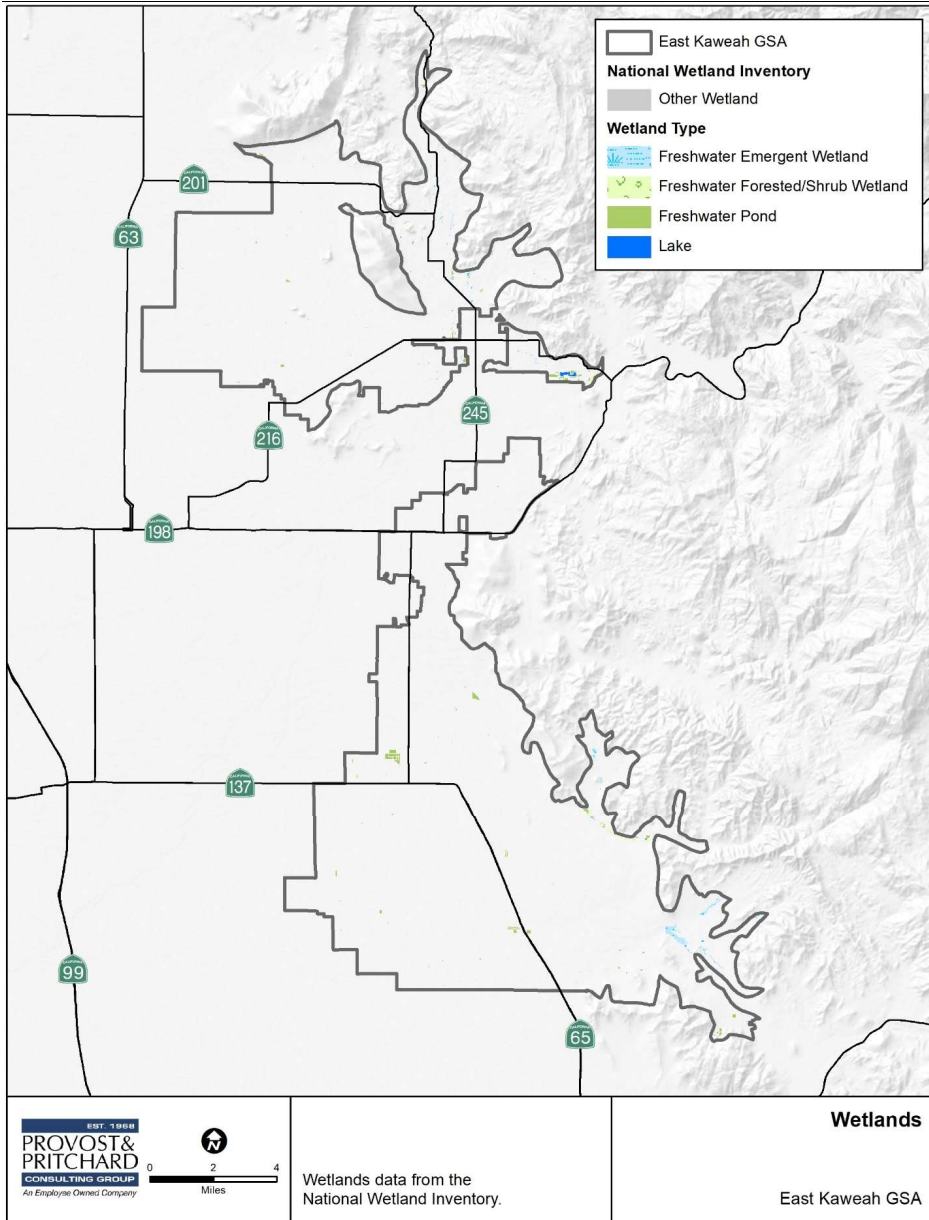


Figure 2-16 Wetlands Map

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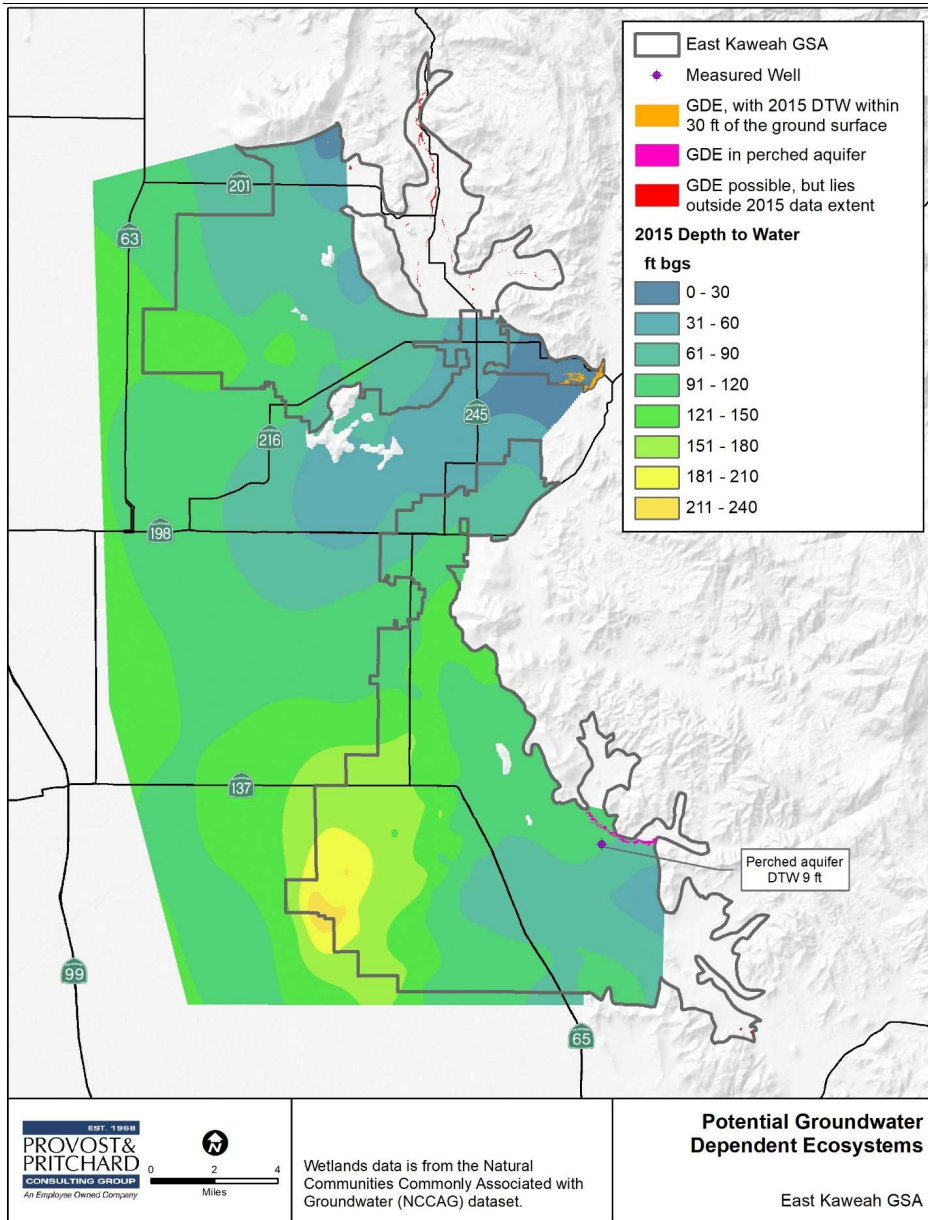


Figure 2-17 Potential Groundwater Dependent Ecosystems

### 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.

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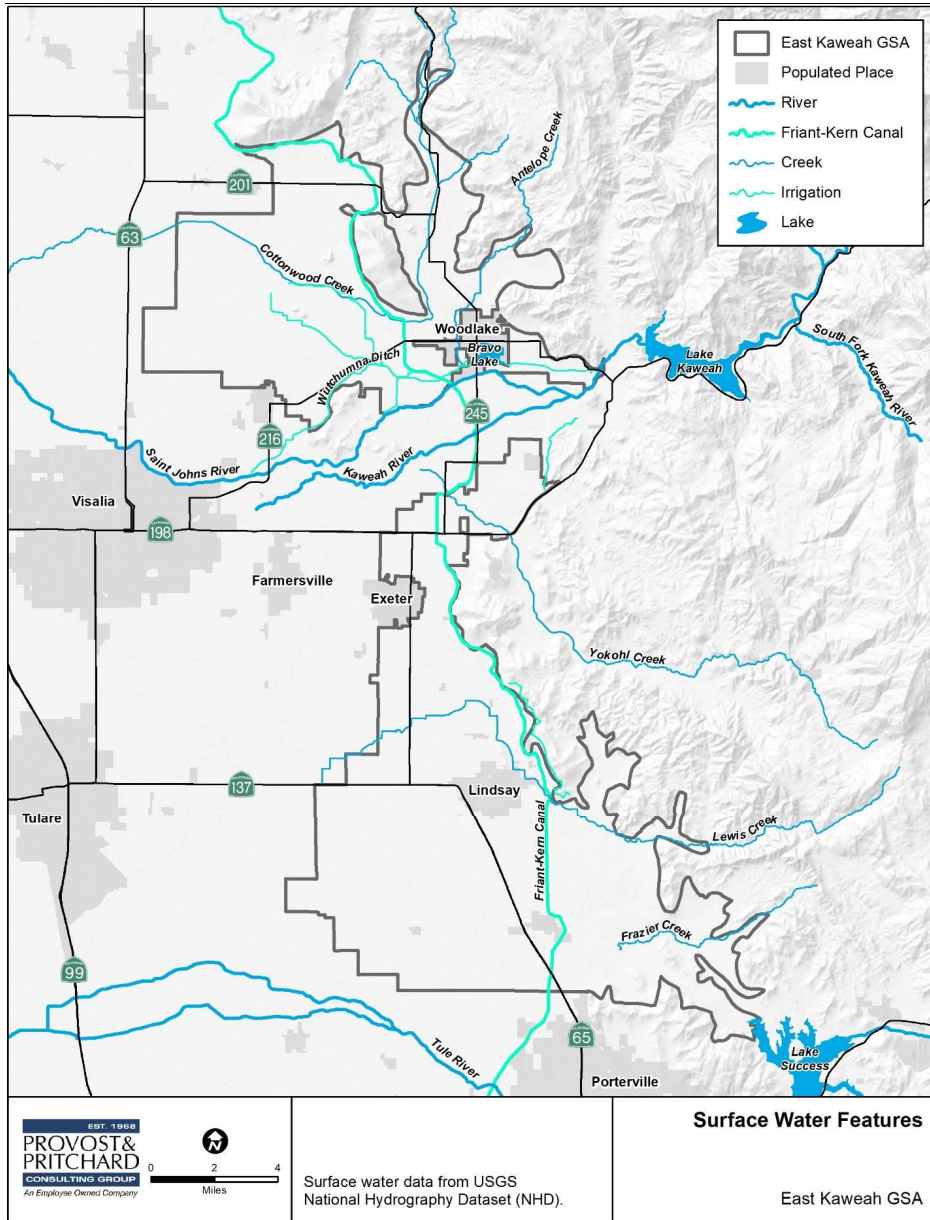


Figure 2-18 Surface Water Features Significant to the Management of the East Kaweah GSA Basin

## 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

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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  $\geq 5$  ppm, then sampling is required quarterly.
- If arsenic is  $\geq 5$  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  $\geq \frac{1}{2}$  the MCL), 6 (when initial monitoring is  $\leq \frac{1}{2}$  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



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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 <sub>2</sub> , NO <sub>3</sub> , NH <sub>3</sub> ), 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.

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Programs or Data Portals	Parameters	Frequency	Objectives	Notes
	available includes all Title 22 regulated constituents.	Nitrate as N annually, if $\geq 5$ ppm, sampled quarterly; VOCs and SOCs sampled every 3 years; Uranium sampling depends on historical results, varies between 1 sample every 3 (when $\geq 10$ 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

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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.	<a href="https://www.cdpr.ca.gov/docs/emon/grdwtr/index.htm">https://www.cdpr.ca.gov/docs/emon/grdwtr/index.htm</a>

### 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 2020

### 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.

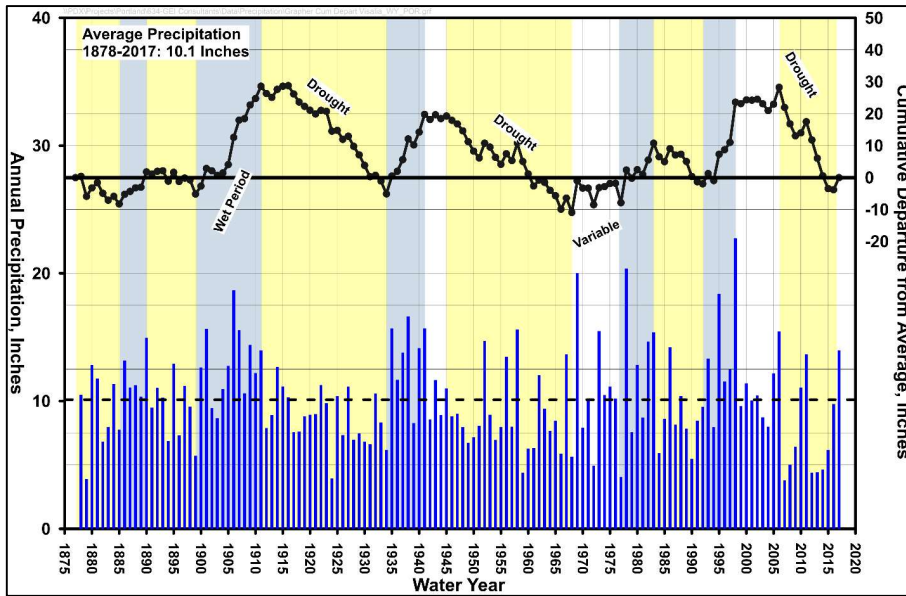


Figure 2-19 Cumulative Departure from Mean Precipitation - Visalia, CA

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).



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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.

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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.

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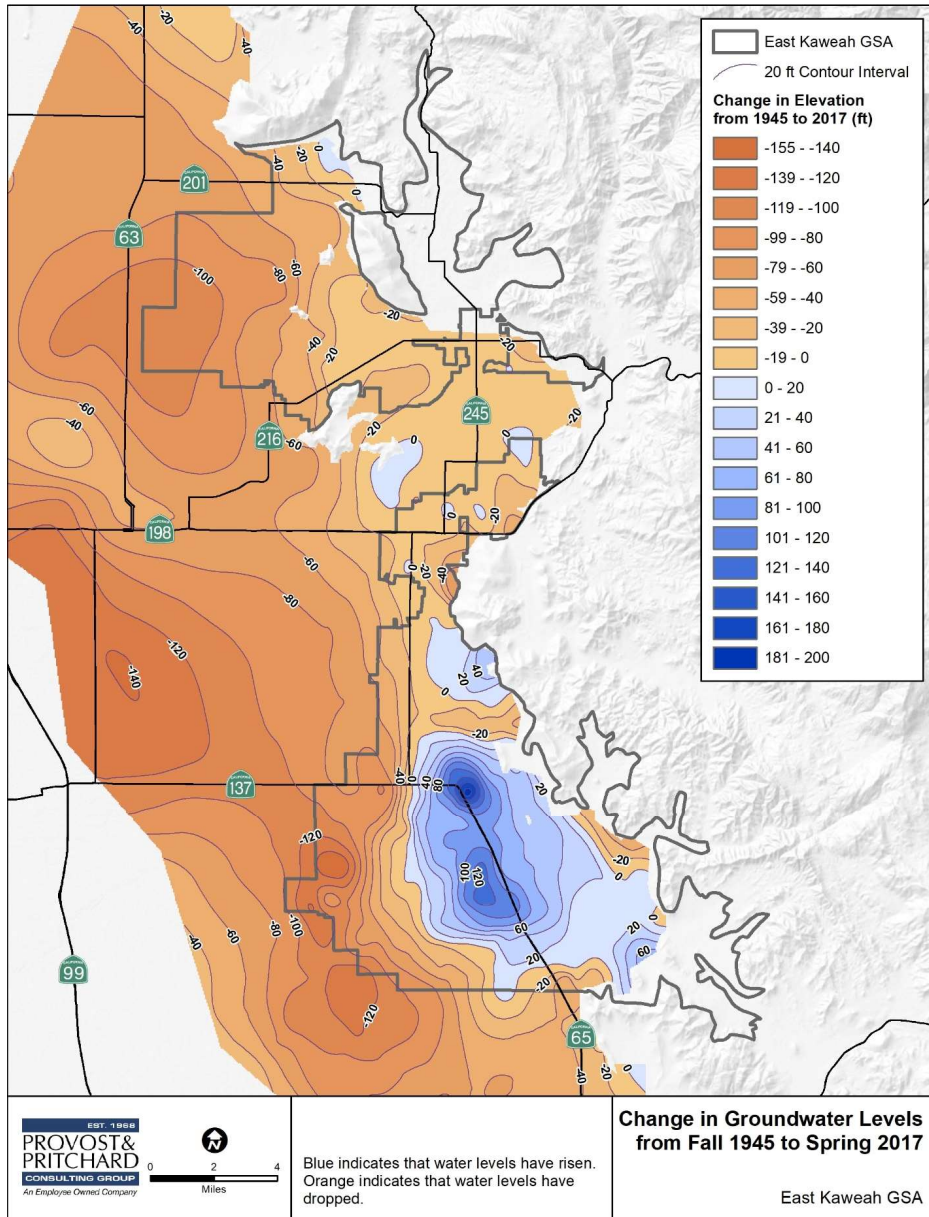


Figure 2-20 Groundwater Level Change from 1945 to 2017

### 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 versus 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.

Chapter Two: Basin Setting  
East Kaweah GSA

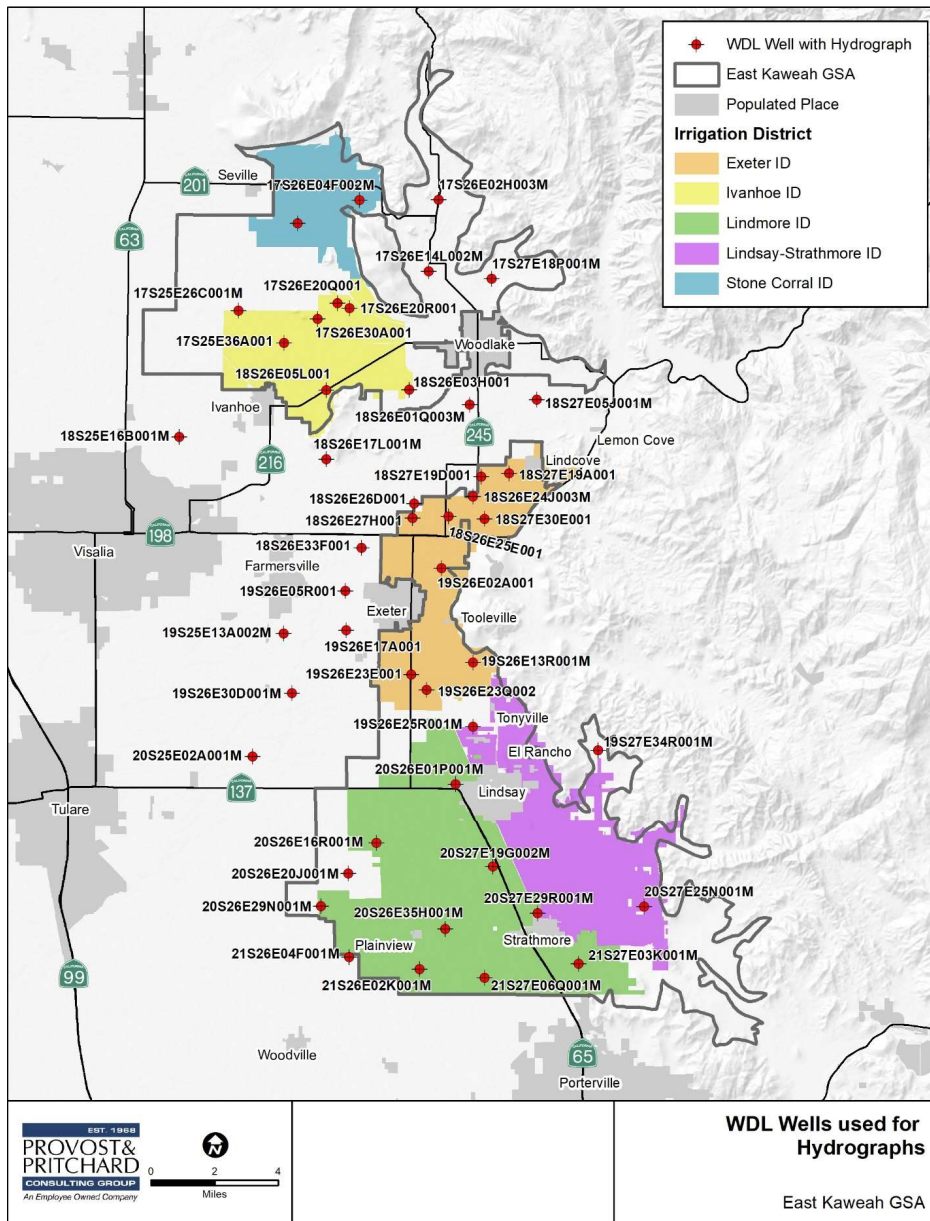


Figure 2-21 Well Hydrographs Location Map

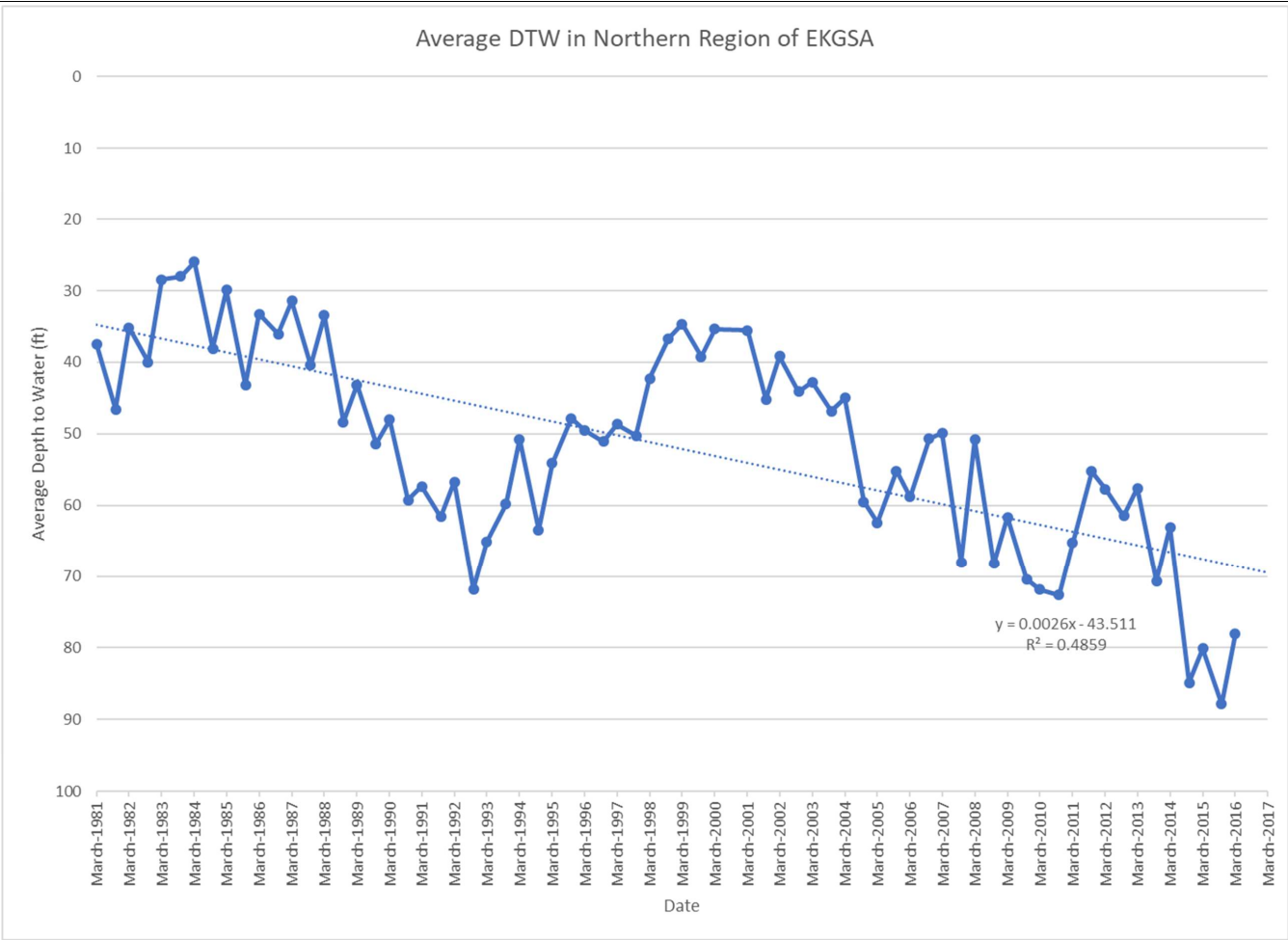


Figure 2-22 EKGSA Average Depth to Groundwater in the Northern Region

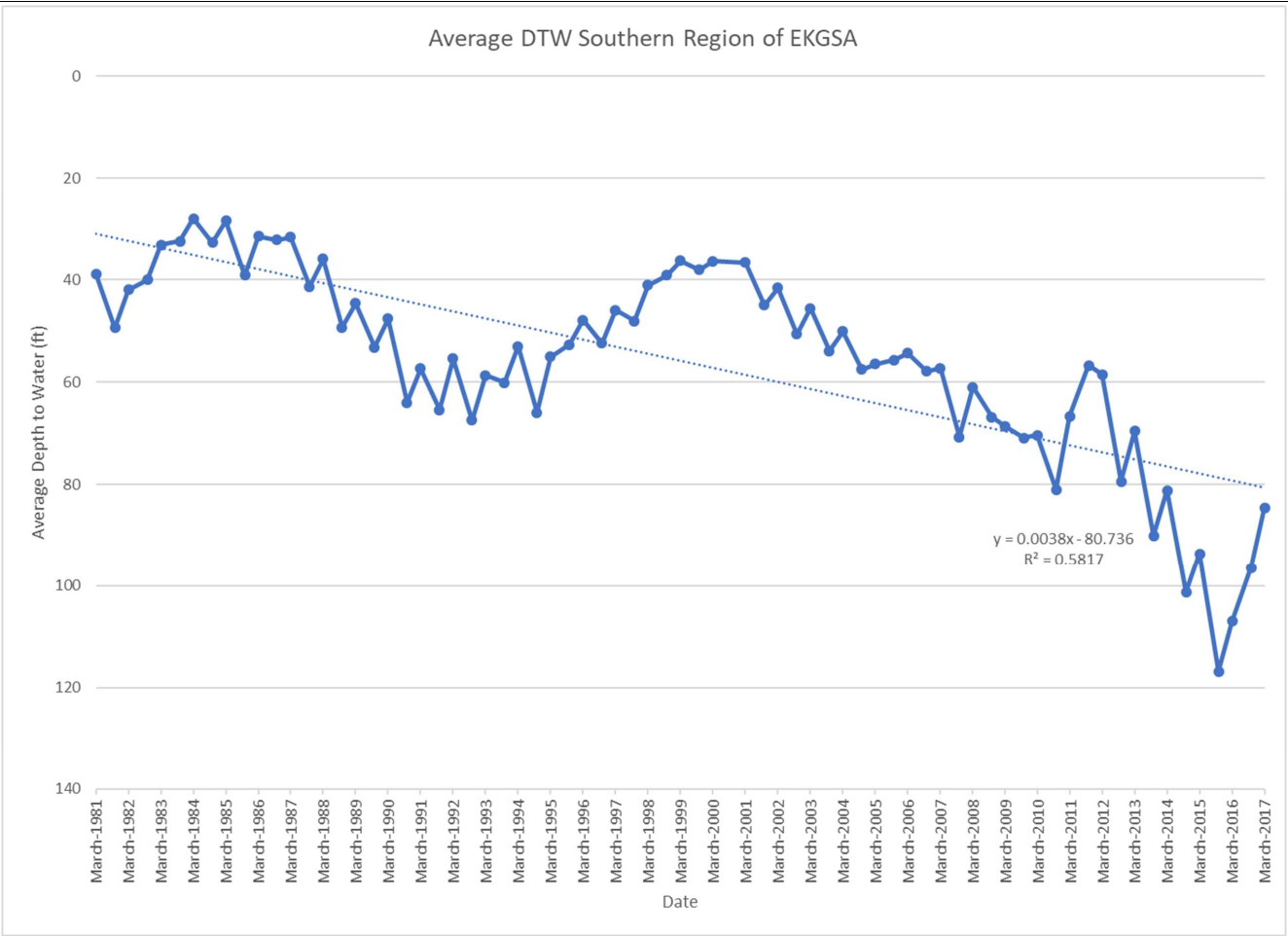


Figure 2-23 EKGSA Average Depth to Groundwater in the Southern Region



### 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.

The minimum well depth for a well in the EKGSA is a 25 ft. agricultural well. This well is located in T20SR27E23. It is unknown if this well is still in place, however it is likely dry unless it is within a perched aquifer known to exist in the area.

The deepest completed alluvial well on the valley floor within the EKGSA is located in T21SR27E06. It is an agricultural well completed to a depth of 846 ft.

In order to find the average well depth in the EKGSA, a weighted average was taken of the average completed depth field for all sections within the EKGSA. This provided an average well depth of 239.7 ft. This analysis does not consider well type, activity status of the well, or what type of aquifer the well was drilled into (i.e. if the well captures water from a fracture-rock aquifer or an alluvial aquifer).

### 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

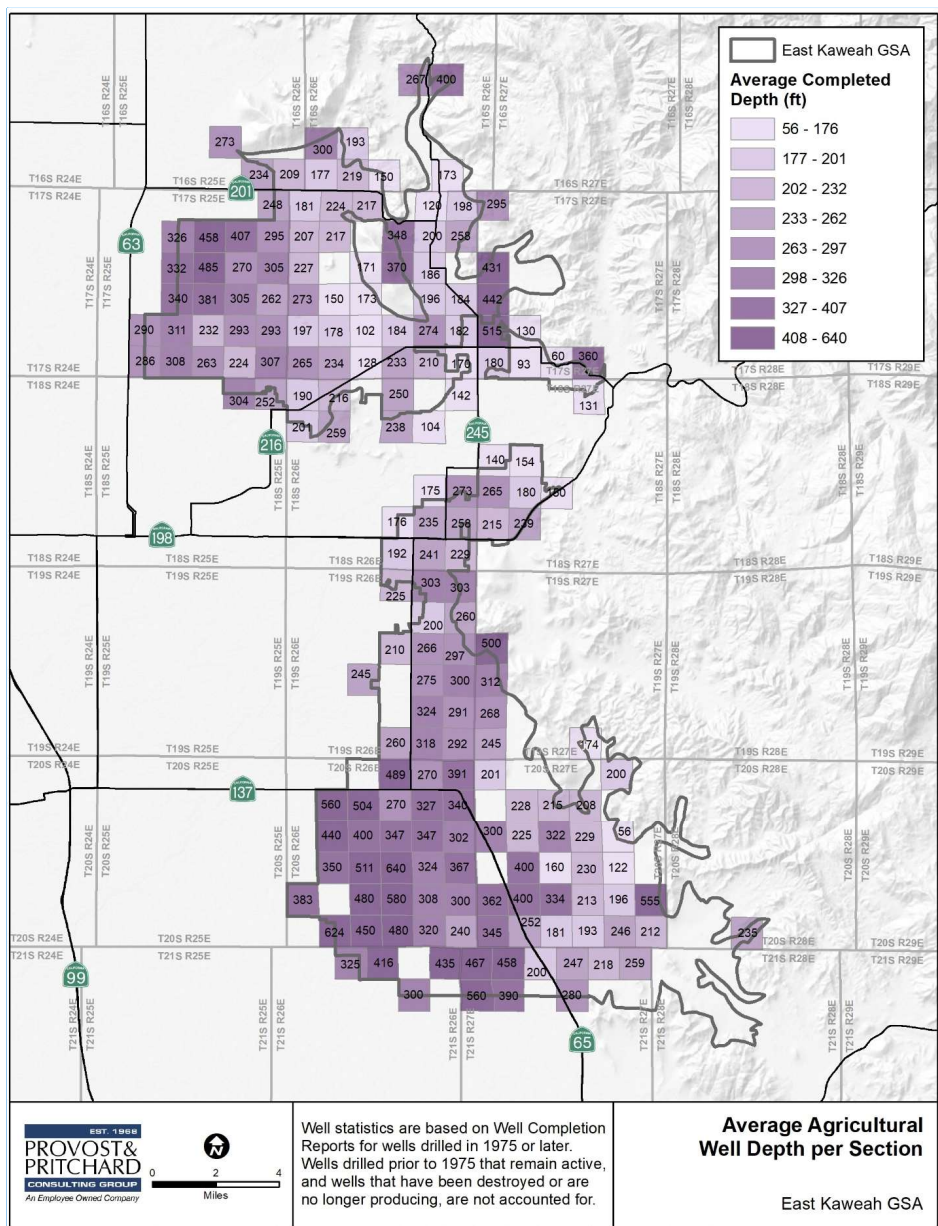
Water levels in an unconfined aquifer system coincide with the top of the zone of saturation, where hydrostatic pressure is equal to atmospheric pressure. Seasonal water level variations in such systems are typically subdued. Groundwater conditions at specific locations vary from regional patterns due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

**Commented [MC2]:** Maps in appendix 2-E are being updated with 2002 well completion data to reference a consistent dataset.

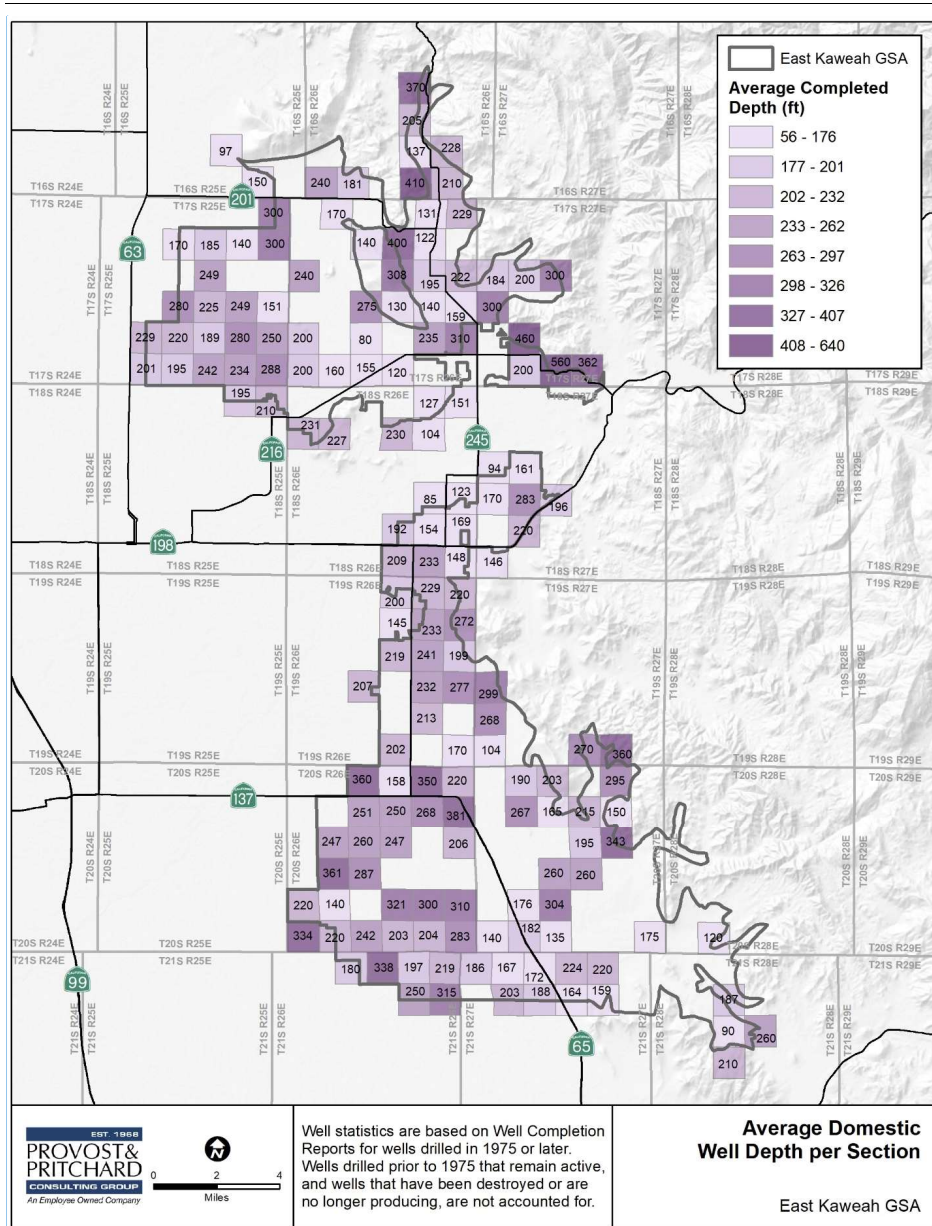
Chapter Two: Basin Setting  
East Kaweah GSA



P  
Figure 2-24 Average Agricultural Well Depth

Commented [MC3]: 7/11 Pending updates from GIS.

Chapter Two: Basin Setting  
East Kaweah GSA



Commented [MC4]: 7/11 pending updates from GIS

Figure 2-25 Average Domestic Well Depth

## Chapter Two: Basin Setting East Kaweah GSA

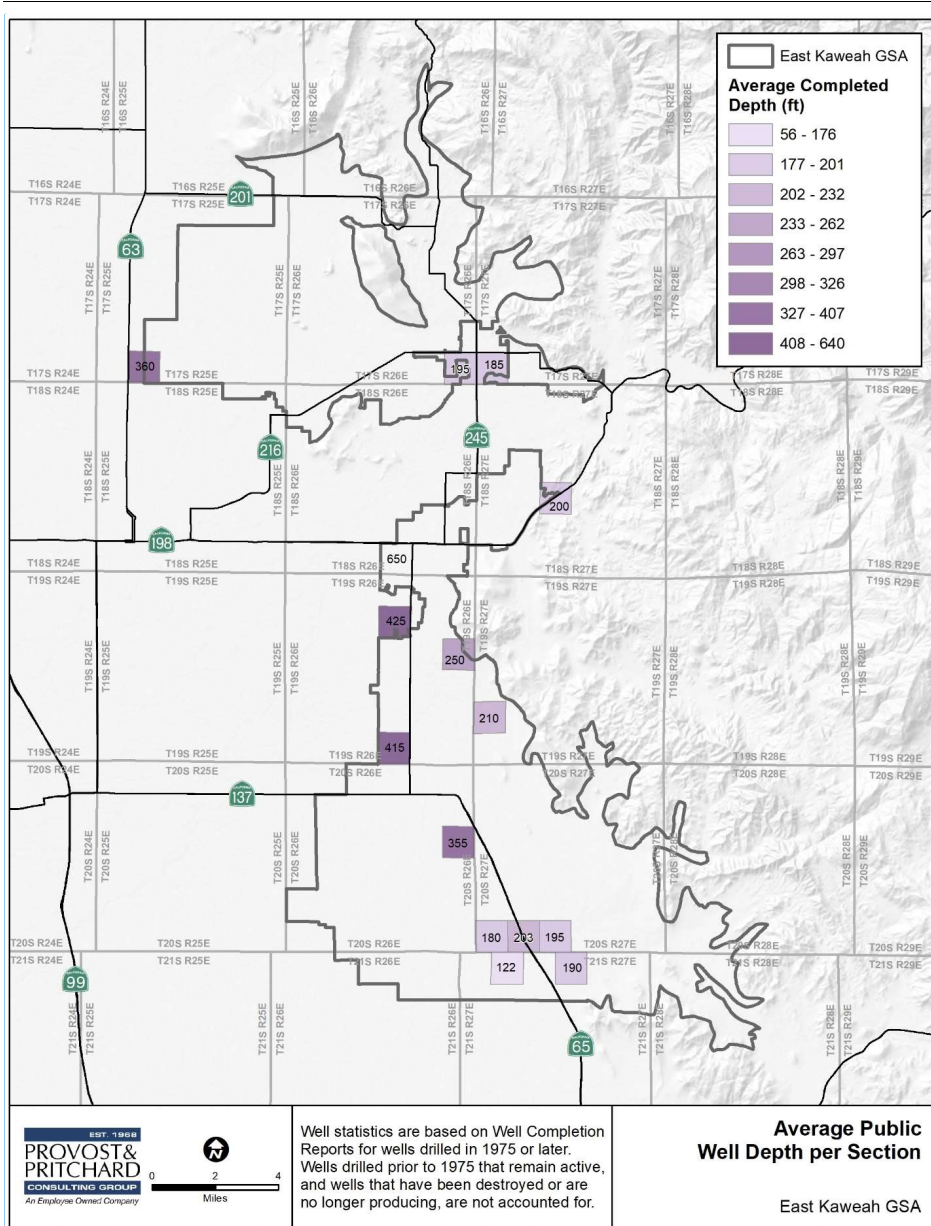


Figure 2-26 Average Public Well Depth

Commented [MC5]: Pending updates from GIS

## 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 that 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 western 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 ppb. 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 Health 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 (NO<sub>3</sub>), 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 ( $\text{ClO}_4^-$ ). 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 volatilize from water or soil surfaces to the air and when released directly to the atmosphere it settles readily through wet or dry deposition.

In the body, perchlorate interferes with the uptake of iodine by the thyroid glands, causing disruption of thyroid hormone production. Inhibited thyroid function can result 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 rocket 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 nematocide. 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

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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 [Figure 2-10](#). 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<sup>2</sup>. 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.

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<sup>2</sup> 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.

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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 <i>(Highest values near Corcoran)</i>	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	



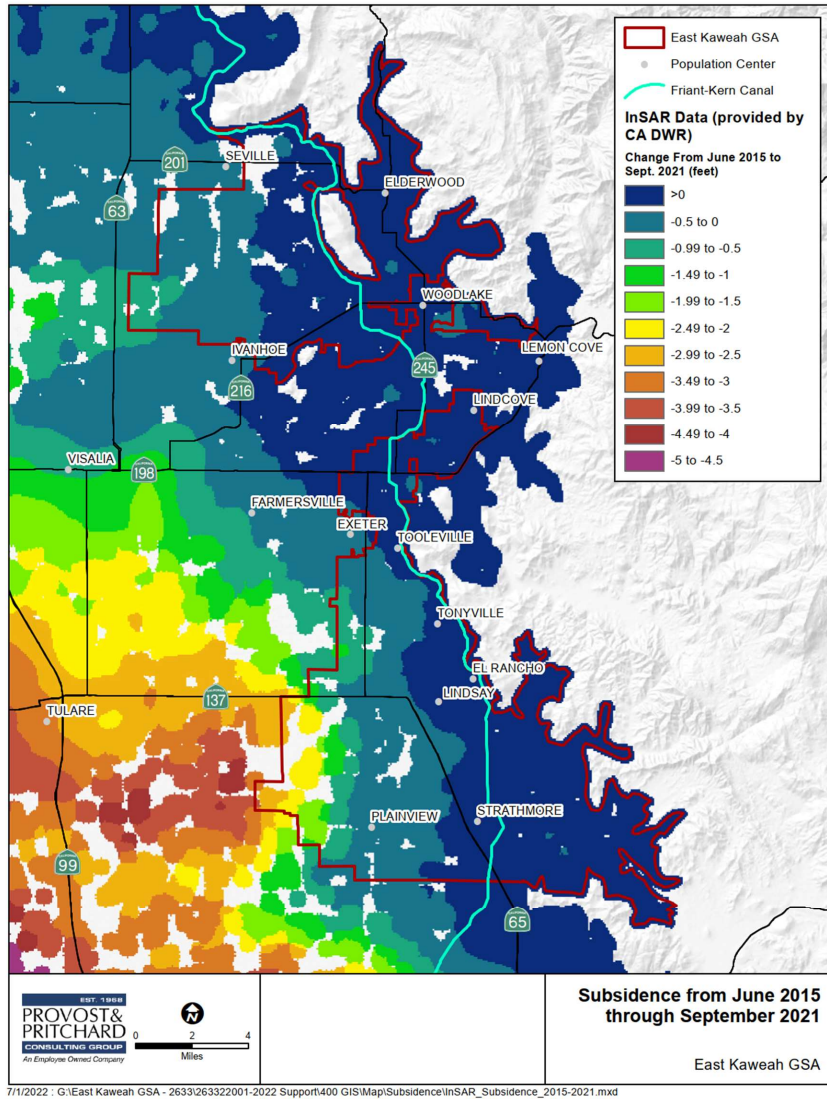


Figure 2-27 InSAR Subsidence Data for the EK GSA

## 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 near 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 [further study going forward 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.

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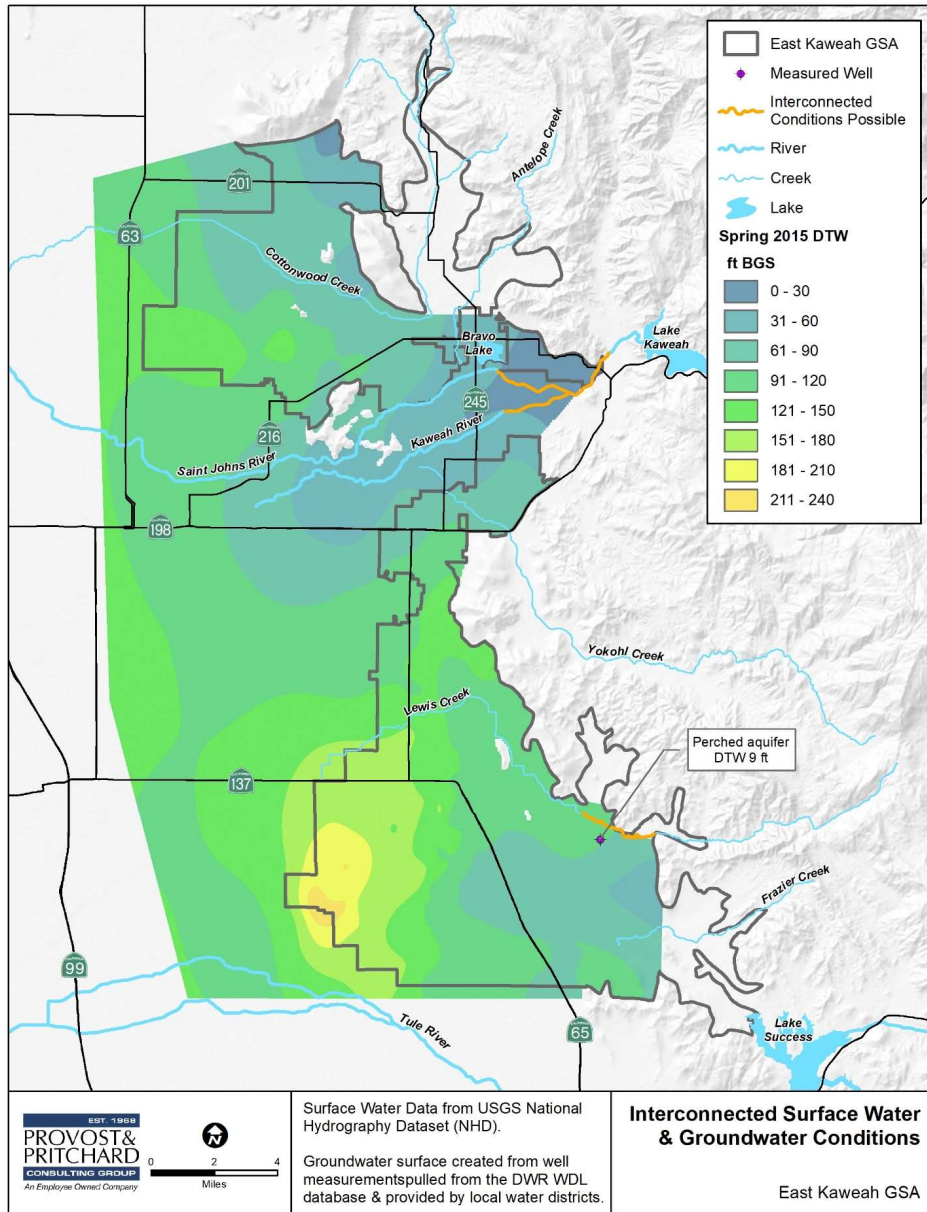


Figure 2-28 Potential Groundwater Dependent Ecosystems

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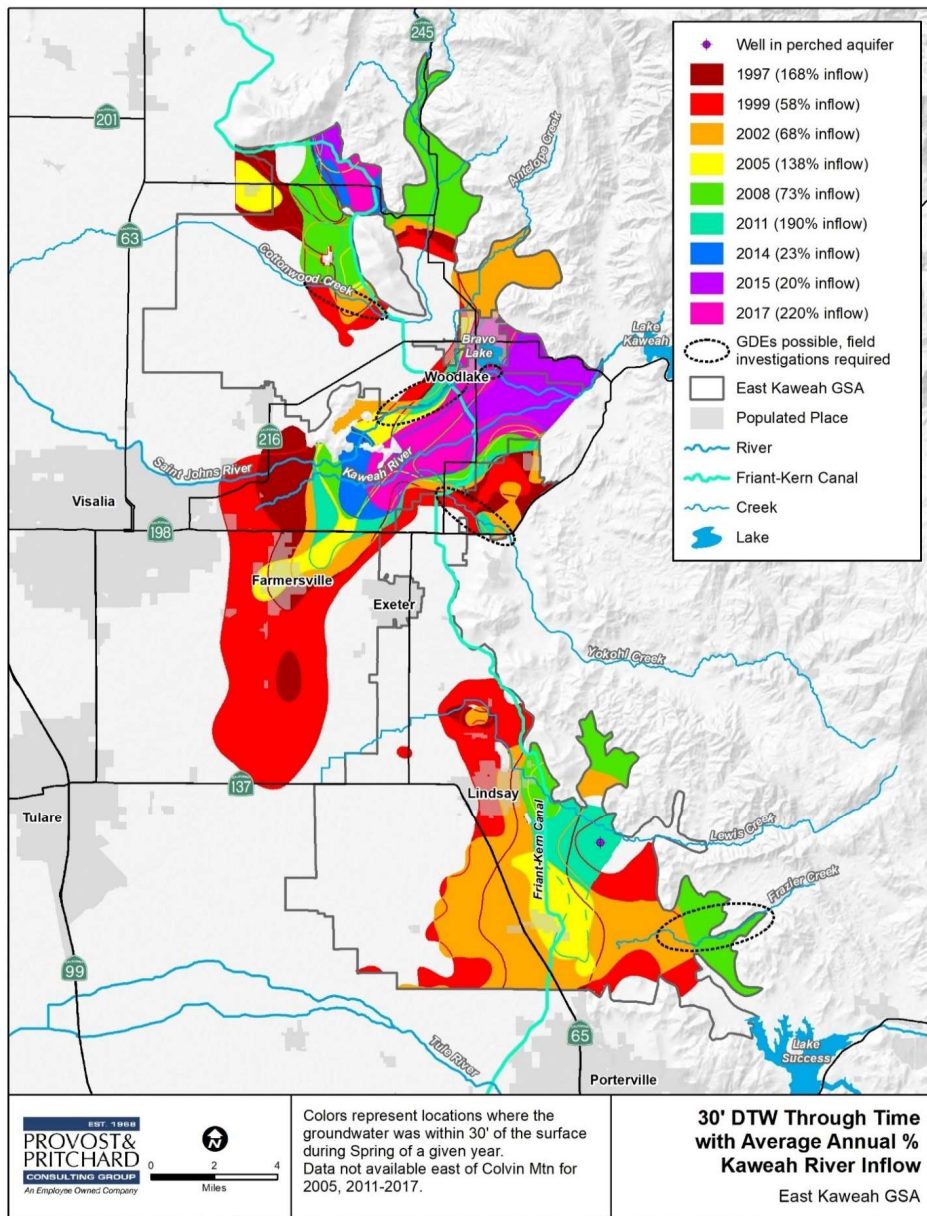


Figure 2-29 Potential GDE Analysis Areas through Select Base Period Groundwater Levels

## 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

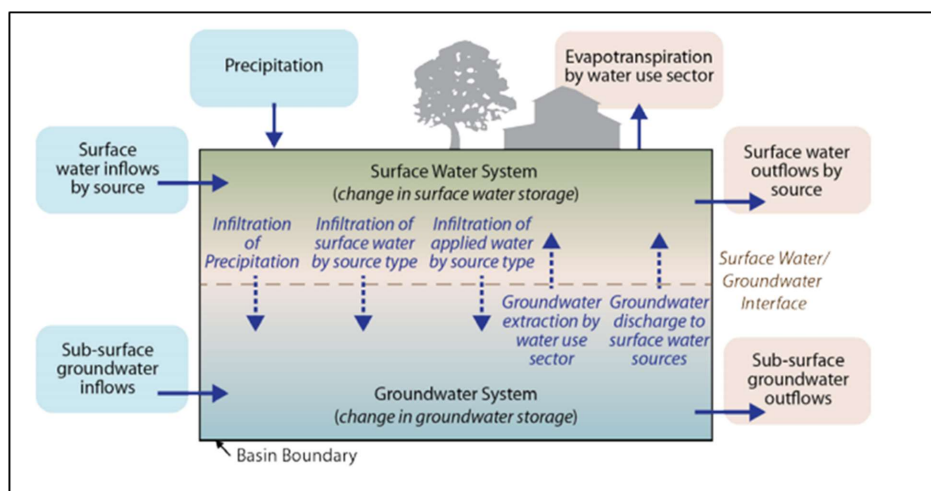


Figure 2-30 Water Budget Components

### 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 (IWF) 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 climatic 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).

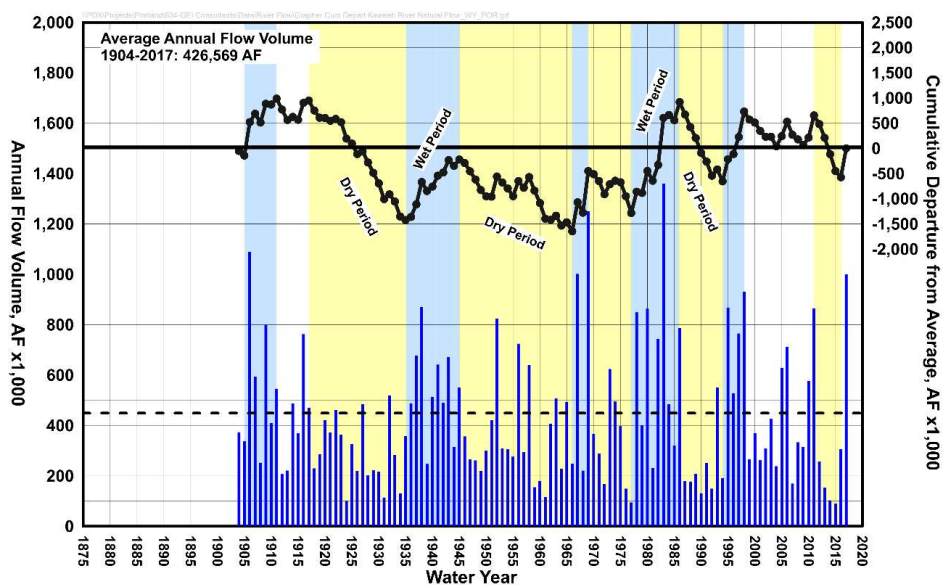


Figure 2-31 Cumulative Departure from Average Annual Flow

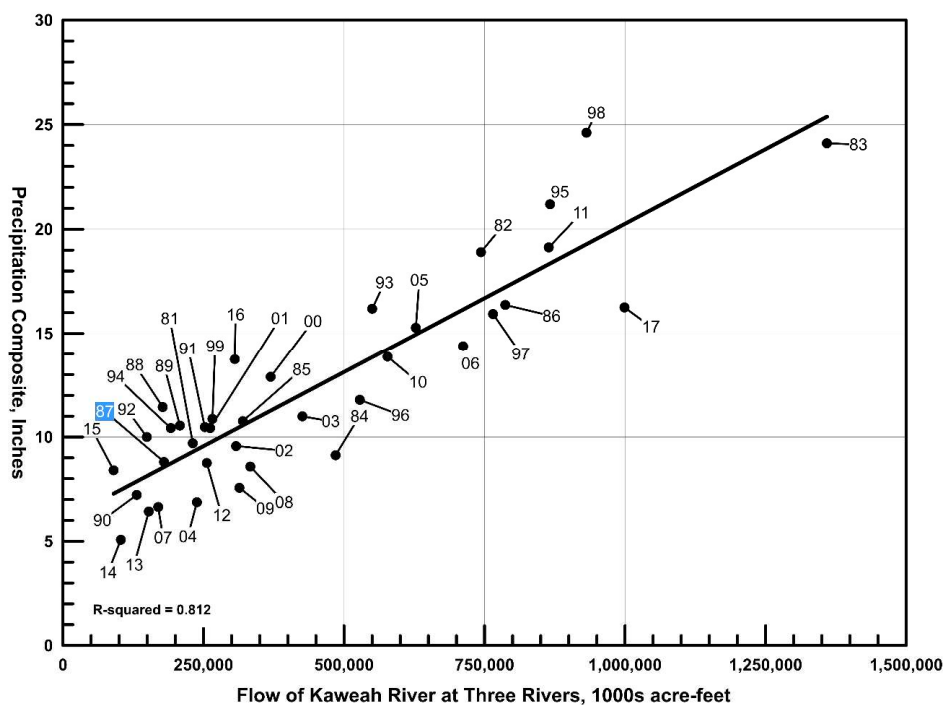


Figure 2-32 Kaweah River Runoff Versus Mean Precipitation

### 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<sub>Div</sub>*)**

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<sub>p</sub>*)**

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<sub>Div</sub>*)**

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  $Q = P_iA$ , where 'P' is the coefficient of aquifer permeability (horizontal hydraulic conductivity), 'P' 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 is 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 -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 (ET<sub>o</sub>) 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](#).

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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 -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 -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.

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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



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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 EKGSA 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 -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 -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

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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**

<b>Native:</b>	<b>Inflows which all well owners have access to on a pro-rata basis</b>
	• Percolation from rainfall
	• Streambed percolation (natural channels) from the Kaweah River watershed sources
	• Agricultural land irrigation returns from pumped groundwater
	• Mountain-front recharge
<b>Foreign:</b>	<b>All imported water entering the Subbasin from non-local sources under contract by local agencies or by purchase/exchange agreements</b>
	• Streambed percolation from imported sources
	• Basin recharge from imported sources
	• Ditch percolation from imported sources
	• Agricultural land irrigation from imported sources
<b>Salvaged:</b>	<b>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</b>
	• 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 -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		
	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	Groundwater Pumpage				Extraction by Phreatophytes	Evaporative Losses					Subsurface Outflow	
									M & I	Gross Applied Irrigation Water (Crop Water Demand)	Delivered Surface Water	GW Pumping for Irrigated Agriculture								Total Net Extraction
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 result 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 three Kaweah Subbasin GSPs developed the following sustainability goal collaboratively amongst the EKGSA, GKGSA, and MKGSA. The goal is also articulated within the Subbasin Coordination Agreement.

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.

## Chapter Three: Sustainable Management Criteria East Kaweah GSA

- 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.
- Application of the Kaweah Subbasin Hydrologic Model (KSHM) – incorporating the initial selection of projects and management actions by the Subbasin GSAs – and its simulation output is summarized in the Subbasin Coordination Agreement to help explain how the sustainability goal is to be achieved within 20 years of GSP implementation.
- 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.

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 Sub-basin, 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 portions of Kings County. The EK GSA intends to apply the larger Kaweah Subbasin sustainability goal to the additional unique groundwater needs of the EK GSA stakeholders such as unincorporated communities and schools, private domestic wells, and other local enterprises unique to the EK GSA not formally encompassed in the Subbasin wide sustainability goal.

The sustainability goal was derived from the basin setting, the Kaweah Subbasin Hydrologic Model (KSHM), historical and current groundwater conditions, and the water budget, as described in Chapter 2. ~~To accomplish this sustainability goal, the~~ The Kaweah Subbasin will manage its aquifer supply in a manner that allows the Subbasin to accomplish its sustainability goal by 2040. ~~will be managed so that the Subbasin has achieved its sustainability goal.~~ This goal will be achieved by the combined implementation of the EK GSA, GK GSA, and MK GSA GSPs. Specifically, all GSPs are designed to identify phased implementation of projects and management actions to reduce long-term groundwater overdraft. ~~Individual GSPs will support the Subbasin-wide sustainability goal by implementing:~~

In order to achieve the goals outlined in the EK GSA'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 EK GSA. 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 EK GSA, 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 and subsidence. Given the strong correlation between groundwater levels, aquifer storage, and subsidence ~~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 represent the groundwater conditions at a representative monitoring site, were determined based on measured data from within the GSA'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. Therefore, seawater intrusion will not be monitored or discussed throughout the rest of this GSP an indicator of sustainable management for the Kaweah Subbasin.

## 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 GSA 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 only include wells drilled in 1975 and after, 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/determine at exactly what water surface elevation a well would be 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 area.

Threshold regions are composed of smaller geographic Township/Range/Section (TRS) units. ~~and~~ TRS units ~~are~~ were 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 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

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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.

By incorporating~~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.

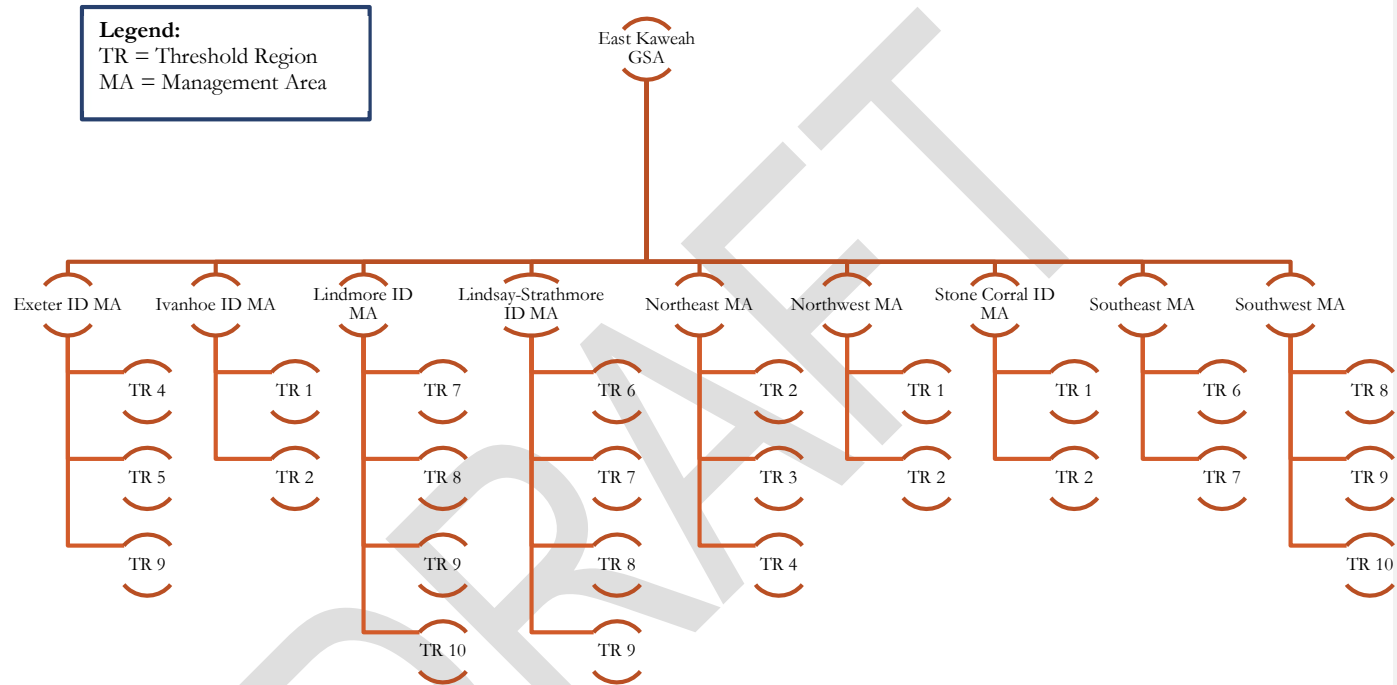


Figure 3-1 Organization Chart of EKGSA Management Areas and Overlapping Threshold Regions

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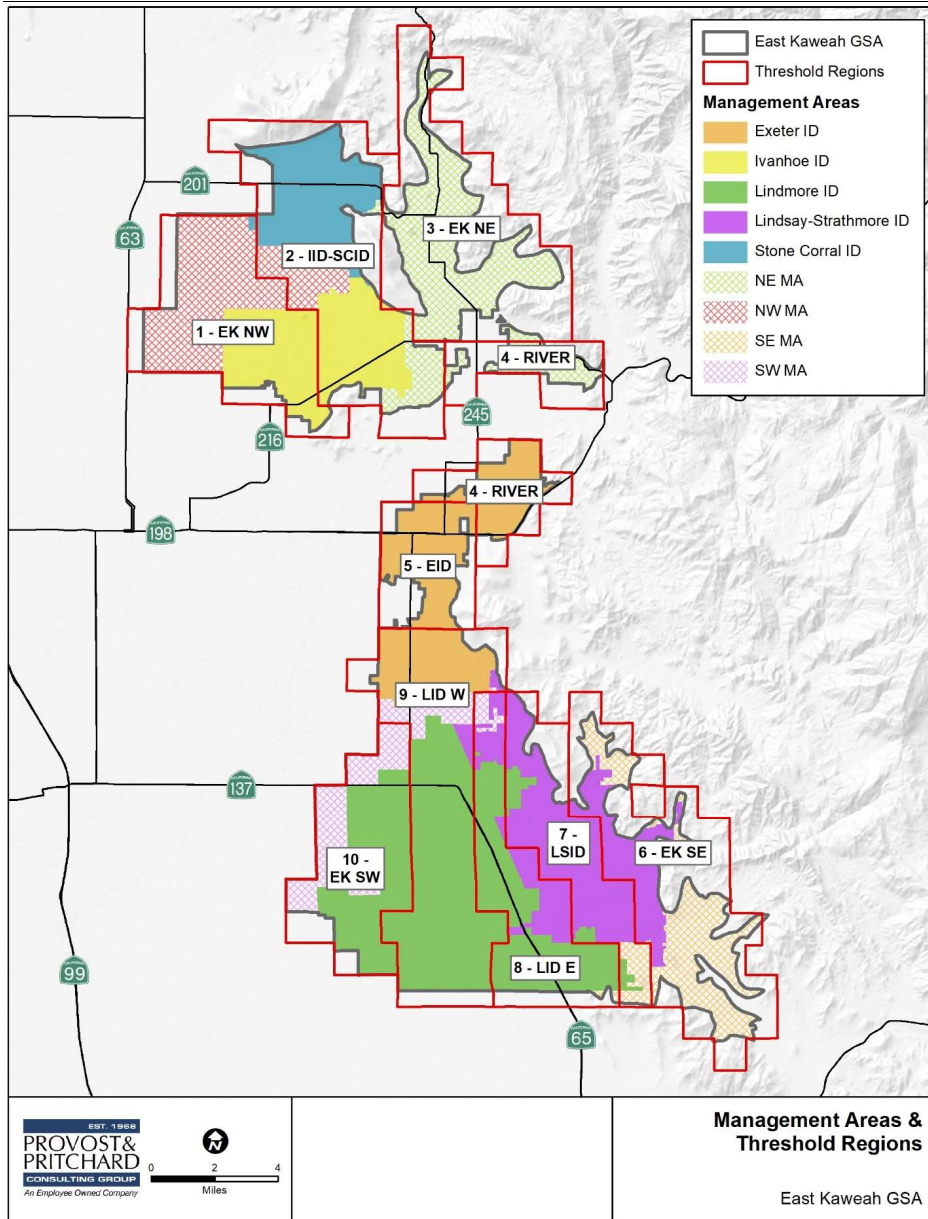


Figure 3-2 Map of EKGSA Management Areas and Overlapping Threshold Regions

### 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. ~~As described in Appendix 3-A, threshold-Threshold~~ region four primarily consists of wells ~~whose that, when projecting the 2040~~ water surface elevation (WSE) ~~minimum thresholds based on the current pumping regime,~~ fall within the 301-400 feet WSE range. Per the same analysis, ~~threshold region five primarily consists of wells that fall within the five's wells have minimum thresholds within the~~ 201-300 feet WSE range. Wells located within threshold region nine ~~have minimum thresholds that would~~ 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 ~~MFTs minimum thresholds~~ fall within ~~projects to the the~~ 101-200 feet WSE range and ~~threshold region two to the~~ consists of wells whose ~~minimum thresholds fall within~~ 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



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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. Per the trend analysis (Appendix 3-A), threshold region seven primarily consists of wells that project to the whose minimum thresholds fall in the 301-400 feet WSE range. Wells located within threshold region eight, nine, and ten have minimum thresholds that fall in projects to 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 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 is 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.

Threshold regions six, seven, eight, and nine fall within the boundaries of the Lindsay-Strathmore ID management area. Based upon 2040 hydrograph projections, WSE in threshold region six project have minimum thresholds in to the 401-500 feet range. Threshold region seven projects to the wells have minimum thresholds in the 301-400 feet WSE range and threshold region eight wells have minimum thresholds in the projects to 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,

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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 ~~projects to the~~wells have minimum thresholds in the 301-400 feet WSE range, while threshold region two ~~projects to the~~wells have minimum thresholds 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. ~~Per the trend analysis,~~ Threshold region one ~~projects to the~~has wells minimum thresholds in the 101-200 feet WSE range and threshold region two ~~projects to the~~has wells with minimum thresholds 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. ~~Per the trend analysis,~~ Threshold region two ~~contains well with minimum thresholds within~~ ~~projects to~~ 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-~~Based upon the trend analysis projections, WSE in threshold region ~~region~~ six ~~projects to~~contains wells whose minimum thresholds are within the 401-500 feet range. Threshold region seven ~~projects to the~~ has wells with minimum thresholds in 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 ~~project to~~contain wells

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~~whose minimum thresholds fall within 201-300 feet, 101-200 feet, and 1-100 feet WSE ranges, respectively, per the trend analysis described in Appendix 3-A.~~

### 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 3.3.1.1 Appendix 3-A](#), the threshold regions were determined ~~using 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, a trend analysis on several individual well hydrographs. The threshold region delineation process focused on combining areas mimicking similar hydrogeologic behavior (corroborated by historical data) in response to the climate and pumping regime experienced during the base period (1997 – 2017).~~ Specifically, minimum thresholds and measurable objectives were set in a holistic manner that evaluated the potential impacts of each region's minimum thresholds on the whole basin's [beneficial uses and users](#). By determining minimum thresholds ~~based from projecting hydrogeologic data over the base period based upon groundwater levels' direct impacts on beneficial users 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.~~

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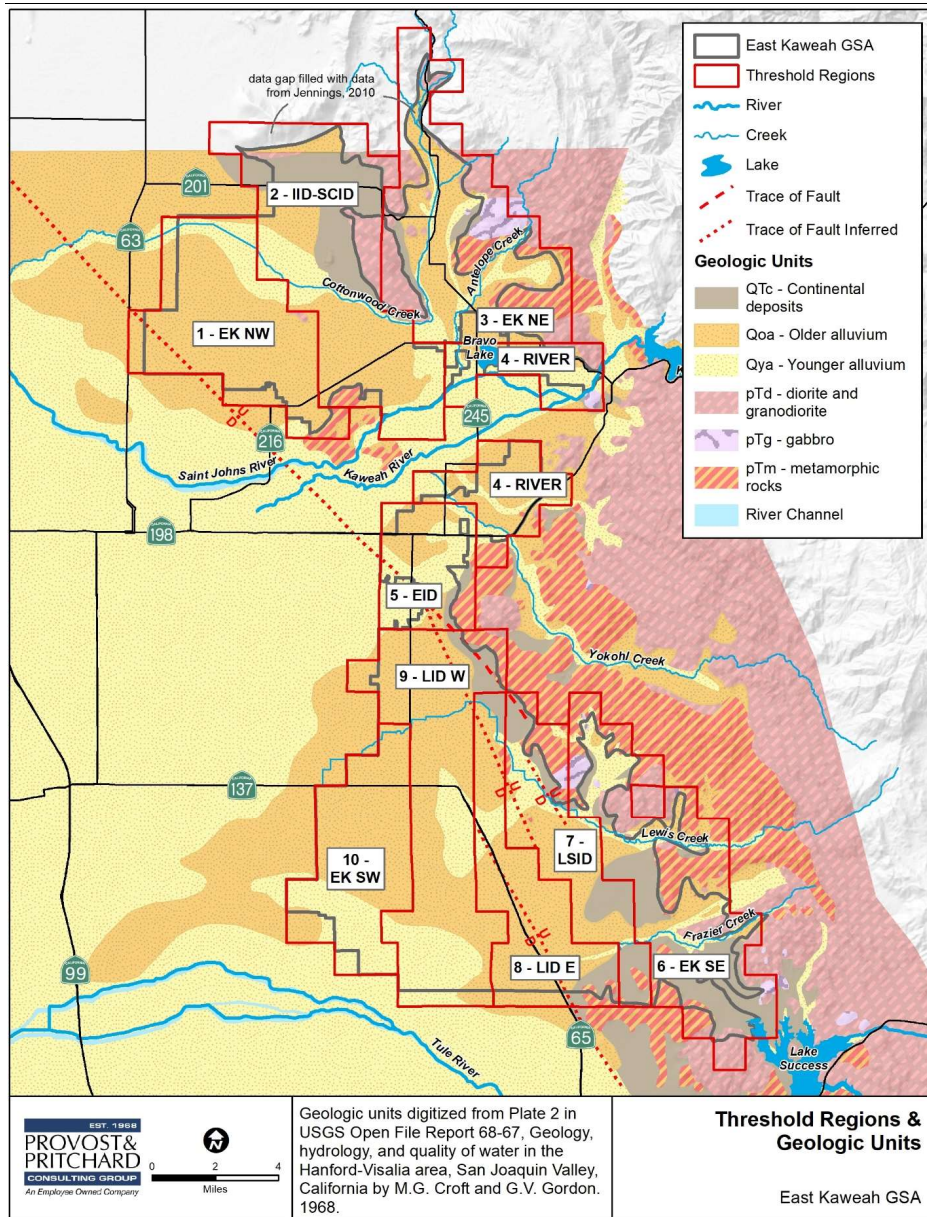


Figure 3-3 EKGSA Threshold Regions and Geologic Units

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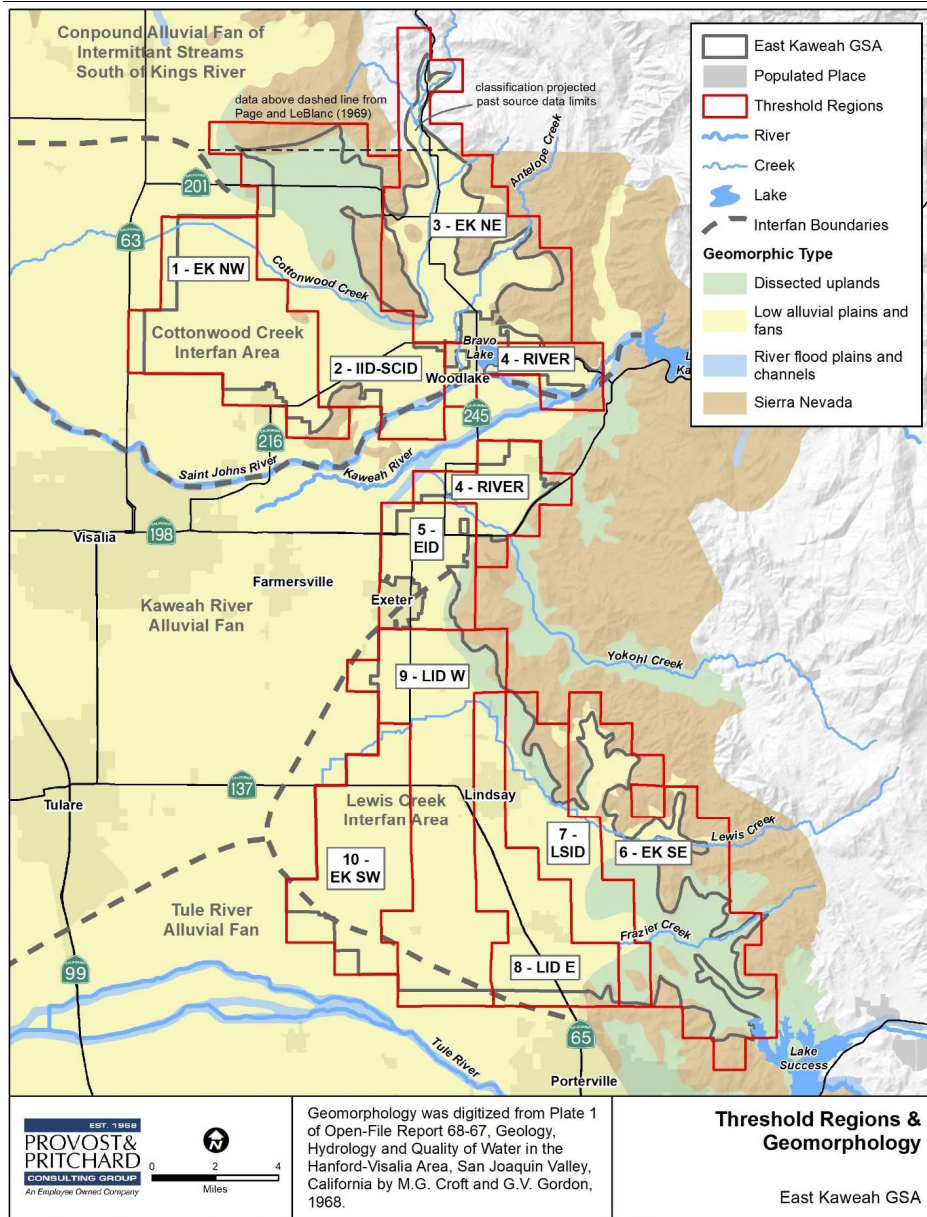
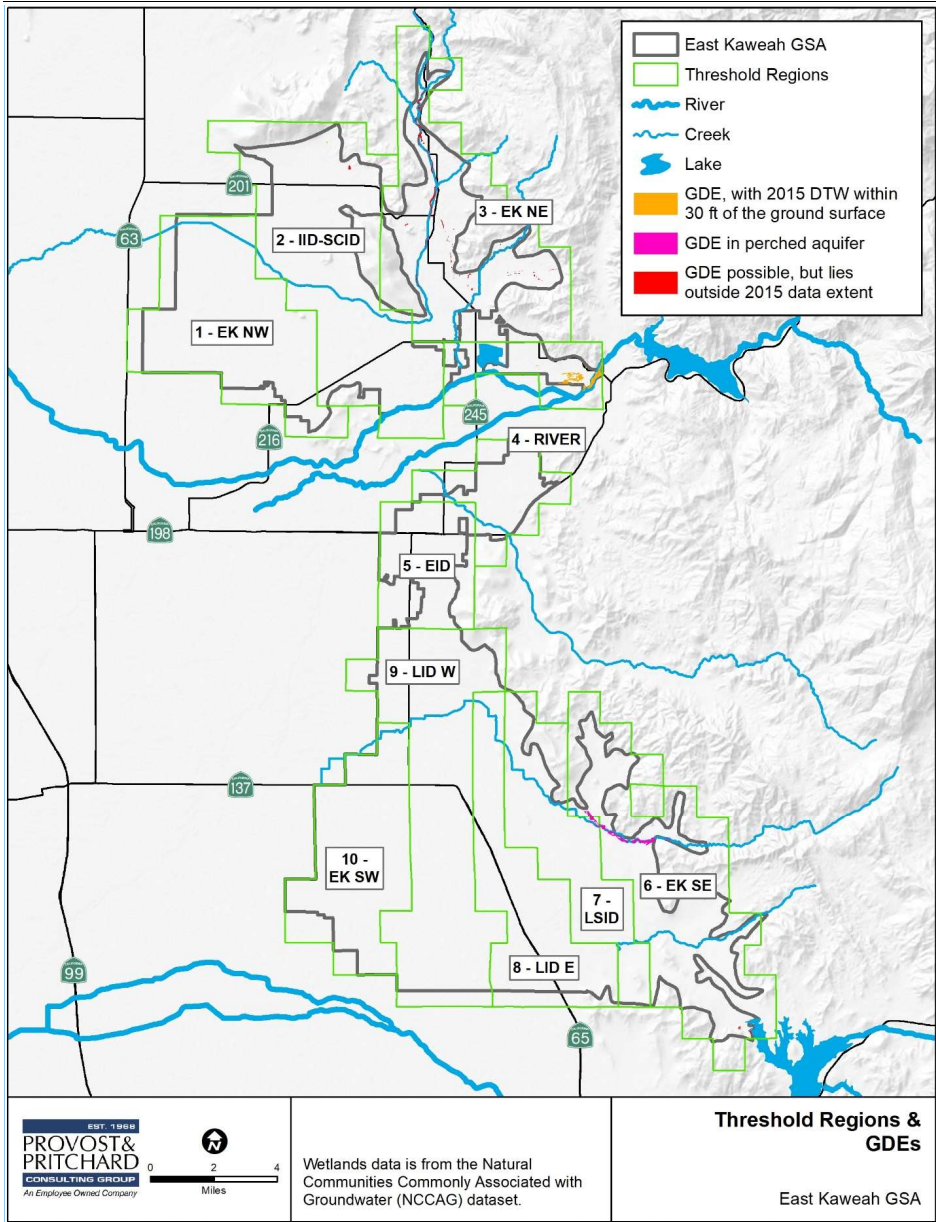


Figure 3-4 EKGSA Threshold Regions and Geomorphology

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**Commented [MC6]:** Figure is now located in Section 3.4.2 Interconnected Surface Water.

Figure 3-5. EKGSA Threshold Regions and Potential Groundwater-Dependent Ecosystems

### 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.

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 or 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. 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 process. 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.

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Based upon the hydrogeologic and institutional boundaries present, the EKGSA developed minimum thresholds for each of the sustainability indicators for each of the threshold regions as described in the previous sections. These geomorphic conditions, in addition to the jurisdictional boundaries of member agencies, made the creation of management zones with unique minimum thresholds. In total, the EKGSA consists of nine management areas and 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 ~~and interconnected surface water depletions~~. The EKGSA proposes to utilize groundwater levels as a proxy metric for these sustainability indicators (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 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. Typically, 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. A summary of the undesirable results, minimum thresholds, measurable objective, and interim milestone for each sustainability indicator is presented in [Table 3-1](#).



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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	Unreasonable reduction in groundwater storage	Unreasonable depletion of interconnected surface water and groundwater, where present	Unreasonable long-term changes of water quality concentrations from baseline conditions to significantly impact users of groundwater	Unreasonable impacts to critical infrastructure (i.e. Friant-Kern Canal)
Measurement Methodology	Groundwater Levels	Groundwater Levels (Proxy)	Groundwater Levels (Proxy)	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	2040 Projected GW elevation based on the baseline (1997-2017) trend analysis of GW levels at wells throughout the GSA (10-Threshold Regions)	2040 Projected GW elevation based on the baseline (1997-2017) trend analysis of GW levels at wells throughout the GSA (10-Threshold Regions)	2040 Projected GW elevation based on the baseline (1997-2017) trend analysis of GW levels at wells throughout the GSA (10-Threshold Regions)	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	Spring 2017	Spring 2017	No unreasonable increase in concentration caused by groundwater pumping and recharge efforts.	No subsidence/impacts to CVP deliveries along the FKC related to groundwater pumping within the EKGSA
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 overdraft 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

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Sustainability Indicator	GW Elevation	GW Storage	SW-GW Connection	GW Quality	Land Subsidence
<u>Undesirable Result</u>	<u>Unreasonable lowering of groundwater levels resulting in significant impacts to supply wells</u>	<u>Unreasonable reduction in groundwater storage</u>	<u>Unreasonable depletion of interconnected surface waterways, where present</u>	<u>Unreasonable long-term changes of water quality concentrations from baseline conditions to significantly impact users of groundwater</u>	<u>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</u>
<u>Measurement Methodology</u>	<u>Groundwater Levels</u>	<u>Groundwater Levels (Proxy)</u>	<u>Surface water depletion rate</u>	<u>Sampling for 3 COCs at Ag wells in Monitoring Network; Utilize public system Title 22 quality monitoring</u>	<u>Annual survey of set Mile Posts along the FKC and InSAR data when available and Plainview well point</u>
<u>Minimum Threshold</u>	<u>The most protective groundwater level in a threshold region based on protective level of at least the 90<sup>th</sup> percentile of all water supply wells and not allowing a rate of groundwater decline greater than the historical groundwater decline experienced between 1997-2017</u>	<u>The most protective groundwater level in a threshold region based on protective level of at least the 90<sup>th</sup> percentile of all water supply wells and not allowing a rate of groundwater decline greater than the historical groundwater decline experienced between 1997-2017</u>	<u>More than 50% losses in interconnected surface waterways when water is present</u>	<u>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</u>	<u>2.5" of subsidence in a year and cumulative (relate to no more than 10% capacity reduction in current capacity of the FKC)</u>
<u>Measurable Objective</u>	<u>Spring 2017 groundwater levels</u>	<u>Spring 2017 groundwater levels</u>	<u>Equal to or less than 30% losses in interconnected surface waterways when water is present</u>	<u>No unreasonable increase in concentration caused by groundwater pumping and recharge efforts</u>	<u>No subsidence throughout the GSA</u>
<u>Interim Milestones</u>	<u>Proportionate to % of overdraft to be corrected in 5-year intervals through implementation period</u>	<u>Proportionate to % of overdraft to be corrected in 5-year intervals through implementation period</u>	<u>Proportionate to % of overdraft to be corrected in 5-year intervals through implementation period</u>	<u>No change from current Objective (re-evaluate at the 5-year milestone pending data collection)</u>	<u>No change from current Objective</u>

### 3.4.1 Chronic Lowering of Groundwater Levels ~~and~~ Reduction of Groundwater Storage, ~~and Depletions of Interconnected Surface Water Bodies~~

#### 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, ~~and of depletions of interconnected surface water bodies.~~

~~Based upon studies conducted by the USGS, water level data can be used to monitor short and long-term changes in groundwater storage. The USGS has also used groundwater level measurements as an appropriate proxy measurement for interconnected surface water depletions and aquifer storage losses due to groundwater pumping in places where there is connection (USGS 2017). A study, sponsored by USGS, depicts a variety of mathematical models that can be used to correlate groundwater depletion with interconnected surface water depletions. For example, an analytical model called the "Grover Solution" can be used to understand the effects of groundwater level on changes to streamflow (Barlow and Leake 2012).~~

$$Q_s^* = Q_w \operatorname{erfc}(z)$$

*Q<sub>s</sub><sup>\*</sup> = expression for the total rate of streamflow depletion as a function of time*  
*Q<sub>w</sub> = product of the pumping rate of a well (either directly measured or calculated based on groundwater level change.*  
*erfc(z) = complementary error function*

~~Variable z in this equation is equal to  $\sqrt{(d^2 S)/(4Tt)}$  in which d is the shortest distance of the well to the stream, S is the storage coefficient of the aquifer (or specific yield, for water table aquifers), T is the transmissivity of the aquifer, and t is the time. There is a lack of abundant streamflow data for all of the surface water bodies that run through the EK GSA. In the future, the EK GSA plans to install stream gauges to be able to collect accurate flow data and calculate the corresponding contributions of baseflow to overall stream flow.~~

With respect to groundwater level declines (as well as storage ~~and surface water depletions~~ 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

**Commented [MC7]:** Replaced by the ISW Work Plan

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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. However, in giving due consideration to the beneficial users and uses of groundwater with the GSA, EKGSA set minimum thresholds at the most protective groundwater level in a threshold region between the protective level of at least the 90th percentile of all water supply wells and not allowing a larger rate of groundwater decline than the historical groundwater decline experienced between 1997-2017. In addition, EKGSA has committed to developing and implementing a mitigation program plan (Section 5.3.8) for wells that may be impacted prior to minimum thresholds exceedances. the EKGSA intends to develop a Well Observation Program which will monitor, evaluate, and notify beneficial users of potential impacts and possible actions that may be taken to avoid or minimize undesirable results.

It is the preliminary determination that the percentages identified herein represent a sufficient number of monitoring sites in the Subbasin such that their exceedance would represent an undesirable result for groundwater level and reductions in groundwater storage, and depletions of interconnected surface water. Based on observed groundwater conditions in the future, no less frequently than at each five-year assessment, the EKGSA will evaluate if these percentages need to be adjusted.

### 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. 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
- Increased (or new) subsidence impacts related to lowering groundwater levels (pressure) in the Subbasin Aquifers
- Adverse effects on health and safety

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.

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### 3.4.1.1.43.4.1.1.2 Causes of Groundwater Conditions that Could Lead to Undesirable Results

Lowering of groundwater levels ~~and~~, reduction in storage, ~~and loss of interconnected surface~~ water can all be caused by groundwater withdrawal in excess of recharge. Given assumed hydrogeologic parameters in the Subbasin, direct correlations exist between changes in water levels and estimated changes in groundwater storage. ~~Causes of groundwater conditions that could lead to undesirable results include over pumping or nominal groundwater recharge operations during drought periods such that groundwater levels fall and remain below minimum thresholds within each threshold region. Pumping beneath the EKGSA directly influences these sustainability indicators through the lowering of groundwater levels. Pumping beneath neighboring GSAs also influences groundwater levels beneath the EKGSA. With the EKGSA being at 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.~~

The primary cause of groundwater conditions that would lead to chronic lowering of groundwater levels is groundwater production in excess of natural and artificial recharge over a multi-year period that includes both wetter than average and drier than average conditions. In addition to natural drought-cycles, the increase in groundwater production may also be the result of restricted access to imported supplies due to a variety of factors, including but not limited to, increased restrictions in the Delta, which may increase the likelihood imported supplies from Millerton Lake to be delivered outside the Kaweah Subbasin. Restrictions on imported supplies may return the Kaweah Subbasin to a state it existed prior to the development of the Friant Division of the Central Valley Project. Climate change may also affect the availability and rate upon which natural and artificial recharge is available.

Pumping beneath the EKGSA directly influences ~~these~~ 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.

Additional potential declines of the water table below minimum threshold levels could be caused by:

- *GSAs not correcting the overdraft at the incremental mitigation rates described later in this section.*
- *Hydrologic cycle significantly drier than historic average conditions.*
- *Extended or worse drought conditions than the historic 2012-2016 drought.*
- *Neighboring GSAs and Basins not correcting boundary flow losses.*
- *Increased demand and pumping beyond what are planned for in the water budget.*

### 3.4.1.1.23.4.1.1.3 Potential Impacts on Beneficial Uses and Users of Groundwater

The primary effect of the chronic lowering of the groundwater table has caused wells to be drilled deeper and deeper to maintain productivity. Without correcting the Subbasin's overdraft and stabilizing the water table, the decades long trend of drilling deeper and deeper wells would continue causing increased financial burden on stakeholders. 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.

### 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 levels minimum thresholds 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 is 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 levels minimum thresholds were set at the most protective groundwater level in a threshold region based on groundwater levels protective of the 90th percentile of all water supply well completed depths \(Method 1\) and not allowing a rate of groundwater decline greater 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 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 \(](#)

[Table 3-2](#)), as those levels were more protective than the 90% well protection level. All EKGSA representative monitoring sites within a threshold region are assigned the same minimum threshold groundwater elevations.

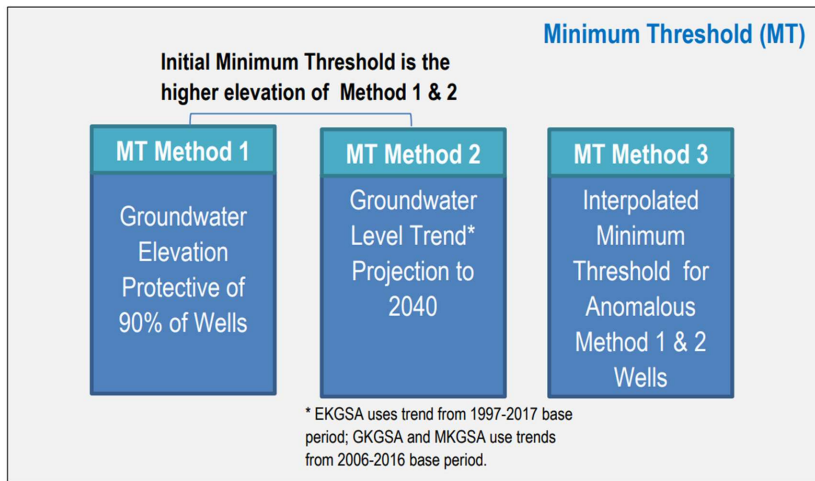


Figure 3-5 Chronic Lowering of Groundwater Levels Minimum Threshold Methodologies

**Method 1 – Protective Elevations for 90th Percentile for Water Supply Wells**

Since wells are how 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 at least 90% of all water supply wells in the Subbasin (“90% well protection level”). Data used to determine a 90% well 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 do 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)**

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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 90% well 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. In EKGSA's eastern analysis zones (also called threshold regions), some initial minimum threshold 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.

In order to fill the data gaps in the WDL, the local irrigation districts provided their water level data directly to the EKGSA. Any well that could not be matched to its spatial location was excluded from being used as a hydrograph. The data was preserved and can be revisited if more accurate geospatial data is acquired and further analysis becomes necessary. Data acquired from the districts is typically very robust. Wells are consistently measured during both spring and fall. On the occasion that a well is not measured during a season or ceases to be measured altogether, the reason for the discontinued measurement is typically stated (e.g. pump is running, well is abandoned, etc.). These notes allow for more efficient evaluation of the quality of individual wells for use in analysis.

#### 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.



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The minimum thresholds for groundwater elevation, groundwater storage, and interconnected surface water depletion were determined based on a hydrograph trend analysis that projected 2040 groundwater elevation based on the pumping and recharge regimes experienced during the base period (1997-2017). The primary data source for the hydrographs was the Water Data Library (WDL). The WDL was a sub-optimal resource due to a circumstance where most of the wells monitored by the groundwater agencies in the EKGSAs ceased to have their well data entered into the WDL circa 2011. Fortunately, the member irrigation districts continued sampling as required by their federal contracts and provided any data records they had collected to the EKGSAs that had not been entered into the WDL. Via this combination of data, the EKGSAs were able to create a robust set of hydrographs. **Appendix 3-A** contains the full methodology, data, and final hydrographs.

For a well's data to be utilized in the hydrographs it had to meet several criteria:

- *Data reported for the entire base period (1997-2017):*
  - *Wells that were drilled after 1997 were immediately disqualified.*
  - *Wells where data ceased to be reported were disqualified.*
  - *Wells with large temporal gaps were disqualified. However, a temporal gap of a year or two was not grounds for a removal from consideration.*
- *Baseline data quality:*
  - *Wells that exhibited a severe degree of erratic behavior (many measurements did not make sense) were immediately disqualified. This was a rare disqualification.*
  - *Wells that exhibited a mild degree of erratic behavior (e.g. one or two measurements that would place the WSE above ground level for a season) were curated. The majority of the data was left untouched, but the impossible measurements were removed. The wells that remained became hydrograph candidates.*
- *Confidence in well location:*
  - *Wells with data pulled from the WDL came with reliable location data. Unfortunately, by the time we had reached this step in the process almost all of the wells had been knocked out of the running by the personnel incident alluded to earlier.*
  - *Any district wells that could not be matched to the WDL and that did not have clear and defined spatial locations were disqualified.*
- *Hydrograph corroboration*
  - *Every well will behave as an individual according to local conditions. Slight variations between two nearby wells are completely natural and not a cause for concern. However, extreme variations in the conditions of adjacent wells should give pause.*

The trends of the hydrographs were projected out to 2040. These projections were used to create a groundwater surface in GIS via the method Spline with Barriers. This groundwater surface revealed locations where the local wells conflicted with one another. The wells in opposition were analyzed to determine consistency of data internally and with other adjacent wells. If data appeared consistent both wells were left alone. That the wells were being analyzed in this way suggests a lack of consistency, though, and so it was more likely that one of the wells would be found somewhat defective. The hydrograph for the lackluster well was excluded from the projection analyses.

#### 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 EKGSAs determined that the minimum thresholds will avoid undesirable results for each Indicator:

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- **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. *For most of the Kaweah Subbasin, there is not connected surface water due to the depths of groundwater and intermittent flows in many river or creek channels. However, there are some potential areas for interconnected surface water on the eastern side of the Subbasin. The Kaweah River, Cottonwood Creek, Lewis Creek, and Frazier Creek have potential for connection with the groundwater below. The most likely is the Kaweah River, which above a location known as McKays Point is locally known as a gaining portion of the River. Local observations suggest this portion of the Kaweah River always has water in the channel, except in 2015 when some portions became dry due to the historic drought. The other creeks have potential for interconnected surface water near the foothills, however due to the intermittent flows in these small watersheds the connection may not be very consistent. Lewis Creek is known to have a perched aquifer under it, but even in midst of the droughts, groundwater dropped from 7 feet depth to water to 13 feet depth, most likely due to less inflow coming in from the mountains. Based on this understanding, 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, and limited impacts of groundwater pumping on interconnected surface water bodies streamflow, it was determined that focusing the minimum threshold on groundwater levels would be appropriate for evaluating any undesirable effects on surface water connection.*
- **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-B](#) [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 *directly on land elevation measurements on or near/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

[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. Basinwide loss of industrial, municipal, and domestic well pumping capacity occurs due to lowering groundwater levels.](#)

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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 the 90th percentile of all water supply wells (Method 1) and not allowing a rate of groundwater decline greater than the historical groundwater 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 (

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Table 3-2), as those levels were more protective than the 90% well protection level. Therefore, the minimum thresholds are protective of at least 90% of all water supply wells within the EKGSA and avoid reduction in the long-term viability of domestic, agricultural, and domestic well pumping capacity. For the less than 10% of wells that may be impacted if groundwater levels reach minimum thresholds, Section 5.3.8.2 outlines a Water Supply Well Mitigation Program to mitigate impacts to well pumping capacity.

Once the hydrographs for the 1997-2017 base period were developed, the EKGSA was able to critically analyze the projected 2040 groundwater levels and determine the magnitude of potential impacts likely to occur due to the current pumping and recharge regime. If overdraft conditions in the Subbasin continue at a pre-SGMA implementation rate (i.e. similar to the base period condition), groundwater levels in many of the EKGSA threshold regions by 2040 will be at groundwater levels that mirror the condition of the basin before the Central Valley Project brought in surface water supplies. Appendix 2-B contains historical information regarding the impacts to the basin and Figure 2-20 shows the change in groundwater elevation pre- and post-CVP. Through this analysis, based on current data availability, it was determined that returning to groundwater conditions similar to that of pre-1950 is an Undesirable Result and thus marked a baseline minimum threshold for groundwater levels. After looking at 2040 projections, candidate water level minimum thresholds were investigated to determine if they were sufficiently protective of aquifer storage capacity and interconnected surface water areas. In the eastern threshold regions of the GSA, some candidate minimum threshold levels were increased due to the shallow depth to the bottom of the aquifer. Each baseline minimum threshold for groundwater levels was also evaluated by the TAC to determine if it was stringent enough by reviewing if the projected level would cause excessive strain to the health of local communities, the agrarian economy, or interconnected surface water areas. More stringent minimum thresholds were, and can continue to be, formed if deemed necessary by the EKGSA, its TAC, and relevant stakeholders.

### 3.4.1.2.4 Impact of Minimum Thresholds on Water Uses and Users

Minimum thresholds for groundwater levels and, by proxy, interconnected surface water depletions, and 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 plan (Section 5.3.8.2) have been established based on the protective level that did not result in a greater rate of decline over water years 2020 to 2040 than experienced between 1997-2017 historic rate of decline and enough operational flexibility to maintain deliver and ensure enough storage to maintain water deliveries during at least a 540-year drought. The minimum thresholds interim milestones and measurable objectives 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 minimum thresholds 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 in two ways by partnering with the Kaweah Subbasin GSAs and County of Tulare to develop a more complete well canvass of the area, and developing a Well Observation Program Drinking Water Well Monitoring Program (Section 5.3.8.1) to monitor and evaluate potential impacts to drinking water wells. Overall, the minimum thresholds have been established to allow for continued beneficial use within the EKGSA and provide improved long-term certainty of groundwater levels and corresponding supply.

Stabilizing the groundwater levels will provide more certainty of the long-term availability of groundwater supply for all beneficial uses and users. An analysis was performed evaluating the Well Completion Report data set on potential impacts to the wells of agricultural, domestic, and public users. The data set has challenges and gaps when evaluating in this manner. There is uncertainty with several completion components such as location and missing or uncertain values related to depth or perforation interval. With these gaps in mind, a preliminary analysis of wells going dry was performed by comparing well bottom perforation elevations and the proposed minimum threshold in each threshold region. The bottom perforation elevation was chosen for the analysis due to this being the point at which no water can be extracted from a well. Wells would be impacted sooner than reaching this elevation, however inherent challenges with the data plus additional challenges such as

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whether the well is still in use or the setting of the pump bowls directed the analysis to focus on bottom perforations. The results from this analysis are summarized in . Across the EKGSA approximately one third of all wells may go dry at the proposed minimum thresholds. Evaluating by well type, one half of the domestic wells may go dry, while approximately one quarter of the agricultural wells and one eighth of public wells would suffer the same fate. Percentages vary by threshold region, and the EKGSA recognizes that some shallow wells will likely go dry until water levels have been stabilized. Without SGMA and the proposed incremental mitigation by the EKGSA, the shallow wells would have gone dry sooner, requiring communities and landowners to deepen these existing wells. The minimum thresholds have been established to allow for continued beneficial use within the EKGSA and provide improved long-term certainty of groundwater levels and corresponding supply. The EKGSA intends to bolster the well data set for future analyses in two ways; partnering with the Kaweah Subbasin GSAs and County of Tulare to develop a more complete well canvass of the area, and developing a Well Observation Program to monitor and evaluate potential impacts to drinking water wells.

### Minimum Thresholds in Relation to Adjacent Basins

The minimum thresholds established are based on projections of incremental historic decline starting immediately and reaching stabilization by 2040. This approach is believed to be conservative and protective from undesirable results. 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 minimum threshold elevations along the boundaries will need to be coordinated during implementation once focus shifts from finalizing the initial GSP documents. The EKGSA will evaluate and coordinate the potential differences between boundary thresholds and work to coordinate needed resolutions and clarifications when GSPs are completed.

#### 3.4.1.2.5 Measurement of Minimum Thresholds

Groundwater levels and storage, storage, and interconnected surface water depletion minimum thresholds 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 \(as described in Section 5.3.7\)](#).

#### 3.4.1.2.6 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.

#### 3.4.1.2.7 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, depth to water (DTW), 2015 DTW, and groundwater surface elevation (WSE) and depth to water (DTW) are included. Appendix 3-A lists the minimum thresholds for each representative monitoring site.

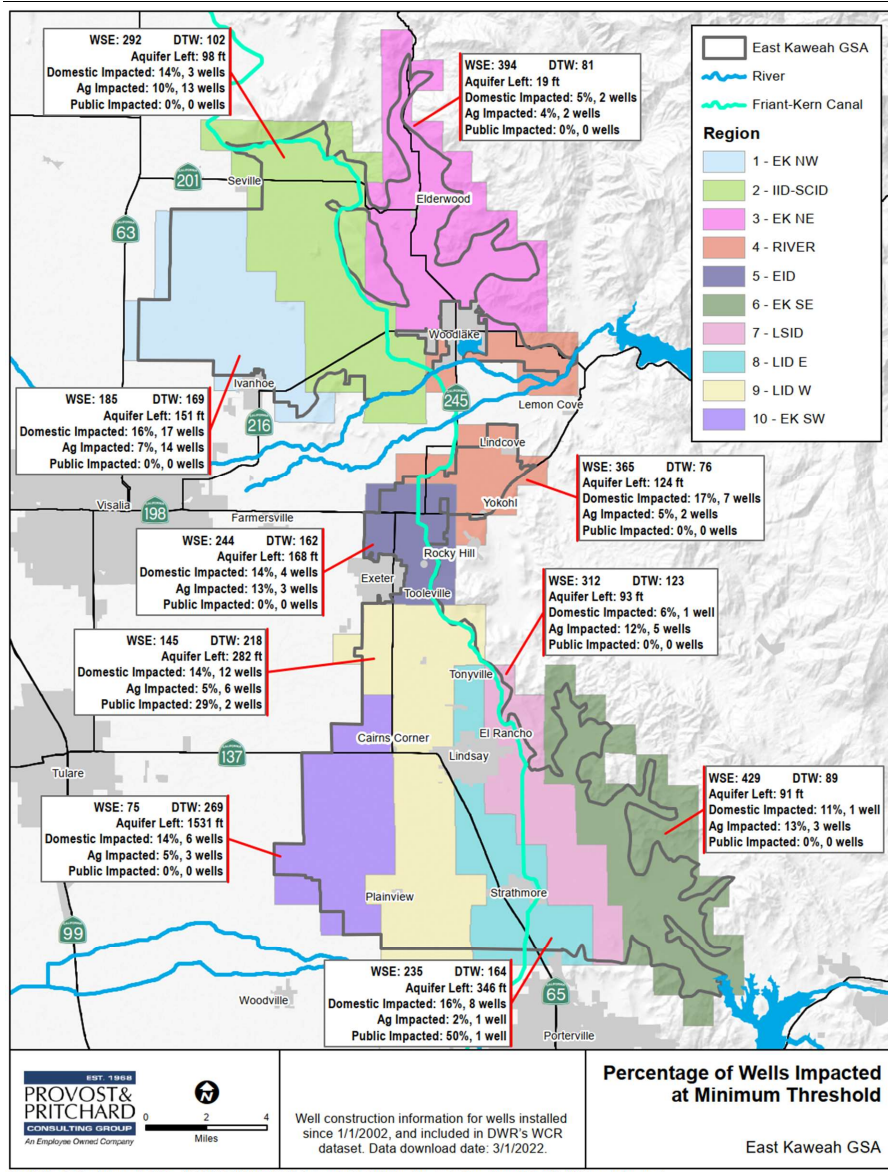
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Table 3-2 Groundwater Level Minimum Thresholds

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.

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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.

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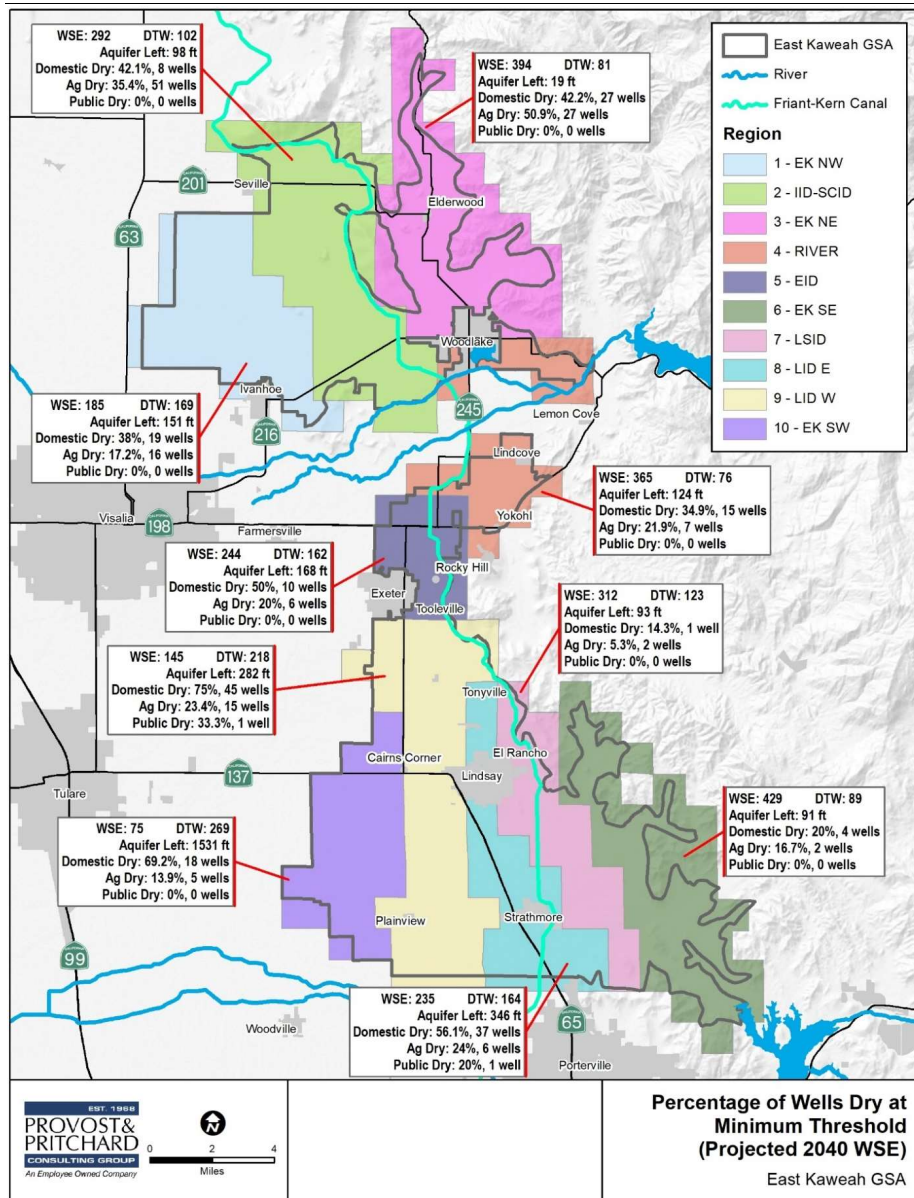


Figure - Groundwater Minimum Threshold and Well Impacts by Threshold Region



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.

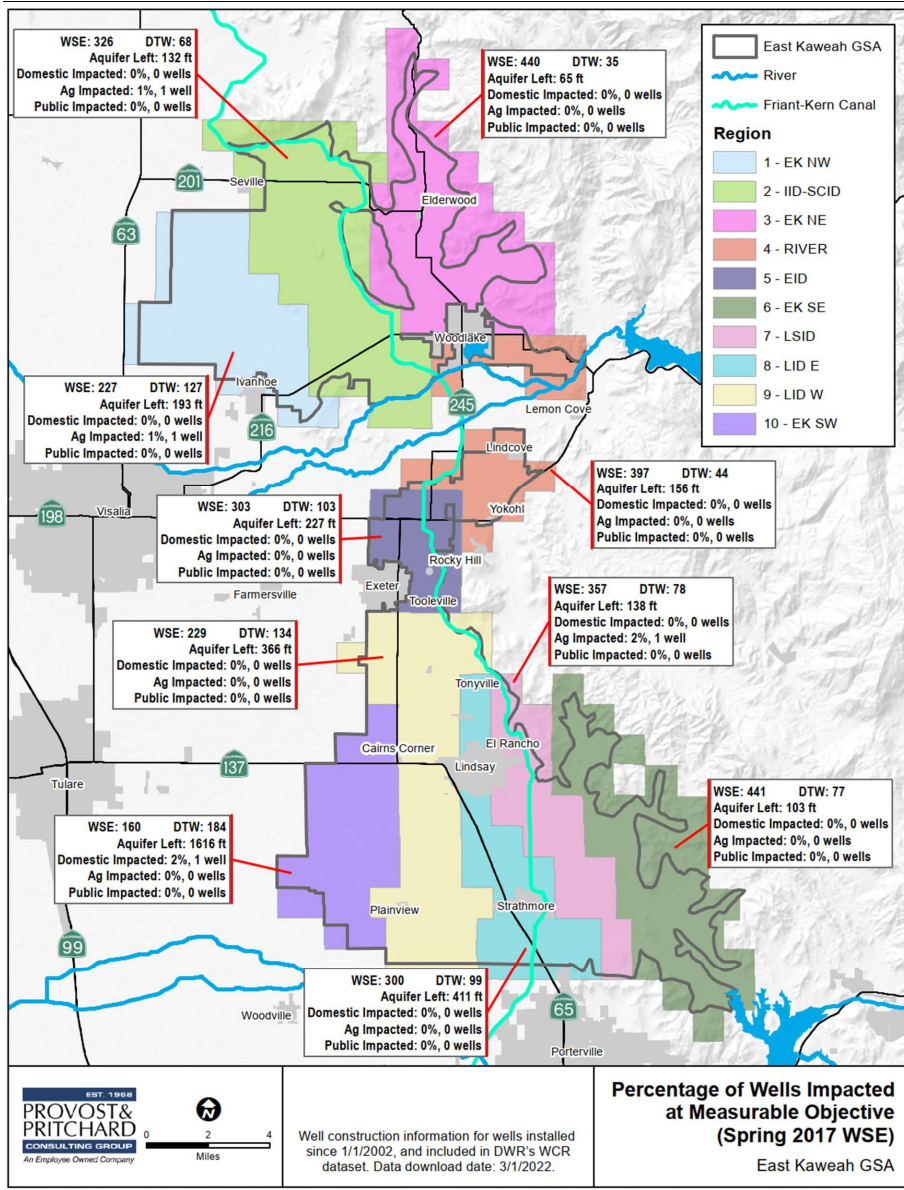
[Measurable objectives \(MOs\) are established at groundwater elevations higher than MTs to provide operational flexibility and reflect the GSAs' desired groundwater conditions in 2040. The margin of operational flexibility accounts for droughts, climate change, conjunctive use operations, other groundwater management activities, and data uncertainty. The GSAs in the Kaweah Subbasin are managing their groundwater sustainability 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. This approach applies to wells where the MT is based on the protective level that did not result in a greater rate of decline over water years 2020 to 2040 than experienced between 1997-2017.](#)

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The analysis evaluating [the Well Completion Report \(WCR\)](#) 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 [bottom perforation depth](#) elevations and the proposed measurable objectives in each threshold region. The results from this analysis [vary by threshold region and](#) are summarized in [Figure 3-7](#). Across the EKGSA approximately [0.32%](#) of all wells may go dry at the proposed measurable objectives. Evaluating by well type, [40.22%](#) of the domestic wells may go dry, while [0.49%](#) of the agricultural wells and no public wells would become dry. [The percentages do vary by threshold region, as shown in the figure.](#)

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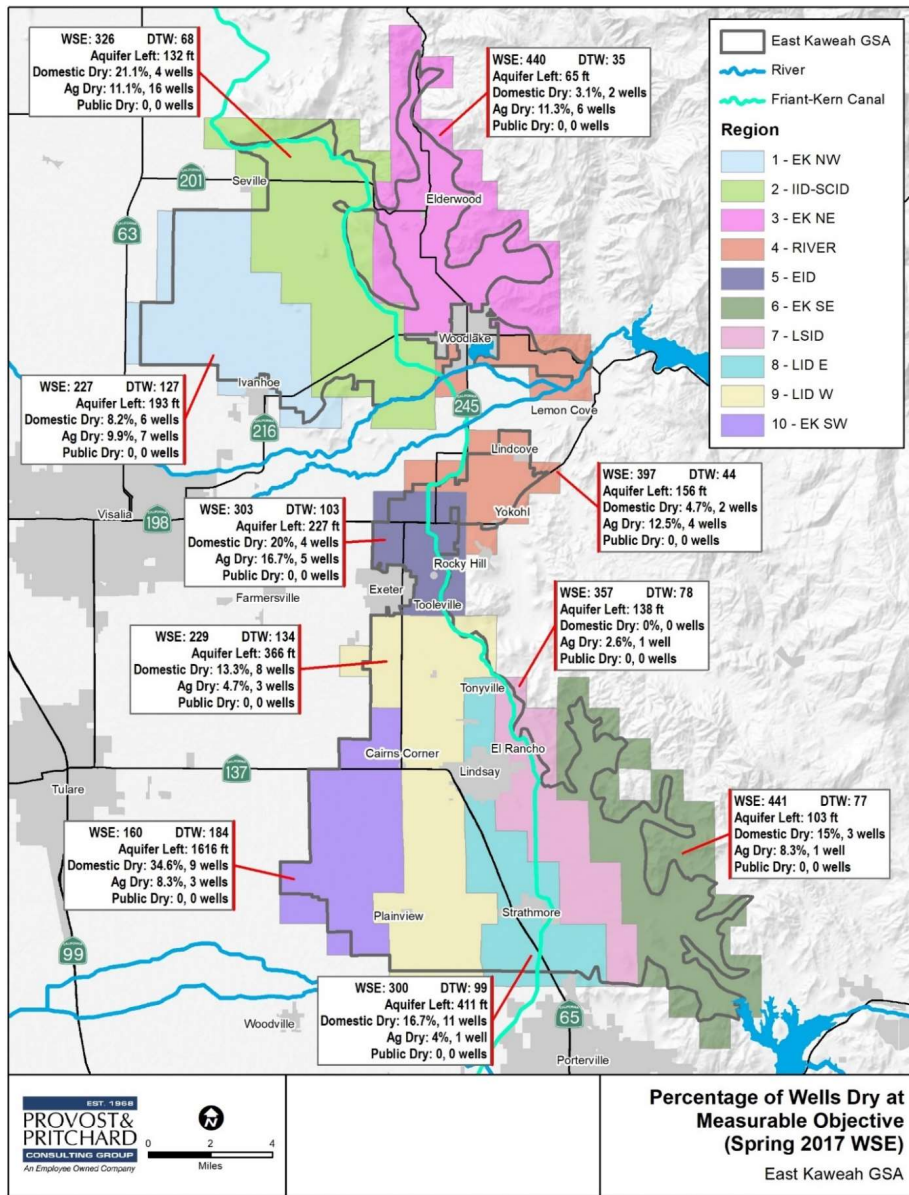


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Figure 3-7 Groundwater Measurable Objective and Well Impacts by Threshold Region

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

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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.

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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

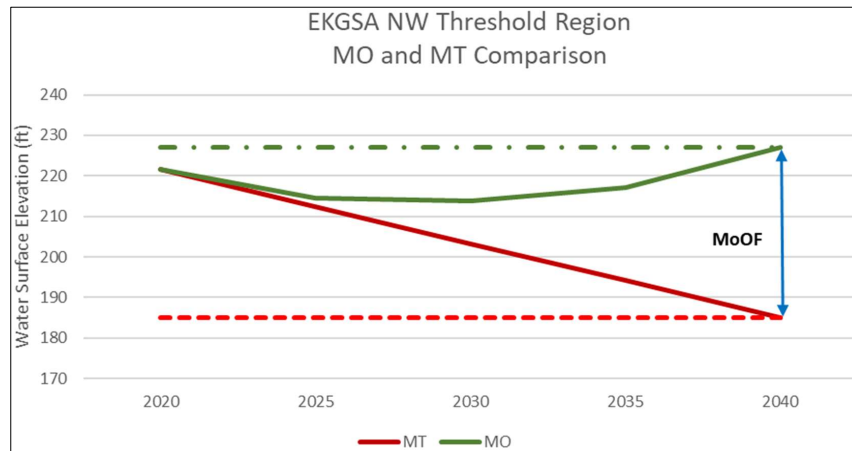


Figure 3-8 Example MO vs. MT Groundwater Level Comparison

### **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. The Work Plan will be performing further investigation 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*

The EKGSA is currently unaware of significant impacts or undesirable results currently occurring with respect to depletion of interconnected surface waters in the Kaweah Subbasin and within the EKGSA boundary. The upcoming Work Plan is aimed at moving the EKGSA to a clearer definition of significant impacts and undesirable results to interconnected surface water depletions caused by groundwater extraction, if such conditions are identified.

The waterways to be evaluated as part of the Work Plan are shown in **Figure 3-10**. 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.

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. If the latter condition is supported by data and information following the Work Plan, the interconnected surface water undesirable results may follow the similar undesirable results criteria of one-third of the representative monitoring sites in all three GSA jurisdictions combined exceed their respective minimum threshold water level elevations. 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.

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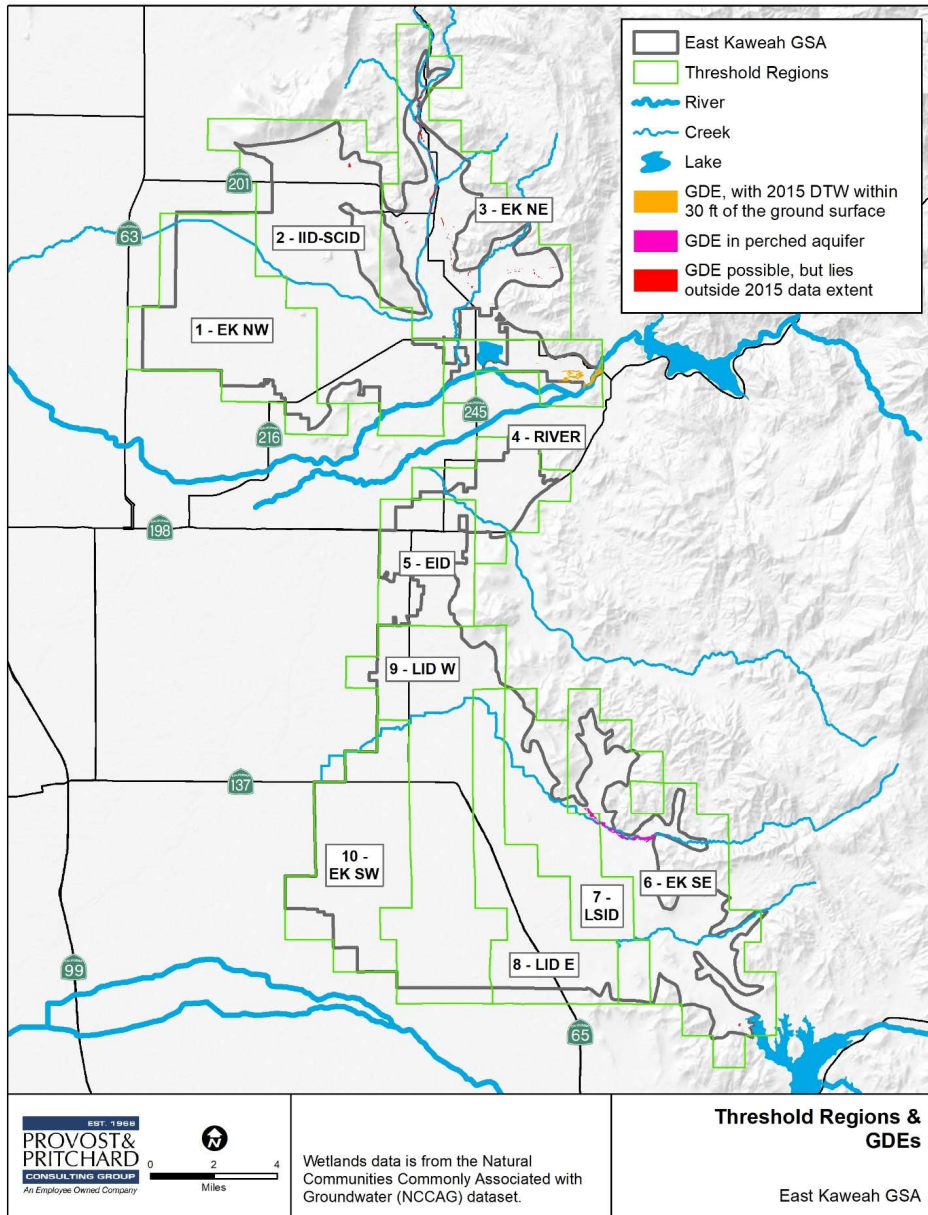
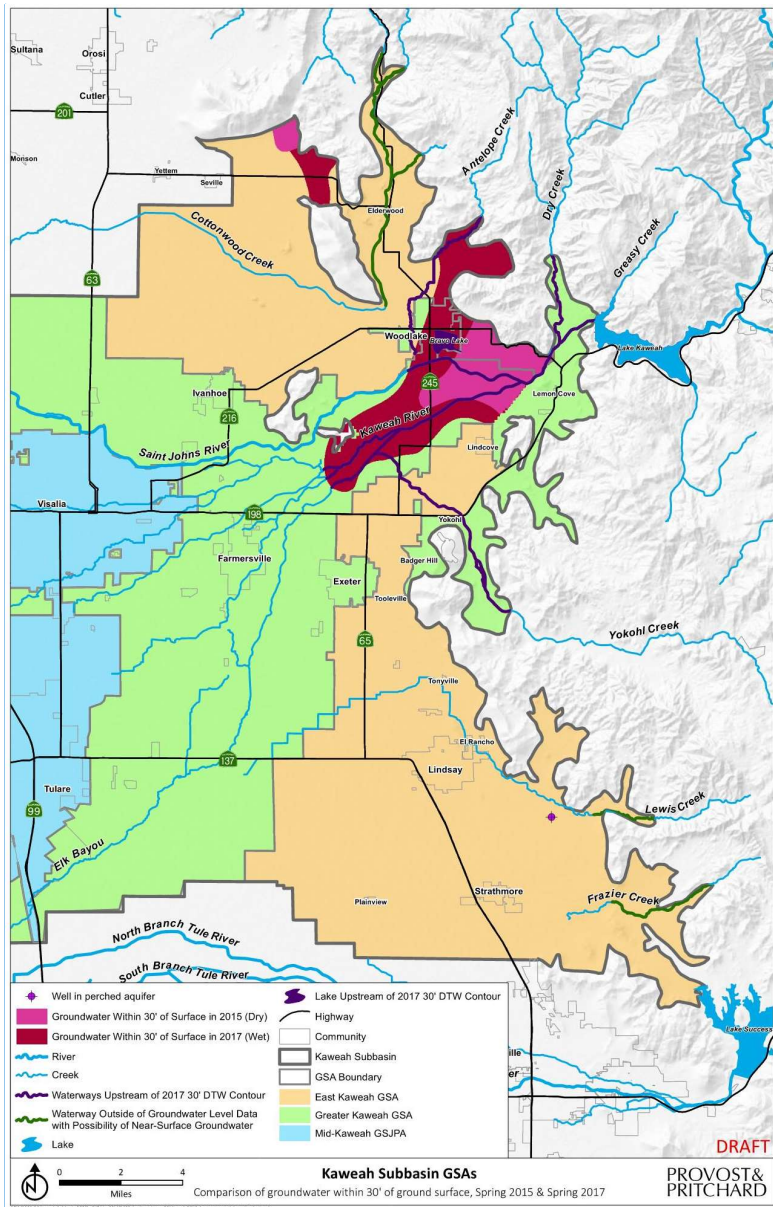


Figure 3-9 EKGSA Threshold Regions and Potential Groundwater Dependent Ecosystems



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Commented [MC8]: Map will be finalized as feedback is returned from GSAs

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

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### 3.4.2.1.2 Causes of Groundwater Conditions that Could Lead to Undesirable Results

Undesirable results associated with interconnect 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 all. Within the Kaweah Subbasin, there are currently significant data gaps related to understanding the potential locations and 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.

### 3.4.2.1.3 Potential Impacts on Beneficial Uses and Users

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:

- *Causing 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. For most of the Kaweah Subbasin, surface waterways are considered disconnected due to the depths of groundwater and intermittent flows in many river or creek channels. However, there are some potential areas for interconnected surface water on the eastern side of the Subbasin. The Kaweah River, Antelope Creek, Yokohl Creek, Cottonwood Creek, Lewis Creek, and Frazier Creek have potential for connection with the groundwater below. The location of highest potential for interconnection is the Kaweah River above a location known as McKays Point. The other creeks have potential for interconnected surface water near the foothills, however due to the intermittent flows in these small watersheds, the connection may not be very consistent. Lewis Creek is known to have a perched aquifer under it. In midst of the drought, groundwater dropped from 7 feet depth to water to 13 feet depth, most likely due to less inflow coming in from the mountains.

### 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 a data or a full understanding 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 minimum thresholds and thus becoming an undesirable result, are increased losses experienced by surface water users and rights holders and loss of potential riparian or groundwater dependent ecosystems. The approach used in setting minimum thresholds for interconnected surface waters does not have a lot of data and technical backing.

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However, the EKGSA is initially setting minimum thresholds for interconnected surface waters largely based on the local experience of surface water purveyors in the area who have operated these waterways for decades. Based on this experience, typical losses in these channels have been on the order of 30% of the flows in the channels. In dry periods these losses have been reported as high as 50%. 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 minimum thresholds for interconnected surface waters based on 50% loss of the channel's flow capacity for when water is present, which is typically in Spring and Summer (hydrology permitting). **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).

**Table 3-6** Preliminary Minimum Thresholds for Interconnected Surface Waters

Waterway	Channel Capacity (CFS/LF)	Minimum Threshold (50% Losses in Channel) (CFS/LF)
Kaweah River	5,700	2,850
Antelope Creek	450	225
Yokohl Creek	3,400	1,700
Cottonwood Creek	4,700	2,350
Lewis Creek	1,800	900
Frazier Creek	1,000	500

### 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

ISW losses will be measured along potentially interconnected stretches 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 minimum thresholds established by the EKGSA are applied to each individual ISW rather than a threshold region. The EKGSA will assess the need for further development of ISW specific threshold regions 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 minimum thresholds for interconnected surface waters, the EKGSA does not have a lot of data and technical backing to support the setting of measurable objectives for ISWs and is largely basing these preliminary MO based on the local experience of surface water purveyors in the area who

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have operated these waterways for decades. Based on this experience, typical losses in these channels have been on the order of 30% of the flows in the channels. At a 30% channel loss rate, the EKGSA is unaware of significant and unreasonable impacts caused by groundwater extraction. Thus, the EKGSA has set starting measurable objectives for ISWs based on 30% loss of the channel's flow capacity for when water is present, which is typically in Spring and Summer (hydrology permitting). **Table 3-7** 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).

**Table 3-7 Preliminary Measurable Objectives for Interconnected Surface Waters**

Waterway	Channel Capacity (CFS/LF)	Measurable Objective (30% Losses in Channel) (CFS/LF)
Kaweah River	5,700	1,710
Antelope Creek	450	135
Yokohl Creek	3,400	1,020
Cottonwood Creek	4,700	1,410
Lewis Creek	1,800	540
Frazier Creek	1,000	300

### 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.

### 3.4.23.4.3 Degraded Water Quality

#### 3.4.2.1.43.4.3.1 Undesirable Results

Water quality degradation will be considered an undesirable result if, due to the impacts of EKGSA's projects or management actions on groundwater flow, concentrations of constituents of concern increase beyond the baseline concentration to significantly impact the beneficial uses and users of Kaweah Subbasin groundwater.

##### 3.4.2.1.43.4.3.1.1 Criteria to Define

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.*

##### 3.4.2.1.23.4.3.1.2 Causes of Groundwater Conditions that Could Lead to Undesirable Results

The research conducted to date indicates that land use practices, natural geologic formations, point sources of contamination, and pumping localities and rates may all contribute to groundwater conditions with constituent of concern concentrations that may exceed recognized water quality standards. As extensively discussed in **Chapter 2**, historical and current land use practices (i.e. agriculture, dairies, and septic systems) and natural

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geologic formations have led to the Subbasin's groundwater aquifer exceeding several contaminant thresholds for some time. Change in groundwater levels may or may not be a cause, depending on location, as some constituents improve with lowering water levels while others decrease, and vice versa.

#### 3.4.2.1.3 3.4.3.1.3 *Potential Impacts on Beneficial Uses and Users*

Groundwater quality degradation has the potential to negatively impact drinking and irrigation water users. Quality degradation that impacts constituent concentrations with agronomic recommended thresholds can have a negative impact on crop health and yield. In extreme situations, it can permanently damage crops. Degraded groundwater quality with respect to drinking water users, could potentially lead to groundwater unfit to meet potable water standards which may lead to added costs for drilling new wells or new treatment needs.

#### 3.4.2.2 3.4.3.2 **Minimum Thresholds**

##### 3.4.2.2.1 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-B](#) [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](#).

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**Table 3-8. Constituents of Concern for the EKGSA with Respective Minimum Threshold**

Constituent	Threshold Level		Threshold Type	Municipal	Agricultural
				Minimum	Minimum
				Threshold	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.

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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 3-8](#).

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.

#### [3.4.2.2.23.4.3.2.2](#) Relationship for each Sustainability Indicator

As demonstrated in [Appendix 3-B](#) [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.

#### [3.4.2.2.33.4.3.2.3](#) 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.

#### [3.4.2.2.43.4.3.2.4](#) 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.

#### [3.4.2.2.53.4.3.2.5](#) 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.

#### **3.4.2.2.6 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.

### **3.4.2.3 3.4.3.3** **Measurable Objectives**

#### **3.4.2.3.1 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.

#### **3.4.2.3.2 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.

#### **3.4.2.3.3 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.

### **3.4.3.3.4.4 Land Subsidence**

#### **3.4.3.1.3.4.4.1 Undesirable Results**

~~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.~~

~~Subsidence will be considered an undesirable result if there are unreasonable impacts on critical infrastructure.~~

##### **3.4.3.1.3.4.4.1.1 Criteria to Define**

The process used to develop the criteria for undesirable results began with the review of existing USGS, DWR, and USBR land subsidence data, and through discussions with stakeholders and landowners regarding locally observed conditions. ~~The criteria for an undesirable result will be the significant loss of functionality of a structure or a facility to the point that, due to subsidence, the feature cannot be operated as designed requiring either retrofitting or replacement.~~

Based on the discussions with stakeholders and landowners, there have been no known undesirable results ~~to date~~ within the EKGSA. Water conveyance structures tend to be the most sensitive to subsidence. However, damage to roads, railways, bridges, pipelines, buildings, flood control facilities, 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.

~~The primary criteria and metric will be the annual rate of reduction in land surface elevation and the total amount of such elevation changes. Subsidence levels are 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 to meet water supply deliveries without either significant repair or replacement. Potential significant and unreasonable impacts include:~~

- ~~• Capacity reduction of 10% in the Friant-Kern Canal – a facility of Statewide importance~~
- ~~• In-channel flood flow capacity reduction of 10% in flood control waterways~~
- ~~• Capacity reduction of 10% in local surface water delivery channels~~
- ~~• Groundwater well failures due to subsidence impacts~~
- ~~• Roadway/ bridges fail resulting in increased economic impacts due to inability to facilitate local commerce~~
- ~~• Cracks in gas lines interrupting service~~
- ~~• Rail failures resulting in impacts due to inability to facilitate commerce~~
- ~~• Interfere with other sustainability indicators~~

~~An undesirable result will occur when one-third of the Subbasin subsidence monitoring sites exceed their respective minimum thresholds.~~

##### **3.4.3.1.23.4.4.1.2 Causes of Groundwater Conditions that Could Lead to Undesirable Results**

Land subsidence is a gradual settling or sudden sinking of the Earth's surface due to movement of earth materials. It can be caused by compression of clay and silt layers in an aquifer system, drainage and oxidation

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of organic soils, and/or the dissolution and collapse of susceptible rocks (USGS 1999). Within the Kaweah Subbasin, causes of subsidence include over-pumping or nominal groundwater recharge operations during drought periods such that groundwater levels fall, dewatering susceptible layers, and/or require wells to pull from deeper aquifers. [Over-pumping and lack of recharge are area specific, and some GSA Management Areas experience greater adverse impacts than others.](#) When diminishing groundwater levels lead to aquifer compaction and subsidence, this negatively affects gravity-driven water conveyance structures by disrupting the natural grade line, reducing the facility's ability to convey water. 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.

[For many of the impacts listed in Section 3.4.4.1.1, subsidence is only 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. The same comparisons may be made for other infrastructure as well.](#)

#### **3.4.3.1.33.4.4.1.3** *Potential Impacts on Beneficial Uses and Users*

In the San Joaquin Valley, the main problems related to land subsidence are the impacts to gravity driven water conveyance structures and increased flooding risk. Gravity conveyance facilities can be sensitive to minor changes in gradients can cause reductions in the designed capacity of the feature. Subsidence can also lead to increased flooding risk if a levee or surrounding area is lowered and overtopping of a water body occurs. Other facilities sensitive to subsidence include roads, railways, bridges, pipelines, buildings, and wells.

[While more focus has been placed on the highly visible infrastructure damage from subsidence, which generally can be repaired, compaction of the aquifer system may permanently decrease its capacity to store water. Most aquifer compaction that occurs is generally irreversible. Any inelastic reduction in storage could be detrimental to the ability of groundwater users in the Subbasin to maintain a resilient groundwater supply.](#)

Within the EKGSA, the beneficial uses and users are most impacted by decreased capacity in the FKC. Considered by many users to be the “lifeflood” 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. [If an exceedance of a minimum threshold at a monitoring site occurs, EKGSA \(in coordination with MKGSA and GKGSAs\) will reach out to the County, cities, water districts, and others, both public and private, and inquire as to any infrastructure has been damaged which may require a corrective course of action, if deemed necessary.](#)

[While more focus has been placed on the highly visible infrastructure damage from subsidence, which generally can be repaired, compaction of the aquifer system may permanently decrease its capacity to store water. Most aquifer compaction that occurs is generally irreversible. Any inelastic reduction in storage could be detrimental to the ability of groundwater users in the Subbasin to maintain a resilient groundwater supply.](#)

### **Minimum Thresholds**

#### **3.4.3.1.43.4.4.1.4** *Description of Minimum Threshold*

Very few subsidence monuments are located within the EKGSA. 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.

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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 ~~5-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 ~~2018-2021~~ is the most recent set to be published and is presented in **Figure 3-11**. According to this data set, ~~the vast majority nearly two-thirds~~ of the EKGSA ~~has experienced less than 0.5 feet (6 inches) falls within the 0 to 0.3 feet of change in elevation range during those three years, indicating either no subsidence or slight uplift. Much of the remaining third experienced 0.0 to 0.5 feet of subsidence.~~ A small portion ~~in the southwestern portion, approximately 5% of the EKGSA west of Lindmore ID has~~ experienced ~~approximately from 0.5 to 2.0 to 2.5 feet of subsidence over the time period in the area west of the Lindmore ID. In short, over 90% of the EKGSA experienced less than 0.5 feet of subsidence between June 2015 and June 2018.~~ The small area of the EKGSA seeing higher subsidence rates may be consequence of actions outside of the EKGSA boundary.

~~Undesirable conditions resulting from subsidence in the EKGSA would be the diminishment of capacity of the FKC, and other harm inflicted on critical infrastructure. Diminished capacity is already documented and slated for repair further south of the EKGSA. Infrastructure within the Kaweah itself does not appear to be at risk. Based upon the surface water needs of stakeholders within the EKGSA, it was determined that no more than a 10% capacity reduction in the current capacity of the FKC due to subsidence would be acceptable. Using the maximum amount of capacity loss and the engineering specifications of the FKC, it was estimated that 9.5” of subsidence in one year in threshold regions near the FKC could result in up to a 10% capacity loss in the FKC. Therefore, the minimum threshold for land subsidence was set at no more than 9.5” of land subsidence in a year to protect the FKC (Table 3-9). 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.~~

~~No known significant clay layers exist within the EKGSA. Compaction due to dewatering and associated loss of storage are locally an issue of less concern. Should subsidence expand or accelerate within the EKGSA this position would be reevaluated.~~

**Table 3-9** 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

~~3.4.3.1.5 — No known significant clay layers exist within the EKGSA. Compaction due to dewatering and associated loss of storage are locally an issue of less concern. Should subsidence expand or accelerate within the EKGSA this position would be reevaluated. Relationship for each Sustainability Indicator~~

~~3.4.3.1.6 3.4.4.1.5 Table 3-9. Subsidence's Relationship with Each Sustainability Indicator~~

**Table 3-10** Subsidence's Relationship with Each Sustainability Indicator

Indicator	Relationship to Land Subsidence
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Water Level	Land subsidence does not impact water levels, rather <del>ground</del> water 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 <del>land</del> inelastic land subsidence occurs.
Groundwater Quality	No current nexus to land subsidence.
Interconnected Surface Water	No current nexus to land subsidence.

3.4.4.1.6 Selection of Minimum Thresholds to Avoid Undesirable Results

Within 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. 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.

Based upon the surface water needs of stakeholders within the EKGSA, it was determined that no more than a 10% capacity reduction in the current capacity of the FKC due to subsidence would be acceptable. Using the maximum amount of capacity loss and the engineering specifications of the FKC, it was estimated that 9.5" of subsidence in one year in threshold regions near the FKC could result in up to a 10% capacity loss in the FKC. Therefore, the minimum threshold for land subsidence was set at no more than 9.5" of land subsidence in a year to protect the FKC. 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 3-10 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

3.4.3.1.73.4.4.1.7 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 critical-sensitive to subsidence as ~~to~~ 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).

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#### 3.4.3.1.83.4.4.1.8 *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.

#### 3.4.3.1.93.4.4.1.9 *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.

### **3.4.3.23.4.4.2 Measurable Objectives**

#### 3.4.3.2.13.4.4.2.1 *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.

#### 3.4.3.2.23.4.4.2.2 *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.

#### 3.4.3.2.33.4.4.2.3 *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.

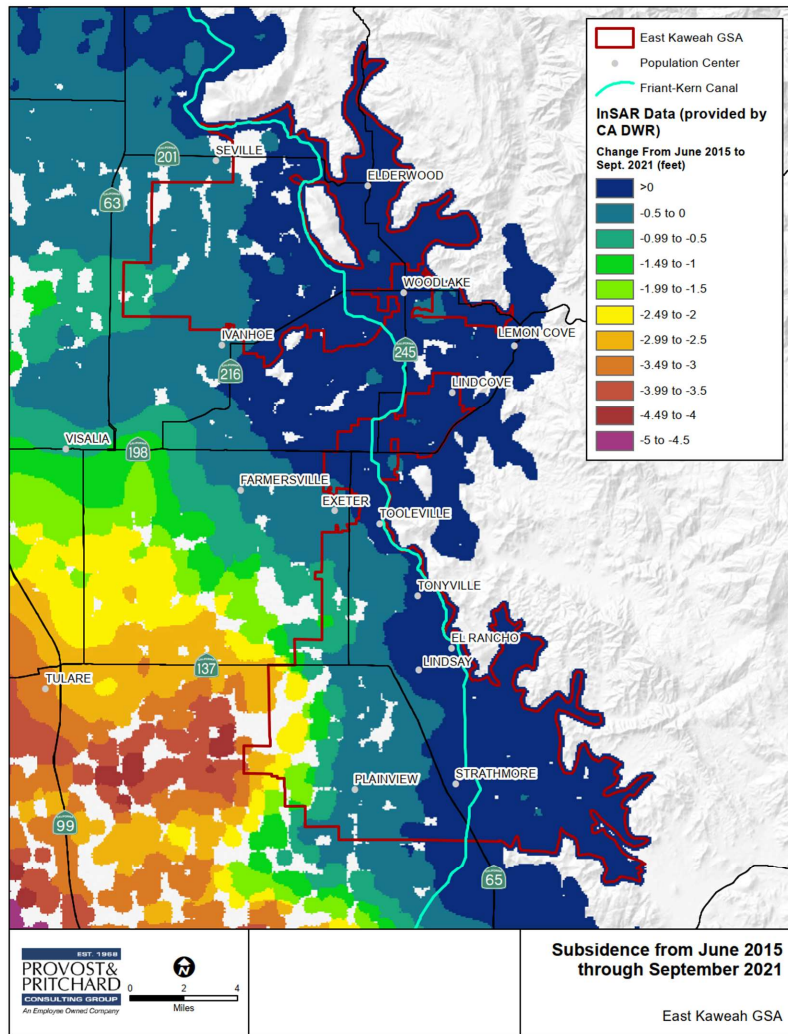
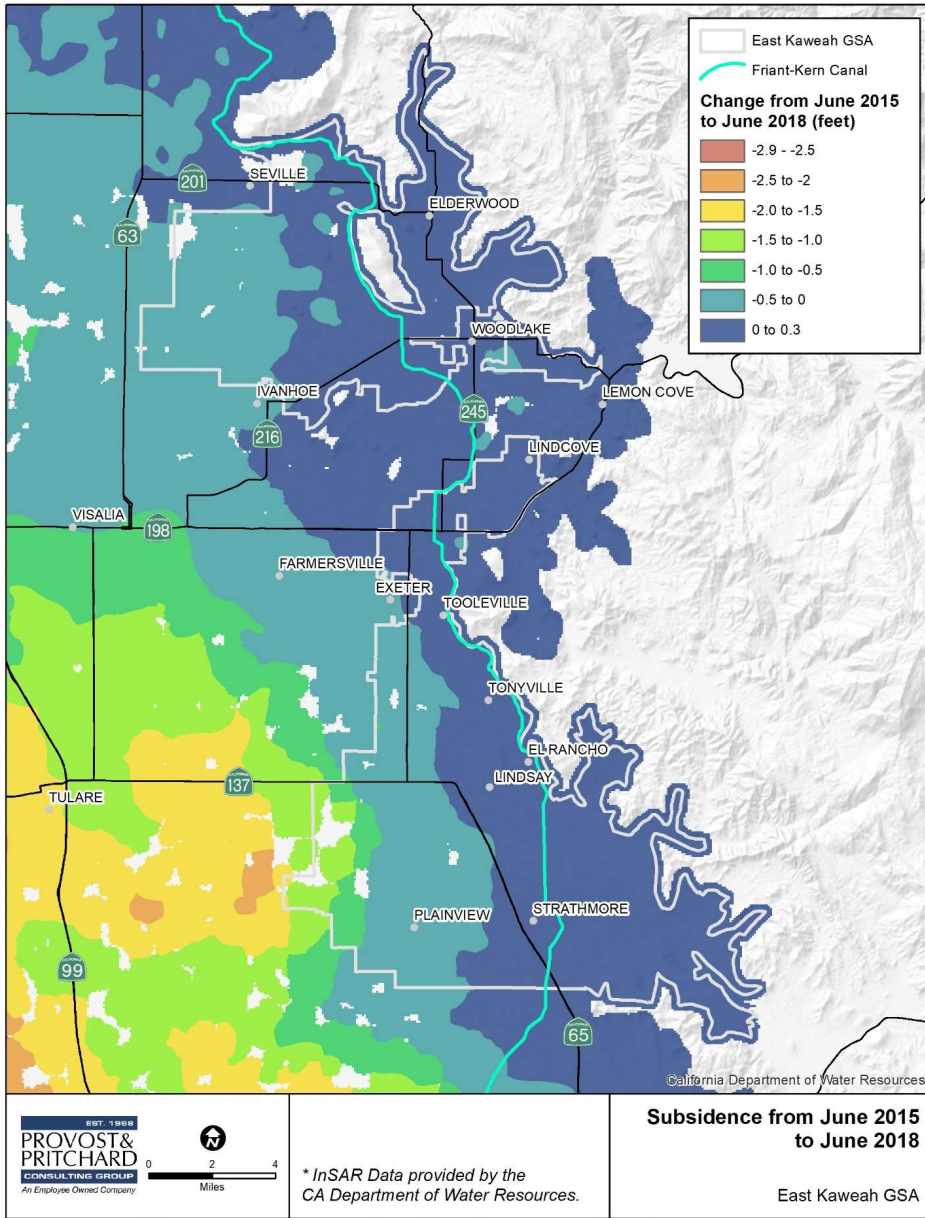


Figure 3-113-10. Subsidence NASA InSAR Data from 2015 to 2018 to 2021 for the EK GSA

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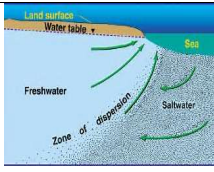



## 4 Monitoring Network

**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

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

## 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 Sub-basin 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 GK GSA, 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.

Chapter Four: Monitoring Network  
East Kaweah GSA

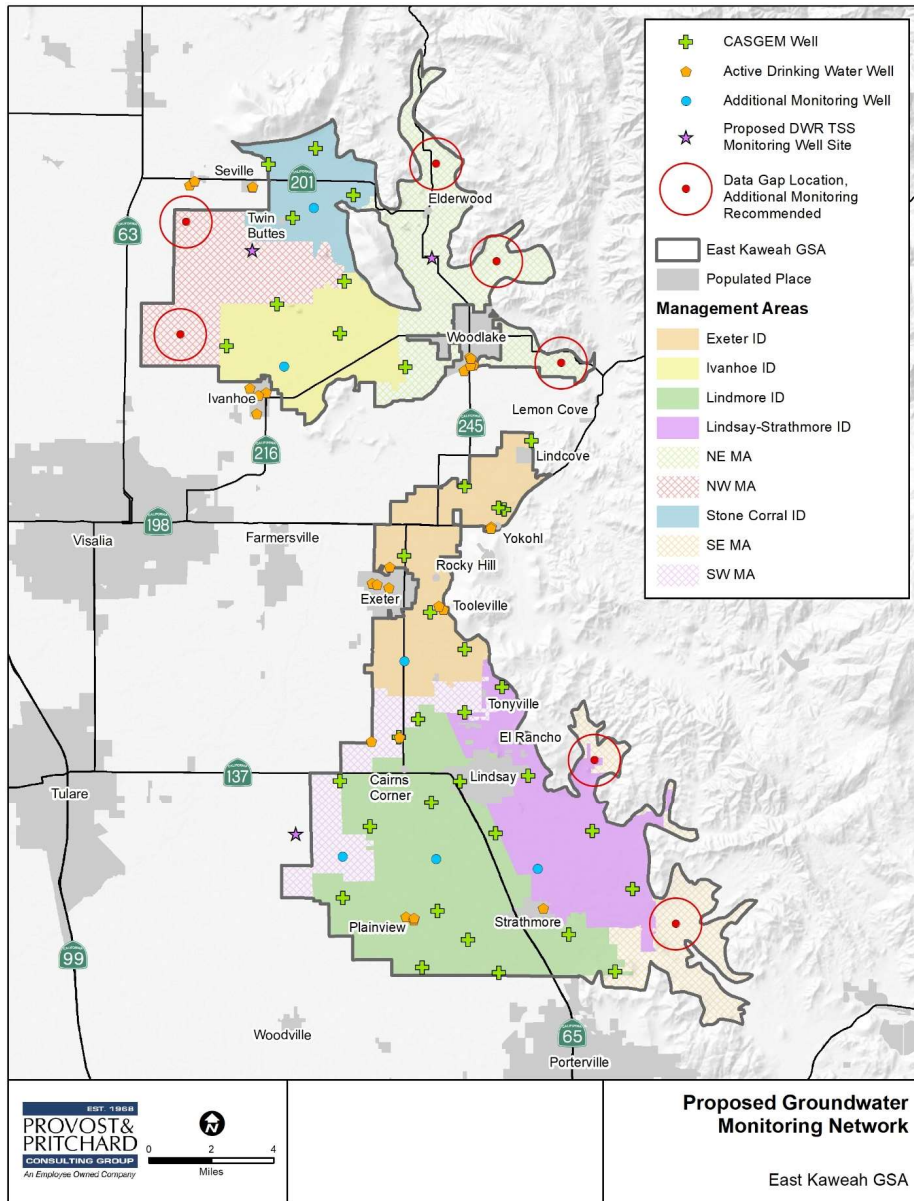


Figure 4-1: Initial Groundwater Monitoring Network

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 - L.SID	36.2506	-119.0795	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	123	78
7 - L.SID	36.2094	-119.0645	Irrigation Monitoring Well	Semi-annual	GW levels, GW Storage, Interconnected SW, GW Quality	123	78
7 - L.SID	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

in the GSP. The EKGSA will try to fill these locations either through agreements with private landowners or by drilling new dedicated monitoring wells.

Other data gaps exist in the fact that most of the proposed monitoring network wells are privately owned production wells that are used for monitoring. Specific well construction information, including depth and perforated interval, are not known for many of the wells. Also, depending on how and when the data was collected, data points in some (or all) years may be skewed. Utilizing a production well as a monitoring well runs the risk of potential influence from recent pumping that may affect the 'static' reading aimed to be captured. It is believed that much of the recorded well data within the EKGSA is credible, however the EKGSA will continue to improve this data set going forward.

#### 4.3.3.4 Plans to Fill Data Gaps

**Legal Requirements:**

§354.38 (d) Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

The EKGSA will oversee the groundwater level monitoring network, including filling areas with data gaps. This will be especially useful for the regions that are not currently monitored, such as outside irrigation district boundaries. As previously stated, **Figure 4-1** depicts the wells intended to fill spatial data gaps for initial implementation. The EKGSA will need to locate accessible private wells or drill new wells in the seven locations shown. Over time the EKGSA will transition to utilizing dedicated monitoring wells in its monitoring network.

To address data quality gaps related to unknown construction information, the EKGSA will utilize the following options:

- **Collect well completion reports.** *Accurate well Completion Reports (WCRs) can potentially provide missing well construction and completion information. These records could be collected from landowners or DWR. Due to the way that data is collected and dispersed, it is often difficult to correlate WCRs with actual wells. Locations of wells as reported on WCRs are often subjective, as they are based on the drillers' ability to convey spatial location. Multiple wells may exist within the area a well's log leads to. In some cases, wells have been destroyed or lost without documentation. Obtaining well logs directly from owners bypasses this confusion, though this is not a perfect solution. Private well owners may be unable or unwilling to provide logs for their wells.*
- **Perform a video inspection of each well to obtain construction information.** *In the absence of verified well logs a video inspection can be performed on wells to determine the total completed depth and perforated interval(s). Each video inspection currently ranges in costs between \$2,500 and as much as \$15,000 if required to lift and reinstall a pump to obtain access in production wells. There would also be additional costs for administration and outreach to landowners. The EKGSA would need to enter into private agreements with individual well owners for the use of these wells; as an incentive for participation the EKGSA would cover the cost of the well video assessment.*
- **Abandoned Wells.** *The EKGSA will assess the likelihood of monitoring former wells that have been abandoned. Use of these wells will potentially bolster the density of the monitoring network in areas with minimal coverage, likely involve less stringent access requirements, and are cheaper than drilling new wells. Additionally, since these wells are no longer in production, the monitoring of abandoned wells allows for better potential in gaining a static water level reading and better fulfill the requirements of Sub-Article 4.*
- **Replace monitoring point with a dedicated monitoring well.** *Dedicated monitoring wells could be installed and used in place of private wells. The construction information would be known and since the EKGSA would locate these wells, access issues would not be an issue. Dedicated monitoring wells are expensive to construct, and their installation will depend on available funding.*
- **Replace monitoring point with another private well.** *Private wells without documented construction information may potentially be replaced with other private wells that have verified well completion information. This option may be simpler and less costly than using video inspection and would be substantially less expensive than drilling new*

*dedicated monitoring wells. This method of network repair would side-step the expense of drilling new wells but would still be subject to availability and limitations arising from the missing historical record.*

## 4.4 Groundwater Storage

### Legal Requirements:

§354.34(c)(2) Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage.

### 4.4.1 Monitoring Network Description

The EKGSA is proposing to monitor changes in groundwater storage by utilizing groundwater levels as a proxy. Put simply, if groundwater levels decline to unacceptable levels it indicates an unacceptable volume of water was lost from groundwater storage or, given the shallow aquifer on the east side, an unacceptable amount of groundwater remains in storage. By utilizing the groundwater level monitoring as a proxy, the monitoring network for groundwater storage is the same as depicted in **Figure 4-1**. More background on groundwater aquifer characteristics and formation cross-sections is needed to evaluate groundwater storage is detailed in the Current and Historical Groundwater Conditions of the Basin Setting (**Chapter 2**). With groundwater level monitoring from year to year, calculations can be performed to estimate change in storage. This method uses average specific yield, basin area, and change in groundwater levels to determine the change in storage from year to year. Additionally, the calibrated Kaweah Sub-basin Groundwater Model can be used to estimate change in storage.

### 4.4.2 Quantitative Values

Groundwater storage values will be determined by comparing groundwater level changes from year to year through the groundwater level monitoring network. Threshold values are presented in **Chapter 3** and include minimum threshold, measurable objective, and interim milestones.

### 4.4.3 Review and Evaluation of Monitoring Network

#### 4.4.3.1 Site Selection

Groundwater storage capacity has historically been calculated using local groundwater levels in conjunction with estimated specific yield values. The inadequacies in past groundwater level monitoring networks impacts these calculations since evaluating the change in groundwater storage is largely based on the spatial and temporal coverage of the groundwater level monitoring network. As such, site selection will correspond with the parameters set forth for the groundwater level monitoring sites.

#### 4.4.3.2 Monitoring Frequency and Density

Change in groundwater storage will be estimated annually by comparing Spring groundwater level readings. Groundwater storage change will be estimated on a regional scale encompassing the entirety of the EKGSA through the development of groundwater contours from the Spring data.

#### 4.4.3.3 Identification of Data Gaps

Gaps in current groundwater level monitoring networks have created corresponding inadequacies in the ability to calculate change in storage. Data gaps associated with aquifer characteristics, such as specific yield values used for storage estimates, are anticipated to be improved through the completion of different projects and studies undertaken by the Kaweah Sub-basin and the EKGSA (i.e. SkyTEM).

#### 4.4.3.4 Plans to Fill Data Gaps

Significant data gaps will be filled using the same methods used to address data gaps in the groundwater level network, as spatial data coverage is a critical component in the change in storage calculations. Aquifer evaluation at a Sub-basin scale was performed through a SkyTEM electromagnetic analysis. The results from this analysis were not ready in time for this initial GSP but will be available for future updates and modeling to improve the general knowledge of the aquifer characteristics moving forward.

## 4.5 Water Quality

### Legal Requirements:

§354.34(c)(4) Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.

### 4.5.1 Monitoring Network Description

Water quality monitoring is an important aspect of groundwater management. It serves the following purposes:

1. Spatially characterize water quality according to soil types, soil salinity, geology, surface water quality, and land use;
2. Compare constituent levels at a specific well through time;
3. Determine the extent of groundwater quality problems in specific areas;
4. Identify groundwater quality protection and enhancement needs;
5. Identify impacts of recharge and surface water use on water quality;
6. Identify suitable crop types that are compatible with the water characteristics; and
7. Monitor the migration of contaminant plumes (such as nitrate).

Baseline groundwater quality conditions for the EKGSA are discussed in the Basin Setting (**Chapter 2**). Several agencies are involved in the monitoring and mitigation of groundwater quality in the surrounding area, such as:

- **Groundwater Ambient Monitoring and Assessment Program (GAMA)**- *California's comprehensive groundwater quality monitoring program was designed to identify the threats to California's groundwater resources as prescribed in the Groundwater Quality Monitoring Act of 2001 (AB 599). The program monitors ambient groundwater quality, provides hydrogeologic technical support to statewide programs, and includes projects that meet the statutory requirements of the Groundwater Quality Monitoring Act. Through collaboration with State and Regional Water Boards, the DWR, Department of Pesticide Regulations (DPR), USGS, Lawrence Livermore National Laboratory, and local well owners and agencies, GAMA aims to improve statewide groundwater quality monitoring and increase the availability of groundwater quality information to the public. More information on the GAMA program can be found at: <https://www.waterboards.ca.gov/gama/>. The GAMA program reports data for*
  - **DHS** – Department of Health Services (now Department of Public Health, DPH).
  - **CA SDWIS** – California Safe Drinking Water Information System
  - **DWR** – Department of Water Resources
  - **DPR** – Department of Pesticide Regulation
  - **USGS** – United States Geological Survey
  - **EDF** – Environmental Defense Fund
  - **Geotracker and Envirostor Databases**
- **Irrigated Lands Regulatory Program**- *The Irrigated Lands Regulatory Program (ILRP) was initiated in 2003 to address pollutant discharges to surface water and groundwater from commercially irrigated lands. The primary purpose of the ILRP is to address key pollutants of concern including salinity, nitrates, and pesticides introduced through*

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runoff or infiltration of irrigation water. Within the EKGSA, the ILRP is administered by the Central Valley Regional Water Quality Control Board (CVRWQCB). The Kaweah Basin Water Quality Coalition (Coalition) was established in 2009 as a Joint Powers Agency to pool resources and combine regional efforts to comply with the regulatory requirements of the ILRP. Historically, the Coalition has only monitored surface water quality, but groundwater quality began being monitored in Fall of 2018. In April 2017, the Coalition released a Groundwater Quality Trend Monitoring Workplan – Phase I and submitted a follow-up Groundwater Quality Trend Monitoring Workplan – Phase II in May 2018. The CVRWQCB will ultimately decide whether the submitted network is representative of the impacts of irrigated agriculture on groundwater quality. Additional details of the monitoring network and specific well selection will follow formal CVRWQCB approval of the workplan. Results from annual monitoring will be documented in an annual report and publicly available via the GAMA Geotracker database. The ILRP groundwater trend monitoring program requires testing annually for nitrate as N, conductivity, pH, dissolved oxygen, and temperature in all network wells. In addition, every five years, network wells must also be tested for total dissolved solids, carbonate, bicarbonate, chloride, sulfate, boron, calcium, sodium, magnesium, and potassium.

- **CV-SALTS-** The Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS) program began in 2006 and is a collaborative stakeholder-driven and managed program to develop sustainable salinity and nitrate management planning for the Central Valley. CV-SALTS developed a Salt and Nitrate Management Plan (SNMP) to meet the requirements set forth in the State Recycled Water Policy adopted in 2009. The SNMP's goals are to provide a safe drinking water supply, achieve balanced salt and nitrate loadings, and implement a managed aquifer restoration program. Combined, the development of the SNMP and the proposed, corresponding Basin Plan amendments will establish a revised regulatory framework and provide the flexibility necessary to make salt and nitrate management decisions at the appropriate temporal, geographic and/or management scales. As a part of the larger SNMP, CV-SALTS also developed a Surveillance and Monitoring Program (SAMP) to monitor groundwater quality and comply with the Recycled Water Policy. The SAMP network developed two monitoring networks – one each for the shallow and deep aquifer zones. It is anticipated that implementation of the surveillance and monitoring program will occur soon after adoption of planned Basin Plan amendments. In March 2017, the CVRWQCB adopted a resolution accepting the SNMP and directing staff to initiate Basin Plan amendments for incorporation into the Basin Plans. On May 31, 2018 the CVRWQCB adopted the suggested Basin Plan amendments. These proposed Basin Plan amendments are currently undergoing the State Water Board adoption process and will be followed with the Office of Administrative Law and US EPA (as appropriate) adoption processes.
- **Municipal Water Suppliers-** Municipal water suppliers in the EKGSA include the City of Lindsay and the Strathmore Public Utility District. These entities test water quality on a routine basis for state and federally regulated inorganic and organic constituents, as well as coliform bacteria, as required by the Division of Drinking Water (DDW). Testing requirements vary based on the size of the system and constituents of concern with a history in the area. Water quality is tested at all production well sites and some monitor wells. The municipal water suppliers also prepare annual Consumer Confidence Reports to inform the public of water quality issues, as required by the State of California.
- **AB 3030 and SB 1938-** AB 3030 was established in 1992 to require certain local agencies to compile groundwater management plans (GMP) and SB 1938 was enacted to require agencies to identify a basin management strategy in the GMP to receive funding. AB 3030 introduced several technical considerations that apply to groundwater quality. The plans are to be updated once every five years. Under this program local agencies must successfully manage their groundwater resources and are encouraged to consider twelve voluntary components:
  1. The control of saline water intrusion.
  2. Identification and management of wellhead protection areas and recharge areas.
  3. Regulation of the migration of contaminated groundwater.
  4. The administration of a well abandonment and well destruction program.
  5. Mitigation of conditions of overdraft.
  6. Replenishment of groundwater extracted by water producers.
  7. Monitoring of groundwater levels and storage.
  8. Facilitating conjunctive use operations.
  9. Identification of well construction policies.

10. *The construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.*
11. *The development of relationships with state and federal regulatory agencies.*
12. *The review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination (AB 3030).*

Data from these groundwater monitoring sources indicate the common constituents of concern (COCs) in the EKGSA include: 1,2,3-Trichloropropane (1,2,3 TCP), 1,2-Dibromo-3-chloropropane (DBCP), Arsenic, Hexavalent Chromium, Nitrate, Perchlorate, Sodium, Chloride, and Total Dissolved Solids (TDS). Wells supplying drinking water (i.e. public systems) will be monitored for all of these COCs quarterly. Wells supplying irrigation water will be monitored for Chloride, Sodium, and TDS on a semiannual basis. Further information about these COCs, corresponding regulatory requirements, and contaminant plumes can be found in the Basin Setting ([Chapter 2](#)). These COCs are proposed to be monitored at all wells in the groundwater level monitoring network, based on their use to develop a more robust data set since current coverage of groundwater quality data is lacking for many parts of the EKGSA.

## 4.5.2 Quantitative Values

Threshold values for COCs are presented in [Chapter 3](#). These values use MCL and prevalence data to provide minimum thresholds, measurable objectives, and interim milestones for each COC. [Table 4-3](#) repeats the monitoring network wells table, but this time shows the baseline 10-year (2008-2017) COC averages for the wells in the network with water quality data available. By comparison, only 15 of the approximately 70 wells to be monitored for water quality have data for establishing a baseline. This represents a significant data gap, however the intent of the EKGSA monitoring will strive to remedy this gap over the first years of implementation. Water quality degradation will be evaluated against the appropriate water quality standard at the time of the sample and on a 10-year rolling average to determine if the actions of the EKGSA degrade the beneficial use of water in the Subbasin.

## 4.5.3 Review and Evaluation of Monitoring Network

### 4.5.3.1 Monitoring Frequency and Density

Water quality monitoring will be conducted at the wells proposed in the groundwater level monitoring network, based on the use of the well water (agricultural or municipal), on a semi-annual or quarterly basis. Agricultural wells will be sampled on a semi-annual basis while municipal wells will be sampled quarterly due to more stringent regulatory requirements. Over time if quality results indicate increasing COC concentrations, monitoring frequency may increase. The frequency of the data collection and the coverage gained by utilizing the groundwater level monitoring network should be sufficient to demonstrate seasonal, short-term (1 to 5 years) and long-term (5 to 10 years) trends in groundwater quality and its relationship to surface conditions and groundwater management activities by the EKGSA.

### 4.5.3.2 Site Selection

The EKGSA is proposing to utilize the wells in the groundwater level monitoring network in order to gain more groundwater quality data throughout the EKGSA to better evaluate the location and concentrations of the COCs. By utilizing the proposed groundwater level network, the sites selected will correspond with the parameters set forth for the groundwater level monitoring sites.

The intent to monitor water quality specific to the well type in the monitoring network is to evaluate potential trends and impacts directly to the beneficial user, with the focus on agricultural and drinking water use. Evaluating agricultural quality goals will allow the EKGSA to evaluate quality trends for some of the largest use. Evaluating specific drinking water wells of communities within or near the EKGSA allows the EKGSA to

evaluate the quality of drinking water for the vast majority of its resident. Sampling wells for the communities of Yettam, Seville, Ivanhoe, Woodlake, Exeter, Tooleville, Tonyville, Lindsay, Plainview, and Strathmore represent 80%-90% of the population within the EKGSA boundaries.

#### **4.5.3.3 Identification of Data Gaps**

The absence of groundwater level data across the entirety of the EKGSA is a data gap. Future monitoring will need to address this data gap so the EKGSA can properly evaluate how groundwater management actions are impacting groundwater quality.

#### **4.5.3.4 Plans to Fill Data Gaps**

The EKGSA's proposal to monitor COCs across the groundwater level monitoring network intends to fill some of the significant data gaps with respect to groundwater quality data. Monitoring over the first five years of implementation should provide more insight on groundwater quality (location, trends, etc.) in the EKGSA. The EKGSA will also collaborate, where appropriate and feasible, with other agencies tasked with tracking and/or improving groundwater quality for additional assistance with data gaps.



Table 4-3 COC Baseline 10-Year Average Concentration (2008-2017)

TR	Latitude	Longitude	Site Type	Arsenic (ppb)	Chloride (ppm)	Chromium VI (ppb)	DBCP (ppb)	Nitrate (as N) (ppm)	Perchlorate (ppb)	Sodium (ppm)	TCP (ppt)	TDS (ppm)
1 - EK NW	36.4281	-119.2092	Irrigation Monitoring Well									
1 - EK NW	36.4086	-119.2381	Irrigation Monitoring Well									
1 - EK NW	36.3992	-119.2051	Irrigation Monitoring Well									
1 - EK NW	36.385905	-119.219633	Drinking Water Monitoring Well	2.40	22.00	1.10	0.01	9.25		43.75	0.02	390.00
1 - EK NW	36.389279	-119.224619	Drinking Water Monitoring Well	2.20	26.33	1.30	0.02	8.02		38.67	0.05	416.67
1 - EK NW	36.387249	-119.215311	Drinking Water Monitoring Well		43.00	1.40	0.05	11.47		42.00		460.00
2 - IID-SCID	36.493	-119.2142	Irrigation Monitoring Well									
2 - IID-SCID	36.5005	-119.187	Irrigation Monitoring Well									
2 - IID-SCID	36.4788	-119.1653	Irrigation Monitoring Well									
2 - IID-SCID	36.4682	-119.2001	Irrigation Monitoring Well									
2 - IID-SCID	36.4388	-119.1703	Irrigation Monitoring Well									
2 - IID-SCID	36.4146	-119.1728	Irrigation Monitoring Well									
2 - IID-SCID	36.399028	-119.135194	Irrigation Monitoring Well									
2 - IID-SCID	36.504083	-119.181382	Subsidence Survey Site	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2 - IID-SCID	36.414025	-119.139866	Subsidence Monument	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2 - IID-SCID	36.483936	-119.156678	Subsidence Survey Site	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2 - IID-SCID	36.453177	-119.223455	Proposed Monitoring Well									
2 - IID-SCID	36.472965	-119.18822	Irrigation Monitoring Well									
3 - EK NE	36.449941	-119.120187	Proposed Monitoring Well									
4 - RIVER	36.3438	-119.1012	Irrigation Monitoring Well									
4 - RIVER	36.3649	-119.0628	Irrigation Monitoring Well									
4 - RIVER	36.333	-119.0784	Irrigation Monitoring Well									
4 - RIVER	36.3338	-119.0817	Irrigation Monitoring Well									
4 - RIVER	36.403201	-119.097777	Drinking Water Monitoring Well									
4 - RIVER	36.4038	-119.098318	Drinking Water Monitoring Well									
4 - RIVER	36.399822	-119.097991	Drinking Water Monitoring Well									
4 - RIVER	36.400218	-119.096258	Drinking Water Monitoring Well									
4 - RIVER	36.397603	-119.101521	Drinking Water Monitoring Well									
4 - RIVER	36.325077	-119.085966	Drinking Water Monitoring Well									
4 - RIVER	36.324287	-119.086025	Drinking Water Monitoring Well									
5 - EID	36.3115	-119.135806	Irrigation Monitoring Well									
5 - EID	36.2853	-119.1209	Irrigation Monitoring Well									
5 - EID	36.325278	-119.106389	Subsidence Monument	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5 - EID	36.311321	-119.135088	Subsidence Monument	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5 - EID	36.296749	-119.144649	Drinking Water Monitoring Well		34.33	2.30	0.07	6.24	4.30	47.00		390.00
5 - EID	36.298267	-119.151426	Drinking Water Monitoring Well		18.67	2.10	0.06	5.19		45.33		390.00
5 - EID	36.306361	-119.144192	Drinking Water Monitoring Well	2.43	68.25	2.50	0.03	3.31		56.25		315.00
5 - EID	36.286649	-119.113386	Drinking Water Monitoring Well		185.00	12.15		8.59		84.50		550.00
5 - EID	36.288174	-119.115877	Drinking Water Monitoring Well	3.50	615.00			8.11		200.00		1350.00
6 - EK SE	36.1833	-119.0278	Irrigation Monitoring Well									

TR	Latitude	Longitude	Site Type	Arsenic (ppb)	Chloride (ppm)	Chromium VI (ppb)	DBCP (ppb)	Nitrate (as N) (ppm)	Perchlorate (ppb)	Sodium (ppm)	TCP (ppt)	TDS (ppm)
6 - EK SE	36.1564	-119.0048	Irrigation Monitoring Well									
7 - LSID	36.2506	-119.0795	Irrigation Monitoring Well									
7 - LSID	36.2094	-119.0645	Irrigation Monitoring Well									
7 - LSID	36.1181	-119.0148	Irrigation Monitoring Well									
8 - LID E	36.1822	-119.0831	Irrigation Monitoring Well									
8 - LID E	36.1353	-119.0412	Irrigation Monitoring Well									
8 - LID E	36.1175	-119.0812	Irrigation Monitoring Well									
8 - LID E	36.1666	-119.058459	Subsidence Survey Site	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8 - LID E	36.130819	-119.05574	Subsidence Survey Site	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8 - LID E	36.165789	-119.059314	Irrigation Monitoring Well									
8 - LID E	36.147461	-119.055979	Drinking Water Monitoring Well	2.40	36.00	2.10		13.81		60.25		365.00
9 - LID W	36.2681	-119.1009	Irrigation Monitoring Well									
9 - LID W	36.2389	-119.1009	Irrigation Monitoring Well									
9 - LID W	36.2356	-119.1278	Irrigation Monitoring Well									
9 - LID W	36.1967	-119.1201	Irrigation Monitoring Well									
9 - LID W	36.2068	-119.1038	Irrigation Monitoring Well									
9 - LID W	36.1461	-119.1165	Irrigation Monitoring Well									
9 - LID W	36.12	-119.1253	Irrigation Monitoring Well									
9 - LID W	36.1328	-119.099	Irrigation Monitoring Well									
9 - LID W	36.2625	-119.1356	Irrigation Monitoring Well									
9 - LID W	36.1703	-119.1173	Irrigation Monitoring Well									
9 - LID W	36.142014	-119.130089	Drinking Water Monitoring Well	2.90	17.00	3.20	0.09	7.29		51.50		260.00
9 - LID W	36.143557	-119.134656	Drinking Water Monitoring Well	3.05	24.00	3.10		10.36		44.00		250.00
9 - LID W	36.142964	-119.130025	Drinking Water Monitoring Well, Subsidence Survey Site	2.90	11.00	3.20	0.02	2.73		54.00		210.00
9 - LID W	36.274669	-119.103826	Subsidence Survey Site	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10 - EK SW	36.2273	-119.1386	Irrigation Monitoring Well									
10 - EK SW	36.2069	-119.1723	Irrigation Monitoring Well									
10 - EK SW	36.1853	-119.1551	Irrigation Monitoring Well									
10 - EK SW	36.1522	-119.1706	Irrigation Monitoring Well									
10 - EK SW	36.1714	-119.1709	Irrigation Monitoring Well									
10 - EK SW	36.227331	-119.138548	Drinking Water Monitoring Well	3.80	182.50	4.20	0.26	6.74	2.30	119.25		577.50
Outside EK	36.298705	-119.154153	Drinking Water Monitoring Well		13.67	1.70	0.08	5.16		41.33		316.67
Outside EK	36.225396	-119.154484	Drinking Water Monitoring Well	2.40	741.43	4.20		4.69		236.00		1721.74
Outside EK	36.377371	-119.220542	Drinking Water Monitoring Well									
Outside EK	36.37186	-119.100079	Subsidence Survey Site	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Outside EK	36.482602	-119.223352	Drinking Water Monitoring Well									
Outside EK	36.482413	-119.223388	Drinking Water Monitoring Well									
Outside EK	36.483424	-119.259406	Drinking Water Monitoring Well									
Outside EK	36.485176	-119.25665	Drinking Water Monitoring Well									

## 4.6 Land Subsidence

### Legal Requirements:

§354.34(c)(5) Land Subsidence. Identify the rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or other appropriate method.

### 4.6.1 Monitoring Network Description

The EKGSA monitoring network plans to rely on multiple data sources including satellite analysis monitored by NASA, monitoring points overseen by the Kaweah Delta Water Conservation District (KDWCD) and CalTrans, and newly selected Friant-Kern Canal monitoring points the EKGSA will survey. The focus will be on how land subsidence is impacting critical infrastructure, namely the Friant-Kern Canal (FKC). Data and local experience suggest subsidence has historically not been an issue within the EKGSA; however, due to the heavy reliance on the FKC by member agencies of the EKGSA, subsidence will be closely monitored. The proposed network monitoring locations are shown in **Figure 4-2**. These points, in addition to data available through NASA and DWR (InSAR) will be used to evaluate subsidence in the EKGSA.

### 4.6.2 Quantitative Values

The quantitative values for measuring subsidence are presented in **Chapter 3**. Minimum thresholds, measurable objectives, and interim milestones have been established based on maximum allowable subsidence rates for maintaining the integrity of key infrastructure in the EKGSA.

### 4.6.3 Review and Evaluation of Monitoring Network

Land subsidence monitoring has been performed by multiple agencies in the past. The coverage over the EKGSA region was sparse until Interferometric Synthetic Aperture Radar (InSAR) was introduced in 2015 to monitor subsidence in the region through satellite imagery analysis. Agencies currently monitoring subsidence in the area include:

**USGS Monitoring Network.** A subsidence monitoring network consisting of 31 extensometers was installed in the 1950s to quantify the subsidence occurring in the San Joaquin Valley. By the 1980's, the land subsidence monitoring efforts decreased. Since then, a new monitoring network was developed. The new network includes refurbished extensometers from the old network, continuous Global Positioning System (CGPS) stations, and use of InSAR. More information can be found on the USGS website:

[https://ca.water.usgs.gov/land\\_subsidence/california-subsidence-measuring.html](https://ca.water.usgs.gov/land_subsidence/california-subsidence-measuring.html)

**NASA Monitoring Network.** NASA obtains subsidence data by comparing satellite images of Earth's surface over time. For the last few years, subsidence maps have been produced using InSAR observations from satellite and aircraft imaging. More information can be found on their website: <https://www.nasa.gov/jpl/nasa-california-drought-causing-valley-land-to-sink>.

**Kaweah Delta Water Conservation District:** KDWCD started a new monitoring network in 2016 and placed extensometers throughout the Kaweah Sub-basin to expand upon the long-standing USGS network of extensometers and establish an adequate number of subsidence monitoring stations to adequately monitor land elevation changes at areas most effected by subsidence in the Sub-basin. The goal is to monitor the inelastic land subsidence resulting from groundwater pumping.

#### 4.6.3.1 Site Selection

FKC monitoring points are being proposed to be added for the EKGSA's subsidence monitoring, given the focus on critical infrastructure. Six locations have been proposed along the FKC. These monitoring points are strategically situated near infrastructure along the FKC that is vital to maintain the long-term delivery capacity of the gravity-driven canal. This infrastructure includes existing check structures and bridges spaced north to south through the EKGSA. These points are depicted in **Figure 4-2**. Presently the FKC is not impacted by subsidence within the EKGSA, but it is a critical issue downstream, just south of the EKGSA. Including these specific monitoring points is considered adequate for evaluating the FKC and its capacity within the EKGSA.

A subsidence monitoring point is also being established at a well in the community of Plainview. Infrastructure such as roads, pipelines, and well casings are also susceptible to subsidence impacts. The EKGSA intends to monitor potential impacts to subsidence in an area of the EKGSA that may be more vulnerable to subsidence.

#### 4.6.3.2 Monitoring Frequency and Density

The proposed FKC and Plainview monitoring points will be monitored annually in March to evaluate subsidence impacts. The combination of monitoring points and additional spatial coverage from InSAR provides the appropriate density for monitoring. The InSAR data set is also available annually. The specific points surveyed by the EKGSA can be compared to the InSAR data.

#### 4.6.3.3 Identification of Data Gaps

Beyond the specific proposed monitoring points, no other data gaps were identified for the land subsidence monitoring network for the EKGSA. Subsidence has been an ongoing issue in portions of the Central Valley, thus monitoring systems have been put in place to evaluate the impacts. Over time these tools and data have improved and become more widespread.

#### 4.6.3.4 Plans to Fill Data Gaps

With the addition of survey points to critical infrastructure, and utilizing the InSAR data set as a backstop, the current subsidence monitoring network is believed to sufficiently cover the EKGSA.

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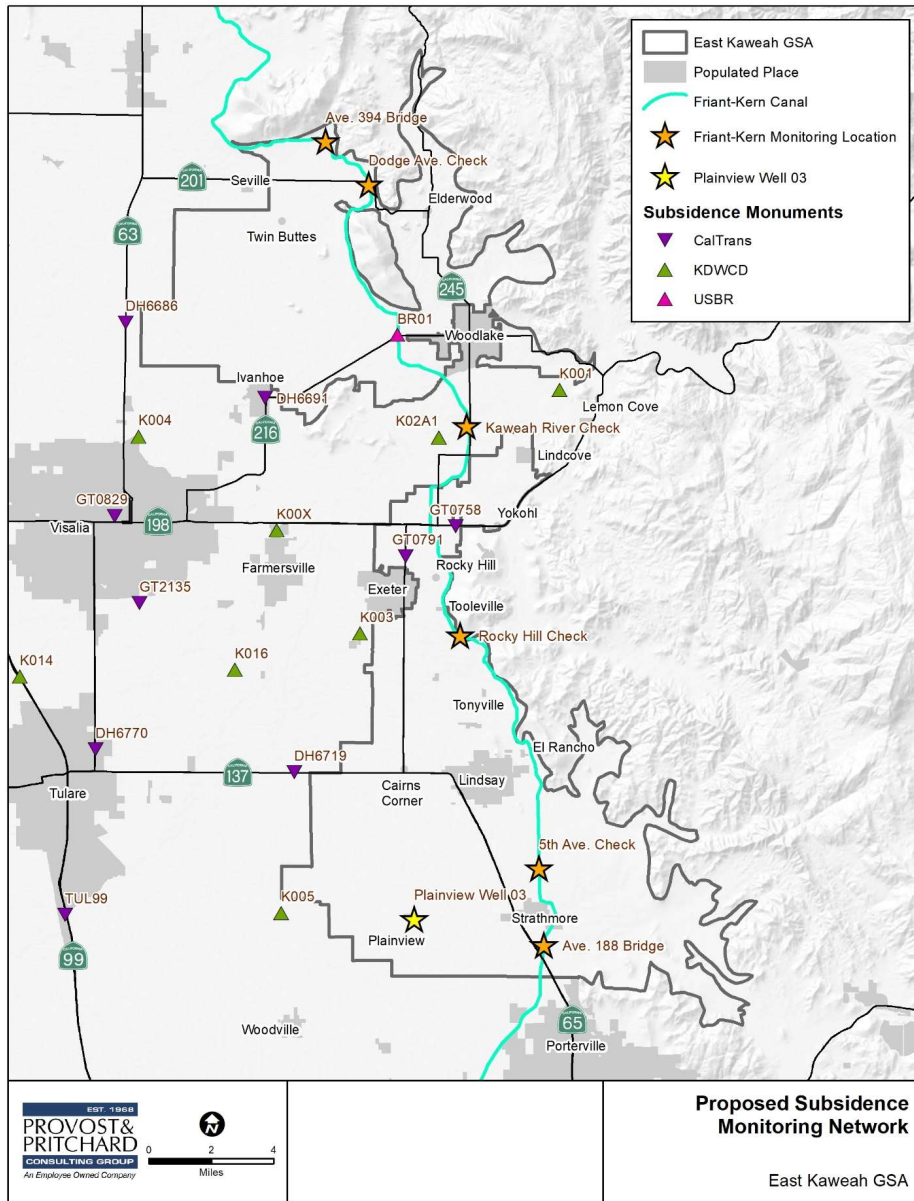


Figure 4-2: Subsidence Monitoring Network

## 4.7 Depletion of Interconnected Surface Water

### Legal Requirements:

§354.34(c)(6) Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:

- A. Flow conditions including surface water discharge, surface water head, and baseflow contribution.
- B. Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.
- C. Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.
- D. Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.

### 4.7.1 Monitoring Network Description

The EKGSA is proposing to monitor interconnected groundwater and surface water by utilizing groundwater levels as a proxy. Groundwater and surface water need to be relatively close (within 30 feet) to have the potential for connection. Thus, tracking groundwater levels will allow the EKGSA to evaluate this sustainability indicator. By utilizing the groundwater level monitoring as a proxy, the monitoring network for interconnected surface water is the same as depicted in [Figure 4-1](#). The EKGSA has identified interconnected surface water as a data gap and therefore does not have enough data to establish a comprehensive monitoring network. Rather, the EKGSA proposes to fill these data gaps via implementation of an Interconnected Surface Water Data Gap Work Plan ([Section 5.3.7](#)).

### 4.7.2 Quantitative Values

The quantitative measures for the depletion of interconnected surface water are explained in further detail in Chapter 3. This includes description of minimum thresholds, measurable objectives, and interim milestones for the measurement of the impact on surface water with potential groundwater connection.

### 4.7.3 Review and Evaluation of Monitoring Network

Due to lack of available ~~Currently there~~ data, there is not a network in place ~~that is specifically designed~~ to monitor groundwater-surface water interconnections. Presently knowledge is obtained from the groundwater contours created from groundwater level monitoring data and local knowledge. Those familiar with the geology in the GSA indicate the Kaweah River is a gaining stream East of McKay's point. This is further substantiated by the fact that two of the Kaweah River's USGS stream gauges have not been dry during droughts throughout the history of the stream monitoring stations. Additionally, local residents do not recall a time, other than 2015, when the Kaweah River east of McKays Point has been dry. In 2015, amongst a critical drought, portions of the Kaweah River began to dry and standing water began to recede upstream. However, there was still some water remaining in the channel. Well records show that wells in this area have a depth to water less than 30 feet, possibly substantiating the claims that there is interconnected surface water. In addition to the Kaweah River, Lewis Creek is also suspected to have potential groundwater connection within LSID. There is a well approximately a half mile from Lewis Creek that consistently reads depth to groundwater less than 10 feet, due to a small perched aquifer. [Figure 4-3](#) depicts Spring 2015 depth to water (DTW) contours in the EKGSA. Areas with depths less than 30 feet are considered potential areas for groundwater-surface water connection. Some of these areas are actively farmed, which would reduce the potential footprint. The contours in [Figure 4-3](#) also show that moving further west, away from the foothills, there is no interconnection due to the large depths to water.

#### 4.7.3.1 Site Selection

The interconnected surface water monitoring ~~will be adequately covered by the expanded groundwater level monitoring locations that were discussed earlier in this chapter.~~ sites will be selected as more data becomes available via the implementation of the Interconnected Surface Water Data Gap Work Plan (Section 5.3.7).

#### 4.7.3.2 Monitoring Frequency and Density

Monitoring ~~frequency and density~~ of interconnected surface water will be ~~evaluated/determined concurrently with groundwater level monitoring~~ during the implementation of the Interconnected Surface Water Data Gap Work Plan (Section 5.3.7).

#### 4.7.3.3 Identification of Data Gaps

~~Due to the absence of historic monitoring specifically related to groundwater surface water connection, there are data gaps beyond that of local experience. The new proposed monitoring effort laid out in this GSP will likely shed light on the areas considered to be 'gaining' streams or connected due to perched groundwater. The new monitoring network may indicate other areas to have possible connection. In these instances, the EKGSA will adapt the monitoring to allow for further evaluation. The EKGSA acknowledges that interconnected surface water is a data gap. This data gap will be addressed via implementation of the Interconnected Surface Water Data Gap Work Plan (Section 5.3.7).~~

#### 4.7.3.4 Plans to Fill Data Gaps

~~Section 5.3.7 describes the EKGSA's plan to fill the interconnected surface water data gap. proposed additions to the groundwater level monitoring network is expected to be a benefit to the understanding of interconnected surface water. This will be especially beneficial in the portions of the EKGSA adjacent the foothills and ephemeral streams.~~

Chapter Four: Monitoring Network  
East Kaweah GSA

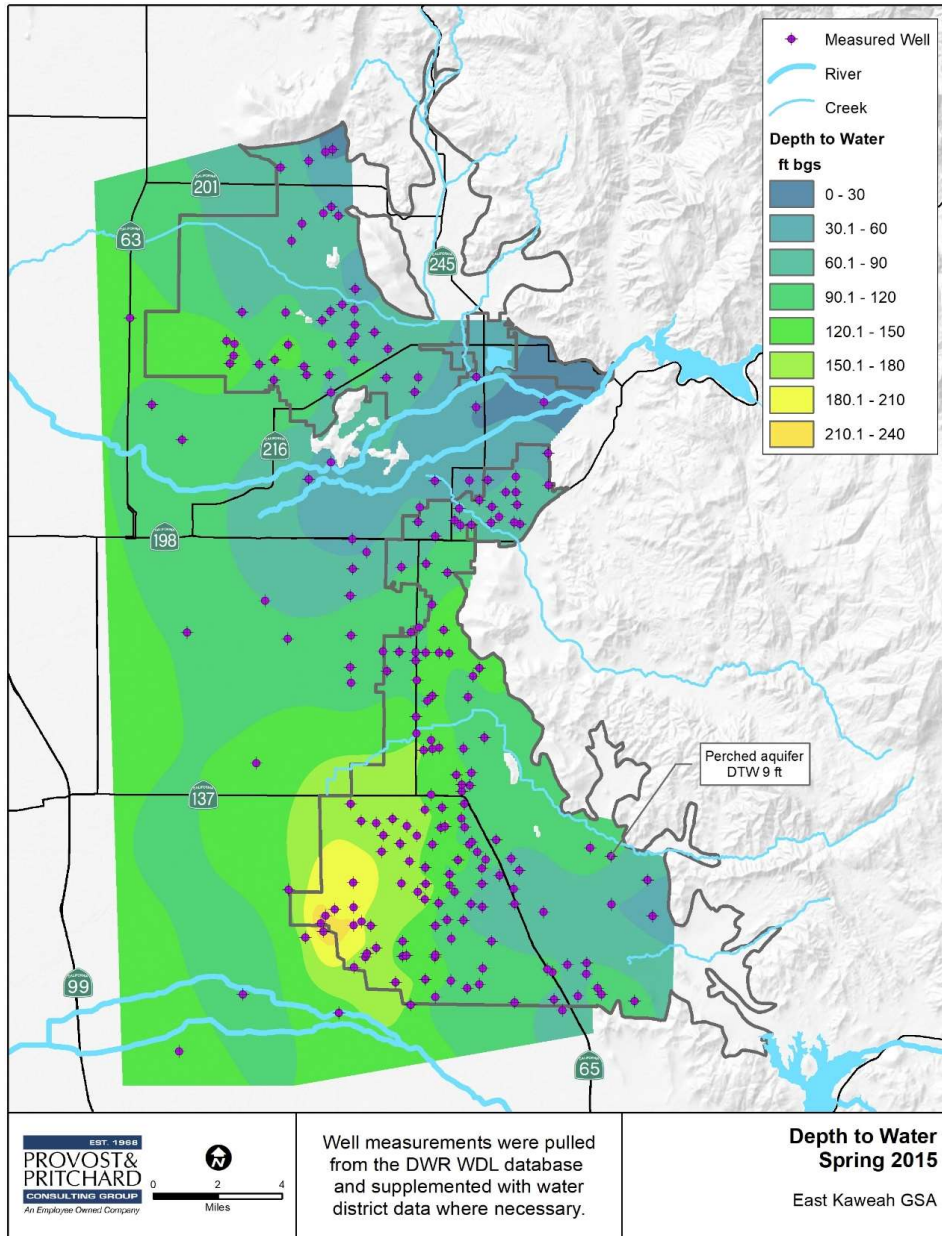


Figure 4-3: Spring 2015 Depth to Water Contours



## 4.8 Consistency with Standards

**Legal Requirements:**

§354.34(g) Each Plan shall describe the following information about the monitoring network:  
(2) Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.

The data gathered through the monitoring networks is and will continue to be consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below.

- *Data reporting units and accuracy;*
- *Monitoring site information;*
- *Well attribute reporting;*
- *Map standards;*
- *Hydrograph requirements;*
- *Groundwater and surface water models;*
- *Availability of input and output files to DWR.*

## 4.9 Monitoring Protocols

**Legal Requirements:**

§354.34(i) The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.

Groundwater level, groundwater quality, and land subsidence monitoring will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, December 2016b). This BMP largely leans on the U.S. EPA's DQO process. Refer to [Appendix 4-A](#) for a copy of the BMP. The EKGSA may develop standard monitoring forms in the future.

The following comments and exceptions to the BMP should be noted:

1. SGMA regulations require groundwater levels are measured to the nearest 0.1 feet. The BMP suggests measurements to the nearest 0.01 feet; however, this is not practical for many measurement methods. In addition, this level of accuracy would have little value since groundwater contours maps typically have 10 or 20-foot intervals, and storage calculations are based on groundwater levels rounded to the nearest foot. The accuracy of groundwater level measurements will vary based on the well type and condition. For instance, if significant oil is found in an agricultural well then readings to the nearest foot are the best one can achieve.
2. If used in a well suspected of contamination or if there are obvious signs of contamination (such as oil), well sounding equipment will be decontaminated after use.
3. Wells will be surveyed to a horizontal accuracy of 0.5 feet.
4. Unique well identifiers will be labeled on all public wells, and on private wells if permission is granted.
5. The BMP states that measurements each Spring and Fall should be taken 'preferably within a 1 to 2-week period'. This is likely not feasible due to the large number of wells in the GSA, and a 4-week period is requested for bi-annual monitoring and potentially be suggested to be taken in the Spring to capture peak groundwater levels.

6. If a vacuum or pressure release is observed, then water level measurements will be remeasured every 5 minutes until they stabilize.
7. In the field, water level measurements will be compared to previous records; if there is a significant difference then the measurement will be verified.
8. For water quality monitoring, field parameters for pH, electrical conductivity, and temperature will only be collected when required for the parameter being monitored. Determining if a well has been purged adequately may be ascertained by calculating a run time before sampling.

## 4.10 Representative Monitoring

### Legal Requirements:

§354.36 Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:

§354.36(a) Representative monitoring sites may be designated by the Agency as the point at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined.

§354.36(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:

- 1) *Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.*
- 2) *Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.*

The EKGSA plans to use groundwater elevations as a proxy for monitoring the sustainability indicators for aquifer storage and interconnected surface water. As mentioned, groundwater elevations will be a critical component of groundwater storage estimation.

Subsidence monitoring is not as straightforward since it cannot be directly attributed to groundwater levels. Therefore, it will be based on vital infrastructure within the EKGSA, namely the conveyance capacity of the Friant-Kern Canal. Reduced conveyance capacity of the Friant-Kern Canal has been recognized as an undesirable result explained in further detail in Section 4: Sustainable Management Criteria.

Groundwater quality is proposed to be tested in the monitoring wells within the EKGSA and compared to the current recognized standard the COCs assigned to a well based on the consumptive use of the groundwater pumped (agricultural or municipal). The intent for monitoring all wells is to develop a more robust data set for the COCs so that better understanding can be gained on the spatial distribution of these contaminants and potential correlation to activities within EKGSA control.

## 4.11 Data Storage and Reporting

### Legal Requirements:

§354.40 Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.

The Kaweah Subbasin is developing and will maintain a Data Management System (DMS) for storing and reporting information for the implementation of this GSP. Specifically, the monitoring network data will be collected and compiled into one central data system that can be easily referenced and displayed when needed. More information on the development and user guide is provided in [Appendix 4-B](#).

## 5 Projects and Management Actions to Achieve Sustainability

### Legal Requirements:

#### § 354.44. Projects and Management Actions

- (a) Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.
- (b) Each Plan shall include a description of the projects and management actions that include the following:
  - (1) A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:
    - (A) A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.
    - (B) The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.
  - (2) If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.
  - (3) A summary of the permitting and regulatory process required for each project and management action.
  - (4) The status of each project and management action, including a timetable for expected initiation and completion, and the accrual of expected benefits.
  - (5) An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.
  - (6) An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.
  - (7) A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.
  - (8) A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.
  - (9) A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.
- (c) Projects and management actions shall be supported by best available information and best available science.
- (d) An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.

### 5.1 Introduction

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 and/or better use the surface 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 employed. 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. The EKGSA considered many potential projects that could mitigate the groundwater overdraft within the EKGSA area and help achieve sustainability, but ultimately determined that not all of these potential projects are currently feasible for implementation. The EKGSA will continue to evaluate potential projects during implementation. Projects that are currently envisioned for implementation are discussed in [Section 5.2](#). The EKGSA, when necessary, will consider management actions that focus on several factors including, but not limited to, reducing water demand and associated reduction of groundwater pumping, increasing data collection, education and outreach, regulatory policies, incentive-based programs, and enforcement actions. The potential management actions that may be implemented following further investigation and analysis are discussed in [Section 5.3](#).

## Chapter Five: Projects and Management Actions to Achieve Sustainability

### East Kaweah GSA

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, the proposed implementation timelines may vary over time and will be reevaluated each time this GSP is updated.

#### 5.1.1 Public Notification

Successful implementation of this GSP over the planning horizon will require ongoing efforts to engage stakeholders and the general public in the sustainability process. This includes communicating the statutory requirement, the objectives of the GSP, and progress toward each identified measurable objective. In the context of this ongoing public communication, announcements of upcoming environmental hearings, project presentations, bid openings and project construction schedules will be made 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 will provide notice to the public and other agencies through public meetings, newsletters, and the EKGSA website [www.ekgsa.org](http://www.ekgsa.org) as each project or management action is being considered, evaluated, and implemented.

#### 5.1.2 Water Supply

The existing or new water supply most likely to be used for each surface water-dependent project is identified in the description of each of the projects. Due to the location of the projects, only certain surface water supplies might be available.

In California, permits, licenses, and registrations give the right to beneficially use reasonable amounts of water within a specific area or Place of Use. The EKGSA area is located within the Place of Use for the USBR Central Valley Project (CVP) and portions of the EKGSA are located within the Place of Use for the Kaweah River, called the Kaweah River Service Area. Therefore, entities could purchase surface water supplies from the Kaweah River and/or CVP and use them for beneficial uses within the EKGSA after going through the various regulatory and environmental processes for a water transfer if there was a willing seller.

The most likely CVP water that could be available in the future is Section 215 water, a federal designation for floodwater. Section 215 water is available when conditions cause Millerton Lake (on the San Joaquin River) to rise to the point that flood control releases are necessary, as mandated by the U.S. Army Corps of Engineers flood control criteria. Priority allocation for Section 215 water is made available to the Friant Division Long-Term and Cross Valley Canal Contractors. Section 215 water can then also be made available to other parties (Non-Long-Term Contractors) in accordance with Reclamation law and contractual requirements. Section 215 water has typically occurred between December and July, with historical data showing the most prolific months for water availability being March through July. Section 215 water is usually available approximately 2 years out of every 5 years. Some Section 215 has been purchased in the past by EKGSA members when available.

It should be noted that the San Joaquin River Restoration Program (SJRRP) can be expected to utilize flood releases when available prior to water being designated as Section 215 water. This program will have the effect of decreasing the amount of water available for use or recharge when Section 215 water does become available. Another option, albeit costlier, would be to purchase Class 1 or Class 2 supplies from Friant contractors, which is far more reliable than Section 215 water.

## 5.2 Projects

The EKGSA has identified potential projects for initial implementation to help achieve groundwater sustainability, and it is likely additional projects will be developed as GSP implementation proceeds. Agencies within the EKGSA have been doing some recharge for years, but additional projects are required to augment the water supply to help overcome the groundwater overdraft.

The EKGSA will maintain a list of proposed projects and their characteristics, along with their development status, and will use this list to prioritize and secure funding as opportunities become available. Projects discussed in this GSP will remain a part of the potential projects that the EKGSA may choose to implement; however, the projects list will be dynamic based on routine cost-benefit analyses. When multiple projects are considered for competing funds, they will be prioritized based on a weighted decision matrix and those deemed most beneficial considering a broad range of categories will be selected for execution. All projects will be supported by the best available information and the best available science.

Implementation through this first GSP will focus on bolstering data sets to fill data gaps, and then projects fully developed based on current and projected conditions. As a result, projects are presently developed to a conceptual level for general evaluation and comparison. Remaining details of projects, such as specific location, will be finalized later. 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 identified 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. The current projects are generally prioritized and summarized in **Table 5-1** and location within the EKGSA is shown in **Figure 5-1**. Detailed discussion is provided further in this section.

Table 5-1 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 & Banking Project	Recharge, Storage, Re-regulation, Banking	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.

Ultimately, each of these projects and those to be developed will fall into at least one of three categories. There may be multiple projects of each type. Project types include:

1. *Recharge*
  - *Basin*
  - *Dry well*
  - *On-farm recharge*
  - *Flood delivery to existing channel*
2. *Existing conveyance facilities rehabilitation or expansion*
3. *Efficiency improvements*

The anticipated process for project implementation follows:

1. *Identify potential projects*
2. *Prepare conceptual level feasibility study and cost estimate*
3. *Prioritize potential projects based on EKGSA and Stakeholder goals*
4. *Obtain agreement with project partner(s)*
5. *Secure funding*
6. *Prepare environmental documents and obtain permit and regulatory approvals, as necessary*
7. *Design and prepare construction documents*
8. *Implement project construction*
9. *Operate and maintain project for sustainability*
10. *Evaluate actual project benefits compared to expected benefits*

Chapter Five: Projects and Management Actions to Achieve Sustainability  
 East Kaweah GSA

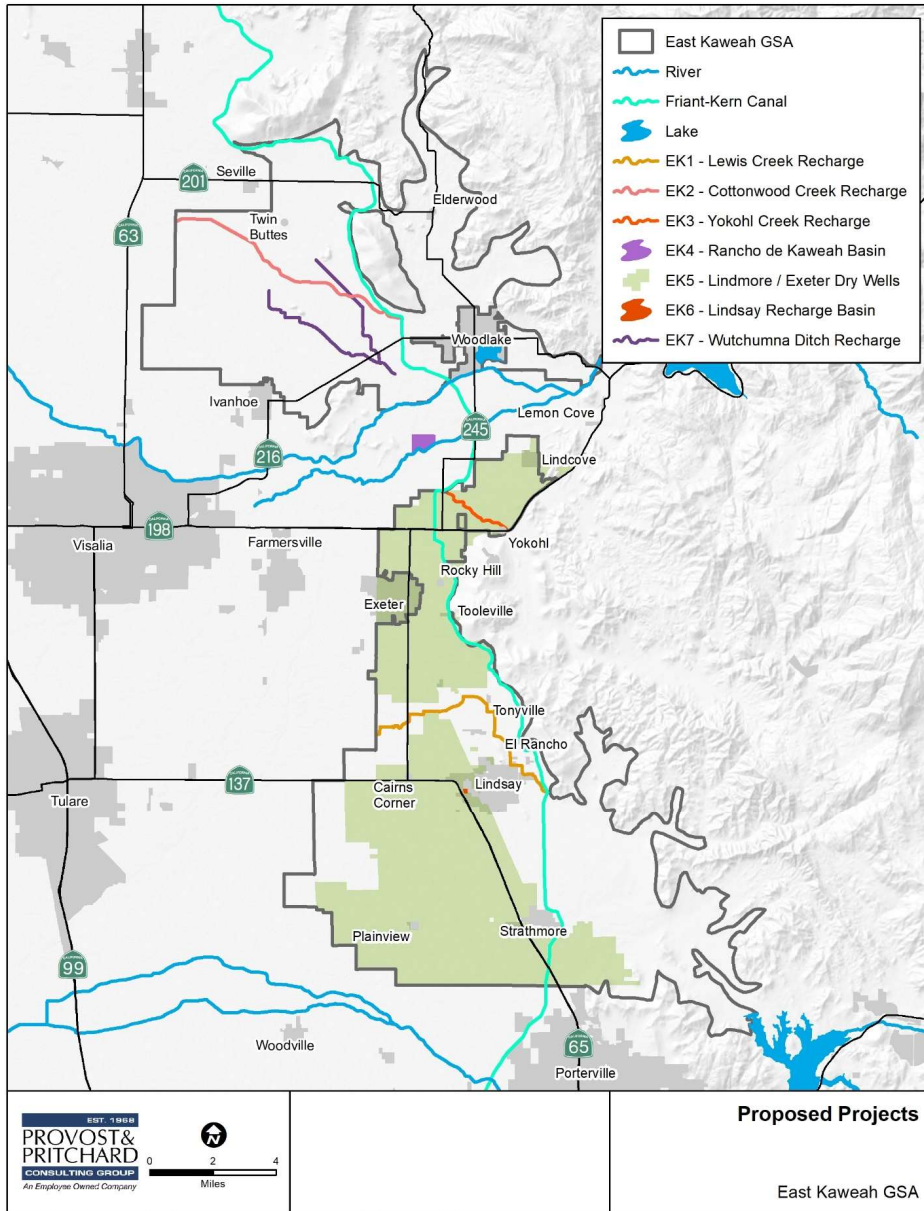


Figure 5-1 EKGS Proposed Projects Location Map

### 5.2.1 Lewis Creek Recharge

The following describes the Lewis Creek Recharge Project, which will capture available surface water and recharge the aquifer through the creek bed. Eventually it may also facilitate in-lieu recharge through decreased use of groundwater wells by using the surface water for irrigation. The length of Lewis Creek expected to be used for recharge is shown in **Figure 5-2**.

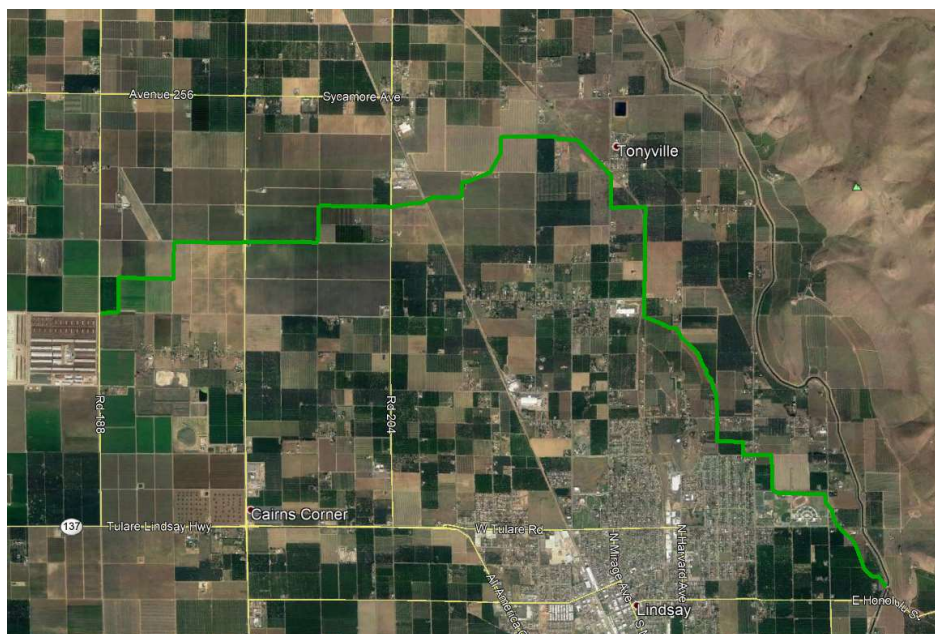


Figure 5-2 Lewis Creek Alignment within EKGSA

<b>Project Title:</b> Lewis Creek Recharge	<b>Project ID:</b> EK1
<b>Project Type</b> Recharge (delivery to existing channel)	
<b>Project Location</b> Lewis Creek from intersection at Friant-Kern Canal east of City of Lindsay and heading west along the channel to the western EKGSA boundary in Tulare County – T20S R27E, T19S R27E, and T19S R26E.	
<b>Implementing Agency</b> Lindmore Irrigation District (LID).	
<b>Project Description - 354.44(a)</b> The Lewis Creek Recharge Project will entail construction of a turnout from Friant-Kern Canal into Lewis Creek to capture CVP water supplies, when available, and recharge the underlying aquifer. The total length of the portion of the creek acting as a recharge facility is nearly 9 miles.	



Chapter Five: Projects and Management Actions to Achieve Sustainability  
East Kaweah GSA

<b>Project Title:</b> Lewis Creek Recharge	<b>Project ID:</b> EK1
<b>Measurable Objective(s) Addressed - 354.44(b)(1)</b>	
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. Indirectly there could be secondary benefits of some groundwater quality improvement from high quality surface water, and reduction in land subsidence.	
<input checked="" type="checkbox"/> Chronic Lowering of Groundwater Levels	<input checked="" type="checkbox"/> Reduction of Groundwater Storage
<input type="checkbox"/> Seawater Intrusion – <i>not applicable</i>	<input checked="" type="checkbox"/> Degraded Water Quality
<input checked="" type="checkbox"/> Land Subsidence	<input checked="" type="checkbox"/> Depletion of Interconnected Surface Water
<b>Circumstances and Criteria for Implementation - 354.44(b)(1)(A)</b>	
The Project is in the conceptual stage and no feasibility study work has begun. Infiltration is expected based on general knowledge of the soil characteristics in the immediate project area. Construction of the project would depend upon successful outcome of a feasibility study including geotechnical work to validate the capacity for percolation. Environmental clearance would be necessary under CEQA and NEPA. This is a high priority project because it utilizes a readily available recharge area to address several of the measurable objectives. It is viewed as an integral piece of the EKGSA's overall effort to reach sustainability.	
<b>Process to Provide Notice of Implementation - 354.44(b)(1)(B)</b>	
The EKGSA will have ongoing efforts to engage stakeholders and the general public in the sustainability process, communicating the statutory requirements, the objectives of the GSP, and progress toward each identified measurable objective. Neighboring landowners will be notified about the project prior to implementation and environmental documents will be available for public review.	
<b>Estimated Annual Project Benefits (AF/yr.) - 354.44(b)(2)</b>	
The actual recharge rate of the proposed project will be determined by the on-site soils. The project is expected to recharge approximately 3,000 acre-feet per year, on average. This is based on an anticipated delivery capacity of 100 AF/day and 30 days of CVP water available per year on average.	
<b>Permitting and Regulatory Requirements - 354.44(b)(3)</b>	
The project will complete all necessary permitting and regulatory requirements. It will require CEQA and NEPA documentation, and potentially a Dust Control Plan (DCP) and a Storm Water Pollution Prevention Plan (SWPPP). The project will utilize CVP water for groundwater recharge.	
<b>Project Schedule - 354.44(b)(4) Anticipated Start &amp; Completion, Timeframe to accrue benefits</b>	
No set project schedule has been determined; however, it is the goal of the EKGSA to have this Project operating by 2022. The key steps that will dictate schedule will be funding, CEQA/NEPA compliance, and construction of a turnout from the FKC into Lewis Creek.	
<b>Evaluation of Benefits - 354.44(b)(5)</b>	
The volume of water delivered for recharge will be measured daily and summarized monthly by LID. The rate of accrual of benefits will depend on the frequency of water availability and the infiltration capacity of the soil. The water level of groundwater wells in the area will be measured and water quality in the vicinity of the project will be monitored. This data will be used to determine project impacts and benefits.	
<b>How will project be accomplished, and what is the water source? - 354.44(b)(6)</b>	
The project will be accomplished by LID with the support of EKGSA. The water source will be CVP supplies when available.	

Chapter Five: Projects and Management Actions to Achieve Sustainability  
East Kaweah GSA

<b>Project Title:</b> Lewis Creek Recharge	<b>Project ID:</b> EK1
<b>Legal Authority - 354.44(b)(7)</b>	
LID has the legal authority to deliver CVP water to Lewis Creek for recharge since portions of the creek are within the District boundaries and is within the CVP Place of Use.	
<b>Project Cost - 354.44(b)(8) Estimated Capital Cost Estimated annual cost/AF</b>	
The estimated project capital cost is approximately \$350,000 and the annual cost over a 20-year return period is estimated to be \$12 to \$15/AF, including operational and capital costs.	
<b>Funding Source - 354.44(b)(8)</b>	
The funding source will likely be a combination of grant funding, EKGSA funds, and possibly LID funds.	
<b>Management of Groundwater Extractions and Recharge - 354.44(b)(9)</b>	
The project would be managed by LID with the oversight by the EKGSA. Recharge volumes will be measured and reported by LID. Groundwater extraction will be by landowners in the area within LID and to the western EKGSA area. Performance of the project would be a necessary part of the EKGSA's reporting requirements as well as evaluations of measurable objectives.	
<b>Level of Uncertainty - 354.44(d)</b>	
The level of uncertainty primarily involves funding availability, permeability of the intended recharge area, and frequency of high flow water. The overall level of uncertainty is moderate for the volume of recharge water indicated.	

### 5.2.3 Cottonwood Creek Recharge

The following describes the Cottonwood Creek Recharge Project, which will capture available surface water and recharge the aquifer through the creek bed. Eventually it may also facilitate in-lieu recharge through decreased use of groundwater wells by using the floodwater for irrigation. The length of Cottonwood Creek expected to be used for recharge is shown in **Figure 5-3**.

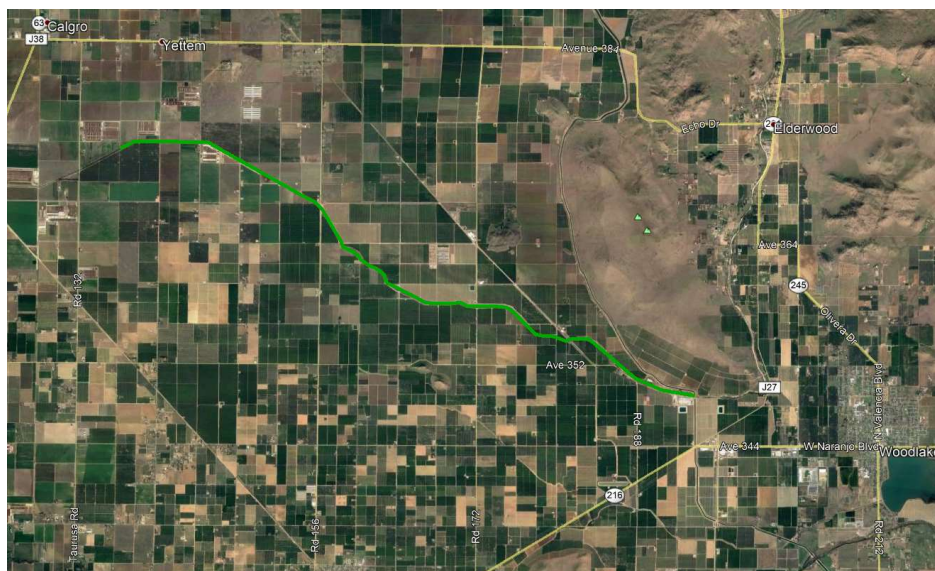


Figure 5-3 Cottonwood Creek Alignment within EKGSA

<b>Project Title:</b> Cottonwood Creek Recharge	<b>Project ID:</b> EK2
<b>Project Type</b>	
Recharge (delivery to existing channel)	
<b>Project Location</b>	
Intersection of Friant-Kern Canal and Cottonwood Creek west to the GSA boundary. West of Woodlake and Northeast of Ivanhoe in Tulare County – T17S R26E and T17S R25E.	
<b>Implementing Agency</b>	
Stone Corral Irrigation District (SCID) & Ivanhoe Irrigation District (IID)	
<b>Project Description - 354.44(a)</b>	
The Cottonwood Creek Recharge Project will entail construction of a turnout from Friant-Kern Canal into Cottonwood Creek to capture CVP water supplies when available and recharge the underlying aquifer. The total length of the portion of the creek acting as a recharge facility is just over 8 miles.	

Chapter Five: Projects and Management Actions to Achieve Sustainability  
East Kaweah GSA

<b>Project Title:</b> Cottonwood Creek Recharge	<b>Project ID:</b> EK2
<b>Measurable Objective(s) Addressed - 354.44(b)(1)</b>	
<p>The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. Indirectly there could be secondary benefits of some groundwater quality improvement from high quality surface water, and reduction in land subsidence.</p> <p> <input checked="" type="checkbox"/> Chronic Lowering of Groundwater Levels      <input checked="" type="checkbox"/> Reduction of Groundwater Storage  <input type="checkbox"/> Seawater Intrusion – <i>not applicable</i>      <input checked="" type="checkbox"/> Degraded Water Quality  <input checked="" type="checkbox"/> Land Subsidence      <input checked="" type="checkbox"/> Depletion of Interconnected Surface Water         </p>	
<b>Circumstances and Criteria for Implementation - 354.44(b)(1)(A)</b>	
<p>The project is in the conceptual stage and no feasibility study work has begun. Infiltration is expected based on general knowledge of the soil characteristics in the immediate project area. Construction of the project would depend upon successful outcome of a feasibility study including geotechnical work to validate the capacity for percolation. Environmental clearance would be necessary under CEQA and NEPA. This is a high priority project because it utilizes a readily available recharge area to address several of the measurable objectives. It is an integral piece of the EKGSA's overall effort to reach sustainability and will be implemented after a feasibility study is completed and funding becomes available.</p>	
<b>Process to Provide Notice of Implementation - 354.44(b)(1)(B)</b>	
<p>The EKGSA will have 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. Neighboring landowners will be notified about the project prior to implementation and environmental documents will be available for public review.</p>	
<b>Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)</b>	
<p>The actual recharge rate of the proposed project will be determined by the on-site soils. The project is expected to recharge approximately 1,800 acre-feet per year, on average. This is based on an anticipated delivery capacity of 60 AF/day and 30 days of CVP water available per year.</p>	
<b>Permitting and Regulatory Requirements - 354.44(b)(3)</b>	
<p>The project shall complete all necessary permitting and regulatory requirements. It will require CEQA and NEPA documentation, a DCP, and a SWPPP. The project will utilize CVP water, when available, for groundwater recharge.</p>	
<b>Project Schedule - 354.44(b)(4) Anticipated Start &amp; Completion, Timeframe to accrue benefits</b>	
<p>No project schedule has been determined, and a project feasibility study and analysis need to be completed, including a geotechnical study. Once a source of project funding is secured, a comprehensive schedule including environmental review, design, permitting and construction will be developed. Project construction and implementation is anticipated to occur within 5 to 10 years of GSP submittal.</p>	
<b>Evaluation of Benefits - 354.44(b)(5)</b>	
<p>The volume of water delivered for recharge will be measured daily and summarized monthly by Stone Corral and/or Ivanhoe IDs. The rate of accrual of benefits will depend on the frequency of water availability and the percolation capacity of the soil. The water level of groundwater wells in the area will be measured and water quality in the vicinity of the project will be monitored. This data will be used to determine project impacts and benefits.</p>	
<b>How will project be accomplished, and what is the water source? - 354.44(b)(6)</b>	
<p>The project will be accomplished by Stone Corral &amp; Ivanhoe IDs with the support of EKGSA. The water source will be CVP water.</p>	

Chapter Five: Projects and Management Actions to Achieve Sustainability  
East Kaweah GSA

<b>Project Title:</b> Cottonwood Creek Recharge	<b>Project ID:</b> EK2
<b>Legal Authority - 354.44(b)(7)</b> Stone Corral & Ivanhoe IDs have the legal authority to deliver CVP water to the creek for recharge since the EKGSA area is within the Place of Use.	
<b>Project Cost - 354.44(b)(8) Estimated Capital Cost Estimated annual cost/AF</b> The estimated project capital cost is approximately \$200,000 and the annual cost over a 20-year return period is estimated to be \$11 to \$14/AF, including operational and capital costs.	
<b>Funding Source - 354.44(b)(8)</b> The funding source will likely be a combination of grant funding, Stone Corral ID, Ivanhoe ID, and/or EKGSA.	
<b>Management of Groundwater Extractions and Recharge - 354.44(b)(9)</b> The project would be managed by Stone Corral & Ivanhoe IDs under the oversight of the EKGSA. Recharge volumes will be measured and reported by Stone Corral & Ivanhoe IDs. Groundwater extraction will be by landowners in the area within Stone Corral ID, Ivanhoe ID, and the EKGSA area. Performance of the project would be a necessary part of the EKGSA's reporting requirements as well as evaluations of measurable objectives.	
<b>Level of Uncertainty - 354.44(d)</b> The level of uncertainty primarily involves funding availability, permeability of the intended recharge area, and frequency of available water. The overall level of uncertainty is moderate for the volume of recharge water indicated.	

### 5.2.4 Yokohl Creek Recharge

The following describes the Yokohl Creek Recharge Project, which will capture available surface water and recharge the aquifer through the creek bed. Eventually it may also facilitate in-lieu recharge through decreased use of groundwater wells by using the floodwater for irrigation. The length of Yokohl Creek expected to be used for recharge is shown in **Figure 5-4**.

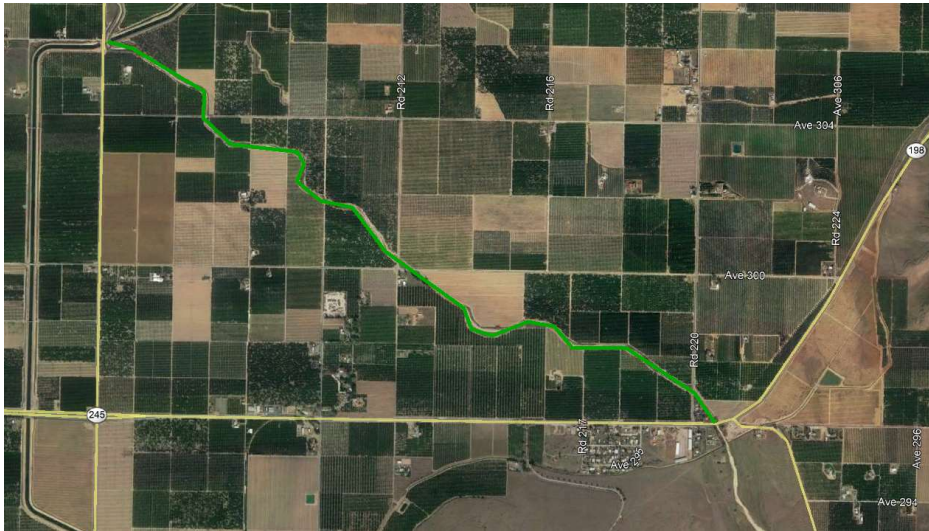


Figure 5-4 Yokohl Creek Alignment within EKGSA

<b>Project Title:</b> Yokohl Creek Recharge	<b>Project ID:</b> EK3
<b>Project Type</b> Recharge (delivery to existing channel)	
<b>Project Location</b> Intersection of Yokohl Creek and Friant-Kern Canal to intersection of Yokohl Creek and HWY 198. North-Northeast of Exeter – T18S R26E and T18S R27E.	
<b>Implementing Agency</b> Exeter Irrigation District (EID)	
<b>Project Description - 354.44(a)</b> The Yokohl Creek Recharge Project will utilize existing EID turnout(s) to deliver CVP water supplies, when available, and recharge the underlying aquifer via the Yokohl Creek channel. The total length of the portion of the creek acting as a recharge facility will be nearly 3 miles.	

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<b>Project Title:</b> Yokohl Creek Recharge	<b>Project ID:</b> EK3
<b>Measurable Objective(s) Addressed - 354.44(b)(1)</b>	
<p>The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. Indirectly there could be secondary benefits of some groundwater quality improvement from high quality surface water, and reduction in land subsidence.</p> <p> <input checked="" type="checkbox"/> Chronic Lowering of Groundwater Levels      <input checked="" type="checkbox"/> Reduction of Groundwater Storage  <input type="checkbox"/> Seawater Intrusion – <i>not applicable</i>      <input checked="" type="checkbox"/> Degraded Water Quality  <input checked="" type="checkbox"/> Land Subsidence      <input checked="" type="checkbox"/> Depletion of Interconnected Surface Water         </p>	
<b>Circumstances and Criteria for Implementation - 354.44(b)(1)(A)</b>	
<p>The EID system has existing connections to Yokohl Creek; however, this project is still in the conceptual stage and no feasibility study work has begun. Infiltration is expected based on general knowledge of the soil characteristics in the immediate project area. Initially, the EKGSA and EID would utilize these existing connections and, pending recharge results, construction to expand the delivery capacity can be considered in the future. This is a high priority project because it utilizes a readily available recharge area to address several of the measurable objectives. It is an integral piece of the EKGSA's overall effort to reach sustainability and will potentially be implemented in 2020.</p>	
<b>Process to Provide Notice of Implementation - 354.44(b)(1)(B)</b>	
<p>The EKGSA will have 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. Neighboring landowners will be notified about the project prior to implementation and environmental documents will be available for public review.</p>	
<b>Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)</b>	
<p>The actual recharge rate of the proposed project will be determined by the on-site soils. The project is expected to recharge approximately 1,800 acre-feet per year, on average. This is based on an anticipated delivery capacity of 60 AF/day and 30 days of CVP water available per year.</p>	
<b>Permitting and Regulatory Requirements - 354.44(b)(3)</b>	
<p>The project shall complete all necessary permitting and regulatory requirements. The project will utilize CVP water for groundwater recharge.</p>	
<b>Project Schedule - 354.44(b)(4) Anticipated Start &amp; Completion, Timeframe to accrue benefits</b>	
<p>No project schedule has been determined, however, given the existing facilities in place, this project could be implemented in 2020.</p>	
<b>Evaluation of Benefits - 354.44(b)(5)</b>	
<p>The volume of water delivered for recharge will be measured daily and summarized monthly by EID. The rate of accrual of benefits will depend on the frequency of water availability and the percolation capacity of the soil. The water level of groundwater wells in the area will be measured and water quality in the vicinity of the project will be monitored. This data will be used to determine project impacts and benefits.</p>	
<b>How will project be accomplished, and what is the water source? - 354.44(b)(6)</b>	
<p>The project will be accomplished by EID with the support of EKGSA. The water source will be CVP water.</p>	

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<b>Project Title:</b> Yokohl Creek Recharge	<b>Project ID:</b> EK3
<b>Legal Authority - 354.44(b)(7)</b> EID has the legal authority to deliver CVP water to the creek for recharge since Yokohl Creek is within its boundary.	
<b>Project Cost - 354.44(b)(8) Estimated Capital Cost Estimated annual cost/AF</b> The estimated project capital cost, for potential capacity enhancement, is approximately \$135,000 and the annual cost over a 20-year return period is estimated to be \$5 to \$10/AF, including operational and capital costs.	
<b>Funding Source - 354.44(b)(8)</b> The funding source will likely be a combination of grant funding, EID, and/or EKGSA.	
<b>Management of Groundwater Extractions and Recharge - 354.44(b)(9)</b> The project would be managed by EID under the oversight of the EKGSA. Recharge volumes will be measured and reported by EID. Groundwater extraction will be by landowners in the area within EID and the EKGSA area. Performance of the project would be a necessary part of the EKGSA's reporting requirements as well as evaluations of measurable objectives.	
<b>Level of Uncertainty - 354.44(d)</b> The level of uncertainty primarily involves permeability of the intended recharge area, and frequency of CVP water available for recharge. The overall level of uncertainty is moderate for the volume of recharge water indicated.	



### 5.2.5 Rancho de Kaweah Water Management & Banking Project

The following describes the Rancho de Kaweah Water Management & Banking Project, which will manage available CVP and/or Kaweah River supplies from project participants and capture excess water in high flow years to recharge the aquifer, store, bank, or re-regulate supplies to help achieve sustainability in the Kaweah Subbasin and potentially benefit others based on participation. The project area is shown in **Figure 5-5**.



Figure 5-5 Rancho de Kaweah Project Area

<b>Project Title:</b>	<b>Rancho de Kaweah Water Management &amp; Banking Project</b>	<b>Project ID:</b> EK4
<b>Project Type</b>	Recharge (basin), Banking, Recovery, and Re-regulation	
<b>Project Location</b>	The project site is located near Exeter Blvd. and the Lower Kaweah River in Tulare County – Portion of Sections 11, 14, 15, 22, and 23 T18S, R26E.	
<b>Implementing Agency</b>	Lindsay-Strathmore Irrigation District (LSID)	

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<b>Project Title:</b> Rancho de Kaweah Water Management & Banking Project <b>Project ID:</b> EK4						
<b>Project Description - 354.44(a)</b>						
The Rancho de Kaweah Water Management & Banking Project will entail constructing recharge and recovery facilities on approximately 1,200 acres. It will provide water management including recharge, storage, re-regulation, and recovery of project participant's CVP and/or Kaweah River water supplies. A conveyance system will be constructed to the project site.						
<b>Measurable Objective(s) Addressed - 354.44(b)(1)</b>						
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project may also re-regulate high flow supplies that would have been potentially underutilized and reduce groundwater pumping by delivering captured water during the irrigation season. Indirectly there could be secondary benefits of some groundwater quality improvement and reduction in land subsidence.						
<table style="width: 100%; border: none;"> <tr> <td style="width: 50%;"><input checked="" type="checkbox"/> Chronic Lowering of Groundwater Levels</td> <td style="width: 50%;"><input checked="" type="checkbox"/> Reduction of Groundwater Storage</td> </tr> <tr> <td><input type="checkbox"/> Seawater Intrusion – <i>not applicable</i></td> <td><input checked="" type="checkbox"/> Degraded Water Quality</td> </tr> <tr> <td><input checked="" type="checkbox"/> Land Subsidence</td> <td><input checked="" type="checkbox"/> Depletion of Interconnected Surface Water</td> </tr> </table>	<input checked="" type="checkbox"/> Chronic Lowering of Groundwater Levels	<input checked="" type="checkbox"/> Reduction of Groundwater Storage	<input type="checkbox"/> Seawater Intrusion – <i>not applicable</i>	<input checked="" type="checkbox"/> Degraded Water Quality	<input checked="" type="checkbox"/> Land Subsidence	<input checked="" type="checkbox"/> Depletion of Interconnected Surface Water
<input checked="" type="checkbox"/> Chronic Lowering of Groundwater Levels	<input checked="" type="checkbox"/> Reduction of Groundwater Storage					
<input type="checkbox"/> Seawater Intrusion – <i>not applicable</i>	<input checked="" type="checkbox"/> Degraded Water Quality					
<input checked="" type="checkbox"/> Land Subsidence	<input checked="" type="checkbox"/> Depletion of Interconnected Surface Water					
<b>Circumstances and Criteria for Implementation - 354.44(b)(1)(A)</b>						
The project is in the conceptual stage and no feasibility study work has begun. Infiltration is expected based on general knowledge of the soil characteristics in the immediate project area—the sandy soils present have a high capacity for percolation. Construction of the project would depend upon successful outcome of a feasibility study including a geotechnical investigation. Environmental clearance would be necessary under CEQA and/or NEPA depending upon the ultimate funding source. This is a high priority project because of the large potential recharge and will address several of the measurable objectives. It is an integral piece of the EKGSA's overall effort to reach sustainability and provide partnering ability within the Kaweah Subbasin.						
<b>Process to Provide Notice of Implementation - 354.44(b)(1)(B)</b>						
The EKGSA will have 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. Neighboring landowners will be notified about the project prior to implementation and environmental documents will be available for public review.						
<b>Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)</b>						
The actual recharge rate of the proposed project will be determined by the on-site soils and size of basin, but it is expected to be approximately 1 ft/day, which would result in approximately 300 AF/day if at least 300 acres of basin area is constructed. This would yield an average annual recharge volume of approximately 9,000 AF/year when Kaweah River water and/or CVP water is available (currently estimated at 30 days per year. Potential storage, recovery, and re-regulation volumes will be determined in the future during further project feasibility and design analysis.						
<b>Permitting and Regulatory Requirements - 354.44(b)(3)</b>						
The project will require CEQA and/or NEPA documentation, permits through the U.S. Army Corps of Engineers and California Department of Fish & Wildlife (CDFW), and construction permits (DCP and SWPPP). The project will likely utilize CVP and Kaweah River water when available. The project shall complete all necessary permitting and regulatory requirements.						
<b>Project Schedule - 354.44(b)(4) Anticipated Start &amp; Completion, Timeframe to accrue benefits</b>						
No project schedule has been determined, and a project feasibility study and analysis need to be completed. Once a source of project funding is secured, a comprehensive schedule including environmental review, design, permitting and construction will be developed. Project construction and						

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**Project Title:** Rancho de Kaweah Water Management & Banking Project **Project ID:** EK4

implementation is anticipated to occur within 5 to 10 years of GSP submittal. Basin recharge can occur after project construction whenever water is available from potential sources.

#### Evaluation of Benefits - 354.44(b)(5)

The volume of water delivered for recharge will be measured daily and summarized monthly. The rate of accrual of benefits will depend on the frequency of water availability and the percolation capacity of the soil. The water level of groundwater wells in the area is measured and water quality in the vicinity of the project is monitored. This data will be used to determine project impacts and benefits.

#### How will project be accomplished, and what is the water source? - 354.44(b)(6)

The project will be accomplished by LSID with the support of EKGSA and cooperation of GKGSA. The water source will be Kaweah River water and/or CVP water that may be available.

#### Legal Authority - 354.44(b)(7)

LSID, as the property owner, has the legal authority to construct the project upon receipt of applicable permits and has the authority to deliver Kaweah River water to the basin as well as CVP water since the area is within the CVP Place of Use.

#### Project Cost - 354.44(b)(8) Estimated Capital Cost Estimated annual cost/AF

The estimated project capital cost is approximately \$12,000,000 and the annual cost over a 20-year return period is estimated to be \$100 to \$150/AF, including operational and capital costs.

#### Funding Source - 354.44(b)(8)

The funding source will likely be a combination of grant funding, LSID, and/or EKGSA.

#### Management of Groundwater Extractions and Recharge - 354.44(b)(9)

The project would be managed by LSID under the oversight of the EKGSA and GKGSA. Recharge volumes will be measured and reported by LSID. Groundwater extraction will be by landowners who partner on the project within the Kaweah Subbasin. Performance of the project would be a necessary part of the EKGSA's reporting requirements as well as evaluations of measurable objectives.

#### Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves funding availability as this project is at the higher end of projected project costs.

### 5.2.7 Lindmore/Exeter Dry Wells

The following describes the Lindmore/Exeter Dry Wells Project, which will capture and recharge water in above average years when surface water is available to help achieve sustainability in the EKGSA. The general project layout is shown in [Figure 5-6](#).

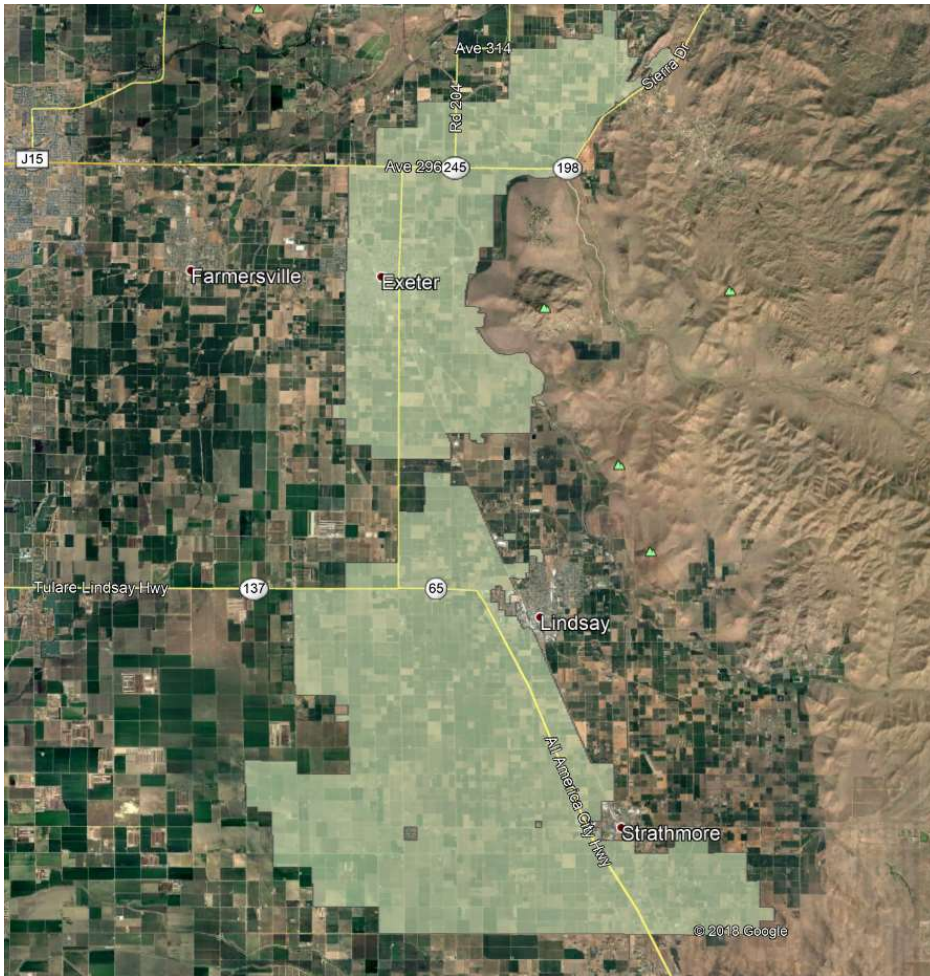


Figure 5-6 Exeter ID and Lindmore ID Boundaries

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<b>Project Title:</b> Lindmore/Exeter Dry Wells	<b>Project ID:</b> EK5						
<b>Project Type</b>							
Recharge (dry well)							
<b>Project Location</b>							
The intent of the dry well projects is to spread multiple wells throughout the Exeter and Lindmore Irrigation Districts to provide recharge throughout the area with a smaller project footprint. Specific locations have not been selected, as they will require coordination with landowners within the two districts. The intent will be to place them near access to surface water connection (i.e. District distribution system) to develop widespread recharge.							
<b>Implementing Agency</b>							
Lindmore ID & Exeter ID							
<b>Project Description - 354.44(a)</b>							
The Lindmore/Exeter Dry Wells Project is still largely conceptual in nature and will entail the Irrigation Districts constructing multiple series of interconnected dry wells that could be used to achieve groundwater recharge when CVP supplies are available to the Districts. The dry well would be a standpipe filled with gravel that would allow water to infiltrate below the soil surface. The size and depth of the dry wells would be site dependent. The dry well recharge system would likely be the recharge method in areas where surface soils are not conducive to recharge and it is necessary to deliver water for recharge below shallow clay layers in the soil, or if recharge in an existing basin would be enhanced by delivering water deeper into the soil profile.							
<b>Measurable Objective(s) Addressed - 354.44(b)(1)</b>							
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. Indirectly there could be secondary benefits of some groundwater quality improvement and reduction in land subsidence.							
<table style="width: 100%; border: none;"> <tr> <td><input checked="" type="checkbox"/> Chronic Lowering of Groundwater Levels</td> <td><input checked="" type="checkbox"/> Reduction of Groundwater Storage</td> </tr> <tr> <td><input type="checkbox"/> Seawater Intrusion – <i>not applicable</i></td> <td><input checked="" type="checkbox"/> Degraded Water Quality</td> </tr> <tr> <td><input checked="" type="checkbox"/> Land Subsidence</td> <td><input type="checkbox"/> Depletion of Interconnected Surface Water</td> </tr> </table>		<input checked="" type="checkbox"/> Chronic Lowering of Groundwater Levels	<input checked="" type="checkbox"/> Reduction of Groundwater Storage	<input type="checkbox"/> Seawater Intrusion – <i>not applicable</i>	<input checked="" type="checkbox"/> Degraded Water Quality	<input checked="" type="checkbox"/> Land Subsidence	<input type="checkbox"/> Depletion of Interconnected Surface Water
<input checked="" type="checkbox"/> Chronic Lowering of Groundwater Levels	<input checked="" type="checkbox"/> Reduction of Groundwater Storage						
<input type="checkbox"/> Seawater Intrusion – <i>not applicable</i>	<input checked="" type="checkbox"/> Degraded Water Quality						
<input checked="" type="checkbox"/> Land Subsidence	<input type="checkbox"/> Depletion of Interconnected Surface Water						
<b>Circumstances and Criteria for Implementation - 354.44(b)(1)(A)</b>							
The project is in the conceptual stage and no feasibility study work has begun. Successful pilot projects must be conducted before significant implementation would occur. If proven feasible, the EKGSA and Districts would develop a program that could be implemented on a larger scale. This is a medium priority project because, while many dry wells are expected to be constructed, there are interim steps to be taken prior to large scale implementation. This project will be implemented after successful pilot projects demonstrate effectiveness and funding options are known.							
<b>Process to Provide Notice of Implementation - 354.44(b)(1)(B)</b>							
The EKGSA will have 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. The EKGSA will provide information about the pilot program as part of SGMA outreach and education and will notify landowners about development of the program. Landowners that can and wish to participate will coordinate water delivery through their local agency.							
<b>Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)</b>							
The number of dry wells that will be constructed for this project is unknown at this time, but an estimate of 150 dry wells could be implemented with an average recharge rate of approximately 0.5 AF/day. Based on the typical availability of CVP supplies, this would equate to an estimated average annual recharge							

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<b>Project Title:</b> Lindmore/Exeter Dry Wells	<b>Project ID:</b> EK5
<p>volume of approximately 2,000 AF/yr. The recharge rate would be highly dependent on the size and depth of the dry wells and the infiltrating soil type.</p>	
<p><b>Permitting and Regulatory Requirements - 354.44(b)(3)</b></p> <p>Permits may need to be obtained from the County and/or the Regional Water Quality Control Board (RWQCB) depending on the size and depth of the dry wells. The recharge program still needs to be established by the EKGSA, and the program will likely need to go through CEQA compliance prior to implementation. The recharge program would have oversight by the EKGSA to assure proper water accounting and evaluate on-going impact (positive or negative) on groundwater quality.</p>	
<p><b>Project Schedule - 354.44(b)(4) Anticipated Start &amp; Completion, Timeframe to accrue benefits</b></p> <p>No project schedule has been determined. It is anticipated that development of the recharge program would occur early on during the first 5 years of GSP implementation, and significant implementation and use of the wells may occur by the end of the first 5 years.</p>	
<p><b>Evaluation of Benefits - 354.44(b)(5)</b></p> <p>The volume of water delivered for recharge will be measured daily and summarized monthly by the local water delivery agency and/or landowner. The rate of accrual of benefits will depend on how many systems are installed, the recharge capacity of each, and the availability and frequency of high flow water.</p>	
<p><b>How will project be accomplished, and what is the water source? - 354.44(b)(6)</b></p> <p>The project will be accomplished by individual landowners that have fields that can access District supplies. The water source will be the District's CVP supplies.</p>	
<p><b>Legal Authority - 354.44(b)(7)</b></p> <p>The Districts have the legal authority to deliver CVP water to the landowner fields within their boundary. Once any necessary permits are obtained, there would be legal authority to construct a dry well.</p>	
<p><b>Project Cost - 354.44(b)(8) Estimated Capital Cost Estimated annual cost/AF</b></p> <p>The estimated project capital cost for constructing 150 wells is approximately \$2,500,000 and the annual cost over a 20-year return period is estimated to be \$70 to \$80/AF, including operation and capital costs.</p>	
<p><b>Funding Source - 354.44(b)(8)</b></p> <p>The funding source will likely be a combination of grant funding, IID, EID, and/or EKGSA.</p>	
<p><b>Management of Groundwater Extractions and Recharge - 354.44(b)(9)</b></p> <p>The project would be managed by the landowner and overlying district under the oversight of the EKGSA. Recharge volumes will be measured and reported by the District. Groundwater extraction will be by the landowner of the well. Performance of the project would be a necessary part of the EKGSA's reporting requirements as well as evaluations of measurable objectives.</p>	
<p><b>Level of Uncertainty - 354.44(d)</b></p> <p>The primary uncertainty involved with small recharge operations is the cost effectiveness. It is slightly decreased in this case due to economy of scale. The other chief uncertainty is the permitting process as this would be a newer recharge methodology in the area. The level of uncertainty for significant implementation is moderate.</p>	

### 5.2.8 Lindsay Recharge Basin

The following describes the Lindsay Recharge Basin Project, which will capture available surface water and recharge the aquifer to help achieve sustainability in the EKGSA area. The general project area is shown in Figure 5-7.



Figure 5-7 City of Lindsay Recharge Basin Site

<b>Project Title:</b>	Lindsay Recharge Basin	<b>Project ID:</b>	EK6
<b>Project Type</b>	Recharge (basin)		
<b>Project Location</b>	The project site is located on APN 199-140-038 and -049 east of the intersection of Mariposa St. (Ave. 230) and Highway 65 in Tulare County – Section 12, T20S, R26E.		
<b>Implementing Agency</b>	Lindmore ID & City of Lindsay		

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<b>Project Title:</b> Lindsay Recharge Basin	<b>Project ID:</b> EK6
<b>Project Description - 354.44(a)</b>	
The Lindsay Recharge Basin Project will entail improving recharge capability of an existing 8-acre basin and constructing conveyance facilities to improve capacity to the basin site. The basin will provide recharge when CVP water is available.	
<b>Measurable Objective(s) Addressed - 354.44(b)(1)</b>	
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. Indirectly there could be secondary benefits of some groundwater quality improvement and reduction in land subsidence.	
<input checked="" type="checkbox"/> Chronic Lowering of Groundwater Levels <input checked="" type="checkbox"/> Reduction of Groundwater Storage <input type="checkbox"/> Seawater Intrusion – <i>not applicable</i> <input checked="" type="checkbox"/> Degraded Water Quality <input checked="" type="checkbox"/> Land Subsidence <input type="checkbox"/> Depletion of Interconnected Surface Water	
<b>Circumstances and Criteria for Implementation - 354.44(b)(1)(A)</b>	
The project is in the conceptual stage and no feasibility work has begun. Environmental clearance would be necessary under CEQA and/or NEPA depending upon the ultimate funding source. This is a medium priority project because, while there is existing infrastructure in place, the projected benefit is not as great as other proposed projects and the cost-benefit is lower.	
<b>Process to Provide Notice of Implementation - 354.44(b)(1)(B)</b>	
The EKGSA will have 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. Neighboring landowners will be notified about the project prior to implementation and environmental documents will be available for public review.	
<b>Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)</b>	
The actual recharge rate of the proposed project will be determined by the on-site soils and size of basin, but the intent is to improve the recharge capability of the existing basin to obtain an extra 5 AF/day and therefore yield an average annual recharge volume of 150 AF/year when CVP water is available.	
<b>Permitting and Regulatory Requirements - 354.44(b)(3)</b>	
The project will complete all necessary permitting and regulatory requirements such as CEQA documentation regarding potential impacts and construction permits (DCP and SWPPP). The program would utilize surplus CVP water when available.	
<b>Project Schedule - 354.44(b)(4) Anticipated Start &amp; Completion, Timeframe to accrue benefits</b>	
No project schedule has been determined. Once a source of funding is identified, a comprehensive schedule including environmental review, design, and construction will be developed. Given there is an existing basin, Project implementation is anticipated to occur within the first 5 years of GSP Implementation. Basin recharge can occur after construction, whenever surplus CVP water is available.	
<b>Evaluation of Benefits - 354.44(b)(5)</b>	
The volume of water delivered for recharge will be measured daily and summarized monthly. The rate of accrual of benefits will depend on the frequency of water availability and the percolation capacity of the soil. The water level of groundwater wells in the area is measured and water quality in the vicinity of the project is monitored. This data will be used to determine project impacts and benefits.	



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<b>Project Title:</b> Lindsay Recharge Basin	<b>Project ID:</b> EK6
<b>How will project be accomplished, and what is the water source?</b> - 354.44(b)(6) The project will be accomplished by LID and the City of Lindsay and with support by the EKGSA. The water source will be CVP water.	
<b>Legal Authority</b> - 354.44(b)(7) LID and the City of Lindsay are both Friant CVP contractors and have the authority to deliver CVP water within their boundary. Both entities also have the legal authority to construct the project components upon receipt of applicable permits and easements.	
<b>Project Cost</b> - 354.44(b)(8) <b>Estimated Capital Cost</b> <b>Estimated annual cost/AF</b> The estimated project capital cost is approximately \$250,000 and the annual cost over a 20-year return period is estimated to be \$100 to \$125/AF, including operational and capital costs.	
<b>Funding Source</b> - 354.44(b)(8) The funding source will likely be a combination of grant funding, LID, City of Lindsay, and/or EKGSA.	
<b>Management of Groundwater Extractions and Recharge</b> - 354.44(b)(9) The project would be managed by LID and/or the City of Lindsay under the oversight of the EKGSA. Recharge volumes will be measured and reported by LID. Groundwater extraction will be by landowners in the area. Performance of the project would be a necessary part of the EKGSA's reporting requirements as well as evaluations of measurable objectives.	
<b>Level of Uncertainty</b> - 354.44(d) The level of uncertainty primarily involves funding availability and improvement to the permeability of the intended recharge area. The overall level of uncertainty is low for the volume of recharge water indicated.	

### 5.2.10 Wutchumna Ditch Delivery

The following describes the Wutchumna Ditch Delivery project, which will capture available excess water in high flow years and recharge the aquifer through the ditch bed. Eventually it may also facilitate in-lieu recharge through decreased use of groundwater wells by using the surplus surface water for irrigation. The length of Wutchumna Ditch expected to be used for recharge is shown in **Figure 5-8**.

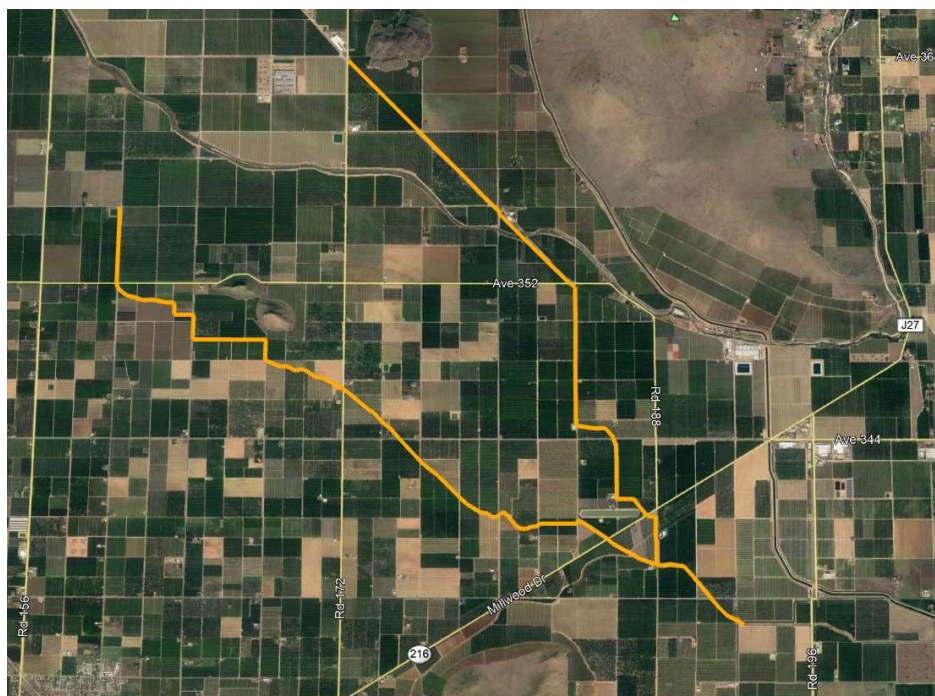


Figure 5-8 Wutchumna Ditch Spurs in EKGSA

<b>Project Title:</b> Wutchumna Ditch Delivery	<b>Project ID:</b> EK7
<b>Project Type</b> Recharge (delivery to existing channel)	
<b>Project Location</b> Intersection of Wutchumna Ditch and Tulare ID turnout west of the FKC and running west into non-districted areas of the EKGSA in Tulare County –T17S, R25E and T17S, R26E.	
<b>Implementing Agency</b> Wutchumna Water Company and Ivanhoe ID	

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<b>Project Title:</b> Wutchumna Ditch Delivery	<b>Project ID:</b> EK7						
<b>Project Description - 354.44(a)</b>							
<p>The Wutchumna Ditch Delivery Project will entail environmental permitting and management agreements. There is an existing connection to FKC through a Tulare ID turnout. Wutchumna Ditch and spur ditches will be used to capture CVP water supplies when available and recharge the underlying aquifer. The total length of ditches acting as a recharge facility is nearly 10 miles.</p>							
<b>Measurable Objective(s) Addressed - 354.44(b)(1)</b>							
<p>The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. Indirectly there could be secondary benefits of some groundwater quality improvement from high quality surface water, and reduction in land subsidence.</p>							
<table style="width: 100%; border: none;"> <tr> <td style="width: 50%;"><input checked="" type="checkbox"/> Chronic Lowering of Groundwater Levels</td> <td style="width: 50%;"><input checked="" type="checkbox"/> Reduction of Groundwater Storage</td> </tr> <tr> <td><input type="checkbox"/> Seawater Intrusion – <i>not applicable</i></td> <td><input checked="" type="checkbox"/> Degraded Water Quality</td> </tr> <tr> <td><input checked="" type="checkbox"/> Land Subsidence</td> <td><input type="checkbox"/> Depletion of Interconnected Surface Water</td> </tr> </table>		<input checked="" type="checkbox"/> Chronic Lowering of Groundwater Levels	<input checked="" type="checkbox"/> Reduction of Groundwater Storage	<input type="checkbox"/> Seawater Intrusion – <i>not applicable</i>	<input checked="" type="checkbox"/> Degraded Water Quality	<input checked="" type="checkbox"/> Land Subsidence	<input type="checkbox"/> Depletion of Interconnected Surface Water
<input checked="" type="checkbox"/> Chronic Lowering of Groundwater Levels	<input checked="" type="checkbox"/> Reduction of Groundwater Storage						
<input type="checkbox"/> Seawater Intrusion – <i>not applicable</i>	<input checked="" type="checkbox"/> Degraded Water Quality						
<input checked="" type="checkbox"/> Land Subsidence	<input type="checkbox"/> Depletion of Interconnected Surface Water						
<b>Circumstances and Criteria for Implementation - 354.44(b)(1)(A)</b>							
<p>The project is in the conceptual stage and no feasibility study work has begun. Infiltration is expected based on general knowledge of the soil characteristics in the immediate project area. Implementation of the project would depend upon successful outcome of coordinating agreements and environmental clearance under NEPA. This is a medium priority project because it utilizes a readily available recharge area to address several of the measurable objectives, but agreements are needed on coordinating deliveries into the channel.</p>							
<b>Process to Provide Notice of Implementation - 354.44(b)(1)(B)</b>							
<p>The EKGSA will have 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. Neighboring landowners will be notified about the project prior to implementation and environmental documents will be available for public review.</p>							
<b>Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)</b>							
<p>The actual recharge rate of the proposed project will be determined by the on-site soils. The project is expected to recharge approximately 480 acre-feet per year, on average. This is based on an anticipated delivery capacity of 16 AF/day and 30 days of CVP water available per year.</p>							
<b>Permitting and Regulatory Requirements - 354.44(b)(3)</b>							
<p>The project will complete all necessary permitting and regulatory requirements. It will require NEPA documentation to utilize CVP water.</p>							
<b>Project Schedule - 354.44(b)(4) Anticipated Start &amp; Completion, Timeframe to accrue benefits</b>							
<p>No project schedule has been determined. Once a source of project funding is secured, a schedule including environmental review and agreements can be developed. Project implementation is anticipated to occur near the end of the first 5 years of GSP Implementation.</p>							
<b>Evaluation of Benefits - 354.44(b)(5)</b>							
<p>The volume of water delivered for recharge will be measured daily and summarized monthly by Wutchumna Water Company. The rate of accrual of benefits will depend on the frequency of water availability and the infiltration capacity of the soil. The water level of groundwater wells in the area will be measured and water quality in the vicinity of the project will be monitored. This data will be used to determine project impacts and benefits.</p>							

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<b>Project Title:</b> Wutchumna Ditch Delivery	<b>Project ID:</b> EK7
<b>How will project be accomplished, and what is the water source?</b> - 354.44(b)(6)	
The project will be accomplished by Wutchumna Water Company with the support of EKGSA. The water source will most likely be CVP supplies and Kaweah River flood water when available.	
<b>Legal Authority</b> - 354.44(b)(7)	
The EKGSA is made up of Friant Contractors that have the legal authority to deliver CVP water. Coordination will be needed amongst the EKGSA and Wutchumna Water Company for delivery into the Wutchumna Ditch, which is within the CVP Place of Use.	
<b>Project Cost</b> - 354.44(b)(8) <b>Estimated Capital Cost</b> <b>Estimated annual cost/AF</b>	
The estimated project capital cost is approximately \$100,000 and the annual cost over a 20-year return period is estimated to be \$15 to \$20/AF, including operational and capital costs.	
<b>Funding Source</b> - 354.44(b)(8)	
The funding source will likely be a combination of grant funding and EKGSA landowners.	
<b>Management of Groundwater Extractions and Recharge</b> - 354.44(b)(9)	
The project would be managed by Wutchumna Water Company with the oversight of the EKGSA. Recharge volumes will be measured and reported by Wutchumna Water Company. Groundwater extraction will be by landowners in the area within the EKGSA area. Performance of the project would be a necessary part of the EKGSA's reporting requirements as well as evaluations of measurable objectives.	
<b>Level of Uncertainty</b> - 354.44(d)	
The level of uncertainty primarily involves permeability of the intended recharge area, and frequency of high flow water. The overall level of uncertainty is moderate for the volume of recharge water indicated.	

### 5.2.11 Additional Project Types

The EKGSA has preliminarily discussed other project concepts that may be utilized in the future, but currently haven't been fully vetted for potential implementation. Future Annual Reports or GSP updates will likely have additional detail on these project concepts.

#### 5.2.11.1 On-farm Recharge and Private Recharge Facilities

On-farm recharge entails spreading excess surface water on operational agricultural fields to recharge the aquifer. The field soil type and crop type must be considered, along with the timing when the excess water is available. Compatibility with crops is necessary for these projects, as some crops tolerate saturated conditions better than others. Tillage operations vary for different crops as well and influence the rate of percolation. On-farm recharge provides a substantial flood control benefit while maintaining agricultural beneficial use of the land. It is anticipated that the program that is developed by the EKGSA may involve incentives to encourage landowners to participate.

The construction of these projects would depend upon successful outcome of a feasibility study including geotechnical work to validate the percolation rate. There would be no permitting or regulatory requirements since it essentially is just over-irrigation of a field. Ultimately, these projects will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. Depending on the location of the on-farm recharge there could be some groundwater quality benefits and some impact on reducing land subsidence. These projects will need to be managed to minimize leaching of fertilizer through the root zone, which could have a negative impact on groundwater quality.

The amount of land that will participate in the program is unknown at this time but based on the SAGBI map of the area it is conservatively estimated that 10,000 acres could participate each year when water is available. The EKGSA will notify participating landowners each time high flow water is available. Landowners will coordinate water delivery through their local district, and the district will report use to the EKGSA. The Friant Districts have the legal authority to deliver surplus CVP water within their boundaries and the entire EKGSA is within the CVP Place of Use.

These projects will have minimal cost. Any improvements required to convey and distribute water on the fields will be paid by the landowner, possibly with assistance from their District, and/or the EKGSA. Performance of the projects would be a necessary part of the EKGSA's reporting requirements as well as evaluations of measurable objectives.

#### 5.2.11.2 Existing Conveyance Facilities Rehabilitation or Expansion

The EKGSA may propose to support the rehabilitation or expansion of existing conveyance facilities, such as diversion systems, check structures, and conveyance facilities. The intent of these improvements is to increase the capacity of the districts to divert more surface water for irrigation as in-lieu recharge, direct on-farm recharge, or for groundwater recharge basins. These projects may require land acquisition or agreements where facilities are expanded. The EKGSA will seek to maximize use of periodic floodwater, which is highly variable.

The objectives of these projects are to use current systems to their full potential, or expand facilities, to increase groundwater storage on an average annual basis. The in-lieu recharge will mitigate groundwater depletion, which has been linked to several undesirable results. Groundwater levels and quality in the nearby area will be monitored before and after implementation of these projects to measure their impacts. Demand reduction will be based on the annualized volume of water delivered for irrigation as a direct result of the conveyance facility rehabilitation or expansion. Flow rates realized before project implementation will not be factored into demand reduction.

### 5.2.11.3 Efficiency Improvements

The EKGSA may develop programs to fund or incentivize projects that increase water use efficiency within the EKGSA area. Execution of these projects will be based upon funding availability and farmer willingness, and they will likely be implemented on a field or farm level. Project examples include installing higher efficiency irrigation systems and/or soil moisture sensors.

Increasing the efficiency of an irrigation system may mean converting from flood to spray, or from spray to drip or subsurface drip. Soil moisture sensors paint a more accurate picture of the moisture content through the soil profile and rootzone. The intent of efficiency improvements would be to refine the irrigation process and ultimately extract only enough groundwater to meet the crop demand, minimizing waste.

### 5.3 Management Actions

Some management actions, such as education and outreach, will be initiated early in the GSP implementation phase, while other management actions are envisioned to be employed to reduce water demand if project development is not proceeding sufficiently to achieve the sustainability required to reduced overdraft and meet the interim milestones. This section discusses a suite of management actions the EKGSA may consider during implementation of the GSP to achieve sustainability. They may not be implemented in a strictly linear fashion, as numbered below, as some management actions must be implemented before others can be achieved, and specific actions may not be implemented at all if sustainability is achieved through projects and other actions. In addition, the EKGSA could implement some management actions area-wide, while others would be developed by the EKGSA but would be implemented by individual landowners. In some cases, the landowner may need to choose which management action they want to implement, such as choosing between crop conversion and fallowing land, because it is an economic decision that affects the livelihood of the landowner and there may not be a consistent answer across the entire area. It is expected the EKGSA will further develop and craft management actions in response to stakeholder input on parallel timelines and adapt to the estimated schedules according to the best available information and best available science at any given time.

The legal authority and basis for the management actions described in this GSP are outlined in the SGMA legislation and related provisions. SGMA describes the powers and authorities - financial authority and enforcement powers - of GSAs in Chapters 5, 8, and 9, respectively. These EKGSA authorities include adopting regulations, regulating groundwater extractions, imposing fees, monitoring, enforcing programs, and more. Though SGMA grants GSAs these powers, the pursuit and implementation of the projects and management actions is each GSA's responsibility. A GSA must enforce their legal authority to the extent necessary to achieve sustainable groundwater management for all beneficial users within a GSA and a Subbasin. In the development of the management actions, the EKGSA intends to embody the lessons learned from other groundwater managed basins and strive to accomplish the following (if applicable):

- *Develop trust by being inclusive and transparent.*
- *Use a portfolio of approaches to achieve sustainability.*
- *Ensure efficient and accurate data collection.*
- *Devise a fair and equitable groundwater allocation.*
- *Potentially craft a groundwater trading structure that reflects local hydrologic conditions.*
- *Address concerns of funding EKGSA management actions.*
- *Assure performance through incentives, penalties, and enforcement.*

The Management Actions that may be considered by the EKGSA are discussed below and grouped into the following general topics:

- EO - Education and Outreach
- WH – Well Head Requirements
- GA – Groundwater Allocation
- GMT – Groundwater Marketing/Trading
- FI – Fees and Incentives
- GP – Groundwater Pumping Restrictions

## 5.3.1 Education and Outreach Management Actions

### 5.3.1.1 Notification of Annual Groundwater Use

#### **EO-1 Regular Communication**

Education and Outreach efforts will continue to educate all landowners within the EKGSA about SGMA and how implementation of the GSP will proceed to address the groundwater overdraft situation. The EKGSA will promote education and outreach to all beneficial users within the GSA as detailed in the [Chapter 1](#). Specific to Projects and Management Actions, the EKGSA may adopt a program which provides groundwater users their approximate groundwater use in acre-feet on a per acre basis as an education tool every year. The program may be established before the EKGSA would consider enforcement action on an established groundwater allocation when an allocation is established in the future as discussed in [Section 5.3.3](#). The goal is to provide ongoing correspondence to groundwater users and promote awareness of the overdraft condition in the EKGSA, particularly for those groundwater users who do not currently have metered wells. This correspondence may provide individual user information as well as aggregated EKGSA groundwater data for comparison purposes. The ongoing correspondence may contain the following information:

- Individual grower's estimated groundwater use amount in acre-feet/acre.
- Average crop demand in acre-feet/acre based upon published CIMIS evapotranspiration values specific to individual's location
- GSA average groundwater extraction amount for individual grower's crop in acre-feet/acre.
- GSA average groundwater overdraft in acre-feet/acre.
- Current status of GSA adoption of groundwater allocation per acre or groundwater allocation, if applicable, per [Section 5.3.3](#).
- Detailed reminder of the EKGSA powers and authorities granted in SGMA.
- Current status of EKGSA adoption of any management actions

In order to determine the individual grower's groundwater extraction amount, the EKGSA may consider multiple quantification methods for a consistent determination of groundwater extraction per acre. The various quantification methods will be discussed further below in [Section 5.3.3](#).

#### **EO-2 Non-Routine Responses to Minimum Threshold Exceedances**

In addition to regular correspondence, the EKGSA may also immediately notify individual growers of a Minimum Threshold (MT) exceedance as defined in [Chapter 3 Sustainable Management Criteria](#). The notice of MT exceedance would alert the monitoring well owner and groundwater extractors within a defined threshold region or management area. The notification may contain the following information:

- Description and location of the MT exceedance.
- Notice of increased frequency of water level and/or water quality monitoring.
- The potential effects to the individual growers (i.e. their well potentially going dry).
- The planned EKGSA response (i.e. trigger of specific projects and managements actions).
- Current funding opportunities available through the EKGSA or other entities, which could be used on projects to combat the determinantal effects of the MT exceedance.
- A written reminder of how individuals can contact the EKGSA, find more information, and provide public input regarding the implementation of the GSP.
- A written reminder of the GSA powers and authorities granted in SGMA, as well as noting the potential for State intervention when Undesirable Results occur that are not reconciled by the GSA.

The regular correspondence and notice of MT exceedance may not generate a quantifiable groundwater demand reduction. However, they would serve as useful education and outreach tools which may change individual



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pumping practices and encourage growers to implement water conservation Best Management Practices (BMPs) and/or other demand reduction solutions.

#### Measurable Objectives Addressed

The goal is to provide education and correspondence with groundwater extractors and promote awareness of the EKGSA overdraft condition particularly for those groundwater extractors who do not currently have metered wells. The measurable objectives would be the number of annual correspondence letters and MT exceedance notices that are mailed each year. In preparation of the quarterly or annual letters and immediate notices, the EKGSA would develop template letters and house a current mailing address database to expedite the notification process. In addition, other ancillary measurable objectives may include the increase of persons on the EKGSA's Interested Person's List, visits to the GSA website, and attendance at public meetings and events. If the education and outreach program did result in a reduction of groundwater extraction, the marginal amount would be estimated at 1-100 acre-feet/year.

**Table 5-2 Education & Outreach Measurable Objectives Checklist**

Groundwater Level	X
Storage Change	X
Groundwater Quality	X
Land subsidence	X
Surface Water-Groundwater Interconnection	X
Seawater Intrusion	NA

#### **5.3.1.2 Circumstances for Implementation EO-1 - EO-2 (Sec. 354.44.b.1.A)**

The education and outreach management action may be developed and implemented shortly after the adoption of the GSP. The policy would remain indefinitely and be reevaluated at least every 5 years. A trigger for the end of this management action may be that another EKGSA management action or program provides comparable annual education letters and outreach notices.

#### **5.3.1.3 Process for Public Notification EO-1 - EO-2 (Sec. 354.44.b.1.B)**

The process for public notification will be addressed by the consistent communication and outreach between the EKGSA and the groundwater extractor. The EKGSA will develop a system to initiate communication with the grower on a regular basis and will additionally respond to overdraft or non-compliance with minimum thresholds with escalating correspondence as deemed necessary. The cost associated with EKGSA correspondence will be assessed on an annual basis.

#### **5.3.1.4 Permitting and Regulatory Process EO-1 - EO-2 (Sec. 354.44.b.3)**

No permit or regulatory process is required for the EKGSA to adopt the policy. The management action may be accomplished by EKGSA policy adoption. This management action does not rely on water from outside the jurisdiction of the EKGSA.

#### **5.3.1.5 Status and Schedule EO-1 - EO-2 (Sec. 354.44.b.4)**

The education and outreach program with annual education letter and notice of MT exceedance has not been drafted. It is expected to commence shortly after the adoption of the GSP and be completed within 1 year. The initial focus will be the annual correspondence letter since the notices of MT exceedance may not occur for many years.

#### **5.3.1.6 Benefit Realization and Evaluation EO1 - EO-2 (Sec. 354.44.b.5)**

The EKGSA will use education and outreach opportunities to encourage active engagement, open lines of communication with interested and affected stakeholders, let them know the future opportunities for input, establish communication channels, and receive feedback on the GSP implementation process.

The expected benefits may mitigate overdraft by educating the public about the current use and quality of groundwater supplies. Groundwater extractors may see that their individual use exceeds published crop demand values, EKGSA average use, and/or EKGSA groundwater allocation. Without levying penalties, the EKGSA intends for all correspondence and mailed notices to educate extractors about the EKGSA's monitoring practices, procedures, and enforcement capabilities. Other program benefits include the transparent and expeditious communication of groundwater overdraft conditions, implementation of specific projects and managements actions, funding opportunities, and potential for State intervention if undesirable results occur.

#### **5.3.1.7 How This Management Action Will Be Accomplished EO-1 - EO-2 (Sec. 354.44.b.6)**

The annual correspondence and escalation letters can be accomplished by utilizing the in-house mailing database that the EKGSA will develop and maintain. All correspondence will be drafted by EKGSA staff and will be in accordance with the actions of the Board of Directors. Further detail regarding communication can be found in [Chapter 1](#).

#### **5.3.1.8 Legal Authority EO-1 - EO-2 (Sec. 354.44.b.7)**

The legal authority and basis for the management actions described in this Chapter are outlined in the SGMA and related provisions. The SGMA legislation describes the powers and authorities, financial authority, and enforcement powers of GSAs in Chapters 5, 8, and 9 respectively.

#### **5.3.1.9 Costs EO-1 - EO-2 (Sec. 354.44.b.8)**

The costs related to the education and outreach management action include one-time expenses and reoccurring annual expenses. The one-time expenses include the labor costs of the EKGSA Staff, Legal Counsel, and Consultant to prepare the formal program description and adopt the management action policy. The written policy would detail the specific content of the chosen correspondence method, the source of the data being reported, the frequency of the correspondence, mailing or delivery logistics, expected costs, and the intent of the policy. Through a Board resolution, the program would be incorporated into the EKGSA's policy manual for transparency. The database of current EKGSA mailing addresses and template letters would be created. These initial costs are estimated at \$20,000. The reoccurring costs for mailed correspondence would include the costs of printing, stuffing envelopes, labeling, and postage among. The GSA may contract with local businesses that perform these mail services. In terms of the content of all correspondence, the costs associated with the EKGSA's selected groundwater extraction quantification method are not to be included in this section; these options and costs will be described in Section 6.4.3. The estimated cost of ongoing correspondence and letter mailings GSA-wide is approximately \$10,000. The reoccurring costs associated with the mailing or delivery of MT exceedance notices are difficult to estimate at this time because there are multiple factors that would change the notice frequency. For example, MT exceedances may not start occurring for 10+ years, notices may only be mailed to affected portions, and exceedances may occur multiple times within a given year.

The estimated program cost/acre-foot yield would not potentially occur until after the one-time expenses of program development. The ongoing estimated program cost/acre-foot yield would be \$100-\$10,000/acre-foot depending upon the amount of water demand reduction (in acre-feet) and number of mailings.

## 5.3.2 Wellhead Requirements Management Actions

### 5.3.2.1 Well Metering and Sampling Requirements

The EKGSA recognizes that community involvement and outreach alone will not curtail groundwater overdraft if management actions must be implemented to reduce water demand. Additional well requirements may be required to more effectively manage and understand the dynamic groundwater conditions. Within the EKGSA, well construction permitting is managed by Tulare County Environmental Health Division (EHD) as detailed in [Chapter 1](#). Obtaining a well permit is currently a ministerial process, not requiring discretionary action or CEQA. The intent of this management action is to have the EKGSA work cooperatively with the EHD to increase well requirements for new wells without disrupting the current ministerial permit process. Additionally, the EKGSA would promote constant communication with the EHD and would seek to maintain more monitoring responsibility. The EKGSA, in conjunction with EHD, may work to develop policy and/or procedures to augment the current well requirements set by the State/EHD and establish new criteria that collaborate with EKGSA and SGMA goals and include the EKGSA in review of all permit paperwork for non-de minimis extractors before EHD permit issuance. These policy and/or procedures may be applied to permits for constructing, deepening, destroying, reconditioning, and/or repairing a well. In order to increase data collection, reporting, and ongoing groundwater management efforts, additional well policy may contain the following information, if deemed appropriate:

- Registration of extraction facilities with the EKGSA to supplement and confirm information obtained from a well canvass of the area.
- Require the installation of flowmeters on all new or repaired wells, and installation of sounding tubes on all new wells.
- Require the well owner to self-report groundwater extraction volumes, static water levels, and water quality data.
- Restrictions on new well construction.

The EKGSA may consider separating the additional well requirements management action into multiple policies or be silent on various bulleted components until they have deemed them necessary. For example, the requirement of installing a flow meter on the pump discharge may be enacted before the requirement of installing a sounding tube.

The desired outcome of additional well permitting requirements is the ability to monitor groundwater extractions, water levels, and water quality in a thorough, accurate, and efficient manner across the GSA. The measurable objectives differ amongst the bulleted considerations.

#### **WH-1 Registration of Extraction Facilities**

As stated in SGMA Section 10725.6, “a GSA may require the registration of a groundwater extraction facility within the management area of the GSA.” The EKGSA may adopt this policy to hopefully improve and supplement the existing well records housed by the EHD and DWR and provide a complete record of the number of wells within the area. The EKGSA has greatly benefited from the current exchange of well information and use of the online DWR Well Completion Report Map Application tool found here: <https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37>.

However, through local outreach and research of the proposed well monitoring network, the EKGSA suspects many existing wells do not have the State and EHD well completion reports (the well driller documentation on the geology and well construction details) or the reports have not been entered into the DWR database and/or EHD records. Unfortunately, the historic well completion reports (especially the older ones) and available DWR 429 Forms (Well Data Form indicating the state well number and detailed well location information) often have insufficient information to confidently locate the exact position of an older well, which is necessary to match up water level and quality information with the area in which pumping is occurring. In recent decades,

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the advances in technology, standardization of forms, and accessibility to GPS location have significantly improved the accuracy of well completion reports through better location identification and recordkeeping. The intent of registration of groundwater extraction facilities would be to complement existing well recordkeeping and ensure that the EKGSA can fully understand and quantify the potential impacts of groundwater decline. Coupled with the registration of extraction facilities, the EKGSA may invest in a complete well canvass study to verify the number of wells and presence or absence of a flow meter.

#### **WH-2 Installation of Well Flow Meters**

The EKGSA will investigate options for quantifying groundwater use by individual landowners as discussed in **Section 5.3.3** and may require the installation of a flow meter on all groundwater extraction facilities in the future to provide accurate quantities of groundwater extraction and serve as the nexus to other management actions. The policy would describe the acceptable types of flow measurement devices, installation standards and requirements, operation and maintenance requirements, and penalties for tampering, neglect, or misconduct. For example, the flow meter would be installed inline on the pump discharge before any other connections or discharge points in accordance with the meter manufacturer's specifications. The meter must accurately quantify the volume of extracted groundwater in acre-feet and be routinely maintained by the well owner. The policy for flow meter installation may require a meter equipped with telemetry for remote reading of the groundwater extraction by the EKGSA. Failure to comply with the policy may result in civil penalty or criminal fine in accordance with SGMA Section 10732. Once the meter installation was complete, a certification report would be submitted by the landowner documenting that the work was completed in accordance with the EKGSA policy.

#### **WH-3 Installation of Sounding Tubes and Water Quality Sample Ports**

The EKGSA may require the installation of a well sounding tube, airline, electric depth gauge, and/or other water level sensor in selected locations for the purpose of measuring water levels throughout the area, especially on new well installations. In addition, the EKGSA may require the installation of a sample port on the well discharge piping in selected locations for the purpose of potentially collecting water quality samples throughout the GSA. The accurate and widespread collection of water level and water quality data could be used to supplement the monitoring network information and provide the EKGSA with additional information to monitor the success/failure of the GSP against the established Sustainable Management Criteria in Chapter 4. The policy would describe the acceptable types of water level measuring devices and sample ports, installation requirements, and penalties for tampering, neglect, or misconduct. The installation must provide or allow for the accurate measurement of static groundwater level in feet below the ground surface and water sample collection. If applicable, the water level measurement device must be routinely maintained by the well owner. Once the installation was complete, a certification report would be submitted by the landowner documenting that the work was completed in accordance with the EKGSA policy.

#### **WH-4 Self-Reporting of Groundwater Extraction**

If the EKGSA selects flow meters as the method of quantifying groundwater extraction, and if the installed meters are not equipped with telemetry, then the GSA may require the well owner to self-report to the EKGSA the metered groundwater extraction volumes on a semi-annual basis. The policy would describe the frequency of reporting, various methods of reporting, due dates, and specific instructions for data submission. The EKGSA may provide extractors with self-addressed mailer for return mailing. The mailer may include information for reporting instructions such as the groundwater extraction volume in acre-feet and include the current flow meter totalizer reading. Other information requests may include self-reporting of static water level readings if the well is equipped with sounding tubes, along with instructions on how static water level measurements should be taken twice per year once water levels have stabilized after pump shutdown. If there is limited compliance with self-reporting, the EKGSA may elect to gather the appropriate data with their own staff. The policy would describe that the frequency of the reporting may be temporarily increased if minimum thresholds are exceeded.

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### WH-5 – Drinking Water Wells Protection Program

While on the path to achieving Subbasin wide sustainability, there are regions of the EK GSA where domestic wells may be negatively impacted if water levels reach the proposed minimum thresholds. Recognizing that there are several communities and citizens that rely on groundwater through small system and private domestic wells within the region, the EK GSA may choose to create a program to protect impacts to water users dependent on groundwater for their drinking water supply. A Drinking Water Wells Protection Program (DWWPP) could include a combination of different strategies that provide solutions to gather critical data, protect groundwater quality and quantity, and provide safe and affordable drinking water to the residents of the EK GSA. Aspects of such a program may include:

- *Drinking Water Wells Monitoring Network*
  - Conduct a drinking water well vulnerability assessment to understand: (1) where drinking water wells that are more vulnerable to groundwater level changes are located, and (2) whether changes in groundwater levels may be exacerbated in specific areas by pumping volume or location.
  - Define drinking water wells monitoring network based on the drinking water wells assessment. This network would be used to assess impacts to drinking water caused by changes in groundwater levels and quality.
- *Adaptive Management System Development*
  - Develop a preventative warning system that alerts groundwater managers when groundwater levels are dropping to a level that negatively affects drinking water users. Such system may include quantitative threshold triggers between the measurable objective and the minimum threshold that can be used to assign levels of warning and recommend corrective action.
- *Drinking Water Well Impact Tool/Model*
  - Develop a model or tool from the monitoring network data and adaptive management framework to evaluate groundwater levels and predict potential groundwater impacts to drinking water wells.
- *Protection Measures*
  - Provide protection measures in response to potential groundwater impacts. Short term solutions could include bottled water, bottled water paired with a water tank, or another combination. Long term water supply solutions could include financial and/or technical support to lower a well pump, drill a deeper well, connect to an alternative water supply, and/or readjusting pumping to avoid impacts.
- *Funding*
  - If implemented, a secure and reliable source of funding for the DWWPP would need to be identified. Options could include land based fee assessments, utilization of grant funding, and/or CV SALTS project funding.

**Commented [MC9]:** Whole section moved under a parent section Well Monitoring and Mitigation

Table 5-3 Wellhead Measurable Objectives Check List

Groundwater Level	X
Storage Change	X
Groundwater Quality	X
Land subsidence	X
Surface Water-Groundwater Intereconnection	X
Seawater Intrusion	NA

### 5.3.2.2 Circumstances for Implementation of WH-1 – WH-45 (Sec. 354.44.b.1.A)

The current situation of critical groundwater overdraft leading to the unsustainable management of groundwater resources justifies the implementation of additional well requirements ~~and a DWPP~~. This policy requires the support and coordination of the EHD for successful implementation with any new wells. For existing domestic wells, this policy requires the support and coordination of resident beneficial users. The beneficial users within the EKGSA must be properly notified far in advance of the policy adoption especially because of the potentially for increased well owner costs and self-reporting efforts. For existing wells, there may be extenuating circumstances where the installation of a flow meter (if required) and/or sounding tube are not practical or financially advisable. These situations would need further analysis on a case-by-case basis. The policy would remain indefinitely or until another program serves the same purpose.

### 5.3.2.3 Process for Public Notification of WH-1 – WH-54 (Sec. 354.44.b.1.B)

The public will be notified of the proposed WH-1 – WH-54 through public meetings, correspondence, and EKGSA website. Educational correspondence regarding self-reporting of groundwater extractions would be accomplished through direct communication between the beneficial user and the EKGSA. This will take place in the form of self-reporting and the monitoring of water level and water quality which is then compiled and distributed through each mailing cycle of correspondence mailings. Should the Board of Directors choose to adopt policy addressing WH-1-WH-54, the public will be notified through established EKGSA correspondence methods as explained in Chapter 1.

### 5.3.2.4 Permitting and Regulatory Process WH-1 -WH-54 (Sec. 354.44.b.3)

The regulatory process would require EHD coordination and support to ensure new well permits issued within the EKGSA adhere to the EKGSA policy. No other environmental or regulatory permits would be required. Modifications to existing wells for installation of a flow meter do not require a permit. This management action does not rely on water from outside the jurisdiction of the EKGSA.

### 5.3.2.5 Status and Schedule WH-1 - WH-54 (Sec. 354.44.b.4)

The additional well requirements policy has not been drafted, nor has there been discussions with the County. ~~DWPP policy has not been drafted and there would need to be discussions with stakeholder groups. Drafting the policy and~~ County discussions may commence shortly after the adoption of the GSP. There currently isn't a timeline for completion.

### 5.3.2.6 Benefit Realization and Evaluation WH1 - WH-54 (Sec. 354.44.b.5)

The expected benefits would include a complete geo-database of groundwater extraction locations. ~~Through the DWPP, a tool may be developed that evaluates potential drinking water well impacts. Requiring new well permits to provide accurate information on location, depth, perforated zone, and measured water use and level would allow for more accurate data analysis of groundwater extraction, storage change, and water table fluctuations. Policy requiring metered wells would also provide private owners with personal usage history and compliment other management actions discussed herein, including education and outreach, groundwater allocation, groundwater marketing and trading, fees and incentives, and pumping restrictions. The expected benefits of water quality sample ports and analytical testing would fill data gaps and provide extractors with useful information. The benefits of self reporting include the avoidance of EKGSA staff or consultant time to individually collect data. The benefits of developing a DWPP include protecting the Human Right to Water within the EKGSA, balancing community and economic development needs, and improved understanding of potential impacts on drinking water quality.~~ The evaluation of these benefits would be reviewed periodically and during the annual reporting cycle.

### 5.3.2.7 How This Management Action Will Be Accomplished WH-1 – WH-5.4 (Sec. 354.44.b.6)

The registration of Extraction Facilities (WH-1) will be accomplished by validating all documented extraction facilities and the EKGSA may authorize a complete well canvass study to verify the number of wells and presence of a flow meter. Additional review will take place in order to confirm the number of reported well permits and to verify the installation of meters, sounding tubes and sample ports (WH-2-WH-3). WH-4 will be accomplished by analyzing the received reports from each mailing cycle and assessing the data for accuracy. ~~The development of WH-5 will be accomplished by bringing together a sub-committee of experts, local stakeholder representatives, and EKGSA representatives to explore and develop the policies required to successfully launch the DWVPP.~~

### 5.3.2.8 Legal Authority WH-1 – WH-5.4 (Sec. 354.44.b.7)

The legal authority and basis for the management actions described in this Chapter are outlined in the SGMA and related provisions. The SGMA describes the powers and authorities, financial authority, and enforcement powers of GSAs in Chapters 5, 8, and 9 respectively.

### 5.3.2.9 Costs WH-1 – WH-5.4 (Sec. 354.44.b.8)

The additional well requirements management action would not directly generate a quantification of demand reduction. However, the foundation for the mitigation of overdraft would be established for on-going monitoring of groundwater extractions, water levels, and water quality.

The costs related to the additional well requirements management action include one-time expenses and ongoing monthly expenses. The one-time expenses include the labor costs of the EKGSA Staff, Legal Counsel, and Consultant to prepare the formal program description and adopt the management action policy. Through a Board resolution, the program would be incorporated into the EKGSA's policy manual for transparency. The database of extraction facilities would be created and include individual fields for owner, location, well construction information, EKGSA additional requirements (i.e. meter, sounding tube, etc.), and future measurement data. These initial costs are estimated at \$30,000. The online reporting tool may be developed for well owners to self-report their monitoring data; initial cost is estimated at \$15,000. If the EKGSA were to separate the additional well requirements management action into multiple policies, the one-time costs for program description and adoption may be duplicated, but coordination efforts with the EHD would be reduced.

The ongoing monthly costs include the database maintenance, reporting website support, self-addressed post cards, and data entry costs are estimated at \$75,000 annually. The adoption of this policy would have other resulting costs for the groundwater extractor including:

- Purchase and installation of the well meter, and potential sounding tube.
- For existing wells, pump discharge modifications to ensure proper meter installation per the manufacturer's specifications.
- Labor costs related to self-reporting.

~~The cost to develop a DWVPP will vary vastly based on the scope and depth of the program. Costs would include both one-time start-up expenses and on-going expenses. The one-time expenses include the labor costs of the EKGSA Staff, Legal Counsel, and Consultant to prepare the formal program description, host stakeholder engagement meetings, incorporate domestic beneficial users feedback, and adopt the management action policy. In addition, there are the one-time costs to canvass and locate drinking water wells within the EKGSA, develop the domestic well database, and build the appropriate modeling tool. These startup costs are estimated at \$100,000. The ongoing monthly costs include database maintenance, data entry costs, monitoring costs including field and analytical fees, and cost of sending outreach to community members, are estimated at \$50,000 annually.~~

The most volatile costs associated with the DWWPP will occur if protection measures for drinking water supply are needed. The length of time, population impacted, and geographic scope of the protection measures will greatly impact the overall magnitude of costs associated with the DWWPP. Short-term provisions of tank or bottled replacement water followed by the implementation of long-term solutions such as well pump lowering or connecting residences to another water provider could range in price from thousands to hundreds of thousands of dollars. Recognizing the enormous potential costs of such a program, the EKGSA is prepared to collaborate with grant programs and other available program funds (i.e. CV-SALTS) to offset the costs.

### 5.3.3 Groundwater Allocation Management Actions

#### 5.3.3.1 Groundwater Allocations

GSAs experiencing annual groundwater overdraft may pursue individual groundwater allocations because the development of projects and new water supplies cannot solely offset the current groundwater demands and overdraft condition. Demand management will become increasingly more important because of the reduced reliability of imported and flood water supplies, especially when taking into consideration the historical drought periods, uncertain role of climate change, and increased competition for available water supplies.

##### **GA-1 Development of Groundwater Allocation Per Acre**

The EKGSA may adopt a policy which provides a groundwater allocation on a per acre basis for the GSA as a whole, or for sub-areas of the EKGSA. The policy would identify and forecast the demands associated with prior rights, domestic, community, and environmental uses. The sustainable yield and ultimate groundwater allocation would take into consideration the existing water rights holders, irrigation districts (IDs), disadvantaged communities (DACs), public utility districts (PUDs), and environmental uses. The EKGSA, through collaboration with its beneficial users, may consider whether an equal-, reduced-, or zero-allocation is given to lands with unexercised groundwater rights. The report *Groundwater Pumping Allocations under California's Sustainable Groundwater Management Act (Environmental Defense Fund et. al, 2018)* identifies several possible methods of establishing groundwater pumping allocations as shown in the following table excerpted from the 2018 report.

There are a myriad of advantages and disadvantages associated with each method of establishing groundwater pumping allocations. The "Comprehensive Allocation Method," which establishes allocations based on a comprehensive consideration of California groundwater law to the extent practical and is recommended by EDF, is one possible approach that could be considered because it offers the important advantage of presenting to the Court an allocation methodology that tracks judicial precedent if an adjudication is ultimately initiated.



**Table 1: Methods for Establishing Groundwater Pumping Allocations**

Method	Description	Advantages and Disadvantages
<b>Pro Rata Allocation per Overlying Acre</b>	This approach divides the available groundwater between overlying landowners proportionate to property size. This system treats all landowners equally, irrespective of whether the landowner has developed groundwater resources.	<p>Approach Advantages</p> <ul style="list-style-type: none"> <li>Recognizes the underlying correlative right of each overlying acre to share in the reasonable use of the water within the subbasin.</li> <li>Is simple in approach and calculation.</li> </ul> <p>Approach Disadvantages</p> <ul style="list-style-type: none"> <li>Does not recognize some of the legal limitations and nuances that affect groundwater rights in a subbasin such as prescription, public use, imported water to the subbasin (see Box 3), and others (or make adjustments to the allocations based upon such limitations and nuances).</li> <li>It allocates a portion of the sustainable yield to overlying lands that may have not yet exercised the right to use groundwater. This raises significant questions about how you provide water for such lands, if at all, and how allocations will be adjusted when, and if, such lands exercise the right to a share of the sustainable yield.</li> <li>It creates inequities between those who have invested nothing to develop the right and those who have invested heavily to utilize the right.</li> </ul>
<b>Pro Rata Allocation per Irrigated Overlying Acre<sup>o</sup></b>	This approach certifies all existing overlying groundwater use (e.g. irrigated acres) and develops an allocation proportionate to land use. In this approach, each irrigated acre would be given a specific quantity of groundwater (e.g. inches/acre per year) that can be applied to the land. This approach grandfathers in existing groundwater users but does not give differential allocations based on historic use. Further, any reductions in the allocations to reduce overdraft would be felt proportionately across all historic users.	<p>Approach Advantages</p> <ul style="list-style-type: none"> <li>Acknowledges existing pumping by overlying landowners.</li> <li>Is reasonably simple in approach and calculations.</li> </ul> <p>Approach Disadvantages</p> <ul style="list-style-type: none"> <li>Does not address the unexercised pumping rights on some overlying lands (to the extent such rights have not been lost to prescription or subordination).</li> <li>Does not consider historic quantities of groundwater pumped, which could disproportionately impact users of high water demand crops grown on overlying acreage.</li> <li>Does not recognize some of the legal limitations and nuances that affect groundwater rights in a subbasin such as prescription, public use, imported water to the subbasin and others (or make adjustments to the allocations based upon such limitations and nuances).</li> </ul>

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**Table 1: Methods for Establishing Groundwater Pumping Allocations**

Method	Description	Advantages and Disadvantages
<i>continued</i>		
<b>Allocation Based Upon a Fraction of Historic Pumping<sup>4</sup></b>	This approach establishes allocations based off historic groundwater use, grandfathering in existing users and excluding those who have not yet developed groundwater resources. This method does not make necessary determinations as to whether historic pumping is supported by claims of overlying users.	<p>Approach Advantages</p> <ul style="list-style-type: none"> <li>Can reduce conflict among existing pumpers.</li> </ul> <p>Approach Disadvantages</p> <ul style="list-style-type: none"> <li>Does not apply the law of correlative rights.</li> <li>Does not identify appropriative or prescriptive rights.</li> <li>Does not recognize potentially disproportionate impacts by pumpers on groundwater overdraft.</li> <li>Does not account for those who have surface water supplies and rely on groundwater only as a supplemental or dry-year supply.</li> <li>Treats all pumping, regardless of amount, the same and may be perceived as unfair by grandfathering in higher per-acre allocations.</li> <li>Requires baseline information about individuals' historic groundwater use, which may not exist.</li> </ul>
<b>Comprehensive Allocation Method (Recommended Method)</b>	This approach establishes allocations based on a comprehensive consideration of California groundwater law to the extent practical. This approach preserves the relative priority of overlying, prescriptive, and appropriative users and can address the unexercised rights of overlayers. See Figure 1 for a decision tree graphic description of how this approach might be applied.	<p>Approach Advantages</p> <ul style="list-style-type: none"> <li>This method would apply California groundwater law to the conditions existing in the subbasin and make allocations accordingly.</li> <li>If an allocation methodology is developed in this manner, it has a reasonable probability of surviving judicial scrutiny in the context of adjudication, especially if the majority of rightholders in the subbasin find the methodology acceptable.</li> </ul> <p>Approach Disadvantages</p> <ul style="list-style-type: none"> <li>The law is in many cases vague and ambiguous, and also requires the exercise of interpretation and judgment.</li> <li>The process for applying this method is complicated and requires information to undertake.</li> <li>Implementing this process leaves open the possibility that someone will disagree and consider triggering an adjudication.</li> </ul>

**GA-2 Groundwater Allocation “Ramp-Down” Gradual Decrease**

Once an individual groundwater allocation is determined, the GSA may adopt a policy which provides a gradual “ramp-down” allocation decrease over time to arrive at the actual groundwater allocation to allow growers time to adjust to the concept of an allocation, which for some growers may result in a significant reduction in groundwater use. The policy would detail the number of years and amount of reduction each year. For example, if the pumping amount is currently 2.50 AF/ac and the groundwater allocation is established at 1.50 AF/ac,

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then a 10% reduction over a 5-year period would achieve the “ramp-down” to a groundwater allocation of 1.50 acre-feet per acre as shown below:

**Table 5-3 Example Ramp Down Scenario**

Year	Groundwater Allocation (AF/ac)	Reduction at Year End (%)	Reduction at Year End (AF/ac)
1	2.50	10	0.25
2	2.25	10	0.23
3	2.02	10	0.20
4	1.82	10	0.18
5	1.64	8.5	0.14
6 Actual	1.50	0	0

The annual changes in groundwater allocation would be provided in the annual correspondence mailer described in the education and outreach management action above, as well as information presented on the EKGSA website.

#### **GA-3 Groundwater Allocation “Adaptive Management” Approach**

The EKGSA may adopt a policy which states an adaptive management approach, whereby the groundwater allocation may be reviewed, changed, and reestablished periodically or during extreme drought as necessary to achieve long term sustainability. It is prudent for the EKGSA to acknowledge the current level of uncertainty in the available data and existing data gaps by providing flexibility in initial groundwater allocations as more data is gathered and analyzed in the upcoming years. Adaptive management is an approach to resource management that “promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a ‘trial and error’ process, but rather emphasizes “learning while doing” (Environmental Defense Fund et al., 2017).

#### **GA-4 Groundwater Quantification Methods**

The EKGSA will evaluate various methods of determining groundwater use immediately following submission of this GSP. The EKGSA may adopt a policy to specify the approved method or methods to quantify the individual and aggregate groundwater extractions for the required SGMA annual reporting and to track groundwater allocation use. If adoption of the additional well requirements policy, specifically the installation of flow meters, takes years to fully implement, the EKGSA may consider a variety or combination of quantification methods. The report *Groundwater Trading as a Tool for Implementing California’s Sustainable Groundwater Management Act* (Environmental Defense Fund et. al, 2017) identifies several possible methods of quantifying groundwater use in-lieu of flowmeters as shown in this table excerpted from the 2017 EDF report.

There are various advantages, disadvantages, and costs to all of the stated quantification methods noted. The EKGSA may consider exploring some of these methods with neighboring GSAs and Subbasin-wide for an aggregated approach and mutual cost savings.

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**Comparison of groundwater quantification methods**

Quantification method	Units	Description and enforcement method
Irrigated area	Irrigated area (acres)	<b>Description:</b> Certifying irrigated area is a coarse measurement for groundwater use, as it does not capture field-level variation in water use due to differences in crops, soils, technologies, practices, or other characteristics. <b>Enforcement:</b> Aerial flyovers or remote sensing
Irrigated area hybrid	Irrigated area (acres); Crop coefficients (acre-feet/acre)	<b>Description:</b> Irrigated acreage can be combined with crop coefficients, which more closely approximates field-level water use. This approach still cannot capture differences between irrigation strategies and technology, best management practices, soil types, and other field-level characteristics that influence water use. <b>Enforcement:</b> Annual crop survey alongside aerial flyovers or remote sensing
Calibrated energy records	Meter calibration (acre-feet/kWh); Energy use (kWh)	<b>Description:</b> Uses energy-use of pumps to estimate the volume pumped. Energy records by themselves can lead to large errors in estimating groundwater use, but can be improved with calibration. They also require that all groundwater pumps be hooked up to electricity, which is often not the case. <b>Enforcement:</b> Energy records and meter calibrations
Flow meters	Applied water (acre-feet)	<b>Description:</b> Flow meters are fairly straightforward, though are costly in terms of the equipment and, if not telemetered, the time spent for staff to conduct meter readings and periodic calibrations. Some flow meters are not tamper-proof. Use of pumped volume, through flow meters or other methods, does not account for the portion of applied water that may return to the groundwater through deep percolation. <b>Enforcement:</b> Meter readings
Remote Sensing	Evapotranspiration (acre-feet)	<b>Description:</b> Quantification of consumptive use, as a surrogate for actual pumping, can be done through methods that combine satellite imagery with ground-based weather data. Such methods are used routinely in some locations and may provide a viable mechanism for quantifying groundwater use. Some remote sensing platforms assume the full crop water requirement is met, which may lead to errors. If a field uses both surface water and groundwater, surface water volumes must be known to estimate groundwater use. <b>Enforcement:</b> Remote sensing

The goals of the groundwater allocation management action are to ensure a fair groundwater allocation, allow groundwater users time to adjust, provide future flexibility in allocation determinations, and to accurately and efficiently quantify groundwater extractions. The measurable objective is the volume of groundwater extraction in acre-feet GSA-wide and on a per acre basis.

The method of evaluation of groundwater extraction in acre-feet depends upon the EKGSA’s selected quantification method or combination of methods. The evaluation of various methods may consider a wide range of factors including cost, accuracy, reliability, timeliness, functionality, personnel required, and legal defense. Once the EKGSA has established a consistent quantification method, the evaluation of the “ramp-down” gradual allocation decrease could be analyzed in the annual comparison of groundwater extraction. Though the annual groundwater extraction amount would be affected by other factors such as weather and available surface water supplies, the total extraction amount could be normalized to an average water year for comparative purposes.

Table 5-4 Groundwater Allocation Measurable Objectives List

Groundwater Level	X
Storage Change	X
Groundwater Quality	
Land subsidence	X
Surface Water Groundwater Interconnection	
Seawater Intrusion	NA

### 5.3.3.2 Circumstances for Implementation GA-1 – GA-4 (Sec. 354.44.b.1.A)

The EKGSA may consider an investigative study to determine the current and future needs of the existing water rights holders, IDs, DACs, PUDs, and unexercised rights to determine the sustainable yield and groundwater allocation. The selection of groundwater extraction method may be implemented shortly after the adoption of the GSP for the purposes of the required SMGA annual reporting. The selected groundwater extraction quantification method may change over time, but the groundwater allocation would remain on-going.

### 5.3.3.3 Process for Public Notification GA-1 – GA-4 (Sec. 354.44.b.1.B)

All public notification will take place in the form of regular correspondence from the EKGSA, as well as any supplementary communication between the grower and the EKGSA as deemed necessary by the Board.

### 5.3.3.4 Permitting and Regulatory Process (Sec. 354.44.b.3)

The EKGSA is responsible to adhere to state water rights law. No permit or regulatory process is required for the EKGSA to adopt the groundwater allocation policy. The GSA may consider the advantages & disadvantages of the listed methods due to differing levels of accuracy and reliability. However, *SGMA 10725.4 (c)* allows GSAs to investigate property and extraction facilities, though encroachment permits, or access agreements may be necessary in some locations. This management action does not rely on water from outside the jurisdiction of the EKGSA.

### 5.3.3.5 Status and Schedule GA-1 – GA-4 (Sec. 354.44.b.4)

The policy for groundwater allocation per acre, ramp-down gradual decrease, adaptive management, and groundwater extraction quantification method (GA-1 – GA-4) have not been drafted, but development is expected to commence shortly after the adoption of the GSP and likely be completed within the first few years of GSP Implementation.

### 5.3.3.6 Benefit Realization and Evaluation GA-1 – GA-4 (Sec 354.44.b.5)

The expected benefits may mitigate overdraft by improving the EKGSA's knowledge of aggregate and individual groundwater extractions. The development of a groundwater allocation per acre may be based on the EKGSA's current understanding of the sustainable yield and may change as more information or knowledge is gained. The groundwater allocation management action alone may generate a negligible quantifiable demand reduction, but it would benefit Education and Outreach (See EO1-EO2) and serve as a prerequisite to other management actions including groundwater marketing and trading, fees and incentives, and pumping restrictions (GMT 1-5, FI 1-4) over the planning horizon and by 2040 at the latest.

### 5.3.3.7 How This Management Action will be Accomplished GA-1 – GA-4 (Sec. 354.44.b.6)

The EKGSA will consider the option of a “Comprehensive Allocation Method” as detailed in the 2018 EDF report as a possible approach in addressing GA-1. The annual correspondence mailer will address any annual changes in groundwater allocation based from annual data reported to the EKGSA (GA-2). The EKGSA will consider utilizing an adaptive management approach in which allocations are assessed and changed as deemed

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necessary by the Board of Directors in order to address GA-3. Lastly, the GSA will adopt necessary policy to assist in establishing quantification methods for obtaining data for the required SGMA reporting requirements.

#### 5.3.3.8 Legal Authority GA-1 – GA-4 (Sec. 354.44.b.7)

The legal authority and basis for the management actions described in this Chapter are outlined in the SGMA and related provisions. The SGMA describes the powers and authorities, financial authority, and enforcement powers of GSAs in Chapters 5, 8, and 9 respectively.

#### 5.3.3.9 Costs GA-1 – GA-4 (Sec. 354.44.b.8)

The costs related to the groundwater allocation management action include one-time expenses and reoccurring annual expenses. The one-time expenses include the labor costs of the EKGSA Staff, Legal Counsel, and Consultant to prepare the formal program description and EKGSA Board adopt the management action policy. The written policy would describe the groundwater allocation method, available source data, assumptions, groundwater allocation per acre, the gradual decrease to actual allocation, the adaptive management approach, the groundwater extraction quantification methods, expected costs, and the overall intent of the policy. Through a Board resolution, the program would be incorporated into the EKGSA's policy manual for transparency. At this time, only preliminary discussions have been held regarding the potential policy.

The reoccurring costs associated with the EKGSA's selected groundwater extraction quantification vary considerably depending upon the selected method and frequency of data collection.

1. Crop Coefficient Calculations – determined by annual crop survey and standard crop coefficients
  - a. \$5,000 labor coordination to and handling cropping information obtained from Agriculture Commissioner or another source.
  - b. \$20,000 for mapping and calculating groundwater demand
  - c. Estimated \$25,000 annually
2. Flow meters – determined by meter readings
  - a. Assumes meters are furnished and installed by well owner following specifications developed by the EKGSA
  - b. Assumes meter readings are self-reported or meters are telemetry
  - c. Estimated \$15,000 annual labor to collect, validate and input meter readings into EKGSA database. Does not include costs of “policing” meter use.
3. Remote sensing of evapotranspiration – determined by remote sensing
  - a. Data purchased from one of several vendors offering remote sensing service of acceptable accuracy for use in individual field water budgets – estimated \$120,000 annually
  - b. Field level water budget analysis tracking surface water deliveries and effective precipitation - estimated \$50,000 annually
4. Calibrated energy records – determined by energy records and meter calibrations
  - a. Bulk rate pricing of \$250/electric meter/year
  - b. Assumes 5,000 to 6,000 meters GSA wide (non-de minimis users).
  - c. Estimated \$1.5 million annually

It is not anticipated that the groundwater allocation management actions would directly result in a quantifiable demand reduction. However, the foundation for the mitigation of overdraft would be established for on-going monitoring of groundwater extractions.

### 5.3.4 Groundwater Marketing/Trading Management Actions

#### 5.3.4.1 Groundwater Marketing and Trading

If a groundwater allocation policy including individual allocations and chosen quantification method is adopted, the EKGSA may pursue a groundwater market and trading program to provide beneficial users more flexibility in utilizing their allocation. This management action would detail a groundwater allocation carryover structure, banking program, water marketing strategy study, trading structure and related rules.

##### **GMT-1 Groundwater Allocation Carryover Structure**

The EKGSA may adopt a policy to define groundwater allocation carryover provisions year-to-year and/or allow multi-year pumping averages. The inter-annual flexibility may be useful to growers who could change cropping patterns or fallow acreage. Though there is a risk that extreme drought may induce exceptionally high pumping in a single year, groundwater extractors may be able to strategize and better manage their assets.

##### **GMT-2 Water Marketing Strategy Study**

The EKGSA may consider a study of water marketing strategies in an effort to acquire more surface water. The study may focus on the development of a groundwater banking/trading program and coordination with other agencies that could potentially market water into the EKGSA.

##### **GMT-3 Groundwater Banking Program**

The EKGSA may adopt a policy to define a groundwater banking program. The banking program would consider using surface water supplies when available in lieu of groundwater pumping. Though not feasible for all users, growers capable of surface water recharge on-farm may be able to percolate surface water, or other transferred water, for recharge credits. There are many complexities and considerations required to initiate and successfully manage a banking program. The EKGSA must acknowledge and discuss any other water bank/credit systems in existence. The EKGSA may approve past replenishment projects and determine the timeframe for any banking efforts that took place prior to banking program adoption. The EKGSA may consider adjusting banked credits if future changes in sustainable yield and/or groundwater allocation require adjustment. The EKGSA may define a "leave-behind" amount for groundwater migration and operational and evaporative losses, as well as to buffer against impacts to neighboring wells. The EKGSA may consider finite timelines or expiration dates on banked water or ongoing "leave-behind" amounts.

##### **GMT-4 Groundwater Trading Structure**

In addition to a groundwater banking program, the EKGSA may adopt a policy to define a groundwater trading structure. The report *Groundwater Trading as a Tool for Implementing California's Sustainable Groundwater Management Act* (Environmental Defense Fund et. al, 2017) identifies several possible groundwater trading structures. The GSA may consider a variety of structures including, but not limited to those shown in this table excerpted from the 2017 EDF report.

There are various advantages, disadvantages, and costs to all of the trading structures noted, and others may exist also. The EKGSA may consider exploring some of these options with the Subbasin GSAs for an aggregated approach and mutual cost savings. Trading may be executed through short-and long-term leases, permanent transfers, inter-annual water exchanges, or dry-year option contracts. The EKGSA may determine physical trade limitations such as distance, aquifer, soil conditions, or management areas.

### Comparison of trading structures

Trading structure	Description	Administrator	Advantages and disadvantages	Participant costs
Bilateral contracts or "coffee shop" markets	The most common form of water transactions worldwide, no formal trading mechanism exists. Participants largely learn of one another by word of mouth.	None; informal and decentralized	<b>Advantages</b> <ul style="list-style-type: none"> <li>• Costless to agency to implement</li> </ul> <b>Disadvantages</b> <ul style="list-style-type: none"> <li>• Difficulty identifying an interested party</li> <li>• Difficulty in price negotiation</li> <li>• Difficulty in regulatory compliance</li> </ul>	No third-party fees; high search and transactions costs
Brokerage	Representation of a buyer or seller in a water rights transaction.	Private sector	<b>Advantages</b> <ul style="list-style-type: none"> <li>• Helps identify interested parties</li> <li>• Helps to negotiate price</li> <li>• Specialized agents help in regulatory compliance</li> </ul> <b>Disadvantages</b> <ul style="list-style-type: none"> <li>• Still somewhat decentralized</li> <li>• Pricing often favors the represented party</li> </ul>	Brokerage fee
Bulletin boards	A physical or electronic board where interested parties can list information about their water rights for others to get in contact with them.	Private sector, regulatory agencies	<b>Advantages</b> <ul style="list-style-type: none"> <li>• Centralizes trading activity to a degree</li> </ul> <b>Disadvantages</b> <ul style="list-style-type: none"> <li>• Difficulty in price negotiation</li> <li>• Difficulty in regulatory compliance</li> </ul>	No third-party fees; moderate search and transactions costs
Auctions and reverse auctions	A physical or electronic system in which buyers outbid one another (auction) or sellers undercut one another (reverse auction) to trade water.	Private sector, regulatory agencies	<b>Advantages</b> <ul style="list-style-type: none"> <li>• Centralizes trading activity to a degree</li> </ul> <b>Disadvantages</b> <ul style="list-style-type: none"> <li>• Asymmetric pricing: One side reaps the benefits or gains of trade</li> <li>• Difficulty in regulatory compliance</li> </ul>	Auction fee if privately run
Electronic clearing-houses or "smart markets"	Leverages the power of computer optimization and a tailor-made algorithm to match participants within the trading rules and by price points.	Private sector, regulatory agencies	<b>Advantages:</b> <ul style="list-style-type: none"> <li>• Centralizes trading activity</li> <li>• Automates regulatory compliance</li> <li>• Includes price discovery mechanism</li> </ul> <b>Disadvantages:</b> <ul style="list-style-type: none"> <li>• Intensive startup costs to develop</li> </ul>	Trading fee, if privately run

#### **GMT-5 Regulate Groundwater Allocation Transfers Outside of GSA**

The EKGSA may adopt a policy to regulate groundwater allocation transfers outside of the EKGSA boundaries. Approval would need to be obtained if water is banked within the EKGSA area and the groundwater allocation is intended to be transferred out of the GSA, or if a common landowner intends on transferring his allocation from in the EKGSA to land he owns in another GSA. The EKGSA may assure performance by enforcing rigid penalties for illegal actions. The EKGSA may approve external transfers in limited quantities for emergency situations and levy fees for metering the transferred amount.



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**Table 5-5 Groundwater Market/Trading Measurable Objectives Checklist**

Groundwater Level	X
Storage Change	X
Groundwater Quality	X
Land subsidence	X
Surface Water Groundwater Interconnection	X
Seawater Intrusion	NA

### **5.3.4.2 Circumstances for Implementation GMT-1 – GMT-5 (Sec. 354.44.b.1.A)**

The carryover policy (GMT-1) may be implemented shortly after the adoption of the groundwater allocation per acre and, once adopted, likely remains indefinitely. With regards to the marketing study (GMT-2), the EKGSA can consider to implement at any time after the initial GSP submittal, however it is recommended to be completed with the first 5 years of GSP Implementation, as it would be critical in developing a groundwater market in the EKGSA. The remaining marketing/trading management action policies (GT-3 – GT-5) require other policies and/or decisions to be made prior to developing. Allocation and measurement policies are required to develop banking, trading, and/or transferring policy. Once these policies are in place, they are likely to remain in place indefinitely.

### **5.3.4.3 Process of Public Notification GMT-1 – GMT-5 (Sec. 354.44.b.1.B)**

All public notification will take place in the form of regular correspondence from the EKGSA, as well as any supplementary communication between the grower and the EKGSA as deemed necessary by the Board.

### **5.3.4.4 Permitting and Regulatory Process GMT-1 – GMT-5 (Sec. 354.44.b.3)**

No permit or regulatory process is required for the EKGSA to adopt policy on any of the groundwater market/trading management actions. However, once policy is in place, groundwater banking (GMT-3) and groundwater trading (GMT-4) will likely require conformance with CEQA. Management actions associated with groundwater banking, trading, and transferring outside the EKGSA may involve external sources of water, pending agreements and partnerships.

### **5.3.4.5 Status and Schedule GMT-1 – GMT-5 (Sec. 354.44.b.4)**

The policy for these actions has not been drafted. It is expected to commence shortly after the adoption of the GSP and potentially implemented within the first 5 years of GSP Implementation.

### **5.3.4.6 Benefit Realization and Evaluation GMT-1 – GMT-5 (Sec. 354.44.b.5)**

The expected benefits for groundwater allocation carryover, market strategy study, groundwater banking, and groundwater trading structure may include increased flexibility for groundwater users to manage supplies, improve water reliability, improve coordination with other users and agencies, and potentially encourage on-farm changes such as crop or irrigation method conversion. The policy for regulating groundwater allocation transfers outside the EKGSA may mitigate local overdraft and deepening cones of depression by ensuring groundwater supplies are consumed or retained within the EKGSA boundary. Emergency groundwater allocation transfers may be accounted and recorded by the EKGSA. Methods for evaluation may be resulting increased water supplies, demand reduction, and/or quantity of GSA transfer permits.

### **5.3.4.7 How This Management Action Will be Accomplished GMT-1 – GMT-5 (Sec. 354.44.b.6)**

The EKGSA will evaluate and establish the policy to be implemented regarding defining groundwater allocation carryover provisions year-to-year and/or allow multi-year pumping averages (GMT-1). The EKGSA will address GMT-2 by considering a study of water marketing strategies. Such a study may focus on the

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development of a groundwater banking/trading program and coordination with other agencies that could potentially market water into the area. The EKGSA will explore, analyze and possibly develop future policy to address groundwater banking and trading structures to be implemented. Lastly in order to address GMT-5 the EKGSA may adopt a policy to limit groundwater allocation transfers outside of the GSA or Subbasin.

#### 5.3.4.8 Legal Authority GMT-1 – GMT-5 (Sec.354.44.b.7)

The legal authority and basis for the management actions described in this Chapter are outlined in the SGMA and related provisions. The SGMA describes the powers and authorities, financial authority, and enforcement powers of GSAs in Chapters 5, 8, and 9 respectively.

#### 5.3.4.9 Costs GMT-1 – GMT-5 (Sec.354.44.b.8)

The costs related to the groundwater marketing/trading management action include one-time expenses and reoccurring annual expenses. The one-time expenses include the labor costs of the EKGSA Staff, Legal Counsel, and Consultant to prepare the formal program description and EKGSA Board adopt the management action policy. The written policy would describe the marketing and/or trading, available source data, assumptions, groundwater measurement methods, the adaptive management approach, potential fees and charges, and the overall intent of the policy. Through a Board resolution, the program would be incorporated into the EKGSA's policy manual for transparency. At this time, no discussions have been held regarding the potential policy.

The estimated costs associated with the EKGSA's selected groundwater marketing and trading management action options are estimated as follows:

1. Groundwater allocation carryover structure
  - a. \$10,000 labor and coordination to draft the policy
  - b. Estimated \$15,000 annually for administration and data management
2. Water Marketing Study
  - a. Estimated \$400,000 to perform study, based on other GSA efforts
  - b. Potential funding to 50% available through the USBR
3. Groundwater Banking Program
  - a. \$20,000 labor and coordination to draft the policy
  - b. On-going annual costs will vary pending program and management method selected
  - c. Fees and charges may be incorporated into the policy to cover on-going administrative costs or supplement funding for other projects or water purchases.
4. Groundwater Trading Structure
  - a. \$20,000 labor and coordination to draft the policy
  - b. On-going annual costs will vary pending program and management method selected
  - c. Fees and charges may be incorporated into the policy to cover on-going administrative costs or supplement funding for other projects or water purchases.
5. Groundwater transfer out of the GSA
  - a. \$10,000 labor and coordination to develop the policy
  - b. Fees and charges may be incorporated into the policy to cover on-going administrative costs or supplement funding for other projects or water purchases.

## 5.3.5 Fees and Incentives Management Actions

### 5.3.5.1 Fees and Incentives

The EKGSA will explore multiple financing options to cover its operational costs as detailed in the GSP Implementation (**Chapter 5.3.8.1.1**). Specific to Projects and Management Actions, the EKGSA may adopt policy to levy groundwater fees and/or provide individual incentives to groundwater users to reduce groundwater extractions. The EKGSA may consider an economic study to determine the best strategy for curbing groundwater overdraft while minimizing economic impact. Potential fee structures and/or incentives would affect groundwater users differently, so a combination fee or incentives structure may also be considered.

#### **FI-1 Pumping Fees for Groundwater Allocations Exceedances**

Once a groundwater allocation policy including individual allocations and chosen quantification method has been adopted, the EKGSA may adopt a policy to levy fees for pumping beyond the current groundwater allocation. The EKGSA realizes certain landowners will need or elect to utilize an amount of groundwater in excess of their annual allocation. In order to meet such demands, while minimizing overdraft conditions and sustaining the groundwater aquifer, the EKGSA must augment water supplies or manage demands. The pumping fee is proposed to fund the costs of augmenting water supplies and/or managing demands. It is likely there will be several fee structures developed throughout the State. The EKGSA may follow one of these examples or develop its own basis for a pumping fee.

#### **FI-2 Pumping Fees for Groundwater Extractions**

If an individual groundwater allocation per acre policy is not established or takes many years to adopt, the EKGSA may adopt a policy to levy tiered fees per acre-feet of pumped groundwater. The EKGSA must first adopt policy on groundwater quantification as described in **Section 5.3.3** to develop this type of policy. If pumping fees were not paid, the EKGSA may consider liens or cease and desist orders.

#### **FI-3 Well Head Fees**

An alternative approach independent of groundwater allocation per acre and quantification method of extraction, the EKGSA may adopt a policy to levy flat rate well head fees. To implement this policy the EKGSA would need to register groundwater extraction facility, such that the GSA can efficiently and accurately collect the well head fee. If well head fees were not paid, the GSA may consider liens or cease and desist orders.

#### **FI-4 Incentives**

The following examples provide basic information on possible incentive program structures should the EKGSA choose to adopt policy that establishes these programs to be implemented. The EKGSA may incentivize these, or other programs as deemed necessary, with Board approval.

Example 1 – May adopt a policy to incentivize groundwater extractors through incentives to construct canal or basin infrastructure to utilize available imported and flood waters.

Example 2 – May adopt a policy to incentivize groundwater extractors through incentives to change crop type to one with lower water demand.

Example 3 – May adopt a policy to incentivize groundwater extractors through incentives to rotate crops and temporarily fallow portions of their irrigated acreage to reduce water demand.

Example 4 – May adopt a policy to incentivize farmers to implement on-farm best management practices (BMPs) such as soil moisture sensors, high efficiency irrigation methods, metering to apply precise irrigation, and deficit irrigation.

Example 5 – May adopt a policy to incentivize farmers to retire or permanently fallow agricultural land.

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Table 5-6 Fees & Incentives Measurable Objectives Check List

Groundwater Level	X
Storage Change	X
Groundwater Quality	
Land subsidence	X
Surface Water Groundwater Interconnection	
Seawater Intrusion	NA

#### 5.3.5.2 Circumstances for Implementation FI-1 – FI-4 (Sec. 354.44.b.1.A)

The EKGSA may consider an investigative study to determine the most effective and equitable fee and incentive structure. Prerequisites of levying groundwater fees may include the installation of a flow meter or other quantification method for groundwater extractors (excluding de minimis extractors). Prerequisites to well head fees may be the registration of groundwater extraction facility and database creation.

#### 5.3.5.3 Process for Public Notification FI-1 – FI-4 (Sec. 354.44.b.1.B)

The EKGSA would utilize continuous correspondence as discussed in EO-1-EO-2 to notify the public as to various opportunities to participate in these programs. Additionally, the EKGSA will utilize such correspondence to inform on policy development and/or implementation regarding fees and incentives.

#### 5.3.5.4 Permitting and Regulatory Process FI-1 – FI-4 (Sec. 354.44.b.3)

No permit or regulatory process is required for the EKGSA to adopt these policies. The EKGSA has the power, through SGMA and related provisions, to adopt these ordinances. Specific canal or basin infrastructure may require CEQA compliance and potentially rely on external water sources.

#### 5.3.5.5 Status and Schedule FI-1 – FI-4 (Sec. 354.44.b.4)

The policies regarding fees and incentives have not been drafted. It is expected to be evaluated during the first 5 years of GSP Implementation and potentially implemented within 2 years of policy adoption. Policy fees, associated non-payment penalties, and incentives amounts may be reviewed by the EKGSA annually.

#### 5.3.5.6 How This Management Action Will be Accomplished FI-1 – FI-4 (Sec. 354.44.b.6)

Groundwater extraction fees and agricultural land conversion have great potential to significantly reduce the demand on groundwater supplies. The quantification of the possible water savings depends on the program pursued and the number of participants.

#### 5.3.5.7 Benefit Realization and Evaluation (Sec. 354.44.b.5)

The expected benefits are potential mitigation of local overdraft by incentivizing groundwater extractors to reduce pumping or pump groundwater supplies in a sustainable fashion. The ancillary benefits include additional funds for the EKGSA to invest in other projects and management actions. The method of evaluation may be reviewing the effective fee structures, amounts and number of fees levied. The groundwater savings are estimated 0 - 30,000 acre-feet per year. It may vary significantly depending upon levied fees, water year, and available transfers/banked credits.

#### 5.3.5.8 Legal Authority FI-1 – FI-4 (Sec. 354.44.b.7)

The legal authority and basis for the management actions described in this Chapter are outlined in the SGMA and related provisions. The SGMA describes the powers and authorities, financial authority, and enforcement powers of GSAs in Chapters 5, 8, and 9 respectively.

### 5.3.5.9 Costs FI-1 – FI-4 (Sec. 354.44.b.8)

The costs related to the fees and incentives management action include one-time expenses and ongoing annual expenses. One-time expenses include the labor costs of the EKGSA Staff, Legal Counsel, and Consultant to prepare the formal program description and adopt the management action policy. Through a Board resolution, the program would be incorporated into the EKGSA's policy manual for transparency. If the EKGSA were to separate the fees and incentives management action into multiple policies, the one-time costs for program description and adoption would be duplicated, but ongoing efforts would be reduced.

Fees: The one-time expenses are estimated at \$15,000 cost to draft and adopt the policy. The ongoing costs related to levying fees of any type include accounting, billing, and processing payments. These costs are estimated at \$25,000 annually. Once adopted, the levied fees will recoup these costs and generate revenue for the EKGSA to fund other projects and management actions.

Incentives: The one-time expenses are estimated at \$15,000 cost to draft and adopt the policy. Since the incentives program would be voluntary with an unknown number of participants, it is assumed the EKGSA would define a maximum budget account with each corresponding type of incentive and would define the parameters of the incentives program. In addition, there would costs associated with field verification prior to enrollment in the Incentives program. Ongoing costs may range from \$10,000 - \$1,000,000 annually.

## 5.3.6 Groundwater Pumping Restrictions Management Actions

### 5.3.6.1 Groundwater Pumping Restrictions

The EKGSA may consider a groundwater pumping restrictions management action encompassing policies related to the prohibition of new groundwater exports, requiring new developments to prove sustainable water supply, pumping restrictions during droughts, and moratorium on new production wells.

#### GP-1 Regulate Groundwater Exports

Though groundwater exports outside of the EKGSA are not currently a common practice, it is understood the changing water market conditions may entice beneficial users to seek financial gains by exporting groundwater. Thus, the EKGSA may adopt a policy to charge a fee for existing groundwater exports and/or prohibit new groundwater exports outside of the EKGSA boundary. The EKGSA may assure performance by enforcing rigid penalties for illegal actions. The EKGSA may approve external exports in limited quantities for emergency situations and levy fees for metering the exported amount. Policy fees and penalties may be reviewed by the EKGSA Board annually.

#### GP-2 Require New Developments to Prove Sustainable Water Supply

The EKGSA may adopt a policy to require new developments (non-de minimis extractors) to prove sustainable water supplies based upon the current groundwater allocation. The EKGSA may review and comment on all new development environmental documents to ensure water balance and corresponding mitigation measures are implemented. This policy requires the support and coordination of the County and/or City during their typical project permitting process.

#### GP-3 Pumping Restrictions

The EKGSA may adopt a policy to reduce or temporarily suspend groundwater pumping during specific intervals and/or in specific regions. Restrictions may be the result of minimum threshold exceedances. The EKGSA may consider significant penalties for violators of excessive abuse.

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**Table 5-7 Groundwater Pumping Restrictions Measurable Objectives Check List**

Groundwater Level	X
Storage Change	X
Groundwater Quality	
Land subsidence	X
Surface Water Groundwater Interconnection	
Seawater Intrusion	NA

### **5.3.6.2 Circumstances for Implementation GP-1 – GP-3 (Sec. 354.44.b.1.A)**

The groundwater pumping restrictions policy may have certain components that may be considered sooner than others. If groundwater export becomes a significant concern in the EKGSA, the EKGSA may act more quickly to develop a policy. Developing policy requirements for new developments will require coordination with the County and/or City.

### **5.3.6.3 Process for Public Notification GP-1 – GP-3 (Sec. 354.44.b.1.B)**

The EKGSA will utilize the established methods of correspondence as described in EO-1-EO-2 to coordinate directly with the grower to address necessary actions associated with groundwater pumping restrictions. If deemed necessary, the EKGSA will adopt policy to, address, issue warnings and implement pumping restrictions if future circumstances require it. Certain circumstances and/or triggers of minimum threshold exceedances may expedite the policy adoption.

### **5.3.6.4 Permitting and Regulatory Process GP-1 – GP-3 (Sec. 354.44.b.3)**

No permit or regulatory process is required for the EKGSA to adopt the policy describing the prohibition of native groundwater exports or pumping restrictions. No external water source is used.

The regulatory process to adopt the policy describing requirements for new developments to provide sustainable water supplies requires cooperation from the County/City to ensure the EKGSA reviewed and commented on the environmental documents prior to County/City approval. The regulatory process would require EHD coordination and support to ensure new well permits issued within the EKGSA adhere to EKGSA policy. This management action does not rely on water from outside the jurisdiction of the EKGSA.

### **5.3.6.5 Status and Schedule GP-1 – GP-3 (Sec. 354.44.b.4)**

The policy has not been drafted. It is expected the EKGSA will evaluate these policy options within the first 5 years of GSP Implementation. During this evaluation and receiving input from stakeholders, the EKGSA will develop a more detailed schedule.

### **5.3.6.6 Benefit Realization and Evaluation GP-1 – GP-3 (Sec. 354.44.b.5)**

The expected benefits may mitigate overdraft and minimum threshold exceedances by ensuring groundwater supplies are utilized in accordance with the groundwater allocation and consumed or retained within the EKGSA boundary. Emergency groundwater exports may be metered and recorded by the EKGSA. The method of evaluation may be reviewing the financial impact, number of new developments, and/or number of emergency export permits. Estimated 0 – 30,000 acre-feet per year may be retained within the EKGSA, which may vary significantly depending upon levied fees, water year, available transfers/banked credits, etc.

### **5.3.6.7 How This Management Action Will be Accomplished GP-1 – GP-3 (Sec. 354.44.b.6)**

The EKGSA may adopt a policy to charge a fee for groundwater exports and/or prohibit groundwater exports outside of the EKGSA boundary in order to accomplish GP-1. Additionally, the EKGSA will be assessing

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groundwater conditions and may adopt policy in which GP-2 and GP-3 would be directly addressed and could become implemented policy.

#### **5.3.6.8 Legal Authority GP-1 – GP-3 (Sec. 354.44.b.7)**

The legal authority and basis for the management actions described in this Chapter are outlined in the SGMA and related provisions. The SGMA describes the powers and authorities, financial authority, and enforcement powers of GSAs in Chapters 5, 8, and 9 respectively.

#### **5.3.6.9 Costs GP-1 – GP-3 (Sec. 354.44.b.8)**

The costs related to the groundwater pumping restrictions management action include one-time expenses and ongoing annual expenses. One-time expenses include the labor costs of the EKGSA Staff, Legal Counsel, and Consultant to prepare the formal program description and adopt the management action policy. Through a Board resolution, the program would be incorporated into the EKGSA's policy manual for transparency. The one-time expenses are estimated at \$15,000 cost to draft and adopt the policy. The ongoing costs related to managing groundwater pumping restrictions and coordinating with the County/City may be covered through a permit fee and/or pumping charge.

### 5.3.7 Interconnected Surface Water Data Gap Work Plan

Within the EKGSA, the presence and understanding of potential interconnected surface water is not well understood. This Management Action sets forth a Work Plan to perform additional efforts specific to filling data gaps and performing additional research and analysis specific to the interconnected surface water indicator in the Kaweah Subbasin, particularly in the EKGSA. Note that absent a full data set and other potential unknowns, some components of the Work Plan are spoken to in generalities as the specific future steps (i.e., type of analytical tool) will be better understood as the Work Plan is undertaken.

#### 5.3.7.1 Management Action Description

EKGSA plans to perform a Work Plan, described below, to fill data gaps and better understand the presence of interconnected surface waters, if any, and potential adverse impacts caused by groundwater extraction. Through the Work Plan and its pending results, the EKGSA can evaluate to the extent interconnected surface waters exist and to what extent whether impacts are significant and unreasonable. This information can then be used to develop sustainable management criteria. This Work Plan is anticipated to be performed in partnership, in part or in whole, with the Greater Kaweah GSA which is also implementing a Work Plan on this topic. The EKGSA will be focusing on the reaches of the Kaweah River, Antelope Creek, Cottonwood Creek, Lewis Creek, Frazier Creek, and Yokohl Creek that are highlighted in **Figure 3-10** and **Section 3.4.2**, which explains the rationale for focusing Work Plan in these areas.

The Work Plan will be performed within the following four (4) major components and are described in further detail below.

Phase 1: Filling Data Gaps and Further Research

Phase 2: Analytical Tool Development

Phase 3: Interconnection Analysis and Determination

Phase 4: SMC Refinement and Incorporation into 2025 GSP Update

#### Phase 1: Filling Data Gaps and Further Research

With interconnected surface water being an identified data gap, the EKGSA will work towards filling data gaps through research and further data collection. There are many different types of data to be gathered and/or better understood to improve the EKGSA's knowledge of interconnected surface waters. The data and research intended to be collected are listed below:

- Groundwater levels – There are gaps in the groundwater level monitoring points near the selected waterways. Without groundwater level data, the EKGSA is unable to understand the proximity of groundwater to the surface water channel and how seasonal or annual groundwater elevations interact with the surface water channels. Early in the Work Plan, the EKGSA will look to identify new monitoring locations through existing wells or new wells to be installed.
- Pumping well locations, beneficial uses, and estimated quantity – Active pumping along or in regional proximity to the selected waterways is not understood in the detail needed for determining whether there are adverse impacts to interconnected surface water ways.
- Stream flow and/or estimated hydrology – Some of the selected water ways have little or no ability monitor surface water flows or have limited development of studies or analyses estimating flows based on hydrological conditions. Pending further research, new or additional stream measurement sites may be installed in locations of the selected waterways.
- Presence of Riparian habitat and/or Groundwater Dependent Ecosystems (GDE) – Further investigations will be performed utilizing available data sets for the presence of riparian and/or GDEs along the selected water ways. Field investigations may be performed to confirm physical presence and current status of these habitats. These efforts, combined



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*with other monitoring efforts of groundwater levels and streamflow, will be used to better understand if adverse impacts are being experienced in the interconnected reaches due to groundwater depletion.*

- *Soils/geological considerations – Further investigation and review of the soils and geological conditions will be evaluated to guide the physical parameters for how surface and groundwater move through the strata present in the selected water ways. The flux through the channel bottoms as well as drawdown characteristics of the regional aquifer around the selected waterways will be reviewed to incorporate into the analytical tool and further analysis to understand mechanics for water movement naturally as well as impacted through groundwater extraction.*
- *Influence of the mountain front recharge – Additional research to determine the volume coming off the mountain front watersheds and how it impacts the upper reaches of the waterways is needed. The Kaweah Subbasin has estimated mountain front recharge in its Water Budgets, however the location and magnitude in different portions of the mountain front is not well understood.*

### Phase 2: Analytical Tool Development

As the additional research and data gaps are being filled, the EKGSA will begin to evaluate an analytical tool that will be appropriate and practical to support decision making and management. At this time, it is unknown the type of tool that will be appropriate but may range from a model, series of equation calculations, or other analytical method that provides for quantifying surface water depletions with respect to groundwater extraction. The USGS Circular 1376 provides guidance on potential approaches and will be closely reviewed during this phase.

It is envisioned this tool will be developed in a manner that can support analysis of a zone of influence around the selected surface waterways to evaluate the impacts groundwater extraction may have on surface flows in all or portions of the studied reaches.

### Phase 3: Interconnection Analysis and Determination

Following the previous phases to perform additional research, fill data gaps, and develop an analytical tool based on the larger data set; the effort of this phase will include the analysis and estimation of the impacts on surface water depletions caused by groundwater extraction, if any. The established study zones from Phase 2 will be analyzed to determine the estimated groundwater extractions and surface water depletion or losses over varying water year types (hydrology) and varying seasons within a water year (i.e., Spring, Fall, etc.). This analytical step will be aimed at driving toward establishing more refined sustainable management criteria in applicable areas for the 2025 GSP update. The refinements may increase or reduce the current reaches with preliminary SMC, pending the results of prior phases.

### Phase 4: SMC Refinement and Incorporation to 2025 GSP Update

The final phase of the Work Plan is the refinement of SMC and incorporation into the 2025 GSP Updates. The level of refinement needed is unknown at this time. However, the EKGSA understands that providing the results of the Work Plan and modifying SMC, where applicable, is targeted for the 2025 GSP updates due in January 2025.

### **5.3.7.2 Circumstances and Criteria for Implementation**

The circumstances for implementing are critical as there is little data and information to inform and support groundwater management related to the interconnected surface water sustainability indicator. The EKGSA is committed to implementing the Work Plan to better understand the presence of interconnected surface waters, if any, and protect against adverse impacts caused by groundwater extractions.

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### **5.3.7.3 Public Notice and Outreach Process**

Appropriate notification and outreach will be conducted consistent with GSA authorities and requirements. As results from the Work Plan become available, they will be reported at EKGSA Board and committee meetings, which are open to the public. Management changes stemming from the results of the Work Plan will occur following a review and public comment period.

### **5.3.7.4 Estimated Annual Project Benefits**

This Work Plan will provide better data and understanding of the location of interconnected surface waters within the EKGSA, if any. The results of the Work Plan could reduce groundwater pumping in the vicinity of interconnected surface waters and protect surface water users and riparian or groundwater dependent ecosystems from adverse impacts related to groundwater extraction. An annual benefit cannot be defined at this time.

### **5.3.7.5 Permitting and Regulatory Process**

Permits for installation of monitoring wells would be needed from Tulare County. However, since these monitoring wells will not have extraction capability, obtaining permits should be procedural. Work within a surface water way, for example to install a stream gauge, could require permits from agencies such as the Army Corps of Engineers, State Water Resources Control Board, and/or California Department of Fish & Wildlife if the action does not fall into an exemption. Right of entry or access agreements with local landowners may be needed pending location.

### **5.3.7.6 Status and Schedule of Management Action**

The Work Plan has yet to begin. The proposed schedule for the Work Plan is summarized in the following table. This is a preliminary schedule. 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.

**Table 5-8 Anticipated Work Plan Schedule**

Phase	Description	Estimated Timeline
1	<u>Additional research: data gap filling (monitoring well installation, stream gauge installation, etc.); data collection</u>	<u>October 2022 – June 2024</u>
2	<u>Analytical Tool Development – the type of tool will be determined with additional data and research</u>	<u>March 2023 – December 2023</u>
3	<u>Interconnection Analysis and Determination</u>	<u>January 2024 – July 2024</u>
4	<u>SMC Development and Incorporation into 2025 GSP</u>	<u>July 2024 – January 2025</u>

### **5.3.7.7 Expected Benefits and Targeted Sustainability Indicators**

The management action will improve knowledge on the timing and volume of interconnected surface water depletions caused by groundwater extraction, if any. Pending the results of the Work Plan, the EKGSA could develop more specific SMC and/or management actions set to protect surface water users and riparian or groundwater dependent habitats from adverse impacts caused by groundwater pumping.

#### **5.3.7.8 Source and Reliability of Water**

An additional water source is not required for this Work Plan effort. However, hydrology is an important factor in understanding the natural variability in surface water way flow behavior. The ephemeral nature of the water ways and the ranges of flows that naturally occur out of the Mountain Front is highly dependent on hydrology. Continuing drought conditions may impact the timeline and results of the Work Plan.

#### **5.3.7.9 Legal Authority Required**

The EKGSA has the authority to implement and perform the Work Plan as the SGMA legislation grants authority to GSAs to perform any act necessary or proper to implement and follow the regulations (§10725.2). This authority allows the EKGSA to implement the Work Plan and move toward better understanding this sustainability indicator with respect to conditions within the Kaweah Subbasin and develop further SMC or rules, pending results of this Work Plan.

#### **5.3.7.10 Costs and Funding**

As described in the Work Plan, there is some uncertainty in the direction next steps will take as more data and information is gathered and better understood. Costs to collect more data, develop a methodology to analyze surface water interconnection and nexus to groundwater extractions, and understand the location of interconnected surface waters within the EKGSA, if any could vary widely. Estimates for performing the Work Plan through 2024 (to be incorporated into the 2025 Update) range from \$150,000 to upwards of \$750,000 for the data gap filling and potential installation of wells and gauges, technical tool development, and analysis. The cost to the EKGSA in implementing will be whole or in part of this estimate. The EKGSA and GKGSAs will be looking to develop partnerships on this effort, as it most directly impacts their GSA boundaries. The EKGSA may also look to funding opportunities at State and/or Federal levels that support such efforts.

**Commented [MK10]:** I estimated between \$50k - \$150k for the next 2ish years pending capital (install) and technical costs

#### **5.3.7.11 Management of Groundwater Extractions**

The management action could lead to better quantification of groundwater production which could deplete interconnected surface waters and the timing and quantity for which it may occur. Pending results of the Work Plan, groundwater extractions in certain proximities of surface water channels could be reduced to minimize or eliminate depletions caused by groundwater pumping.

#### **5.3.7.12 Level of Uncertainty**

There is high certainty the Work Plan will be implemented, the EKGSA is committed to following the Work Plan as previously set forth. The level of uncertainty associated with the direction of the Work Plan and the corresponding results are high as, absent current data, the certainty related to presence of interconnected surface waters and the nexus to groundwater production is not well understood. Specifically, the potential inability to monitor streamflow data during a range of hydrologic conditions due to persistent, multi-year drought conditions may impede the gathering of foundational data needed to significantly understand any potential interconnectivity between surface water ways and groundwater.

### 5.3.8 Well Monitoring and Mitigation

#### 5.3.8.1 Drinking Water Well Monitoring Program

While on the path to achieving Subbasin-wide sustainability, there are regions of the EKGSA where domestic wells may be negatively impacted if water levels reach the proposed minimum thresholds. Recognizing that there are several communities and citizens that rely on groundwater through small system and private domestic wells within the region, the EKGSA may choose to create a program to monitor impacts to water users dependent on groundwater for their drinking water supply. A Drinking Water Wells Monitoring Program (DWWMP) could include a combination of different strategies that provide solutions to gather critical data, protect groundwater quality and quantity, and provide safe and affordable drinking water to the residents of the EKGSA. Aspects of such a program may include:

- Drinking Water Wells Monitoring Network
  - Conduct a drinking water well vulnerability assessment to understand: (1) where drinking water wells that are more vulnerable to groundwater level changes are located, and (2) whether changes in groundwater levels may be exacerbated in specific areas by pumping volume or location.
  - Define drinking water wells monitoring network based on the drinking water wells assessment. This network would be used to assess impacts to drinking water caused by changes in groundwater levels and quality.
- Adaptive Management System Development
  - Develop a preventative warning system that alerts groundwater managers when groundwater levels are dropping to a level that negatively affects drinking water users. Such system may include quantitative threshold triggers between the measurable objective and the minimum threshold that can be used to assign levels of warning and recommend corrective action.
- Drinking Water Well Impact Tool/Model
  - Develop a model or tool from the monitoring network data and adaptive management framework to evaluate groundwater levels and predict potential groundwater impacts to drinking water wells.
- Protection Measures
  - At-risk wells may be eligible for mitigation via the EKGSA's well mitigation program ([Section 5.3.8.1.1](#)).
- Funding
  - If implemented, a secure and reliable source of funding for the DWWMP would need to be identified. Options could include land-based fee assessments, utilization of grant funding, collaboration with CV-SALTS management zones replacement drinking water efforts, and/or Safe and Affordable Funding for Equity and Resilience (SAFER) Program grant funds.

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### 5.3.8.1.1 Circumstances for Implementation (Sec. 354.44.b.1.A)

The current situation of critical groundwater overdraft leading to the unsustainable management of groundwater resources justifies the implementation of a DWWMP.

### 5.3.8.1.2 Process for Public Notification (Sec. 354.44.b.1.B)

The public will be notified of the DWWMP through public meetings, correspondence, and EKGSA website.

### 5.3.8.1.3 Permitting and Regulatory Process (Sec. 354.44.b.3)

No environmental or regulatory permits are expected to be required at this time to implement a DWWMP. Land access agreements with drinking water well owners may be needed to conduct monitoring.

### 5.3.8.1.4 Status and Schedule (Sec. 354.44.b.4)

The DWWPP policy has not been drafted and there would need to be discussions with stakeholder groups. Drafting the policy may commence shortly after the adoption of the GSP. There currently isn't a timeline for completion.

### 5.3.8.1.5 Benefit Realization and Evaluation (Sec. 354.44.b.5)

The expected benefits would include a complete geo-database of groundwater extraction locations. Through the DWWPP, a tool may be developed that evaluates potential drinking water well impacts. The expected benefits of water quality sample ports and analytical testing would fill data gaps and provide extractors with useful information. The benefits of developing a DWWPP include protecting the Human Right to Water within the EKGSA, balancing community and economic development needs, and improved understanding of potential impacts on drinking water quality. The evaluation of these benefits would be reviewed periodically and during the annual reporting cycle.

### 5.3.8.1.6 How This Management Action Will Be Accomplished (Sec. 354.44.b.6)

The development of a DWWPP will be accomplished by bringing together a sub-committee of experts, local stakeholder representatives, and EKGSA representatives to explore and develop the policies required to successfully launch the DWWPP.

### 5.3.8.1.7 Legal Authority (Sec. 354.44.b.7)

The legal authority and basis for the management actions described in this Chapter are outlined in the SGMA and related provisions. The SGMA describes the powers and authorities, financial authority, and enforcement powers of GSAs in Chapters 5, 8, and 9 respectively.

### 5.3.8.1.8 Costs to Implement (Sec. 354.44.b.8)

The cost to develop a DWWPP will vary vastly based on the scope and depth of the program. Costs would include both one-time start-up expenses and on-going expenses. The one-time expenses include the labor costs of the EKGSA Staff, Legal Counsel, and Consultant to prepare the formal program description, host stakeholder engagement meetings, incorporate domestic beneficial users feedback, and adopt the management action policy. In addition, there are the one-time costs to canvass and locate drinking water wells within the EKGSA, develop the domestic well database, and build the appropriate modeling tool. These startup costs are estimated at \$100,000. The ongoing monthly costs include database maintenance, data entry costs, monitoring costs including field and analytical fees, and cost of sending outreach to community members, are estimated at \$50,000 annually.

### **5.3.6.105.3.8.2 Water Supply Well Mitigation Program**

The Kaweah Subbasin GSAs have agreed to each implement a Mitigation Program to mitigate for impacts caused to beneficial uses and users due to groundwater level declines and land subsidence. The framework for this coordinated Mitigation Program is in the Kaweah Subbasin Coordination Agreement included in Appendix 1-A. The following describes the EKGSA's Mitigation Program in conformance with the Coordination Agreement.

The purpose of the Mitigation Program is to mitigate for continued overdraft pumping for groundwater levels and land subsidence. Each Kaweah Subbasin GSA will adopt and implement a Mitigation Program to identify impacts caused by pumping within the GSA's boundaries that may require mitigation. Each Mitigation Program will separately identify the impacts to beneficial uses that the Mitigation Program is intended to address. Each Mitigation Program will include a claim process to address impacts to: (i) domestic and municipal wells; (ii) agricultural wells; and (iii) critical infrastructure. Because the Mitigation Program will resolve impacts from groundwater management, significant and unreasonable results to wells and land uses that may occur prior to reaching Minimum Thresholds will be avoided.

#### **5.3.8.2.1 Mitigation Program Framework Process-**

##### Identification of Need for Mitigation

The Mitigation Program will begin with a plan to establish the process for identification of wells or land uses in need for mitigation. The process may include: 1) an application process by the landowner or well user; or 2) data collection by the GSA and outreach to the affected user. The GSPs in the Subbasin set Measurable Objectives and Minimum Thresholds based on 2015 groundwater levels and land elevation. Impacts from that point further will be evaluated as potentially affected due to the allowance of some level of continued overdraft.

##### Evaluation

Once a potential well or land use has been identified as possibly impacted, an evaluation will occur by EKGSA to determine whether the well has been adversely impacted by declining groundwater levels or by land subsidence which have been identified as occurring because of allowable continued overdraft conditions. The EKGSA plans to use a "stoplight" approach to well mitigation that provides mitigation to impacted wells prior to hitting minimum thresholds. EKGSA specific mitigation plan triggers, conditions, qualifications, outreach methods, mitigation proposed, and groundwater management action responses are summarized in Table 5-9.

##### Qualifications

GSAs may qualify mitigation based on a user's compliance with the GSA's GSP, Rules & Regulations, and other laws or regulations. For example, a user who has caused or contributed to overdraft may not qualify for the Mitigation Program.

##### Mitigation

Once a well has been identified as adversely impacted due to declining groundwater levels or land subsidence, the proper mitigation to alleviate impacts must be determined.

For groundwater level impacts, this could include any of the following:

- Repairing the well;
- Deepening the well;
- Constructing a new well;
- Modifying pump equipment;

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- Provide temporary or permanent replacement water;
- Coordinate consolidation with existing water systems; or
- With the consent of the affected user, providing other acceptable means of mitigation.

For land use impacts, this could include any of the following:

- Increased restrictions in groundwater extractions for certain regional areas;
- Repair to canals, turnouts, stream channels, water delivery pipelines, and basins;
- Repair to damaged wells;
- Addressing flood control;
- Repair to other damaged infrastructure including highways, roads, bridges, utilities, and buildings; or
- With the consent of the affected user, providing other acceptable means of mitigation.

Various factors may reflect the proper mitigation methods for the specific well or land use at issue. For example, age, location, the financial impact to the beneficial user as a result of mitigation, and the beneficial user of the well may reflect which mitigation measures are optimal.

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Table 5-9 EKGSA Domestic Well Mitigation Triggers, Conditions, Investigations/Qualifications, Outreach, Mitigation, and Groundwater Management Actions

Trigger	Conditions	Investigation/ Qualifications	Outreach	Mitigation	GW Management
Green	<u>Groundwater conditions are stable at or above established MO. No issues are anticipated.</u>	<u>Typical monitoring schedule and GSP Management.</u>	<u>Annual Monitoring Report.</u>	<u>None expected.</u>	<u>Continue GSP Planning at measurable objective management</u>
Yellow	<u>Groundwater conditions below established MO and above 50% of established MT by Threshold Region.</u>	<u>Monitoring Network indicating some areas may need further investigation. Initiation of investigation and vetting of specific conditions. Evaluate monitoring frequency.</u>	<u>Annual Monitoring Report; Visual representation of impacted area on GSA map.</u>	<u>Following investigation/qualification - GSA implementing applicable mitigation method for the specific issue.</u>	<u>GSA to evaluate annual allocation amount in next allocation period.</u>
Orange	<u>Groundwater conditions below 50% of operational range and above the established MT by Threshold Region.</u>	<u>Monitoring Network indicating areas need further investigation. Initiation of investigation and vetting of specific conditions. Evaluate monitoring frequency.</u>	<u>Annual Monitoring Report; Visual representation of impacted area on GSA map; Increased communications.</u>	<u>Following investigation/qualification - GSA implementing applicable mitigation method for the specific issue.</u>	<u>GSA to evaluate localized groundwater pumping limits or actions.</u>
Red	<u>Groundwater conditions at or below established MTs by Threshold Region.</u>	<u>Monitoring indicating many areas need further investigation. Initiation investigation and vetting of specific conditions. Monitoring frequency increased.</u>	<u>Annual Monitoring Report; Visual representation of impacted area on GSA map; Increased communications; Working with local agencies.</u>	<u>Following investigation/qualification - GSA implementing applicable mitigation method for the specific issue. Looking into larger, long-term solutions to address significant impacts.</u>	<u>GSA to evaluate broader groundwater pumping limits or actions.</u>



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### 5.3.8.2.2 Circumstances for Implementation (Sec. 354.44.b.1.A)

This is a high priority program that is necessary to mitigate the impacts of declining water levels and land subsidence and provide water supply to meet basic health and safety needs. EKGSA, in coordination with GKGSA and MKGSA, is committed to implementing this Program. Funding is available for the Program through GSA's implementation of assessments, fees, charges, and penalties. In addition, the GSAs will explore grant funding.

### 5.3.8.2.3 Process for Public Notification (Sec. 354.44.b.1.B)

Public outreach and education will be provided during development of the Mitigation Program and prior to implementation by each GSA. Prior to implementation, extensive outreach will be geared toward notifying landowners of the Mitigation Program requirements, facilitate how to qualify for the Mitigation Program, and how to apply for assistance. Outreach will be offered in multiple languages as appropriate for the GSA. Outreach methods could include workshops, mailings, flyers, website postings, Board meeting announcements, etc.

Common elements developed at the Kaweah Subbasin level shall be shared with the public through coordinated workshops and public meetings. As material and data become available, the Kaweah Subbasin GSAs will coordinate workshops for the public to attend. While special workshops can be utilized, the Kaweah Subbasin GSAs will utilize the quarterly Kaweah Subbasin Management Committee (Management Committee) meetings as a resource to share Workplan updates. The Management Committee is a coordinated meeting between representatives from each GSA, and the public is invited to attend and participate in the meetings. Meetings shall be noticed on GSA websites and shall be sent to interested parties. Interested parties are collected on an ongoing basis in the Kaweah Subbasin. Individual outreach plans specific to each GSA Mitigation Program shall be developed and shared with the public via individual outreach efforts at each.

### 5.3.8.2.4 Permitting and Regulatory Process (Sec. 354.44.b.3)

The GSAs will be required to comply with any CEQA requirements prior to approval and implementation of the Program. No other permits or other regulatory requirements are expected to be necessary for the Program at this time.

### 5.3.8.2.5 Status and Schedule (Sec. 354.44.b.4)

Each GSA will formulate and implement a mitigation claims process for domestic and municipal use impacts within the first quarter of 2023, and complete all other aspects of the Mitigation Program by June 30, 2023. The initial claims process shall include reference to local programs and resources from the County, State, non-profit organizations, and the Kaweah Water Foundation (local CV-SALTS Management Zone).

As the Kaweah Subbasin GSAs anticipate that the individual Mitigation Programs will require time to be developed and established in a public and transparent fashion, in the interim, the Kaweah Subbasin GSAs will coordinate the development of an Interim Domestic Well Mitigation Program at a yet to be determined funding level and emergency criteria to make the limited funding available for drinking water well mitigation.

### 5.3.8.2.6 Benefit Realization and Evaluation (Sec. 354.44.b.5)

The proposed Program will directly mitigate impacts due to chronic lowering of groundwater levels and land subsidence. The Program will provide a direct benefit to the beneficial users in the GSA who have had their well impacted because of continued overdraft conditions while the GSA implements other project and management actions to achieve sustainability. The metric for measuring program benefits will be the number of wells that are impacted and mitigated under this Program.

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The Kaweah Subbasin GSAs intend to utilize the Annual Report submitted to DWR to report on and update progress on the Mitigation Program(s). With the information presented, the Kaweah Subbasin GSAs anticipate pursuing locating and refining the potential number of wells impacted by lowering of groundwater levels to the MTs in the Kaweah Subbasin. The Kaweah Subbasin GSAs intend to leverage new tools developed by the DWR, such as the Dry Domestic Well Susceptibility Tool, and well surveys to establish a refined estimate of drinking water well impacts. The Kaweah Subbasin GSAs will continue to evaluate impacts to beneficial uses and users of land subsidence.

### 5.3.8.2.7 How This Management Action Will Be Accomplished (Sec. 354.44.b.6)

The project will be implemented by the GSA once fully developed and a funding source is identified. This program relies on available groundwater. The GSAs may evaluate alternative sources of supply.

### 5.3.8.2.8 Legal Authority (Sec. 354.44.b.7)

California Water Code Section 10725.2 provides the GSA has the powers and authorities “perform any act necessary or proper” to implement SGMA regulations and allows the GSA to adopt rules, regulations, ordinances, and resolutions necessary for SGMA implementation. Because the Department is required to evaluate whether the Plan provides a reasonable means to mitigate for continued overdraft, a mitigation program is an act necessary or proper to implement SGMA. (23 CCR §355.4(b)(6).)

### 5.3.8.2.9 Costs and Funding (Sec. 354.44.b.8)

Following are preliminary ~~estimated~~ costs drivers for implementing the program. These will be refined during project development and finalized prior to efforts to secure funding.

Development of Policies and Procedures. Each GSA will have consulting and legal costs to develop the Program policies and procedures, which costs will vary by GSA.

Develop Funding. The Subbasin will collaborate with programs and funding sources that already exist. Each GSA will need to develop long-term funding. This could include preparation of grant applications, a land-based fee assessment, or other options. These costs will vary by GSA.

Public Outreach. Public outreach will be performed in each GSA. These costs will vary by GSA and will be estimated during development of the Program.

Project Administration. General administration costs for the program will vary by GSA and will be determined during the development of the Program.

Well Mitigation. Well mitigation costs will vary by GSA and location within each GSA in accordance with groundwater levels and the specific minimum thresholds that have been determined. An estimate of well mitigation costs will be developed by each GSA as part of their Program development and funding plan development. As a preliminary estimate to understand approximate magnitude, the number of wells that may be impacted within the EK GSA based on known data at this time (as described in ~~Appendix 3-D Section 3.X.X~~) is approximately 450115 wells. Recent estimates for drilling a new PVC domestic well is in the range of \$88 - \$125 per linear foot (LF). For estimating the potential magnitude of cost for this program, it was assumed that 100 LF could be needed for assisting potentially impacted wells beyond their current construction. Applying the cost per LF to 150 wells results in a range from \$1.3 - \$1.9 million.

Each GSA will develop a funding mechanism for the Mitigation Program, which is dependent on the specific GSA needs for specific expected impacted wells, critical infrastructure, and land uses within each GSA. Funding is anticipated to be available for each GSA's Mitigation Program through implementation of assessments, fees, charges, and penalties. In addition, the GSAs will explore grant funding. The State has many existing grant

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programs for community water systems and well construction funding. County, state, and federal assistance will be needed to successfully implement the respective Mitigation Programs. Each GSA may, separately or in coordination with other GSAs, also work with local NGOs that may be able to provide assistance or seek grant monies to help fund the Mitigation Program. GSAs may act individually or collectively to address and fund mitigation measures.

Below is a list of funding being sought within the Kaweah Subbasin:

- *The Safe and Affordable Funding for Equity and Resilience (SAFER) Program through the California State Water Resources Control Board*
- *Household Water Well Program through the United State Department of Food and Agriculture*
- *Household Water Well System Grant Program through the United State Department of Food and Agriculture*

### 5.3.8.2.10 Management of Groundwater Extractions

The Program will may impact groundwater extractions, if impacts show accelerated rates of groundwater extraction needs to occur. The Program will not directly impact recharge activities, but actively encourages that course of action. The Program is meant to mitigate for impacts caused by continued overdraft pumping until sustainability has been reached.

### 5.3.8.2.11 Level of Uncertainty

The GSAs are committed to the Program and required through the Coordination Agreement to implement the Program by the scheduled defined herein. There are uncertainties associated with mitigation costs and funding sources.

## 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 in a sustainable manner. While the GSP is being reviewed by DWR, the EKGSA will coordinate with various stakeholders and beneficial users to improve the monitoring networks and begin the implementation process for projects and management actions.

### 6.1 Estimate of GSP Implementation Costs

#### **Legal Requirements:**

##### **§ 354.6. Agency Information**

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

(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 preliminary estimate of plan implementation costs includes four categories:

1. *GSA Administration*
2. *Ongoing GSP Implementation*
3. *Plans to Fill Data Gaps*
4. *Projects & Management Actions*

#### GSA Administration

This includes the costs of annually operating the EKGSA including, but not limited to, the executive officer's salary, audit, legal counsel, insurance, and potentially office space. The extent of administrative costs will be impacted by the direction the EKGSA follows in the years ahead. The EKGSA is utilizing a shared staff model where all labor for executive leadership, engineer, analyst, and administration are shared with a member agency. In the future, the EKGSA can evaluate moving to a hired executive staff model where all labor for executive leadership and administration costs, and all other work is performed by consultants. The current costs, estimated using the shared staff model currently in use, is approximately \$211,000 annually.

#### Ongoing GSP Implementation

The ongoing costs of GSP implementation include, but are not limited to, basin coordination/policy development, engineering, outreach, monitoring, annual reporting, and data collection for 5-year updates. The expected implementation costs may vary based on EKGSA staffing and/or policy decisions in the future. Costs are estimated using the existing shared staff model and is approximately \$856,100 annually.

#### Plan to Fill Data Gaps (One-Time Cost)

Proper implementation of this GSP, especially as it relates to execution of projects and management actions, is contingent upon filling current data gaps. This process will require determining which measures are necessary to build and maintain a comprehensive assessment of the water budget and ultimately verify groundwater sustainability. This plan to fill data gaps includes, but is not limited to, installing stream gauges, dedicated monitoring wells, and conducting a Proposition 218 vote. Costs are estimated to be approximately \$1,230,000.

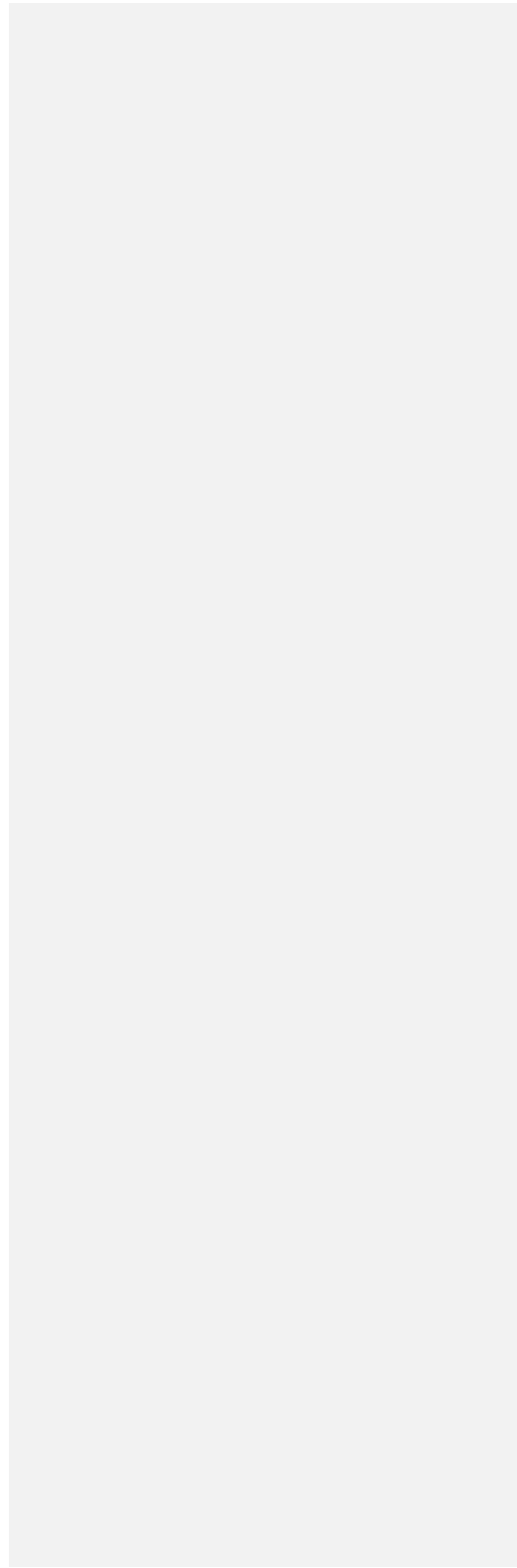
#### Projects & Management Actions

Projects and management actions/programs will be required to achieve groundwater sustainability. Estimated costs generally include planning, design, and construction of infrastructure. The project costs listed are estimates and may be adapted, added to, or eliminated by the EKGSA Board should it be deemed necessary. The funding

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for projects and management actions will likely come from specific project proponents and/or beneficiaries. Thus, these costs are not included in



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**Table 6-1** summarizing the EKGSA implementation costs. Further discussion regarding projects and their individual components, as well as their estimated timelines can be found in the Projects and Management Actions Chapter (**Chapter 5**).

Table 6-1 Estimated EKGSA Implementation Costs

<b>East Kaweah GSA</b>	
<b>Initial GSP Implementation Budget</b>	
<b>Activity</b>	<b>Est. Budget</b>
<b>GSA Administration</b>	
Executive Leadership (Executive/Analyst)	\$ 125,000
Administration	30,000
Office Space and Correlated Costs	-
Legal	35,000
Engineering (Gov.)	5,000
Auditing	5,000
Insurance	6,000
Miscellaneous	5,000
<b>Total GSA Administration</b>	<b>\$ 211,000</b>
<b>GSP Implementation</b>	
Basin Coordination/Policy Development	\$ 100,000
Engineering	190,000
Outreach	10,000
Monitoring	
GW Level Monitoring (Semi Annual)	12,000
GW Quality Monitoring (Quarterly)	200,000
Subsidence Monitoring (Annual)	1,600
Satellite Imagery - Demand (Monthly)	250,000
DMS Management	15,000
Annual Reporting	25,000
Collection for For 5-year Update	75,000
<b>Annual Ongoing GSP Imp Costs</b>	<b>\$ 878,600</b>
<b>Total Annual Costs</b>	<b>\$ 1,089,600</b>
<b>Fill Data Gaps</b>	
Stream Gauges (5)	\$ 200,000
Dedicated Monitoring Wells (7)	525,000
Well Video Logging	175,000
Five Year Update	250,000
Prop 218	80,000
<i>Mitigation Program</i>	<i>1,600,000</i>
<i>Interconnected Surface Water Work Plan</i>	<i>500,000</i>
<b>Total to Fill Data Gaps</b>	<b>\$ 4,935,000</b>
<b>Estimated GSP Implementation Costs</b>	<b>\$ 6,024,600</b>

## 6.2 Identify Funding Alternatives

Shortly after the GSP is submitted, the EKGSA ~~will pursue~~<sup>pursued</sup> a Proposition 218 Election for securing funds for annual administration and general implementation costs associated with implementation of this GSP.

The Proposition 218 Election, ~~will aim to establish which was approved by voters in October 2020, established~~ a maximum rate in a given fiscal year ~~with the highest possible rate being \$9.37/acre (\$XX/acre).~~ The assessment rate will be set annually by the GSA Board, based on the budget needs, but will not exceed the proposed maximum rate established in the Proposition 218. ~~At this time the assessment rate is unknown because the actual GSP implementation costs will not be fully determined until after the GSP is adopted.~~ The projects and management actions proposed in this GSP will require supplemental funding ~~beyond the 2020 Proposition 218 effort as only the annual administration and general implementation efforts were included more than the maximum potential Proposition 218 assessments.~~ Therefore, other funding mechanism(s) will be required.

The EKGSA and/or its member agencies or other Kaweah Subbasin GSAs will apply for various grant funding opportunities to offset some of the capital costs associated with implementation of the GSP, whether it be a water supply project or to fill an existing data gap. The EKGSA will explore federal and state grant funding opportunities and low interest loans to help finance the initial steps of plan implementation.

If local, state, and federal funding is not readily available or insufficient, the EKGSA may consider implementing policies or actions to impose fees which, after formal adoption, would generate a revenue stream for future GSP implementation costs. The fees could be based on several factors including, but not limited to, allocating projects costs to project beneficiaries, estimated pumping quantities, land area, or other method as determined by the EKGSA. The EKGSA could elect to impose penalties for not meeting milestones or exceeding allocation limits. Penalty revenue could be utilized to fund projects.

### 6.3 Schedule for Implementation

Figure 6-1 shows the estimated timeline for project implementation starting in 2020 and spanning to 2040. It is important to note that projects may initiate at different times and the estimation of implementation may be altered by the EKGSA at any time, should it be deemed necessary. Additionally, the availability of surface water necessary for projects is subject to hydrology which is unpredictable and variable. The EKGSA plans to continue broadening its scope in attempting to obtain additional resources to be utilized by these and other projects. The depicted schedule does not list specific implementation steps (i.e. environmental documentation, agreements, project design, and construction) for each project or management action.

Figure 6-2 represents the glide path to sustainability for the EKGSA GSP, shown as a cumulative mitigation. The overall EKGSA overdraft is currently estimated to be approximately 28,000 acre-feet prior to the development of the GSP. It is assessed that by 2025, 5% of the pre-existing overdraft value will have been resolved. In the year 2030 it is estimated that through GSP implementation 25% of the estimated overdraft will have been resolved. In 2035 the percentage jumps to 55%, with 100% of the overdraft resolved by 2040. This figure provides is an estimated projection, and actual results from both projects and management actions may differ from this expectation.



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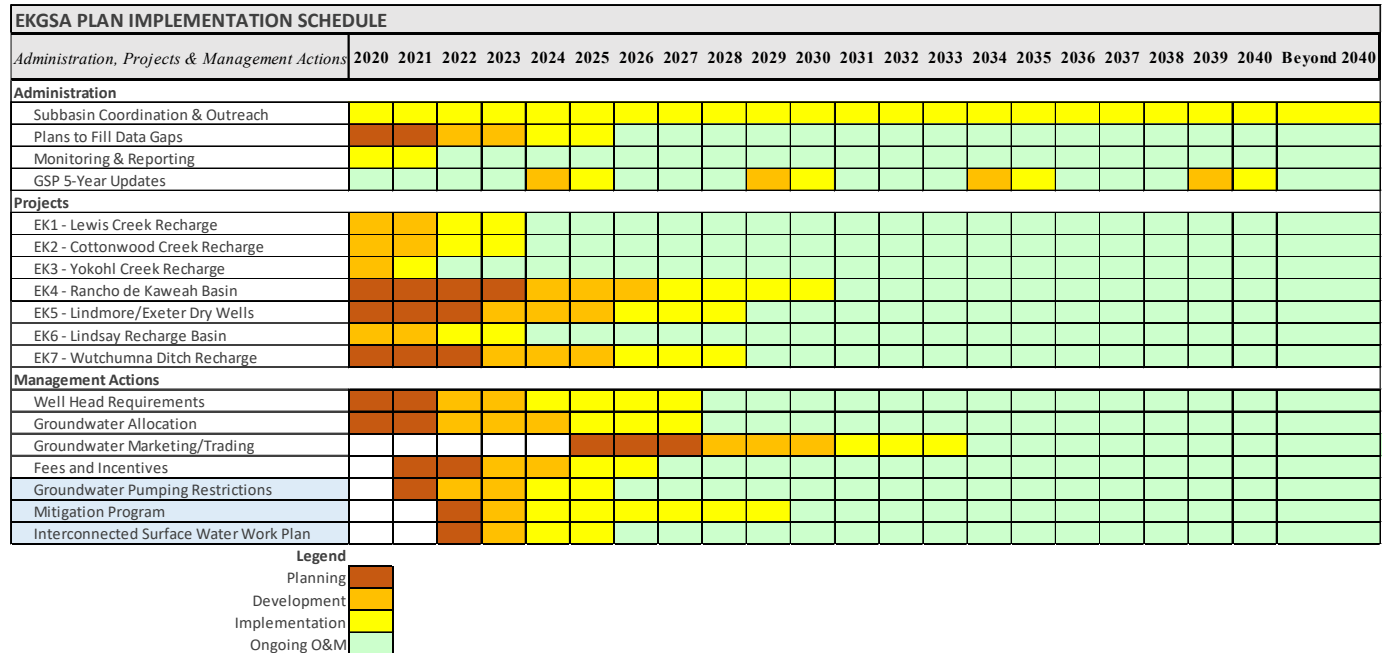


Figure 6-1 EKGSA GSP Implementation Schedule

### EKGSA GLIDE PATH TO SUSTAINABILITY

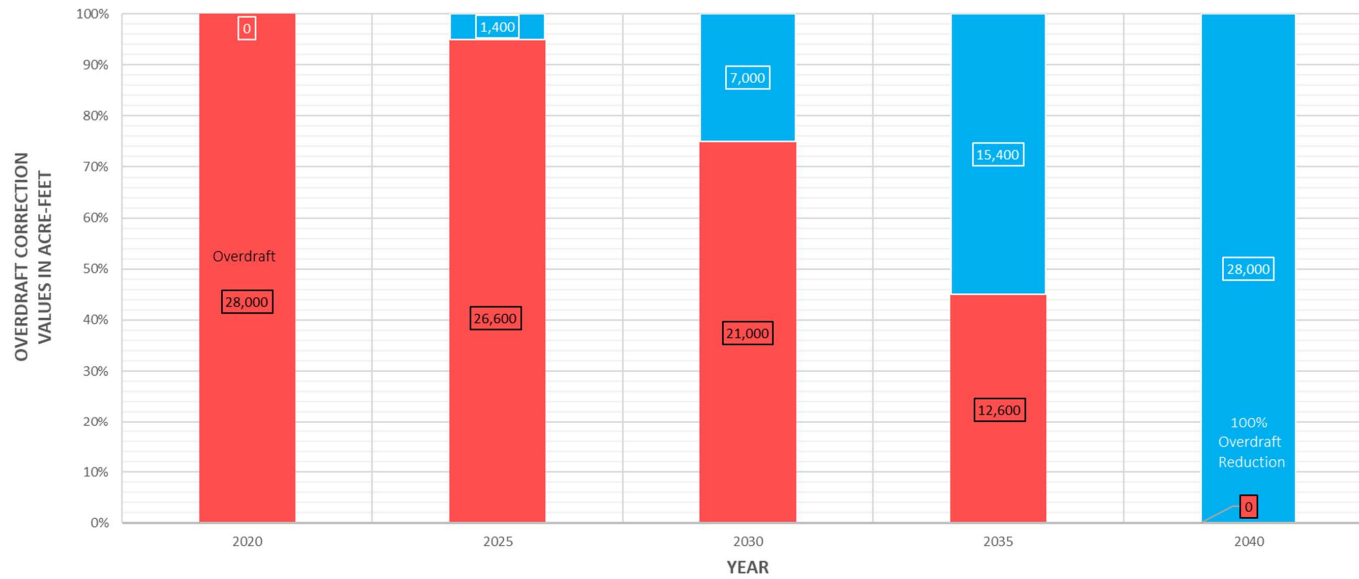


Figure 6-2 EKGSA Glide Path to Sustainability

## 6.4 Data Management System

The EKGSA's Data Management System (DMS) will be coordinated with all the Kaweah Subbasin GSAs. A single location for data collection, aggregation, and analysis will benefit not only the EKGSA, but all GSAs within the Kaweah Subbasin. The DMS platform, GSA management, and functionality is further defined in the Kaweah Subbasin Coordination Agreement and in [Appendix 1-A](#).

## 6.5 Annual Reporting

### Legal Requirements:

#### § 356.2. Annual Reports

Each Agency shall submit an annual report to the Department by April 1 of each year following the adoption of the Plan. The annual report shall include the following components for the preceding water year:

- (a) General information, including an executive summary and a location map depicting the basin covered by the report.
- (b) A detailed description and graphical representation of the following conditions of the basin managed in the Plan:
  - (1) Groundwater elevation data from monitoring wells identified in the monitoring network shall be analyzed and displayed as follows:
    - (A) Groundwater elevation contour maps for each principal aquifer in the basin illustrating, at a minimum, the seasonal high and seasonal low groundwater conditions.
    - (B) Hydrographs of groundwater elevations and water year type using historical data to the greatest extent available, including from January 1, 2015, to current reporting year.
  - (2) Groundwater extraction for the preceding water year. Data shall be collected using the best available measurement methods and shall be presented in a table that summarizes groundwater extractions by water use sector, and identifies the method of measurement (direct or estimate) and accuracy of measurements, and a map that illustrates the general location and volume of groundwater extractions.
  - (3) Surface water supply used or available for use, for groundwater recharge or in-lieu use shall be reported based on quantitative data that describes the annual volume and sources for the preceding water year.
  - (4) Total water use shall be collected using the best available measurement methods and shall be reported in a table that summarizes total water use by water use sector, water source type, and identifies the method of measurement (direct or estimate) and accuracy of measurements. Existing water use data from the most recent Urban Water Management Plans or Agricultural Water Management Plans within the basin may be used, as long as the data are reported by water year.
  - (5) Change in groundwater in storage shall include the following:
    - (A) Change in groundwater in storage maps for each principal aquifer in the basin.
    - (B) A graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year.
- (c) A description of progress towards implementing the Plan, including achieving interim milestones, and implementation of projects or management actions since the previous annual report.

The EKGSA will develop and submit annual reports on April 1 of each year following the initial GSP (2020). The annual reports will follow the guidelines set forth in §356.2 of the SGMA legislation. Per the guidelines, there will be three key sections in the report as shown in the outline below.

1. *General Information*
  - a. *Executive Summary for the annual report*
  - b. *Location map of the region covered by the annual report*
2. *Basin Conditions*
  - a. *Groundwater elevation monitoring data, including contour maps and hydrographs*
  - b. *Groundwater extraction data*
  - c. *Surface water supply data*
  - d. *Total water use data*
  - e. *Change in groundwater storage, including maps and comparison to January 1, 2015*
3. *Progress of GSP implementation.*
  - a. *Progress on GSP implementation*
  - b. *Progress towards achieving sustainability*

## 6.6 Periodic Evaluations

### Legal Requirements:

#### § 356.4. Periodic Evaluation by Agency

Each Agency shall evaluate its Plan at least every five years and whenever the Plan is amended and provide a written assessment to the Department. The assessment shall describe whether the Plan implementation, including implementation of projects and management actions, are meeting the sustainability goal in the basin, and shall include the following:

- (a) A description of current groundwater conditions for each applicable sustainability indicator relative to measurable objectives, interim milestones and minimum thresholds.
- (b) A description of the implementation of any projects or management actions, and the effect on groundwater conditions resulting from those projects or management actions.
- (c) Elements of the Plan, including the basin setting, management areas, or the identification of undesirable results and the setting of minimum thresholds and measurable objectives, shall be reconsidered and revisions proposed, if necessary.
- (d) An evaluation of the basin setting in light of significant new information or changes in water use, and an explanation of any significant changes. If the Agency's evaluation shows that the basin is experiencing overdraft conditions, the Agency shall include an assessment of measures to mitigate that overdraft.
- (e) A description of the monitoring network within the basin, including whether data gaps exist, or any areas within the basin are represented by data that does not satisfy the requirements of Sections 352.4 and 354.34(c). The description shall include the following:
  - (1) An assessment of monitoring network function with an analysis of data collected to date, identification of data gaps, and the actions necessary to improve the monitoring network, consistent with the requirements of Section 354.38.
  - (2) If the Agency identifies data gaps, the Plan shall describe a program for the acquisition of additional data sources, including an estimate of the timing of that acquisition, and for incorporation of newly obtained information into the Plan.
  - (3) The Plan shall prioritize the installation of new data collection facilities and analysis of new data based on the needs of the basin.
- (f) A description of significant new information that has been made available since Plan adoption or amendment, or the last five-year assessment. The description shall also include whether new information warrants changes to any aspect of the Plan, including the evaluation of the basin setting, measurable objectives, minimum thresholds, or the criteria defining undesirable results.
- (g) A description of relevant actions taken by the Agency, including a summary of regulations or ordinances related to the Plan.
- (h) Information describing any enforcement or legal actions taken by the Agency in furtherance of the sustainability goal for the basin.
- (i) A description of completed or proposed Plan amendments.
- (j) Where appropriate, a summary of coordination that occurred between multiple Agencies in a single basin, Agencies in hydrologically connected basins, and land use agencies.
- (k) Other information the Agency deems appropriate, along with any information required by the Department to conduct a periodic review as required by Water Code Section 10733.

The EKGSA will amend the GSP at least every five years as prescribed in the SGMA Legislation. Periodic evaluations will include the result of Basin operations and progress in achieving sustainability. Progress will be evaluated using current groundwater conditions, status of projects or management actions, evaluation of undesirable results relating to measurable objectives and minimum thresholds, changes in the monitoring network, summary of enforcement or legal actions, and agency coordination efforts. This is in accordance with SGMA law §356.4. Periodic Evaluation by Agency.

Certain components of the GSP may be re-evaluated more frequently than every five years, if deemed necessary. This may occur, for example, if sustainability goals are not being met, additional data is acquired, or priorities change. While the EKGSA is evaluating various components of the GSP (i.e. sustainable management criteria), the EKGSA will be seeking feedback from stakeholders through a public process utilizing adequate and appropriate materials. Decisions will be made at public board meetings and coordinated at the Subbasin level, as needed. Results from these processes and any changes will be incorporated into the GSP when it is resubmitted to DWR every five years.

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# **Appendix 1-A**

## **Kaweah Subbasin Coordination Agreement**



# Appendix 1-B

# Appendix 1-C

# Appendix 1-D

# Appendix 2-A

# Appendix 2-B

# Appendix 2-C

# Appendix 2-D

# Appendix 2-E



# Appendix 2-F

# Appendix 2-G

# Appendix 2-H

# Appendix 3-A

# Appendix 3-B

# Appendix 3-C

# Appendix 3-D

# Appendix 4-A



# Appendix 4-B