Prepared by

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4CREEKS

GREATER KAWEAH
GROUNDWATER
SUSTAINABILITY
AGENCY

GROUNDWATER SUSTAINABILITY PLAN

AMENDED
2024

PUBLIC REVIEW DRAFT

2024 Second Amended Groundwater Sustainability Plan

Greater Kaweah Groundwater Sustainability Agency

June 2024

Prepared under the Kaweah Subbasin Coordination Agreement with Mid-Kaweah GSA and East Kaweah GSA

Report Prepared for:

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Appendices correspond with GSP Section. Note that there is no Appendix to Chapters 7 or 8.

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ACRONYMS & ABBREVIATIONS

AEM........................Airborne Electromagnetic Surveying
AF ....acre-feet
APPS.......................Automatic Precise Positioning Service
ASO.........................NASA's Airborne Snow Observatory
BMP ....Best Management Practice
Board.......................State Water Resources Control Board
C&E ....Communications and Engagement
CalOES ....California Office of Emergency Services
CASGEM................California Statewide Groundwater Elevation Monitoring
CCR.........................California Code of Regulations
CEQA......................California Environmental Quality Act
CIMIS ....California Irrigation Management Information System
CIT ....California Institute of Technology
CORS ....continuously operating reference station
CVP.........................Central Valley Project
CVPIA.....................Central Valley Project Improvement Act
CWSC ....California Water Service Company
DGPS ....Differential GPS
DMS........................Data Management System
DWR ....California Department of Water Resources
DWSAP...................Drinking Water Source Protection
EKGSA ....East Kaweah Groundwater Sustainability Agency
FEMA ....Federal Emergency Management Agency
gpcd.........................gallons per capita per day
GEI..........................GEI Consultants, Inc.
GKGSA...................Greater Kaweah Groundwater Sustainability Agency
GIPSY-OASIS ....Inferred Positioning System and Orbital Analysis Simulation Software
GNSS ....Global Navigation Satellite System
GRAT......................Groundwater Recharge Assessment Tool
GSA.........................Groundwater Sustainability Agency
GSP or Plan.............Groundwater Sustainability Plan
HCM ....Hydrogeologic Conceptual Model
ID ....Irrigation District
IM............................Interim milestone
InSAR ....Interferometric Synthetic Aperture Radar
ITRC ....Irrigation Training & Research Center
JPA..........................Joint Powers Authority
JPL ....Jet Propulsion Laboratory

KDWCD ....Kaweah Delta Water Conservation District
KSHM.....................Kaweah Subbasin Hydrologic Model
KSJRA ....Kaweah and St. Johns River Association
MA ....Management Area
MAF........................Million Acre Feet
MCL........................Maximum Contaminant Level
MKGSA ....Mid-Kaweah Groundwater Sustainability Agency
MO ....Measurable Objective
MSL ....Mean Sea Level
MT...........................Minimum Threshold
NASA......................National Aeronautics and Space Administration
NAVD88.................North American Vertical Datum of 1988
NDVI.......................Normalized Difference Vegetation Index
NEPA ....National Environmental Policy Act
NGO........................Non-Governmental Agency
OPUS ....Online Positioning User Service
PPP..........................Precise point positioning
RO ....Reverse Osmosis
RP............................Reference Point
SCADA ....Supervisory Control and Data Acquisition
SGMA ....Sustainable Groundwater Management Act
SJRRP ....San Joaquin River Restoration Project
SMARA ....Surface Mining and Reclamation Act
SMC ....Sustainable Management Criteria
SOP ....Standard Operating Procedure
SOR.........................System Optimization Review
SWRCB...................State Water Resources Control Board
TAF ....Thousand acre-feet
TDS ....Total Dissolved Solids
TID ....Tulare Irrigation District
UWMPs...................Urban Water Management Plans
USBR ......................U.S. Bureau of Reclamation
USGS ......................U.S. Geological Survey
WHPA.....................wellhead protection area
WWTP .... wastewater treatment plant

DEFINITIONS

This list of definitions apply to this Groundwater Sustainability Plan (GSP) but may also be found in the Appendices or other attachments to the Greater Kaweah Groundwater Sustainability Agency's GSP.

Adjudication action	An action filed in the superior or federal district court to determine the rights to extract groundwater from a basin or store water within a basin, including, but not limited to, actions to quiet title respecting rights to extract or store groundwater or an action brought to impose a physical solution on a basin.
Agency	A groundwater sustainability agency as defined in the Sustainable Groundwater Management Act.
Agricultural water management plan	A plan adopted pursuant to the Agricultural Water Management Planning Act as described in Part 2.8 of Division 6 of the Water Code, commencing with Section 10800 et seq.
Annual report	The report required by Water Code Section 10728.
Areal Electro Magnetics – SKYTEM	The collection of subsurface information on the relative conductivity of subsurface material from ground surface to an approximate depth of 1,000 feet. This information is collected from a helicopter equipped with equipment to both transmit and receive information.
Baseline or baseline conditions	Historic information used to project future conditions for hydrology, water demand, and availability of surface water and to evaluate potential sustainable management practices of a basin.
Basin	A groundwater basin or subbasin identified and defined in Bulletin 118 or as modified pursuant to Chapter 3 (commencing with Section 10722).

Basin setting	The information about the physical setting, characteristics, and current conditions of the basin as described by the Agency in the hydrogeologic conceptual model, the groundwater conditions, and the water budget, pursuant to Subarticle 2 of Article 5.
Best available science	The use of sufficient and credible information and data, specific to the decision being made and the time frame available for making that decision, that is consistent with scientific and engineering professional standards of practice.
Best management practice	A practice, or combination of practices, that are designed to achieve sustainable groundwater management and have been determined to be technologically and economically effective, practicable, and based on best available science.
Bulletin 118	DWR’s report entitled California’s Groundwater: Bulletin 118 updated in 2003, as it may be subsequently updated or revised in accordance with Section 12924.
CASGEM	California Statewide Groundwater Elevation Monitoring Program developed by the Department pursuant to Water Code Section 10920 et seq., or as amended.
Coordination agreement	A legal agreement adopted between two or more groundwater sustainability agencies that provides the basis for coordinating multiple agencies or groundwater sustainability plans within a basin pursuant to this part.

Current Water Budget	For GKGSA, "current water budget" refers to the period between water years 1999 and 2022. For the Kaweah basin this was the period over which the best data and information were available to calculating a water budget. Because this period has the lowest degree of uncertainty in terms of quantification of each water budget component, it was this period that was used for calibrating and verifying the numerical groundwater budget during the development of the 2020 GSP. This period is distinguished from the Historical Water Budget (1999-2022) and the projected future water budget (2023-2072).
Data gap	A lack of information that significantly affects the understanding of the basin setting or evaluation of the efficacy of Plan implementation and could limit the ability to assess whether a basin is being sustainably managed.
De minimis extractor	A person who extracts, for domestic purposes, 2 acre-feet or less per year.
Dry Well Susceptibility Analysis	An impact-based analysis that evaluates the count of potentially impacted wells under different groundwater elevation surface scenarios. The Dry Well Susceptibility Analysis is used to inform (1) upper aquifer water level sustainable management criteria and (2) mitigation plan/program cost estimates.
Governing body	The legislative body of a groundwater sustainability agency.
GPS Monitoring Station	For this purpose of the GKGSA GSP, this term refers to survey benchmarks measured periodically using GPS technology for the purpose of measuring changing in elevation overtime.
Groundwater	Water beneath the surface of the earth within the zone below the water table in which the soil is completely saturated with water but does not include water that flows in known and definite channels.

Groundwater dependent ecosystem	Ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface.
Groundwater extraction facility	A device or method for extracting groundwater from within a basin.
Groundwater flow	The volume and direction of groundwater movement into, out of, or throughout a basin.
Groundwater recharge or recharge	The augmentation of groundwater, by natural or artificial means.
Groundwater sustainability agency	One or more local agencies that implement the provisions of this part. For purposes of imposing fees pursuant to Chapter 8 (commencing with Section 10730) or taking action to enforce a groundwater sustainability plan, groundwater sustainability agency also means each local agency comprising the groundwater sustainability agency if the plan authorizes separate agency action.
Groundwater sustainability plan or plan	A plan of a groundwater sustainability agency proposed or adopted pursuant to this part.
Historical Water Budget	Also known as a "base period," the GKGSA "historical water budget" was selected to be between the years of 1999 and 2022. Fulfills DWR's regulatory requirement that, "a quantitative assessment of the historical water budget (be prepared) starting with the most recently available information (2022 in the case of Kaweah and extending a minimum of 10 years, or as 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."

Individual impact	A singular impact that can be induced by groundwater conditions associated with sustainability indicators. A specific count or combination of individual impacts are what constitutes "significant and unreasonable effects" Examples of individual impacts: a single domestic well going dry, a canal experiencing a loss of conveyance capacity, an ag well unable to meet production needs
In-lieu use	The use of surface water by persons that could otherwise extract groundwater in order to leave groundwater in the basin.
Interconnected surface water	Surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.
Interested parties	Persons and entities on the list of interested persons established by the Agency pursuant to Water Code Section 10723.4.
Interim milestone	A target value representing measurable groundwater conditions, in increments of five years, set by an Agency as part of a Plan. Interim milestones are targets such as groundwater elevations that will be achieved every 5 years to demonstrate progress towards sustainability.
Key Well	Wells preliminarily selected for the Kaweah Subbasin to establish a consistent, long-term source of data to monitor water levels in various aquifers over the long-term.
Land surface subsidence	The inelastic compaction that 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 caused by groundwater pumping.
Local agency	A local public agency that has water supply, water management, or land use responsibilities within a groundwater basin.

Management area	An area within a basin for which the Plan may identify different minimum thresholds, measurable objectives, monitoring, or projects and management actions based on differences in water use sector, water source type, geology, aquifer characteristics, or other factors.
Measurable objectives	Specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin. Measurable objectives are goals that the GSP is designed to achieve, and that groundwater management is being informed by.
Minimum threshold	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. – (DWR - Sustainable Management Criteria BMP; page 6)
Mitigation Program	A Subbasin-wide program document that details the standardized Mitigation/Technical Assistance Claims Process, program qualification criteria, and considerations to be made in each GSA-specific Mitigation Plan.
Mitigation Plan	A GSA-specific planning document that details GSA-specific roll out of the Kaweah Subbasin Mitigation Program, GSA funding mechanism, and localized mitigation needs context.
Model calibration	Adjustment of model input parameter such as hydraulic conductivity of aquifer storativity to improve the match between simulated and empirical data. During the development of the Kaweah GSPs only limited calibration us performed including adjusting only hydraulic conductivity of all three model layers between verifications runs in order to improve the match of simulated and empirical data. Calibration can be very time consuming and

	expensive, so the consulting team was only able to complete limited calibration give the time and budget constraints that existing during development of the 2020 GSPs. Calibration recommendations have been provided completion in the future as funding becomes available.
Model verification	Groundwater model runs performed for the purpose of checking or verifying how well the model generated heads match empirical values at key wells.
NAD83	The North American Datum of 1983 computed by the National Geodetic Survey, or as modified.
NAVD88	The North American Vertical Datum of 1988 computed by the National Geodetic Survey, or as modified.
Operator	A person operating a groundwater extraction facility. The owner of a groundwater extraction facility shall be conclusively presumed to be the operator unless a satisfactory showing is made to the governing body of the groundwater sustainability agency that the groundwater extraction facility actually is operated by some other person.
Owner	A person owning a groundwater extraction facility or an interest in a groundwater extraction facility other than a lien to secure the payment of a debt or other obligation.
Personal information	Personal information has the same meaning as defined in Section 1798.3 of the Civil Code.
Plain language	Language that the intended audience can readily understand and use because that language is concise, well-organized, uses simple vocabulary, avoids excessive acronyms and technical language, and follows other best practices of plain language writing.
Plan	A groundwater sustainability plan as defined in the Act.

Plan implementation	An Agency's exercise of the powers and authorities described in the Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities.
Plan manager	An employee or authorized representative of an Agency, or Agencies, appointed through a coordination agreement or other agreement, who has been delegated management authority for submitting the Plan and serving as the point of contact between the Agency and the Department.
Planning and implementation horizon	A 50-year time period over which a groundwater sustainability agency determines that plans and measures will be implemented in a basin to ensure that the basin is operated within its sustainable yield.
Principal aquifers	Aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems.
Projected water budget	For the Kaweah basin, "projected water budget" refers to the period between water years 2023 and 2072, fulfilling the DWR regulatory requirement that the GSP utilize 50 years of hydrology, and consider the impact of climate change on precipitation, evapotranspiration, streamflow.
Protective threshold	A depth within a well where if water levels were to decline below, the well is assumed to experience operational impacts. The protective threshold is a key component of the Dry Well Susceptibility Analysis, as all wells with available construction and location data were assessed under different groundwater level surface scenarios to evaluate if the water table was falling below the protective threshold at and should not be confused with 'minimum thresholds' which are set only at representative monitoring sites.
Public water system	Public water system has the same meaning as defined in Section 116275 of the Health and Safety Code.

Recharge area	The area that supplies water to an aquifer in a groundwater basin.
Reference point	A permanent, stationary and readily identifiable mark or point on a well, such as the top of casing, from which groundwater level measurements are taken, or other monitoring site.
Representative monitoring	A monitoring site within a broader network of sites that typifies one or more conditions within the basin or an area of the basin.
Seasonal high	The highest annual static groundwater elevation that is typically measured in the Spring and associated with stable aquifer conditions following a period of lowest annual groundwater demand.
Seasonal low	The lowest annual static groundwater elevation that is typically measured in the Summer or Fall and associated with a period of stable aquifer conditions following a period of highest annual groundwater demand.
Seawater intrusion	The advancement of seawater into a groundwater supply that results in degradation of water quality in the basin and includes seawater from any source.
Significant and unreasonable	The tipping point at which the groundwater conditions throughout the Subbasin cause impacts to beneficial uses, users, land uses and property interests that cannot be sustained or mitigated. This must be stakeholder driven. Significant and unreasonable is not defined in the Regulations. However, the definition of undesirable results states, “Undesirable results occur when significant and unreasonable effects … are caused by groundwater conditions….” This GSP adopts the phrase significant and unreasonable to be the qualitative description of undesirable conditions due to inadequate groundwater management. Minimum thresholds are the quantitative measurement of significant and unreasonable conditions.

Statutory deadline	The date by which an Agency must be managing a basin pursuant to an adopted Plan, as described in Water Code Sections 10720.7 or 10722.4.
Sustainability goal	The existence and implementation of one or more groundwater sustainability plans that achieve sustainable groundwater management by identifying and causing the implementation of measures targeted to ensure that the applicable basin is operated within its sustainable yield.
Sustainability indicator	Any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results, as described in Water Code Section 10721(x). The five sustainability indicators relevant to the Subbasin include chronic lowering of groundwater levels, reduction of groundwater storage; degraded groundwater quality, land subsidence, and depletion of interconnected surface water. Seawater intrusion is not applicable because the Subbasin is located over 100 miles from the Pacific Ocean.
Sustainable groundwater management	The management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.
Sustainable management criteria	Minimum thresholds, measurable objectives, and interim milestones and are quantitative criteria measured at a network of representative monitoring sites that provide adequate coverage such that undesirable results are avoided and the basin is on track with the sustainability goal.
Sustainable yield	The maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus that can be withdrawn annually from a groundwater supply without causing an undesirable result.

Uncertainty	A lack of understanding of the basin setting that significantly affects an Agency's ability to develop sustainable management criteria and appropriate projects and management actions in a Plan, or to evaluate the efficacy of Plan implementation, and therefore may limit the ability to assess whether a basin is being sustainably managed.
Undesirable result	A combination of minimum threshold exceedances that that quantitatively reflect the presence of significant and unreasonable effects. Undesirable result is not defined in the Regulations. However, the description of undesirable result states that it should be a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the subbasin. Undesirable results should not be confused with significant and unreasonable conditions. Significant and unreasonable conditions are qualitative descriptions of conditions to be avoided; an undesirable result is a quantitative assessment based on minimum thresholds.
Urban water management plan	A plan adopted pursuant to the Urban Water Management Planning Act as described in Part 2.6 of Division 6 of the Water Code, commencing with Section 10610 et seq.
Water budget	An accounting of the total groundwater and surface water entering and leaving a basin including the changes in the amount of water stored.
Watermaster	A watermaster appointed by a court or pursuant to other law.
Water Accounting Framework	The agreed-upon methodology to account for various components of the water budget consistent with commonly accepted rules regarding surface water and groundwater rights. This framework is reflected in the Subbasin Coordination Agreement.

Water source type	The source from which water is derived to meet the applied beneficial uses, including groundwater, recycled water, reused water, and surface water sources identified as Central Valley Project, the State Water Project, the Colorado River Project, local supplies, and local imported supplies.
Water use sector	Categories of water demand based on the general land uses to which the water is applied, including urban, industrial, agricultural, managed wetlands, managed recharge, and native vegetation.
Water year	The period from October 1 through the following September 30, inclusive.
Water year type	The classification provided by the Department to assess the amount of annual precipitation in a basin.
Wellhead protection area	The surface and subsurface area surrounding a water well or well field that supplies a public water system through which contaminants are reasonably likely to migrate toward the water well or well field.

EXECUTIVE SUMMARY [§354.4(A)]

§354.4 General Information. *Each Plan shall include the following general information:*
(a) *An executive summary written in plain language that provides an overview of the Plan and description of groundwater conditions in the basin.*

ES-1. Introduction

The State of California enacted the Sustainable Groundwater Management Act (SGMA), effective January 1, 2015, to mandate comprehensive sustainable groundwater resources management. SGMA provides a statewide framework for groundwater management by locally formed Groundwater Sustainability Agencies (GSAs). The Greater Kaweah Groundwater Sustainability Agency (GKGSA) was formed in 2015 to satisfy the requirement for a GSA to cover a portion of the Kaweah Subbasin, alongside 2 additional GSAs of the Kaweah Subbasin: East Kaweah GSA (EKGSA) and Mid-Kaweah GSA (MKGSA) (Figure ES-1). The Kaweah Subbasin is surrounded by the Kings Basin to the north, Tulare Lake Subbasin to the west, and Tule Subbasin to the south (Figure ES-2).

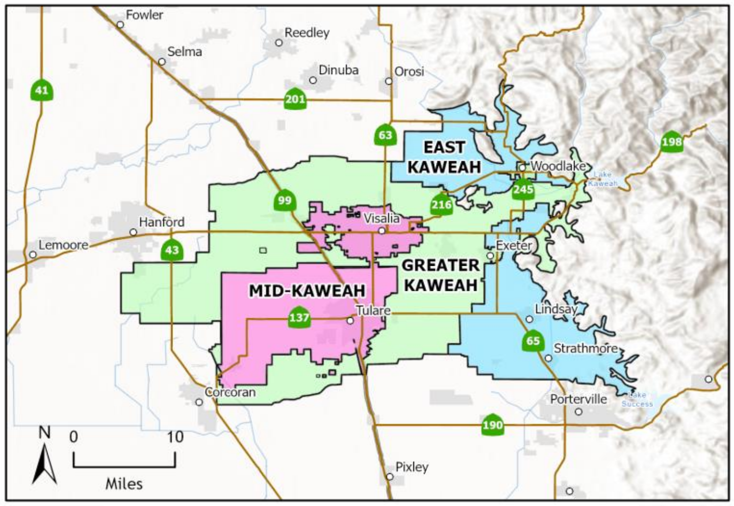


Figure ES-1. Kaweah Subbasin Groundwater Sustainability Agencies

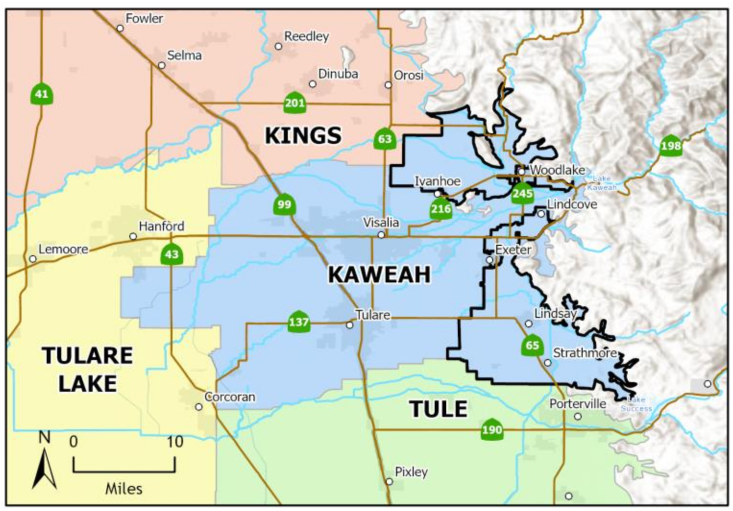


Figure ES-2. Neighboring Subbasins

Following submittal of an initial notification in 2017, GKGSA began development of the initial Groundwater Sustainability Plan (GSP) to comply with SGMA's statutory and regulatory requirements and initiated planning by engaging with stakeholders and holding public meetings. This GSP is the second amended GSP, following a first amended GSP adopted in 2022 to address comments and plan deficiencies identified by the California Department of Water Resources (DWR). This GSP includes greater protections for the most vulnerable beneficial users, uses and property interests through revised sustainable management criteria, coordinated methodology between GSAs and surrounding Subbasins, consistency between different sustainability indicators' sustainable management criteria, and a clarified sustainability path with predictive modeling to demonstrate that the Kaweah Subbasin will eliminate overdraft and achieve sustainability by 2040.

The goal of this GSP is to sustainably manage the groundwater resources of GKGSA for the benefit of current and anticipated future beneficial users of groundwater and the welfare of the general public who rely directly or indirectly on groundwater. This GSP outlines the approach to achieve and maintain a sustainable groundwater resource free of undesirable results pursuant to the SGMA, while establishing long-term reliability no later than 20 years from GSP adoption.

The content of the GSP includes administrative information, description of the basin setting, development of quantitative sustainable management criteria that consider the interests of all beneficial uses and users of groundwater, identification of projects and management actions and monitoring networks that will ensure the Basin is demonstrably managed in a sustainable manner no later than the 20-year sustainability timeframe and for the duration of the entire 50-year planning and implementation horizon.

This GSP is generally organized as follows:

Chapter 1 - Introduction

Chapter 2 – Plan Area

Chapter 3 - Basin Setting

Chapter 4 – Monitoring Networks

Chapter 5 - Sustainable Management Criteria

Chapter 6 - Projects and Management Actions

Chapter 7 - GSP Implementation

Chapter 8 - References

ES-2. Plan Area

The GKGSA jurisdictional area is approximately 340 square miles (50% of the subbasin) and is situation across the subbasin, from an apex on the eastern side where the Kaweah River enters the subbasin to the western side. The East Kaweah GSA area is located on the eastern flank of the subbasin and is bisected by GKGSA. The Mid-Kaweah GSA area is located within the central to western side of the subbasin and is surrounded by GKGSA, except for a portion of its western boundary.

KDWCD is the primary local agency that measures groundwater levels at numerous wells within the GKGSA area along with DWR for the California Statewide Groundwater Elevation

Monitoring (CASGEM) program. KDWCD has also established land subsidence monitoring stations throughout the subbasin.

General plans have been prepared by Tulare and Kings Counties and by the Cities of Exeter, Farmersville, and Woodlake. These plans promote the conservation of water and the protection of the quantity and quality of groundwater in their respective areas. The GKGSA will support these polices and work for improvements, as necessary, during the implementation of the GSP. Public outreach was included in the development of the GSP to address the interests of beneficial uses and users of groundwater. GKGSA conducted a voluntary online survey of users and held focused meetings with various organizations during 2019 as well as conducting regular meetings of the Board of Directors, the Technical Advisory Committee, the Rural Communities Committee, and the Stakeholders Committee.

ES-3. Basin Setting

Section 3 provides summary information for the GKGSA portion of the basin setting, which was developed for the entire subbasin and presented in **Appendix 3A**. The basin setting is comprised of a hydrogeologic conceptual model, groundwater conditions, and a water budget.

Groundwater Level Trends

In general, groundwater flows across the GKGSA in a southwesterly direction and to local cones of depression during the irrigation season. A single aquifer is present in the eastern half of the subbasin but is split into two aquifers by the Corcoran Clay in the western half. The vertical flow gradient is from shallow to deep conditions. Groundwater quality data are available for public water supply wells across the GKGSA area and from a limited sampling of domestic wells. Several legacy constituents of concern were identified due to concentrations near maximum contaminant levels (MCLs) or due to increasing trends in concentration, most notably arsenic, nitrate, certain volatile organics, and 1,2,3-trichloropropane (1,2,3 TCP).

Land Subsidence

Land subsidence due to overpumping has occurred throughout the San Joaquin Valley during the last 100 years. The Corcoran Clay, which is the primary regional confining layer, and other fine-grained units within the Kaweah Subbasin's aquifer systems are susceptible to subsidence. The greatest subsidence in the Subbasin occurs along the western and southern boundaries of the MKGSA area. Greater amounts of subsidence have occurred beyond the Kaweah Subbasin to the west and south. Groundwater levels throughout the majority of the Kaweah Subbasin do not appear to support Interconnected Surface Waters or Groundwater Dependent Ecosystems (GDEs). However, data availability are limited at this time and additional work is proposed under a new work plan included in the Management Actions Section 7.3 to better understand interconnected surface water presence and nexus of depletions due to groundwater pumping, if any.

Groundwater Quality

Groundwater quality is generally good, but available data are primarily located in the northern and eastern portions of the GKGSA corresponding with public water supply wells. Several constituents of concern have been identified due to concentrations near Maximum Contaminant Levels (MCLs) or due to increasing trends, including arsenic, nitrate, certain volatile organics, uranium, and 1,2,3-trichloropropane.

Water Budgets

The Subbasin groundwater flow model was used to quantify water budgets for the historical, current, and projected conditions, including the evaluation of uncertainty due to climate change. The historical, current, and projected water budgets summarize overall groundwater conditions, and the benefits of groundwater management activities on groundwater sustainability in the Subbasin.

This GSP includes both a groundwater budget and a land surface budget, which combined, serve as the water budget. In agricultural areas such as the Kaweah Subbasin, a land surface budget is an additional useful element to review to assess changes in water demands over time and evaluate the water demand versus water supply balance due to climatic variations and land use changes. A diagram of the groundwater budget inflow and outflow components is available in Figure ES-5 and a diagram of the land surface budget inflow and outflow components are available on Figure ES-6.

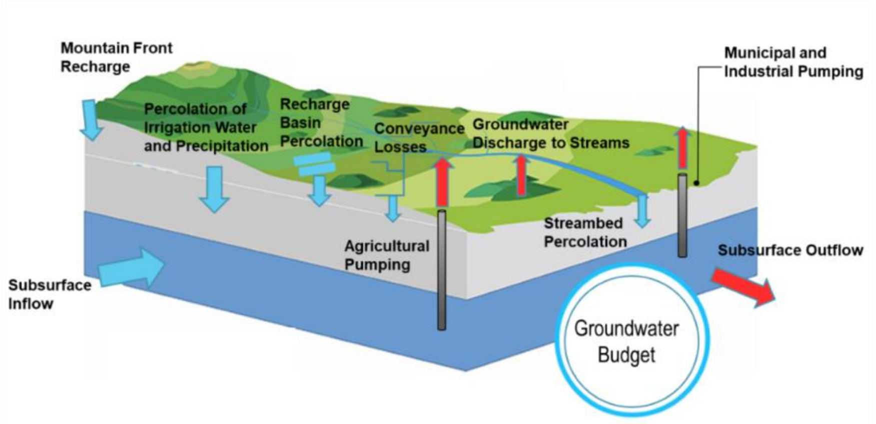


Figure ES-4. Diagram of Groundwater Budget Components

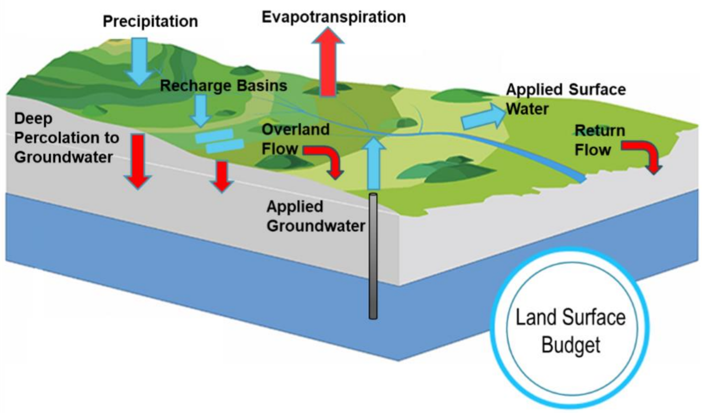


Figure ES-3. Diagram of Land Surface Budget Components

Components

The current groundwater budget shows an average annual aquifer storage loss of 226,600 AFY. Recharge projects and demand management actions are already being implemented in the Subbasin and it is imperative they be expanded soon to achieve sustainable groundwater conditions and limit land subsidence during the GSP implementation period.

For the projected water budget, the Subbasin's implementation of projects and pumping reductions results in a modest, increase in groundwater storage in the aquifer of about 6,600 AF/year. The elimination of overdraft, along with avoiding undesirable results, demonstrates that projects and management actions planned by all 3 GSAs are sufficient to achieve sustainability during the GSP implementation period. Projections are based on the assumed future hydrology, surface water availability and conditions in neighboring Subbasins.

Sustainable Yield

The sustainable yield of the Subbasin is an estimate of the quantity of groundwater that can be pumped on a long-term average annual basis without causing undesirable results. Basin-wide pumping within the sustainable yield estimate is neither a measure, nor proof of, sustainability. Sustainability under SGMA is only demonstrated by avoiding undesirable results for the applicable sustainability indicators. However, estimates of sustainable yield using the current and projected simulations may prove useful in estimating the need for projects and management actions to help achieve and maintain sustainability.

Groundwater elevations simulated in the projected GSP implementation model scenario through 2070 compared to MTs, indicate undesirable results are unlikely. Therefore, average annual pumping in the GSP implementation scenario can be used as an estimate of sustainable yield for the Subbasin. However, the projected groundwater budget indicates an average annual increase in groundwater storage of 6,600 AF. Accordingly, this number is added to average annual projected pumping to arrive at a sustainable yield of 550,000 AF of groundwater pumping per year.

ES-4. Monitoring Networks

Monitoring is a fundamental component of a groundwater management program. Monitoring is the method by which progress towards reaching measurable objectives and the goal of groundwater sustainability is measured. The Kaweah Subbasin and GKGSA representative monitoring network includes monitoring sites from existing programs and recently constructed wells dedicated to monitoring for SGMA and other purposes. The representative monitoring network is organized in three parts: (1) groundwater level representative monitoring network, (2) groundwater quality representative monitoring network, and (3) land subsidence monitoring network.

Chapter 4 provides information on the monitoring network for surface water flow, groundwater levels, groundwater quality, and land subsidence for the GKGSA area.

ES-5. Sustainable Management Criteria

Sustainable Management Criteria (SMC) were developed using the best available science and information for the Subbasin, involved the stakeholder engagement process (Figure ES-3), and were developed in coordination with all three GSAs and their respective technical teams and stakeholder committees.

Just as important as establishing limits to avoid undesirable results through minimum thresholds, it is important to establish the sustainability goal to design measurable objectives, policies, projects and management actions, and adaptive strategies to achieve sustainable conditions by 2040. The sustainability goal for the Kaweah Subbasin is as follows.

> *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 [the Kaweah Subbasin area within] Tulare County and within portions of Kings County.*

GKGSA, along with the other 2 GSAs, characterized undesirable results and established minimum thresholds, measurable objectives, and interim milestones for each applicable sustainability indicator:

1. Chronic lowering of groundwater levels (Section **5.5**)
2. Land subsidence (Section **Error! Reference source not found.**)
3. Reduction of groundwater storage (Section **5.7**). *For this GSP and pursuant to GSP Emergency Regulations §354.28(d), groundwater elevations are used as a proxy for the depletion of groundwater storage.*
4. Degraded water quality (Section **5.8**).
5. Depletion of interconnected surface water (Section **5.9**)

For the GKGSA area, SMCs are not developed for seawater intrusion due to the vast distance from the Pacific Ocean or for depletion of interconnected surface water due to depth to groundwater being greater than 60 feet below ground and thus disconnected from surface water.

A key part of the SMC development process is defining undesirable results for each sustainability indicator. The process for defining undesirable results consisted of multiple steps:

1. First, potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other effects were evaluated and described qualitatively.
2. The qualitative statement on potential effects was then translated and quantified into minimum thresholds at specific monitoring network sites.
3. Lastly, a combination of minimum threshold exceedances representing undesirable results in the Basin was established.

ES-6. Projects and Management Actions

Section 6 provides an accounting of various types of water within the Kaweah Subbasin for the three GSAs. The total volume of water was 660 TAF and was comprised of three primary types, including native water at 364 TAF, foreign water at 73 TAF, and salvaged water at 223 TAF. The GKGSA was apportioned 46% of the total volume, including 50% of the native water, 21% of the foreign water and 49% of the salvaged water.

Chapter 6 provides a description of 16 projects and 16 management actions to enable the GKGSA to succeed at the sustainable management of its groundwater resources. The options include improvements to existing recharge basins, new recharge and storage facilities, changes in operations to gain access to wet-year flows that would previously pass through the subbasin, agricultural and urban conservation, and fallowing as well as further study of wells and the subbasin plus assistance with impaired wells. In addition, the potential use of flow meters would facilitate the application of several management programs, including fees and incentives, a groundwater market, and groundwater allocations.

A key component of this 2nd amended GSP is the establishment of a Subbasin Mitigation Program and GSA-specific Mitigation Plans that establishes requirements for drinking water well mitigation. The Mitigation Program directly addresses the impacts of chronic lowering of groundwater levels, reduced groundwater in storage, groundwater quality, and land subsidence caused by lowered groundwater levels by providing funding for replacement wells, well modifications, alternative water supplies, or critical infrastructure (if applicable) improvements to eligible landowners.

ES-7. GSP Implementation

Implementation of the GKGSA GSP requires significant administrative and financial structures with adequate human resources and funding to ensure compliance with SGMA. Activities associated with GSP implementation are:

1. Agency administration
2. Legal counsel
3. Outreach and coordination
4. Monitoring (groundwater levels, groundwater quality, and land subsidence)
5. Addressing data gaps (groundwater monitoring wells, and flow gages)
6. Required annual reporting
7. Developing projects and management actions

8. Updating the groundwater model
9. Updating the data management system
10. Evaluating/amending the GSP at least every 5 years
11. Responding to DWR and State Water Resources Control Board (SWRCB) comments

1 INTRODUCTION TO THE KAWEAH SUBBASIN SECOND GROUNDWATER SUSTAINABILITY PLAN AMENDMENT

1.1 Introduction [§354]

§354 Introduction to Plan Contents. This Article describes the required contents of Plans submitted to the Department for evaluation, including administrative information, a description of the basin setting, sustainable management criteria, description of the monitoring network, and projects and management actions.

This second amended Groundwater Sustainability Plan (GSP) covers the Greater Kaweah Groundwater Sustainability Agency's (GKGSA's) jurisdiction within the Kaweah Subbasin and has been prepared in compliance with the Sustainable Groundwater Management Act (SGMA).

The Kaweah Subbasin [#5-22.11 per California Department of Water Resources (DWR) Bulletin 118] (DWR, 2003, 2016), occupying some 700 sq. miles within the larger San Joaquin Valley Basin, is situated primarily within Tulare County, California. It is one of the prime agricultural regions in the Central Valley and home to numerous small towns and communities, as well as the larger cities of Tulare and Visalia. The region's surface water supplies consist of the local Kaweah River system, as well as the Friant Unit of the Central Valley Project (CVP). Conjunctive-use recharge operations, which make use of these sources, have been a longstanding practice in the Subbasin.

Most urban communities rely exclusively on groundwater, and agricultural lands possess a mix of surface supplies as well as groundwater, depending on location. The Subbasin is considered to be in critical overdraft, estimated to average 104,000 acre-feet (AF) per year. Land subsidence caused by historical groundwater overdraft is an issue also faced by the Subbasin. Groundwater quality concerns related primarily to small-system and domestic wells are diffusely spread across the Subbasin and stem from legacy fertilizer applications in agricultural areas, contaminant plumes from other land uses, and possible degraded individual septic systems as a result of age, poor maintenance, and/or lack of routine service.

1.2 Purpose [§354]

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 in which the Greater Kaweah Groundwater Sustainability Agency (GKGSA) is located, the deadline for achieving sustainability is 2040.

The three Groundwater Sustainability Agencies (GSAs) responsible for groundwater management of the Kaweah Subbasin initially received an incomplete determination from the California Department of Water Resources (DWR) for the 3 GSPs and coordination agreement (collectively referred to as the Plan for the Subbasin) on January 28, 2022. The revised Plan for the Kaweah Subbasin in response to DWR's incomplete determination was subsequently found to be inadequate by DWR on March 2, 2023. The inadequate determination[1] was made because actions taken to correct identified deficiencies were not sufficient. Two of the 3 deficiencies apply to the GKGSA GSP:

> Deficiency 1 – the Plan does not set SMC for chronic lowering of groundwater levels in the manner required by SGMA and the GSP regulations.
>
> Deficiency 2 - the Plan does not set sustainable management criteria for subsidence in the manner required by SGMA and the GSP regulations.

Once DWR determines that a GSP is inadequate, primary jurisdiction shifts from DWR to the State Water Resources Control Board (State Board), which may designate the Subbasin probationary.

The GKGSA GSP addresses SGMA compliance aspects in a coordinated fashion with the 2 other Subbasin GSAs (EKGSA and MKGSA). The 8 chapters of this Plan, which in general introduce the GKGSA, describe the basin setting, monitoring networks, Subbasin sustainability goals, and sustainable management criteria (SMC) leading to sustainability, and projects and management actions needed to achieve those objectives. The content of the various chapters are listed below:

> **Chapter 2**: Describe the GSP Plan Area.
>
> **Chapter 3**: Describe the Basin Setting (Hydrogeologic Conceptual Model, HCM) to define and describe the geographic and geologic setting of the GKGSA boundaries. In order to comply with the requirements of SGMA, GKGSA and the 2 other Kaweah GSAs contracted with GEI Consultants, Inc. (GEI) for development of the basin setting used for

[1] https://sgma.water.ca.gov/portal/service/gspdocument/download/9589

the 2020 GSPs. This 2020 Basin Setting (Appendix 3A) still applies, but more current groundwater conditions updates have been added to Chapter 3.

> **Section 3.3**: Describe historical and current groundwater conditions within the Kaweah Subbasin.

> **Section 3.4**: Report the historical, current, and projected groundwater budgets for GKGSA and the Kaweah Subbasin.

Chapter 4: Describe the monitoring networks within the Kaweah Subbasin and those particular to EKGSA.

Chapter 5: Identify and describe the Sustainable Management Criteria (SMC) for the Kaweah Subbasin:

> Identify and describe the Undesirable Results for applicable sustainability indicators, as they pertain to the GKGSA.

> Identify and describe the Minimum Thresholds (MTs) and Measurable Objectives (MOs) required for the GKGSA to achieve the Sustainability Goal.

Chapter 6: Define and describe Projects and Management Actions proposed by EKGSA to achieve the Sustainability Goal.

Chapter 7: Describe how the Projects and Management Actions and SMC together will result in the Kaweah Subbasin achieving sustainability by 2040.

Chapter 8 : References

1.3 Agency Information [§354.2 and §354.6(a),(b),(c)]

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

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

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

Agency Name:	Greater Kaweah GSA
Agency Address:	2975 Farmersville Rd, Farmersville, CA
Agency Phone Number:	(559) 747-5601
Agency Fax Number:	(559) 747-1989
Agency Website:	greaterkaweahgsa.org
Contact Person:	Mark Larsen
Contact Person Title:	General Manager

Letter of Intent to Form GSAs: See Appendix 1A

The GKGSA is a joint powers authority formed by five member agencies. The board of directors is comprised of one representative from each member agency, except the Kaweah Delta Water Conservation District (KDWCD), which is allotted two representatives. In addition, the board of directors includes one representative from the Rural Communities Committee, one representative from the Stakeholder Committee, and one representative from California Water Service Company. The total number of directors is nine.

Currently, the only staff of the GKGSA is a General Manager and one technical support staff, whose services are contracted through KDWCD, a member agency of the GKGSA. Staff from KDWCD is available to assist the General Manager as needed. The General Manager of the GKGSA, at the direction of the GKGSA board of directors, is the person with management authority for implementation of the Plan.

As agreed to in the Coordination Agreement, attached hereto and incorporated by reference as Appendix 1B, the Plan Manager for the Kaweah Subbasin is the General Manager for the GKGSA, currently Mark Larsen, whose contact information is located above.

1.4 Legal Authority [§354.6(d)]

§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:

(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.

On August 23, 2016, the Kaweah Delta Water Conservation District (KDWCD), the Kings County Water District, the Lakeside Irrigation Water District, St. John's Water District, and the County of Tulare entered into a Joint Powers Authority (JPA) Agreement to form the Greater Kaweah Groundwater Sustainability Agency (GKGSA). Under this JPA Agreement, the GKGSA was granted the Authority to complete all acts necessary for the exercise of all powers authorized under SGMA and necessary to satisfy the requirements of SGMA. This JPA Agreement is included in **Appendix 2A**.

1.5 GSP Implementation Costs [§354.6(e)]

§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 GKGSA, on behalf of its member agencies, will incur costs to implement its GSP and maintain the plan via annual reports and 5-year updates. These costs and sources of funding are described below.

Table 1-1 presents an estimate of the costs associated with the implementation of the GKGSA GSP and measures associated with SGMA compliance.

Table 1-1: Estimated Costs for GSP Implementation

Item	Description	Estimated Cost
Annual Monitoring	Equipment, vehicles, SCADA, software	$100,000
Projects	Projects with estimated capital or startup costs per Section 7	$43,000,000
Management Actions	Management Actions with estimated annual costs per Section 7	$7,000,000
Annual Report	Compilation per DWR Regulations	$25,000
5-Year GSP Update and Report	Compilation per DWR Regulations, Assessment Report	$250,000
GSA / GSP Administration	Administration, Legal, Data management, Enforcement, other	$500,000

1.6 Agency Coordination [§354.8(c)]

§354.8 Description of Plan Area. Each Plan shall include a description of the geographic areas covered, including the following information:

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

The three Kaweah Subbasin GSAs worked to coordinate the Subbasin-wide sustainability goal, undesirable results, and SMC, among many other items pertaining to this GSP. The Coordination Agreement submitted with this GSP is included as Appendix 1B.

2 PLAN AREA [§354.8]

The GKGSA is located entirely within the Kaweah Subbasin, as defined in DWR Bulletin 118, in the Tulare Lake Hydrologic Region of the San Joaquin Valley Groundwater Basin. The Kaweah Subbasin is bounded by the Kings River Subbasin to the north, the Tulare Lake Subbasin to the west, the Tule Subbasin to the south, and the Sierra Nevada Mountains to the east. The Kaweah and St. Johns Rivers and Cottonwood and Mill Creeks flow through the northern portion of the GKGSA jurisdictional area, from the Sierra Nevada Mountains, turning southwest and draining toward the Tulare Lake Basin. The GKGSA is roughly bisected by California State Highway 99 and the Mid-Kaweah GSA is located within the west-central portion of the GKGSA. The following section describes the area covered by the GKGSA GSP.

2.1 Geographic Area Covered [§354.8 (a)(1),(2)]

§354.8 Description of Plan Area. Each Plan shall include a description of the geographic areas covered, including the following information:

(a) One or more maps of the basin that depict the following, as applicable:
   (1) The area covered by the Plan, delineating areas managed by the Agency as an exclusive Agency and any areas for which the Agency is not an exclusive Agency, and the name and location of any adjacent basins.
   (2) Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.

As shown in **Figures 2-1 and 2-2**, the GKGSA's jurisdictional area (343 square miles) represents nearly half (49%) of the area within the Kaweah Subbasin (696 square miles), with boundaries coincidental to the boundaries of the Mid-Kaweah GSA, the East Kaweah GSA, and the perimeter of the Kaweah Subbasin. The GKGSA is adjacent to the Kings River Subbasin to the north, Tule Subbasin to the south, the Tulare Lake Subbasin to the west, and the foothills to the Sierra Nevada Mountains to the east. The Mid-Kaweah GSA is located within the west-central portion of the GKGSA area in the vicinity of Visalia and Tulare and west of Tulare.

2.2 Plan Area Setting [§354.8(a)(4)]

§354.8 Description of Plan Area. Each Plan shall include a description of the geographic areas covered, including the following information:

(a) One or more maps of the basin that depict the following, as applicable:
   (4) Existing land use designations and the identification of water use sector and water source type.

The GKGSA is located entirely within the Kaweah Subbasin, as defined in DWR Bulletin 118, in the Tulare Lake Hydrologic Region of the San Joaquin Valley Groundwater Basin (see **Figure 2-1**). The Kaweah Subbasin is bounded by the Kings River Subbasin to the north, the Tulare Lake Subbasin to the west, the Tule Subbasin to the south, and the Sierra Nevada Mountains to the east. The Kaweah and St. Johns Rivers and Cottonwood and Mill Creeks flow through the northern portion of the GKGSA jurisdictional area, from the Sierra Nevada Mountains, turning southwest and draining toward the Tulare Lake Basin. The GKGSA is roughly bisected by

California State Highway 99 and the Mid-Kaweah GSA is located within the west-central portion of the GKGSA. The following section describes the area covered by the GKGSA GSP.

As shown in **Figures 2-1 and 2-2**, the GKGSA's jurisdictional area (343 square miles) represents nearly half (49%) of the area within the Kaweah Subbasin (696 square miles), with boundaries coincidental to the boundaries of the Mid-Kaweah GSA, the East Kaweah GSA, and the perimeter of the Kaweah Subbasin. The GKGSA is adjacent to the Kings River Subbasin to the north, Tule Subbasin to the south, the Tulare Lake Subbasin to the west, and the foothills to the Sierra Nevada Mountains to the east. The Mid-Kaweah GSA is located within the west-central portion of the GKGSA area in the vicinity of Visalia and Tulare and west of Tulare.

Land use within the GKGSA consists mainly of field crops, grain and hay crops, or pasture west of California State Highway 99, as shown in **Figure 2-7**. The eastern portion of GKGSA, outside of the City of Visalia, is mostly deciduous fruit and nut trees with grain and hay crops in the southeastern portion of the GKGSA area. The areas within the limits of the cities of Exeter, Farmersville, and Woodlake are classified as urban, as are the service areas for Ivanhoe Public Utility District, Patterson Tract Community Service District, and Tract 92 Community Service District.

2.3 Jurisdictional Boundaries within Plan Area [§354.8(a)(1),(2),(3)]

§354.8 Description of Plan Area. Each Plan shall include a description of the geographic areas covered, including the following information:

(a) One or more maps of the basin that depict the following, as applicable:
  (1) The area covered by the Plan, delineating areas managed by the Agency as an exclusive Agency and any areas for which the Agency is not an exclusive Agency, and the name and location of any adjacent basins.
  (2) Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.
  (3) Jurisdictional boundaries of federal or state land (including the identity of the agency with jurisdiction over that land), tribal land, cities, counties, agencies with water management responsibilities, and areas covered by relevant general plans.

Within the GKGSA jurisdictional area, population centers include three incorporated cities and several unincorporated communities. The City of Exeter, the City of Farmersville, and the City of Woodlake are completely located within the GKGSA. A portion of the City of Hanford is also located in the western portion of the GKGSA. Unincorporated communities within the GKGSA area include Goshen, Ivanhoe, Tract 92, and Patterson Tract, as shown on **Figure 2-2**. In addition, **Figure 2-1** shows various water conveyance systems within the Kaweah Subbasin while **Figure 2-2** shows the jurisdictional areas of the KDWCD, Kings County Water District (KCWD), St. Johns Water District, and Lakeside Irrigation Water District within the GKGSA area. Other groundwater users include numerous *de minimus* domestic wells and multi-parcel water systems within the GKGSA, which will be covered by this GSP.

2.3.1 Local Agencies within Plan Area [§354.8(a)(1)]

The lands located within the service areas of KCWD, KDWCD, Lakeside Irrigation District, and St. Johns Water District may have access to both surface water supply and groundwater supply. The incorporated communities, community service districts (CSDs), public utility districts (PUDs), and undistricted lands within the GKGSA area are supplied by groundwater only. Refer to **Figure 1-2** for the locations of these areas within the GKGSA.

Each of the three incorporated cities in GKGSA's area have adopted General Plans. For the areas not within the limits of the incorporated cities, the Tulare County General Plan applies. The General Plans for the cities and the General Plan for the County each have land use elements which address water usage. These elements are to be considered in this GSP.

2.3.2 State and Federal Agencies within Plan Area [§354.8(a)(3)]

The member agencies of the GKGSA have existing relationships with state and federal regulatory agencies. Local supplies are impounded by the Terminus Dam, which is owned and operated by the US Army Corps of Engineers (ACOE). The Kaweah and St. Johns River Association, managed by KDWCD staff, works closely with the ACOE on both water supply and flood control for local supplies. In addition, KDWCD is a CVP, Friant Division Contractor with the US Bureau of Reclamation and remains in close communication regarding importation of CVP water.

2.3.3 Tribal Lands within Plan Area [§354.8(a)(3)]

There are no tribes with designated tribal lands within the GKGSA's boundaries. Per the Native American Heritage Commission (NAHC's) letter response, the record search of the NAHC's Sacred Lands File identified that the Wuksache Indian Tribe/Eshom Valley Band has a sacred land in the area known as Rocky Hill. The Rocky Hill area is in the foothills east of the City of Exeter and is presumed to be outside both the boundaries of the GKGSA and Kaweah Subbasin. Section 2.7.19 further describes a list of several California Native American Tribes, their status and contact information.

2.3.4 Absence of Adjudicated Areas or Areas Covered by Alternative Plans [§354.8(a)(2)]

There are no adjudicated areas or areas covered by Alternative Plans within the Kaweah Subbasin.

2.4 Water Use by Service Sector within Plan Area [§354.8(a)(4)]

§354.8 Description of Plan Area. Each Plan shall include a description of the geographic areas covered, including the following information:

(a) One or more maps of the basin that depict the following, as applicable:
  (4) Existing land use designations and the identification of water use sector and water source type.

Figure 2-3 shows the various water sources and water use sectors in the GKGSA. The majority of the GKGSA uses a combination of surface water and groundwater for mostly agricultural uses, followed by commercial/industrial uses. The southwestern corner of the area relies on groundwater for mostly agricultural uses and the urban areas within GKGSA also rely solely on groundwater.

2.4.1 Surface Water and Conjunctive Use [§354.8(e)]

§354.8 Description of Plan Area. Each Plan shall include a description of the geographic areas covered, including the following information:

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

Kaweah Delta Water Conservation District, various private ditch companies, and Lakeside Irrigation District have, for many decades, supported the conjunctive use of surface water and groundwater and the recharge of the groundwater system with surface water. The GKGSA will facilitate these ongoing efforts by these various surface water entities.

2.4.2 Groundwater-Dependent Use [§354.8(g)]

§354.8 Description of Plan Area. Each Plan shall include a description of the geographic areas covered, including the following information:

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

All the communities in the GKGSA area are dependent on groundwater, including three incorporated cities (Exeter, Farmersville, Woodlake), several unincorporated communities, and the small community systems owned and operated by California Water Service Company (**Figure 2-2**), as well as the numerous domestic water users (*de minimus*) and multi-parcel water systems..

2.4.3 Well Density within Plan Area [§354.8(a)(5)]

§354.8 Description of Plan Area. Each Plan shall include a description of the geographic areas covered, including the following information:

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

(5) The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the Department, as specified in Section 353.2, or the best available information.

Figures 2-4, 2-5, and 2-6 are well density maps and show the overall distribution of domestic, production, and public supply wells within the GKGSA, respectively. These maps are based on information from the DWR's Online System of Well Completion reports (OSWCR). The SGMA regulation [§ 354.8(a)(5)] requires the mapping of agricultural, industrial, and domestic wells based on DWR data; and these figures are provided for that requirement. The DWR data appears to have combined agricultural and industrial wells into the production well category although the majority of production wells in the GKGSA are likely agricultural wells. The status of these wells (active, inactive, abandoned, destroyed) is not yet known and confirming the status is beyond the scope of this version of the GSP.

GKGSA conducted a preliminary reconnaissance-level survey of all wells in the Agency area in the Summer of 2019 using remote sensing and GIS tools. This survey was intended to create a foundation for an immediate well registration process following implementation of the Plan. The survey identified potential well locations, classified wells according to use and probability of current activity (active, possibly active and inactive). In conjunction with parcel ownership data, this information will be used to develop a targeted outreach distribution list for the purposes of well registration to gain a more precise and current understanding of wells in the region.

The figures show the 'square-mile' sections that are covered in whole, or in part, of the GKGSA area. This GSP was not intended to produce any finer resolution than provided by the DWR map application.

Table 2-1 summarizes the well completion report density information for wells that are classified as new construction from 01/01/2002 to 03\01\2022 as available from the DWR OSWCR. Only wells with intended use for domestic, agricultural, or public purposes are included. Well completion report data was summarized by section and assigned to GKGSA if the centroid of the section fell within the GSA boundary. Data from the remaining section centroids outside of GKGSA but within the subbasin are also included.

Table 2-1: Summary of Well Information

Location of Section Centroid		Total	Domestic	Agricultural	Public
Number of Wells	Within GKGSA	1,468	618	784	66
	Outside GKGSA	1,533	537	944	52
	Total	3,001	1,155	1,728	118

Well Density	**Max**	Within GKGSA	39	24	13	2
		Outside GKGSA	41	20	18	3
	Mean	Within GKGSA	8	4	3	1
		Outside GKGSA	7	3	3	1

Overall, a total of 3,001 well completion reports met the above criteria within the entire subbasin. Of those, 1,468 were assigned to GKGSA based on the section centroid method. Approximately 42% (618) were classified as domestic, 53% (784) as agricultural, and 5% (66) as public. Maximum density of wells per section was similar within and outside of GKGSA at 39 and 41 respectively. The mean densities for overall and each category were also almost identical within and outside of GKGSA.

The higher density domestic well sections within the GKGSA are generally located around population centers in the northeastern portions of the GKGSA area, east of Tulare, around Visalia, between Exeter and Farmersville, and in the vicinity of Woodlake. Production wells show lesser densities but are generally more evenly distributed across the GKGSA area. The distribution of public wells is quite low, with the highest density around Visalia and Farmersville.

2.5 Land Use Planning in Plan Area [§354.8(b),(c),(f)]

§354.8 Description of Plan Area. Each Plan shall include a description of the geographic areas covered, including the following information:

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

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

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

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

Land use within the GKGSA consists mainly of field crops, grain and hay crops, or pasture west of California State Highway 99, as shown in **Figure 2-7**. The eastern portion of GKGSA, outside of the City of Visalia, is mostly deciduous fruit and nut trees with grain and hay crops in the southeastern portion of the GKGSA area. The areas within the limits of the cities of Exeter, Farmersville, and Woodlake are classified as urban, as are the service areas for Ivanhoe Public Utility District, Patterson Tract Community Service District, and Tract 92 Community Service District.

The GKGSA will track updates to the land use plans of Tulare County, Kings County, and the Cities of Exeter, Farmersville, and Woodlake to ensure sustainable groundwater management can be accomplished in the Kaweah Subbasin. Tulare County is itself a member agency of the GKGSA. In addition, the communities both have representation on the board as well as the Rural Communities Committee.

The lands located within the service areas of KCWD, KDWCD, Lakeside Irrigation District, and St. Johns Water District may have access to both surface water supply and groundwater supply. The incorporated communities, community service districts (CSDs), public utility districts (PUDs), and undistricted lands within the GKGSA area are supplied by groundwater only. Refer to **Figure 2-7** for the locations of these areas within the GKGSA. Each of the three incorporated cities in GKGSA's area have adopted General Plans. For the areas not within the limits of the incorporated cities, the Tulare County General Plan applies. The General Plans for the cities and the General Plan for the County each have land use elements which address water usage. These elements are to be considered in this GSP.

2.5.1 County of Tulare General Plan

The 2030 General Plan Update for the County of Tulare, adopted on August 28, 2018, does not have a specific update to address water usage and supply. However, the 2012 County's General Plan has a Water Resources Element that requires the County to adopt ordinances and measures to:

1. Regulate the permanent extraction and exportation of groundwater from Tulare County.
2. Assure that all watershed planning is done on a complete regional and watershed basis, and that such planning considers a balance between urban and agricultural demands.
3. Where feasible, the County shall participate in coordinated local, regional, and Statewide groundwater monitoring and planning programs.
4. Encourage active participation by local stakeholders and develop groundwater monitoring partnerships with local groundwater users and developers. Avoid the destruction of established recharge sites.
5. Work with federal, State, local, and regional agencies to improve local groundwater pollution detection and monitoring.

6. Encourage responsible agencies and organizations to install additional groundwater monitoring wells in areas where data gaps exist.
7. Research the development of an education program to inform homeowners regarding water quality concerns.
8. Incorporate provisions, including evaluating incentives, for the use of reclaimed wastewater, water conserving appliances, drought tolerant landscaping, and other water conservation techniques into the County's building, zoning.
9. Identify and evaluate conditions within established watersheds which are causing deterioration of the water quality, water supply, or declining water yields.
10. Develop an education program to inform residents of water conservation techniques and the importance of water quality and adequate water supplies.
11. Protect groundwater recharge areas.
12. Amend County ordinances to include development standards which protect groundwater basins and surface water drainage areas and provide incentives for use of conservation techniques.
13. Establish development or design standards for the protection of groundwater recharge areas.
14. Work with other local/regional agencies, water purveyors, and interest groups to seek funding sources to implement a variety of surface and groundwater restoration activities.

2.5.2 Kings County General Plan

The 2035 Kings County General Plan was adopted on January 26, 2010 addresses water in the objectives and policies of various elements, primarily in Resource Conservation (RC) and in Dairy, as listed below. The RC element recognizes that nearly one-third of its annual water use is derived from groundwater, which is replenished by precipitation, surface and subsurface flows, and imported water. The plan acknowledges that recharge to the aquifer beneath the Corcoran Clay occurs to the north and east of Kings County. The Air Quality element recognized improvements in agricultural practices that provide benefits to energy and air quality, including water well efficiency upgrades, conversion to electric motors to pump water versus the use of diesel engines, and the application of fertilizers and pesticides with irrigation water.

Element	Statement
Introduction	Protect water, natural lands, agriculture, prime soils, native plant and animal habitat, threatened and endangered species, fishing, energy,

	mineral, and archeological, cultural and historical resources throughout the County.
Land Use Objective A1.2	Protect natural waterways to ensure continued water delivery and recharge to surrounding agricultural uses and related homesites, while maintaining the natural aesthetic appeal of the Kings River and Cross Creek waterway channels.
RC Policy A1.1.1	Cooperate with water purveyors and water management agencies to manage groundwater resources within the County to assure an adequate, safe and reliable groundwater supply for existing and future water users.
RC Policy A1.1.2	Review new discretionary development proposals, including new or expanded uses within agricultural zone districts, to ensure that there are adequate water supplies to accommodate such uses. Projects should provide evidence of adequate and sustainable water availability prior to approval of a tentative map or other land use approval.
RC Policy A1.1.3	Discourage the net export of groundwater and surface water resources currently allocated to water users within Kings County.
RC Policy A1.1.5	Encourage and support regional groundwater management strategies such as an Integrated Regional Water Management Plan.
RC Policy A1.1.6	Support expansion of joint management of surface water and groundwater supplies that contributes to the protection, reliability and sustainability of local and regional water supplies.
RC Policy A1.2.1	Encourage and support the development of educational programs by water purveyors and public agencies, in order to increase public awareness of water conservation opportunities and the potential benefits of implementing water-saving measures and programs.
RC Policy A1.2.3	Continue to support efforts and educational programs intended to reduce water consumption on agricultural lands and enhance groundwater recharge.
RC Objective A1.4	Protect the quality of surface water and groundwater resources in accordance with applicable federal, state and regional requirements and regulations.
RC Policy A1.4.1	Evaluate proposed land uses and development projects for their potential to create surface and groundwater contamination from point and non-point sources. 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 waste; floating debris; and runoff from the site.

RC Policy A1.4.2	Monitor and enforce provisions to control water pollution contained in the U.S. EPA National Pollutant Discharge Elimination System (NPDES) program as implemented by the California Water Quality Control Board, Central Valley Region (RWQCB).
RC Policy A1.4.3	Require the use of feasible and cost-effective Best Management Practices (BMPs) and other measures designed to protect surface water and groundwater from the adverse effects of construction activities and urban and agricultural runoff in coordination with the RWQCB.
RC Policy A1.4.4	Encourage and support the identification of degraded surface water and groundwater resources and promote restoration where appropriate.
RC Objective A1.5	Avoid the placement of potential pollution sources in areas that have the potential to foster groundwater recharge.
RC Policy A1.5.1	Cooperate with local agencies in the preservation and purchase of natural sloughs for use as water recharge and drainage basins.
RC Objective A1.6	Protect groundwater quality by applying development standards which seek to prevent pollution of surface or groundwater and net loss of natural water features.
RC Policy A1.6.2	Support measures to ensure that water users do not unreasonably use groundwater resources.
RC Policy A1.6.3	Protect groundwater by enforcing the requirements for installation of wells in conformity with the California Water Code, the Kings County Well Ordinance, and other pertinent state and local requirements.
Health and Safety Objective A3.1	Prepare for long term countywide drought conditions by encouraging water conservation measures among urban, rural, and agricultural users, and increase regional water storage capacity to enhance groundwater recharge and capture of floodwater.
Dairy Policy 1.2d	High groundwater areas. New dairies, or the expansion of existing dairies, are prohibited in shallow or perched groundwater areas of the County unless the applicant can demonstrate that the minimum vertical distance between proposed lagoon bottoms/corral surfaces and highest anticipated groundwater levels is at least five feet. Highest groundwater levels shall be established based on available records and site-specific geotechnical investigation by qualified registered professional engineer or hydrogeologist.
Dairy Policy 1.2h	Separation of dairy facilities by ¼ mile. The minimum distance between a Dairy Facility and other Dairy Facilities or confined animal feeding operations shall be one-quarter (¼) mile. This restriction includes only the actual dairy facilities, i.e., corrals, milk barns, feed storage areas, manure storage areas, etc., but not cropland used to spread dairy process water and manure. These separations are required to avoid potential nuisance

	problems, potential inter-herd disease transmission, soil and groundwater contamination, and cumulative air quality degradation.
Dairy Policy 3.1.a	With each application for a new or expanded dairy, a technical report shall be prepared and shall address the following siting issues: A. Ground and surface water quality and quantity, ….
Dairy Policy 3.2.a	The *Technical Report* shall address water issues in the Groundwater Evaluation (see Component 1b of Appendix J), …. A. Minimum separation from bottom of all lagoons, manure and feed storage areas, and corrals and the groundwater level shall be at least five (5) feet at all times. B. The source of potable water for the Dairy Facility, and the safeguards to protect that water source must be identified.
Dairy Policy 3.2.c	Minimum Dairy Facility setbacks from water wells and water bodies shall be required: A. Manured and feed storage areas on dairy facilities shall be set back 150 feet from wells and water bodies as required by the RWQCB. B. Dairy Facilities shall be designed to ensure that no runoff into surface waters, including rivers, creeks, intermittent streams, canals, reservoirs, lakes, ponds, sloughs, stormwater basins, groundwater recharge basins, floodplains, floodways, etc., will occur. This can be done by constructing barriers or grading the facility away from such water bodies.
Dairy Policy 3.2.d	Dairy process water shall not be discharged into any surface water, including rivers, creeks, intermittent streams, canals, reservoirs, lakes, ponds, sloughs, stormwater basins, or groundwater recharge basins.
Dairy Policy 3.2.h	*Hydrogeologic Sensitivity Assessment* (HSA): Whenever groundwater is being pumped from a hydrogeologic setting within one-half (½) mile of a proposed dairy site, or an expanding dairy, which is underlain by karst, fractured bedrock, or gravel, the applicants shall retain a qualified Certified Hydrogeologist or Professional Engineer to conduct a HSA. A. The HSA shall evaluate whether hydrogeologic setting would offer adequate barriers to pollutant migration to drinking water supplies. The evaluation shall be conducted in accordance with the principles contained in the EPA’s Ground Water Rule.
Dairy Policy 3.2.i	All existing active and inactive domestic and irrigation water supply wells (including those located at the dairy site) at a proposed new dairy or proposed expansion of an existing dairy shall be inspected by a qualified professional to ensure that each well is properly sealed at the surface to prevent infiltration of waterborne contaminants into the well casing or surrounding gravel pack. If any of the wells are found not to comply with the California Well Standards or RWQCB Standards, the

	applicant or dairy operator shall retain a licensed well driller to install the required seal or functional equivalent certified by a licensed engineer or other qualified registered professional. Documentation of the inspections and seal installations, if any, shall be maintained on the dairy site and made available to the Code Compliance personnel upon their request. This policy applies to all wells located on the Dairy Facility or on any farmland controlled by the dairy and used for the application of dairy process water.
Dairy Policy 4.1a	*Manure Nutrient Management Plan* (MNMP) Components: The following components shall be addressed in the MNMP. *B. Manure Handling and Storage* – Manure must be handled and stored properly to prevent water pollution from dairies. Manure and dairy process water handling and storage practices shall consider odor and other environmental and public health problems. Handling and storage considerations shall include: 2. *Prevent leakage* – Construction and maintenance of buildings, collection systems, conveyance systems, and storage facilities shall prevent releases of organic matter, nutrients, and pathogens to ground or surface water by implementing the following measures: a. All manure separation pits and process water lagoons shall be constructed so that the bottoms of the pits and lagoons are at least five feet above the highest expected groundwater levels.
Dairy Policy 4.1b	*Land Application of Manure* *B. Timing and methods of application* – Care must be taken when applying manure and process water to the land to prevent it from entering groundwater, streams, other water bodies, or environmentally sensitive areas. The timing and method of application shall prevent the loss of excess nutrients to groundwater or surface water.
Dairy Policy 4.1c	*Land Management* – Tillage, crop residue management, grazing management, and other conservation practices shall be utilized to minimize movement to surface water and groundwater of soil, organic materials, nutrients, and pathogens from lands where manure is applied.
Dairy Policy 4.1d	*Dead Animals Management Plan* – A Dead Animal Management Plan (see Component 5 of Appendix J) shall be prepared and implemented for the disposal of all dead animals in a way that does not adversely affect groundwater or surface water, create public health concerns, or cause nuisances due to odor or vectors.
Dairy Policy 4.4a	The County hereby adopts compliance with the water quality objectives of the Basin Plan as the threshold of significance for impacts to water quality from implementation of the Dairy Element. Therefore, dairy projects that 1) comply with the Basin Plan and 2) comply with the

	provisions in the Element allowing approval of a site plan review (SPR), do not create cumulatively significant environmental impacts on water quality.
Dairy Policy 6.2f	*Minimum standards for water quality monitoring program*: Water quality monitoring shall comply with all requirements and orders of the RWQCB. Copies of all reports that are required by, and submitted to, the RWQCB by any new or expanded dairy regulated under this Dairy Element shall also be provided a copy of those reports to the Kings County Zoning Administrator. A. Installation of groundwater monitoring wells at each dairy adequate to characterize the variations in depth to uppermost groundwater at the Dairy Facility and chemical quality of the uppermost groundwater zone. If noncontinuous perched groundwater zones underlie the facility, deeper aquifers may require monitoring. Vadose zone monitoring using lysimeters shall be required to monitor the quality of soil water, particularly in the vicinity of the lagoons. The design and installation of water quality monitoring system shall be performed under the direction of a Registered Geologist or a Professional Engineer in accordance with California Well Standards. B. Groundwater and soil water samples shall be analyzed, at minimum, for TDS, electrical conductivity, general mineral content, Nitrogen as nitrate and nitrite, phosphorus, and coliform or other appropriate indicator of biological contamination. This list of constituents to be analyzed may be modified at the request of the RWQCB. All samples should be analyzed by a State-certified analytical laboratory. C. Sampling of all wells and/or lysimeters shall be conducted prior to dairy operation to establish background levels and thereafter on an annual basis. In addition, the depth to water in each well shall be measured to within an accuracy of 0.01 feet twice each year, once in the spring and once in the fall.
Dairy Policy 6.4.d	Each dairy operator shall retain a qualified professional (i.e., Professional Engineer or Certified Hydrogeologist) to compile and evaluate the water quality data required by Policy DE 6.2f. The Code Compliance personnel shall review the data to determine whether violations have occurred, or if corrective action is required. When considering response action for identified violations, the County shall consult with the RWQCB.

The GKGSA will address these issues with the adoption and implementation of its GSP in support of the Counties' efforts to address these objectives in their respective General Plans.

2.5.3 City of Farmersville General Plan

The 2025 General Plan Update for the City of Farmersville, adopted on November 6, 2002, has numerous objectives to promote its future, including the fifth objective which states: "Protect and preserve natural resources, such as farmland, air and water quality and native vegetation, while facilitating growth of the community." According to the General Plan, the City obtains its water supply from the underlying aquifer and the well system draws water from 240 to 400 feet below ground level. The water table is recharged by percolation from the Kaweah River and its distributary system and from irrigation waters.

In Chapter 4, which addresses the Conservation, Open Space, Parks, and Recreation Element of the General Plan, the City includes air and water quality as Issue Five and states that it "must provide for long-range community water needs and protect [ground]water quality and quantity." Moreover, its goal is to "protect air and water quality from negative impacts" and the Water Quality sub-section provides the following objectives and action plans:

15. Promote a community awareness program that will educate the community in water-saving methodologies at the home and the work place.
    a. The Public Works department will provide the community with information brochures containing water-saving techniques. Further the department should prepare a Water Conservation Ordinance for adoption by the City Council.
16. Promote the use of native and drought-tolerant new landscaping in existing and future parks.
    a. The City is planning to prepare a Water Conservation Ordinance which shall stress the use of native and drought-tolerant species.
17. Allow for adequate groundwater recharge by developing storm ponding and retention basins where feasible. In some areas these ponds or basins can be incorporated into a recreational area or used as wildlife habitat area.
    a. The Engineering Department shall implement the policies of this Element with regard to locations of future park/pond basins.

2.5.4 City of Exeter General Plan

The Exeter General Plan, 2000 - 2020 was adopted by the City Council on March 8, 2003 and addresses water supply and usage in the Resources section of the Land Use Element. Water is listed as a natural resource along with air, land, and native plants and animals. The Plan promotes the "wise use and management of these resources" and provides the following goals:

- Conserve natural resources, including native trees, agricultural land, and water.

- Promote groundwater recharge.
- Promote energy and water conservation.

The Plan promotes the continued improvement to its water system, including funding for new water wells, but does not provide specific actions to address these goals. The GKGSA GSP will address these goals directly, particularly groundwater recharge and water conservation.

2.5.5 City of Woodlake General Plan

The Woodlake General Plan, 2008 to 2028, was adopted during 2009 and is similar to the Plans by the Cities of Exeter and Farmersville. The Land Use Element of the Plan lists water as a natural resource along with air, land, and native plants and animals; promotes the "wise use and management of these resources"; and provides the following goals:

- Conserve natural resources, including native trees, agricultural land, and water.
- Promote ground water recharge
- Promote energy and water conservation

The Conservation Element of the Plan identified the following components, goals, objectives, and actions:

1. Conservation, development and utilization of natural resources, including water, forests, soils, rivers and other waters, wildlife, and other natural resources.
2. Reduce the possibility of water quality contamination from surface contaminants by drawing water from 240 to 400 feet below the ground's surface level. The City has abandoned wells due to high nitrate concentrations.
3. Aquifer recharge is derived from the St. Johns River and from irrigation water stored in Bravo Lake and conveyed by the Wutchumna Ditch.
4. Monitor activities of local canal and irrigation districts and promote the preservation of these established recharge sites and waterways.
5. Promote a community awareness program that will educate the community in water-saving methodologies at the home and the work place and prepare a water conservation ordinance for adoption by the City Council.
6. Allow for adequate groundwater recharge by developing storm ponding and retention basins where feasible and incorporate these features into recreation or wildlife habitat areas.
7. Promote the use of native and drought-tolerant species in private and public landscaping areas.

The GKGSA will address these issues with the adoption and implementation of its GSP in support of these cities' efforts to address the objectives in their respective General Plans.

2.6 Additional GSP Elements [§354.8(g)]

§354.8 Description of Plan Area. Each Plan shall include a description of the geographic areas covered, including the following information:

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

The GKGSA 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.

2.6.1 Wellhead Protection [§354.8(f)(4)]

Tulare County does not have a specific program for wellhead protection and recharge areas but the region (Kings and Tulare Counties) was identified in a 2-page fact sheet (January 2018) on wellhead protection via the Southern San Joaquin Valley Management Practices Evaluation Program (SSJVMPEP). which produced a 2-page fact sheet on wellhead protection in January 2018 along with a similar fact sheet on abandoned and inactive wells.

Kings County has established a wellhead protection program for the handling and application of certain pesticides, including offset distances from wells, dwellings, schools, and other designated areas; well site requirements to minimize runoff to the wellhead area plus requirements for applicator certification, permitting, notifications, and other limitations related to unlined canals/ditches and to recharge basins. In 2004, Kings County designated a nominal 8-square mile area along Cross Creek, within the northwestern portion of the GKGSA area, as a runoff-type groundwater protection area (California Department of Pesticide Regulation, 2020).

2.6.2 Well Construction Policies

Tulare and Kings Counties have each adopted an ordinance for the construction of wells, based on California Well Standards as presented in DWR Bulletins 74-81 and 74-90. These requirements are administered by their respective environmental health departments. Details are available at the respective links: https://tularecountyeh.org/eh/index.cfm/our-services/water-wells/ https://tchhsa.org/eng/index.cfm/public-health/well-drilling/ and https://www.countyofkings.com/departments/health-welfare/environment-health-service/drinking-water/drinking-water-1.

2.6.3 Well Permitting Process [§354.8(f)(4)]

Well permits are required by Tulare County pursuant to various sections (4-13) of Tulare County Code Part IV, Chapter 13, Article 1. The ordinance is administered by the County Environmental Health Division and regulates the location, construction, reconstruction, destruction, and inactivation of all wells to ensure each well will produce high-quality water and to protect the quality of the groundwater. The ordinance incorporates the various DWR bulletins related to well standards (74-81 and 74-90). The county has updated and revised their well permit application in collaboration with GSAs with jurisdiction in the County. The revised permit application is intended to meet the needs of the County in permitting new wells and to meet the needs of the GSAs in implementing their authorities in accordance with SGMA. The County has revised the well permit application to include more robust data collection, providing the GKGSA with a better understanding of how groundwater is used in the Subbasin. The County has also implemented, in cooperation with local GSAs, a well permit notification and comment process. GSAs are notified when a well permit is submitted, along with receiving the well permit request. GSAs are allowed to review and comment on the well permit prior to issuance. Upon issuance of a well permit, the County notifies the GSA of the issuance.

More information on Tulare County's well permitting process is available at https://tularecountyeh.org/eh/our-services/water-wells/

and include the following information as of June 2022:

- Water Well Guidance
- Water Well Forms
- Water Well Contractors
- Voluntary Water Well Testing Program

2.6.4 Well Abandonment and Well Destruction Programs

The Tulare County Environmental Health Services Division is responsible for the ordinance that regulates the disposition of wells according to Chapter 13, Part IV of the Ordinance Code of Tulare County. Article 1, Section 4-13-1005, defines "Abandoned Well" as a well which has been inactive for at least one year or is incapable of producing water, and "Destruction of Wells" as filling and sealing the well to prevent human and animal exposure to physical harm from an open well and to prevent surface water, waste, debris and contaminants from entering the well. Similarly, the Kings County Environmental Health Services Department addresses well abandonment and destruction via Ordinance 587 where abandoned wells are defined as wells "whose use has been permanently discontinued" and must be destroyed accordingly.

Both counties require a well permit and the destruction work must be completed by a licensed (C-57) contractor. The ordinances incorporates various requirements of the DWR bulletins related to well standards (74-81 and 74-90). Tulare County received grant monies to facilitate the identification and destruction of more than 80 abandoned wells.

2.6.5 Control of Saline Water Intrusion

Saline water intrusion is the induced migration of seawater into a freshwater aquifer system and is typically observed in coastal aquifers where over-pumping of the freshwater aquifer causes ocean water to encroach inland, degrading the freshwater aquifer. The GKGSA is located over 80 miles from the Pacific Ocean, which negates the possibility of saline water intrusion.

2.6.6 Migration of Contaminated Water

The GKGSA does not actively participate in enforcement programs to address the presence and migration of contaminated groundwater as state and local agencies have established programs to address this topic. The GKGSA will encourage prompt and timely actions from responsible parties and these regulatory agencies to address/resolve the presence of contaminated groundwater and will not implement projects or management actions that exacerbate the condition. The GKGSA anticipates a point in the near future where water quality data can be assembled in a comprehensive package that will foster a program of proactive response to areas of concern, allowing for GKGSA to track contaminated issues and evaluate opportunities to pre-mitigate.

2.6.7 Measures Addressing Groundwater Contamination

The California Regional Water Quality Control Board, Central Valley Region (RWQCB) has implemented two long-term water quality programs to address wide-spread agricultural impacts throughout the Central Valley. These efforts include the Irrigated Land Regulatory Program (ILRP) and the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) program.

2.6.8 Groundwater Dependent Ecosystems

The Nature Conservancy (TNC) has identified potential groundwater dependent ecosystems (GDEs) in the Kaweah Subbasin and the vegetation and wetland areas associated with the relatively large surface water channels. Interconnected Surface Water is a sustainability indicator and is defined as “surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.” Interconnection between the surface water and groundwater could lead to GDEs and must be considered by the Plan. However, surface water channels are without flow in the GKGSA area for much of the year. Figure 19 of the Basin Setting Report (Appendix 3A) identified potential GDEs within the forebay area (east corner of the GKGSA) of the Subbasin and a small GKGSA area along the northern boundary of the subbasin (total area is over 9,000 acres) because depths to groundwater were within 50 feet of the ground surface during spring 2015. A review of the potential GDE map did not identify any vegetation or wetlands at the small area along the northern boundary. In the highlighted forebay area, approximately 850 acres support potential GDEs, including about 500 acres of tree vegetation, 220 acres of wetlands, and nearly 140 acres of a mixture of both categories. The tree vegetation only areas are dominated by Goodding's Willow (~40%) along with Valley Oak (~20%), and Fremont Cottonwood (~20%) while seven other species are present in the remainder. These trees are present in the mixed habitat area, and the Goodding's Willow is dominant (~60%) compared to the Valley Oak and Freemont Cottonwood (~30% together). The wetland areas are comprised of riverine (~70%) and palustrine (~30%) conditions and this proportion is reversed in the mixed habitat area where palustrine is dominant (~70%) compared to riverine (~30%). Given that groundwater is produced from aquifers more than 50 feet deep beneath the GSA, the vegetation and wetlands listed by TNC are believed to be surface water dependent. Further study will be taking place going forward through the Interconnected Surface Water Data Gap Work Plan included in the Management Action Section 7.7 of this GSP.

2.6.9 Groundwater Replenishment

Groundwater replenishment occurs naturally through deep percolation of rainfall, storm runoff via stream and river channels, and irrigation water via unlined channels and ditches and from irrigated fields. In addition, intentional replenishment occurs via deep percolation at recharge basins and wastewater effluent basins. KDWCD, as a water conservation district, engages in numerous groundwater replenishment activities. The primary sources of groundwater recharge are local supplies from the Kaweah River and imported water supplies from the CVP.

Tulare County recognizes the presence of groundwater contamination in some areas and has a voluntary well testing program for selected constituents, including bacteriological, nitrate, dibromochloropropane, and gross alpha. The County charges reasonable fees for the collection and analysis of samples from new private and public domestic wells.

2.6.10 Efficient Water Management Practices

The GKGSA supports the efforts of Tulare County and the Cities of Exeter, Farmersville, and Woodlake to implement efficient water management practices as well as encouraging its constituents to pursue such practices.

2.6.11 Existing Monitoring and Management Programs

Existing Monitoring and Management programs are detailed in **Section 4.1 Existing Monitoring Networks and Programs.**

2.7 Notice and Communication [§354.10(a)(b)(c)(d)]

§354.10 Notice and Communication. 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.
(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) A communication section of the Plan that includes the following:
   (2) Identification of opportunities for public engagement and a discussion of how public input and response will be used.
   (3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.
   (4) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

SGMA and subsequent Emergency Regulations developed by the DWR in May 2016 identified a number of requirements for public notice and communication related to GSA formation and GSP development. California Code of Regulations §354.10 identifies the requirements for notice and communication information in a GSP. Below is the identification of beneficial users and uses of groundwater in the GKGSA, the description of participating agencies in the GKGSA, followed by a series of descriptions of notice and communication activities utilized by the GKGSA to reach out, connect, educate, and solicit comments from beneficial users and uses of groundwater for GKGSA implementation activities and GSP development.

2.7.1 Beneficial Users and Uses [§354.10(a)]

§354.10 Notice and Communication. 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 uses of groundwater within GKGSA's jurisdiction primarily include agricultural, industrial, municipal and domestic water supply. GKGSA serves as GSA for the area comprising the collective jurisdictional area of its members. Beneficial users and uses of groundwater were identified and engaged by GKGSA based on the place and interest-based categories described in SGMA and codified in Water Code §10723.2. Beneficial uses and user of groundwater are codified in Water Code §10723.2 as:

(a.) Holders of overlying groundwater rights, including:

   (1) Agricultural users, including farmers, ranchers, and dairy professionals
   (2) Domestic well owners

(b.) Municipal Well Owners
(c.) Public water systems
(d.) Local land use planning agencies

(e.) Environmental users of groundwater

(f.) Surface water users, if there is a hydrologic connection between surface and groundwater bodies

(g.) The federal government, including, but not limited to, the military and managers of federal lands

(h.) California Native American

(i.) Disadvantaged communities, including, but not limited to, those served by private domestic wells or small community water systems

(j.) Entities listed in Section 10927 that are monitoring and reporting groundwater elevations in all or a part of a groundwater basin managed by the groundwater sustainability agency Beneficial users and uses representing these categories and nature of consultation with these users are further described below.

2.7.1.1 Disadvantaged Communities

Data published by the U.S. Census Bureau (Bureau) in 2016 show ten areas within the jurisdiction of the GKGSA that meet the annual Median Household Income (MHI) criteria[2] to be considered a Disadvantaged Community (DAC) or severely disadvantaged community (SDAC). DACs in the region that meet the 2016 Bureau criteria for Census Designated Places—as well as the broader criteria for Census Tracts and Block Groups—are the City of Exeter and the communities of Lemon Cove and Patterson Tract. The cities of Farmersville and Woodlake, and the communities of Linnell Camp, Ivanhoe, and West Goshen have been identified as SDACs. Unincorporated communities that meet the Census Tract and Block Group criteria for DACs and SDACs, respectively, are the Cameron Creek Colony and Hypericum. While a DAC per Bureau data, a door-to-door survey conducted in 2014 by Self-Help Enterprises and California State University, Fresno, indicate that Cameron Creek Colony qualifies as a SDAC.

Consultation with these communities occurred primarily through the Rural Communities Committee, further described in Section 1.4.5. These committee meetings served as a collaborative forum for both community members and committee members to identify and resolve potential issues important for Plan development activities. In addition, the GKGSA followed best practices for engaging DAC and SDAC community members and eliminating potential access barriers these individuals may face. These practices included translating materials into Spanish and holding public workshops in coordination with the Community Water

[2] A DAC is defined as a census geography community with an annual MHI that is less than 80 percent of the Statewide annual MHI (PRC Section 75005(g))]. A SDAC is a census geography community with an annual MHI that is less than 60 percent of the Statewide annual MHI. The statewide MHI for the U.S. Census Bureau American Community Survey 5-Year Data: 2012 – 2016 is $63,783. Therefore, the calculated DAC and SDAC thresholds are $51,026 and $38,270, respectively.

Center, Leadership Counsel for Justice and Accountability, and the Union of Concerned Scientists at locations convenient for the targeted community.

2.7.1.2 Agricultural Users

Agriculture and rangeland cover a broad area of the Kaweah Subbasin. Agricultural interests were represented in GSP during the Plan's development by water, conservation, and irrigation districts. Representatives from the agricultural community serve on both the GKGSA Board of Directors (Board) and the Stakeholder Committee, further described in Section 1.4.5. During the Plan's development, this included participation from the Consolidated Peoples Ditch Company, Farmers Ditch Company, Fleming Ditch Company, Foothill Ditch Company, Lemon Cove Ditch Company, Mathews Ditch Company, and the Wallace Ranch Water Company. As with the Rural Communities Committee, each Stakeholder Committee meeting is conducted as a collaborative forum where members and community members can discuss and resolve topics important for development of this Plan. Individual agricultural water users were also consulted and kept informed through existing communication channels of participating ditch companies, periodic electronic communication by the GKGSA and its sister GSAs in the Kaweah Subbasin.

2.7.1.3 Private Domestic Well Owners

Private domestic well operators within the GKGSA primarily include rural residents interspersed with active farmlands and rural schools. These domestic well water users are located in the unincorporated area of Tulare County and are represented on the Board by the County of Tulare. Domestic well owners had the opportunity to consult on the Plan during Board and Stakeholder Committee meetings, and review of this Plan.

2.7.1.4 Municipal Well Owners

Municipal and industrial (M&I) water supplies within the GKGSA are drawn exclusively from groundwater resources. Replenishment of this shared resource has been historically lead by the KDWCD in coordination with the local 27 irrigation districts and other regional partners. The M&I well operators include the cities of Exeter; Farmersville, Woodlake, and Hanford; Ivanhoe Public Utilities District; Patterson Tracy Community Services District; Tract 92 Community Services District, Lemon Cover Sanitary District; and California Water Service Company.

The M&I well operators are represented on both the Board and Rural Communities Committee. In addition, local M&I water providers in turn conducted outreach to and consulted with their customers through distribution of informational materials and postings on their websites and social media accounts, as available.

2.7.1.5 Public Water Systems

Public water systems within the GKGSA include the cities of Exeter, Farmersville, Woodlake; Lemon Cove Sanitary District; Patterson Tract Community Services District; Tract 92

Community Services District; Ivanhoe Public Utilities District; and the County of Tulare. Each of these agencies is consulted through representation on the Rural Communities Committee. In addition, the Rural Communities Committee appoints one representative to serve on the Board. The County of Tulare supports two County Service Areas, one of which serves the community of Wells Tract—a small community east of the City of Woodlake's sphere. Residents of Wells Tract receive drinking water and wastewater service from the City of Woodlake through an agreement with the County of Tulare.

2.7.1.6 Surface Water Users

Given their connection to agricultural users, surface water users have been continually consulted regarding Plan development. Surface water supplies in the GKGSA region are diverted primarily from the Kaweah and St. John's Rivers, with supplemental supplies from the Friant Division of the Central Valley Project. The Kaweah River St. Johns Association manages distribution of surface water supplies from local supplies on behalf of surface water right holders. The KDCWD conducts groundwater recharge operations with surface water from the Kaweah River and the Friant Division. Surface water users within GKGSA primarily include farm, ranch, and dairy operations. These users were consulted through representation on the Stakeholder Committee, as well as regular communications through GKGSA member agencies' existing community platforms.

2.7.1.7 Federal Government

Water Code section 10723.2(g) codifies the federal government as a beneficial user of groundwater. No federal lands were identified in the GKGSA that are using groundwater.

2.7.1.8 Governmental and Land Use Planning Agencies

Governmental and land use planning agencies in the GKGSA include the planning commissions of the cities of Exeter, Farmersville, and Woodlake; and counties of Tulare and Kings. The County of Tulare is a member agency of the GKGSA and has one seat on the Board. The cities of Woodlake, Farmersville, and Exeter were consulted through their representation on the Rural Communities Committee. In addition, GKGSA representatives provided a presentation to the City of Woodlake and City of Farmersville Planning Commissions on February 25, 2019 and April 17, 2019, respectively. The presentations' content included an overview of SGMA, the status of development of the Plan, and government and land use planning agencies' obligations under SGMA in association to general plan updates. Other local planning commissions were also invited to provide comment on this Plan.

2.7.1.9 California Native American Tribes

As part of its 2016 formation notification to DWR, the GKGSA preliminarily identified five California Native American Tribes for potential engagement in the planning process. The

GKGSA submitted a Sacred Lands File and Native American Contacts List Request to the Native American Heritage Commission (NAHC) on May 15, 2018. The GKGSA's request to the NAHC included a general description of the GKGSA and map identifying US Geological Survey quadrangles wholly or partially in the GKGSA's boundaries. The NAHC replied to the request on May 22, 2018 and identified five potentially affected California Native American Tribes in the area of potential effect. These tribes, and their status, is identified in **Table 2-2**.

There are no tribes with designated tribal lands within the GKGSA's boundaries. Per the NAHC's letter response, the record search of the NAHC's Sacred Lands File identified that the Wuksache Indian Tribe/Eshom Valley Band has a sacred land in the area known as Rocky Hill. The Rocky Hill area is in the foothills east of the City of Exeter and is presumed to be outside both the boundaries of the GKGSA and Kaweah Subbasin.

Table 2-2: Native American Tribes Identified in NAHCs Sacred Lands File and Native American Contacts List Request Response

Tribal Name	Contact	Title	Address	City/State/Zip	Sacred Lands File?
Kern Valley Indian Community	Robert Robinson	Chairperson	P.O. Box 1010	Lake Isabella, CA 93240	Yes
Santa Rosa Indian Community of the Santa Rosa Rancheria	Leo Sisco	Chairperson	P.O. Box 8	Lemoore, CA 93245	Yes
Tubatulabals of Kern Valley	Robert L. Gomez Jr.	Chairperson	12600 Mountain Mesa Road	Lake Isabella, CA 93240	Yes
Tule River Indian Tribe	Neil Peyron	Chairperson	P.O. Box 589	Porterville, CA 93258	Yes
Wuksache Indian Tribe/Eshom Valley Band	Kenneth Woodrow	Chairperson	1179 Rock Haven Court	Salinas, CA 93906	Yes

GKGSA staff began engaging tribes during GSA formation. In October 2016, GKGSA staff sent a letter to the Santa Rosa Indian Community of the Santa Rosa Rancheria informing them about potential formation of the GKGSA and inviting a representative of the tribe to serve on the Stakeholder Committee. No tribes in the region expressed interest in serving on the Stakeholder Committee. All tribes listed in **Table 2-2** above were notified of the availability of the draft Plan for public comment.

2.7.1.10 Environmental Users of Groundwater

Initially, GKGSA has not identified environmental users of groundwater within the region. The GKGSA did consult with organizations representing environmental interests, including the Tulare Basin Wildlife Partners and Sequoia Riverlands Trust, during development of this Plan. Representatives from these organizations served on the Stakeholder Committee and were consulted extensively on the topics of interconnected streams, ecosystem multi-benefit projects, and potential mitigation of groundwater dependent ecosystems. Members of these groups were kept up to date on GKGSA activities and development of this Plan through existing communication channels led by their representatives that serve on the Stakeholder Committee. More recently, the Sequoia Riverlands Trust has engaged with the GKGSA in regard to best defining interconnected surface water in the eastern areas of the Subbasin.

2.7.1.11 Groundwater Elevation Monitoring and Reporting Entities

Groundwater elevation monitoring and reporting in the GKGSA is primarily led by KDWCD, a member agency of GKGSA. Since 1995, the KDWCD led the Groundwater Management Plan for the Kaweah Subbasin in accordance with the implementing provisions of AB3030, and managed a series of wells registered in the California Statewide Groundwater Elevation Monitoring Program (CASGEM).

2.7.1.12 Citizens Groups and General Public

Citizens groups and members of the general public, many of which are also beneficial users, were invited to engage in Board and Committee meetings, and other public meetings coordinated by GKGSA. In addition, outreach was conducted to civic organizations of the cities of Exeter, Woodlake, and Farmersville; and periodic presentations to the Tulare County Water Commission. These included presentations to the Woodlake Kiwanis Club, Rotary Club of Farmersville, Rotary Club of Woodlake, and the Exeter Kiwanis Club. **Table 2-4** lists all organizations that received presentations as parts of the GKGSA Speaker's Bureau Program, further described below.

2.7.2 Participating Agencies [§354.10(a)]

The GKGSA Joints Powers Agreement and Bylaws (attached hereto and incorporated by reference as **Appendix 2A**) describe in detail the GKGSA JPA's decision-making process.

The governing body of the GKGSA JPA consists of a nine-member Board of Directors (Board) that includes two seats held by the KDWCD; one seat for each founding agency; one seat held by California Water Service (Cal Water); and one seat each from a representative nominated by the Rural Communities Committee and Stakeholder Committee. The Cal Water representative on the Board is nominated by the utility and appointed by the Board. All decisions require a majority vote of the present and voting Board of Directors.

Cal Water is a privately held water utility regulated by the California Public Utilities Commission. Its participation on the Board was made possible through an amendment to Senate Bill 13 by Senator Fran Pavley and chaptered in California Water Code §10723.6(b)[3]. Cal Water's participates in the GKGSA's decision-making process through an agreement with the GKGSA JPA (See **Appendix 2A**). The agreement applies to Cal Water operations in East Tulare Villa (known as "Tulco"), West Goshen, Goshen and Oak Ranch. Cal Water service operations

[3] (b) A water corporation regulated by the Public Utilities Commission or a mutual water company may participate in a groundwater sustainability agency through a memorandum of agreement or other legal agreement. The authority provided by this subdivision does not confer any additional powers to a nongovernmental entity.

in the City of Visalia are within the jurisdictional boundary of the Mid-Kaweah GSA, a sister agency of GKGSA in the Kaweah Subbasin.

The decision-making structure of the GKGSA Board, shown in **Figure 2-8** below, is supported through a hierarchical structure that includes the GSA's Manager, Kaweah Subbasin Management Team, Technical Group, Rural Communities Committee, Stakeholder Committee, and Technical Advisory Committee. The Rural Communities Committee is comprised of local public agencies eligible to serve as a GSA pursuant to conditions described in California Water Code 10721(n)[4]. These communities include cities of Exeter, Farmersville and Woodlake, and the unincorporated communities of Ivanhoe, Lemon Cove, Patterson Track and Track 92. The Stakeholder Committee is comprised of private ditch companies, domestic well operators, growers, and non-profit organizations focused on ecosystem stewardship and enhancement. The Technical Advisory Committee is comprised of one technical person appointed by each Director. This group is led by a Director nominated by the full Board. To provide for a venue for consultation with community members, GKGSA and all of its committees, conduct and notice their respective meetings consistent to the Brown Act.

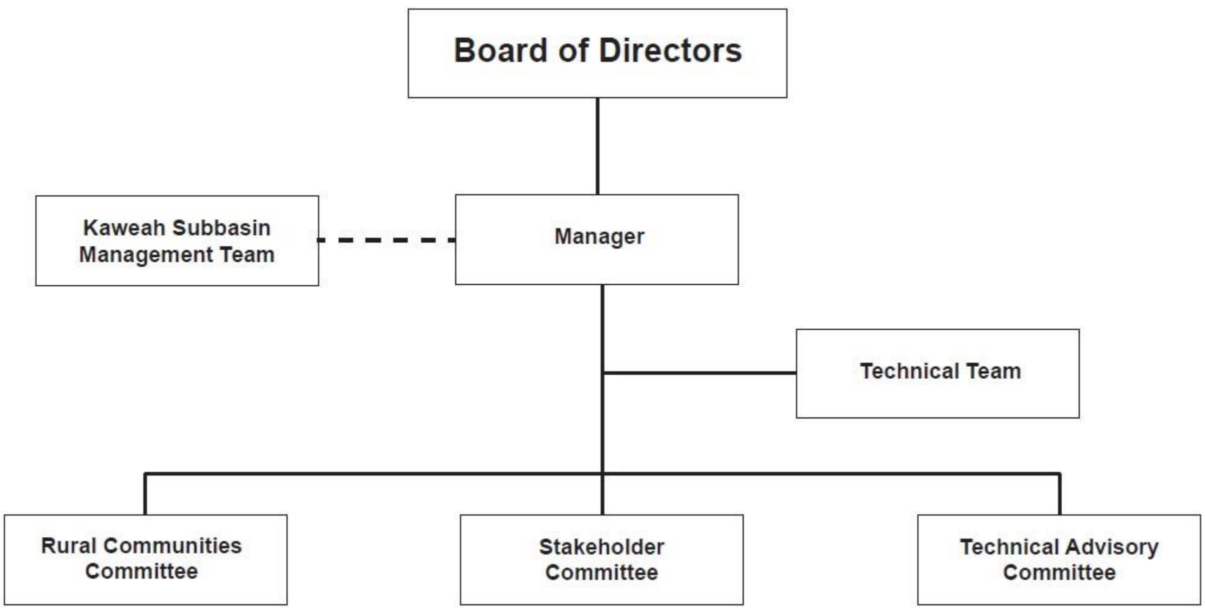


Figure 2-8: GKGSA Decision-Making Structure

[4] 10721(n) "Local agency" means a local public agency that has water supply, water management, or land use responsibilities within a groundwater basin.

2.7.3 Communication and Outreach Plan [§354.10]

§354.10 Notice and Communication. 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:

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

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

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

Notification and communication activities for the development of this Plan were guided by the GKGSA Communications and Engagement Plan of November 2018 (attached hereto and incorporated by reference as **Appendix 2B**. The C&E Plan serves to identify notification and communication activities that would meet or exceed the requirements and intent of the State legislature in passage of SGMA.

The nature of the consultation to beneficial users of groundwater and other interested parties was approached by segmenting stakeholders into one of three "groups," based on a stakeholder's level of interest in, or contribution to, GSP development. These groupings are as follows:

> **Group 1:** *Collaborated (Inform + Consult + Collaborate*) – This group has been closely connected during the planning process through direct engagements aimed to exchange information through active two-way communication. As a proactive and reactive activity, these engagements gather information, and develop solutions to existing and emerging issues.
>
> **Group 2:** *Consulted (Inform + Consult*) – This group has been connected during planning through written informational materials and scheduled presentations. This engagement is a proactive activity that seeks to gather stakeholder opinions to information presented by GKGSA.
>
> **Group 3:** *Connected (Inform*) – This group has been connected during planning through distribution of written informational materials and prepared informational presentations. Presentations would be held in response to stakeholder requests.

These groupings framed the approach GKGSA implemented to engage interested parties and stakeholder groups to participate in development of this Plan. Individuals and organizations were initially assigned one of the three groups by the GKGSA's Stakeholder Committee, with the anticipation that each stakeholder's involvement would change based on consultation with stakeholder and Plan content needs. All outreach efforts and engagement activities were tracked in a Community Engagement and Activities Database (CE & AD) that was continuously monitored and updated, consistent with DWR Emergency Regulations §354.10(b) and §354.10(d)

To encourage active participation during Plan development by the diverse social, cultural, and economic interests in the region, the GKGSA, in coordination with its Kaweah Subbasin sister agencies – East Kaweah GSA and Mid-Kaweah GSA – established the Kaweah GCP.

Established pursuant to Water Code §10723.4, the Kaweah GCP is a shared database of interested parties in the Kaweah Subbasin and provides for distribution of notices and announcements by email. In addition to the Kaweah GCP, the platform supports self-enrollment to an email database of the GSA or GSAs of the stakeholder's choice.

Additional tools to support public and stakeholder engagement included the GKGSA website (www.greaterkaweahgsa.org), the primary location for stakeholders within the GSA's boundaries to review information related to SGMA and implementation of this Plan. Information provided on the website includes: an overview of SGMA, GKGSA member agencies, Board, Board meeting notices and summaries, public outreach and timeline information, frequently asked questions, news, links, and a contact list. Past and upcoming workshops and public meetings are also on the site. The website also serves as a repository for outreach collateral, workshop materials, and meeting packets and minutes for the GKGSA Board, Stakeholder Committee, Rural Communities Committee, Technical Advisory Committee, and Kaweah Subbasin Management Team. The site is cross-linked to the Mid-Kaweah GSA and the East Kaweah GSA websites, the DWR SGMA information portal, and other related sites.

The primary opportunities for interested parties and members of the public to engage in development of this Plan included GKGSA Board and committee meetings, a public call for GSP projects and management actions, and the Plan public comment period. As described above, the GKGSA Board meets monthly and each of the three GKGSA committees meet, at a minimum, quarterly. All Board and committee meetings are open meetings pursuant to the Brown Act. Members of the public were notified of these meetings through notices sent to the interested parties database and postings on the GKGSA website. In addition, GKGSA representatives conducted a series of presentations to local organizations aimed at educating members of the general public about SGMA and encouraging participation at the Board and committee meetings. Each of these public engagement activities are further described below.

The GKGSA notified interested parties of the opportunity to provide input on the Public Review Draft Plan by posting on the GKGSA website, sending a notice to the interested parties database, and placing a notice in the local newspaper. Pursuant to SGMA, the GKGSA also sent a notice to cities and counties within the GKGSA's area of jurisdiction. Comments received from the public on the Public Review Draft Plan will be considered by the Board prior to Plan adoption. All comments received on the Public Review Draft Plan will be summarized in the Final GSP with a response from the GKGSA to each credible comment.

2.7.3.1 Stakeholder Surveys

To better understand and serve its community, the GKGSA gathered a large quantity of information on beneficial users within the boundaries of the Greater Kaweah subbasin by allowing stakeholders to participate in a voluntary water users survey. The survey was conducted online via a platform called Survey Monkey. The survey was five pages long and encompassed 85 questions that, among other questions, asked users which GSA they belonged to; what beliefs they had about groundwater and the environment; and what their knowledge of SGMA was;

what they thought were the most pressing issues or challenges surrounding groundwater usage; and what ideas or suggestions they had regarding sustainability. The survey was made available to stakeholders in March of 2019. The survey has garnered a total of 138 responses as of July 2019. The GKGSA saw a positive completion rate of 86 percent by stakeholders with a general end time of four minutes and nine seconds.

2.7.3.2 Public Call for Projects and Management Actions

In 2018, the GKGSA began soliciting concept proposals for projects and management actions from stakeholders that are consistent with the region's groundwater sustainability objectives. In preparation for this Plan, the GKGSA created the proposal system by putting together a document that would allow not only stakeholders, but the public at large to submit their own ideas and suggestions for actionable sustainability projects that they believed should be brought to the GSA’s attention.

2.7.4 Public Meetings [§354.10]

§354.10 Notice and Communication. 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.

The GKGSA bylaws (**Appendix 2A**) require regular quarterly meetings of its Technical Advisory Committee, Rural Communities Committee, and Stakeholders Committee; and monthly meetings of its Board. These meetings are noticed and open to the public, in accordance with the Brown Act. In addition to these meetings, the GKGSA participates in a monthly Kaweah Subbasin Management Team meeting as signatory to the Kaweah Subbasin Coordinated MOU and Kaweah Subbasin Coordination Agreement (**Appendix 1B**), which includes representatives from the three GSAs in the Kaweah Subbasin.

The following agencies have participated in public outreach activities, as JPA members of the GKGSA:

- Kings County Water District
- Kaweah Delta Water Conservation District
- Lakeside Irrigation District
- St. John’s Water District
- Tulare County

In addition to activities within its own jurisdictional area, the GKGSA has also participated in subbasin-wide SGMA outreach activities with the Mid-Kaweah GSA and East Kaweah GSA, with participation from the Tulare County Farm Bureau. Additional public outreach workshops were held for the GKGSA and are documented in **Appendix 2C** of this Plan.

2.7.4.1 Newsletter

Recognizing the establishment of SGMA, the GKGSA, and the GSP development were all new concepts for the beneficial users and uses of groundwater, in 2017 the GKGSA mailed the Greater Times newsletters out to landowners in the Subbasin to inform, educate and connect them with the Subbasin activities. Table 2-3 provides a lists of this and other forms of outreach and notice, all as a part of the GKGSA's adaptive process in involving stakeholders and public.

2.7.4.2 Kaweah Subbasin Presentations

The GKGSA reached out to more than 10 community organizations, stakeholder groups and agencies as part of a Speaker's Bureau Program to raise awareness of the agency and encourage participation in development of this Plan at Board and Committee meetings. The Speaker's Bureau Program sought to present information about the agency and status of Plan development during meetings hosted by the identified group. While the focus of the Speaker's Bureau Program is to secure placement on the agenda of meetings where members of a community gather, it is also a method to raise awareness in a stakeholder community by sharing information to individuals active in the community. Overall, the Speaker's Bureau resulted in 5 presentations and the distribution of GKGSA information to 11 organizations. Table 2-3 provides a lists of this and other forms of outreach and notice, all as a part of the GKGSA's adaptive process in involving stakeholders and public.

Table 2-3: Speaker's Bureau Program Presentations

Type	Group	Date Range	Number of Events	Attendees/ Audience	Participating GSA	Key Agenda Topics
Newsletter	Greater Kaweah GSA	October 2016 - Current	6 Editions	2000 + landowners	1	Update landowners on monthly activity and key decisions.
Outreach Events	Greater Kaweah GSA	October 2018- June 2023	8 Events	100+ Landowners	3	Communicate with Landowners to provide detailed information about SGMA and the GSAs.
Public Workshops	Greater Kaweah GSA	October 2018- June 2023	4 Workshops	1000+ Landowners	3	Review current activities, discuss policies with the public, review technical data, answer SGMA & GSA related questions
Speakers Bureau	Speakers Bureau	June 2019- 2024	5 Events	120 club members	1	Information about the agency and status of Plan development
Open House	Greater Kaweah GSA	January 2024- Current	5 Held	35+ landowners	1	Landowner Feedback, SGMA 101, Provide resources and tools to Landowners in the GKGSA

2.7.4.3 Board of Directors Meetings

Board meetings served, in part, as a venue for planning staff to receive direction for major technical and policy issues. Comments on these topics from the public, committee members, and other interested parties were welcomed during scheduled public comment sessions. Comments received during these sessions were responded to by Board members or staff, as appropriate. These meetings also served as key opportunities for the public and stakeholders to engage and consult in development of the GSP and to track its progress. Information and notification of Board meetings was publicly provided in accordance with the Brown Act. Meeting agendas and summaries were additionally posted on the agency website and distributed to stakeholders that registered as interested parties on the Kaweah Groundwater Communication Portal (GCP), as described in Section 1.4.6.

The Board met monthly, unless otherwise publicly noticed in accordance with the Brown Act. Since August 23, 2016, the Board has held 88 meetings, with the majority of the meetings held at the offices of Kaweah Delta Water Conservation District, 2975 N. Farmersville, CA. Several Board meetings were also held off site in larger venues when the subject matter suggested a large attendance. The list of meetings is available on the agency website. The meetings represented opportunities for the public and stakeholders to participate in Plan development and exchange ideas and concerns with Board members and agency staff. Standard agenda items at each Board meeting included a public comment session, an update on intra-basin coordination activities, and a report of committee activities.

2.7.4.4 Committee Meetings

Publicly noticed Stakeholder, Rural Communities, and Technical Advisory Committee meetings are important venues for development of recommendations to the Board to key technical, policy, and outreach issues. Interested members of the public were encouraged to engage and consult in these discussions and assist committee members in their consideration of a preferred approach. These recommendations were later provided to the Board for their consideration. Written notification for each meeting were posted on the GKGSA website and sent via email to all parties that subscribed to the Kaweah GCP. Notifications were additionally posted for public review at the meeting location, as required by the Brown Act.

Each of the committees holds monthly, public meetings, unless otherwise noticed. The Rural Communities Committee and Stakeholder Committee frequently hold joint meetings to discuss Plan development topics applicable to their respective beneficial water users. During Plan development, the majority of the committees' meetings were held at the KDWCD office in Farmersville. Common agenda topics for the Rural Communities Committee and Stakeholder Committee included updates on GKGSA activities and Plan development, subbasin coordination activities, inter-basin coordination activities, and public and stakeholder communication and engagement. Technical Advisory Committee agenda topics typically covered key Plan elements, such as the basin setting, sustainable management criteria, groundwater monitoring network, and projects and management actions. Agenda's, minutes, and materials from each committee meeting is posted on the GKGSA website.

2.7.4.5 Open House

Monthly Open House events where held by GKGSA in their office site in 2023 and 2024 to provide a topic oriented venue for growers to hear about policy discussions and development, program assistance, and tools for managing their groundwater resources. The events were informal opportunities to ask questions and comment on GSP implementation and policy direction. Table 2-3 provides a lists of this and other forms of outreach and notice, all as a part of the GKGSA's adaptive process in involving stakeholders and public.

2.7.5 Public Comments [§354.10]

> §354.10 Notice and Communication. 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:
>
> (c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.

The GKGSA has received and incorporated Stakeholder and public comment into this 2nd Amended Draft GSP throughout the preparation process. This Draft document will be circulated in a formal public comment process. Upon receipt of public comments, they will be incorporated into the final document.

2.7.6 Interbasin Coordination [§354.10]

354.10 Notice and Communication. 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:

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

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

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.

Development of this Plan was supported through a series of intra-basin and inter-basin coordination activities. The key intra-basin coordination activity was the Kaweah Subbasin Management Team (KSMT), a committee comprised of representatives from each of the three Kaweah Subbasin GSAs: East Kaweah, Greater Kaweah, and Mid-Kaweah. As members of the KSMT are appointed by their respective Board of Directors, all meetings of this group were publicly noticed consistent with the Brown Act. These meetings focused on development and evaluation of key policy and technical issues mutually shared by Kaweah Subbasin GSAs. Members of the public that attended these meetings were invited to provide comments on these topics. The schedule of KSMT and other intra-basin activities is provided in **Table 2-4**.

Inter-basin coordination activities included participation in events scheduled by other organizations, or events led by Kaweah Subbasin GSAs. These inter-basin activities focused on GSAs within the groundwater subbasins that comprise the Tulare Lake Basin, and provided opportunities for GSA managers, technical consultants, and the public to collaborate on topics of mutual concern. The schedule of these meetings is provided in **Table 2-4**.

Table 2-4: Inter-Basin, Intra-Basin Coordination Meetings

Type	Basin	Date Range	Number of Events	Attendees/ Audience	Participating GSA	Key Agenda Topics
South Valley SGMA	Inter Basin	July 2016 - 2024	6	30 + Landowners & Members	3	Subbasin updates, DWRs SGMA technical assistance, SkyTEM In the South Valley, headwaters coordination
Management Team Committee Meeting	Intra Basin	June 2018-2024	20	30 + Landowners & Members	3	GSA Updates and progress, coordination agreement, consultant presentations and recommendations
Farmer Rancher	Inter Basin	June 2019-2024	5	50+ Landowners	3	SGMA & GSP Development
Technical Group Meeting	Intra Basin	June 2019-2024	16	15+ Landowners & Members	3	SkyTEM proposal, technical memorandum discussing accounting framework, water budgets
The Community Water Center: Drinking Water Vulnerability Assesment Tool Kick Off	Inter Basin	June 2019-2024	1	100+ Landowners & Members	3	Development of an accessible, interactive and publicly available drinking water vulnerability assessment web tool, groundwater management needs of SDACs for GSPs

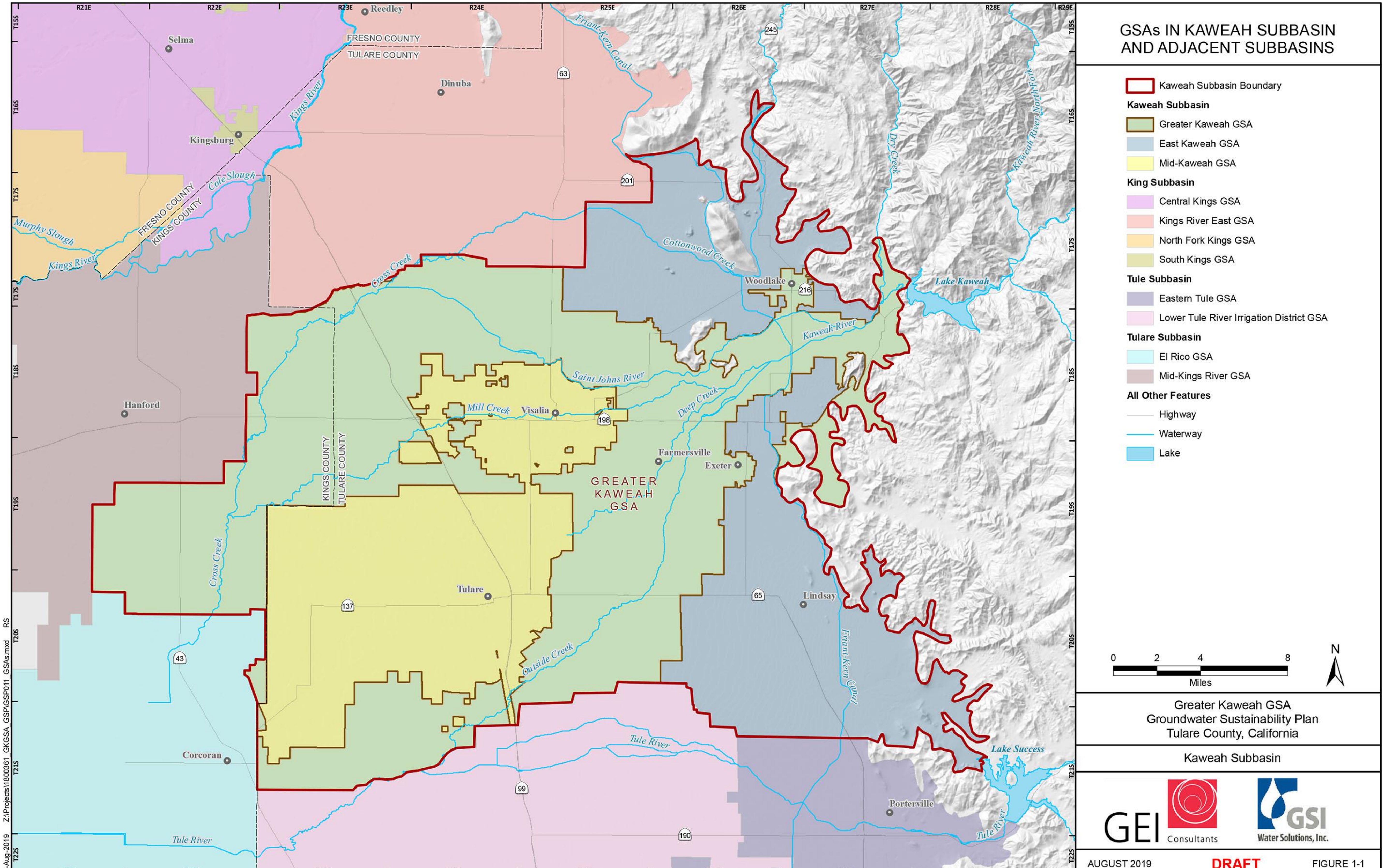


Figure 2-1: Greater Kaweah Jurisdictional Boundaries

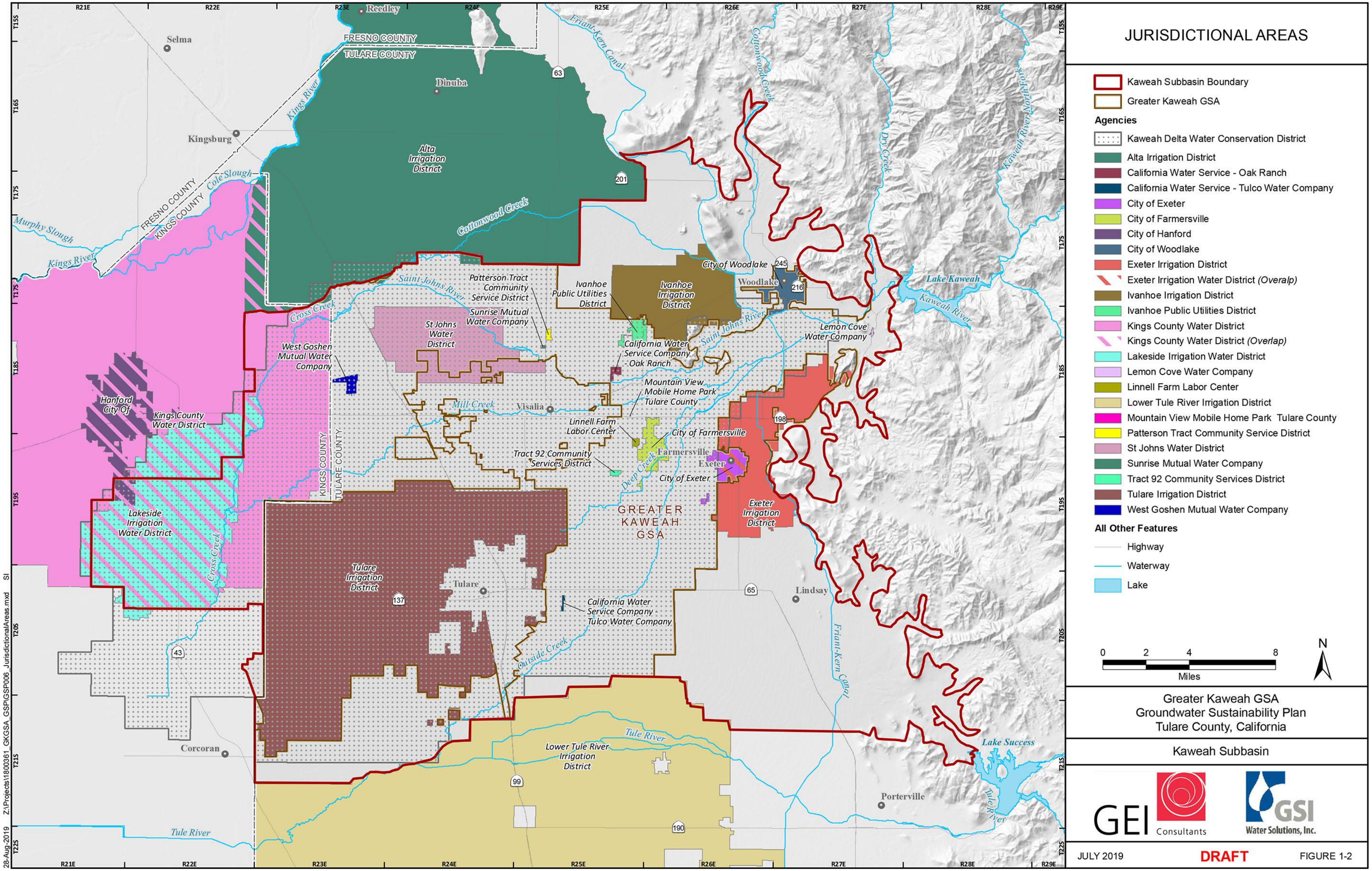


Figure 2-2: Jurisdictional Areas

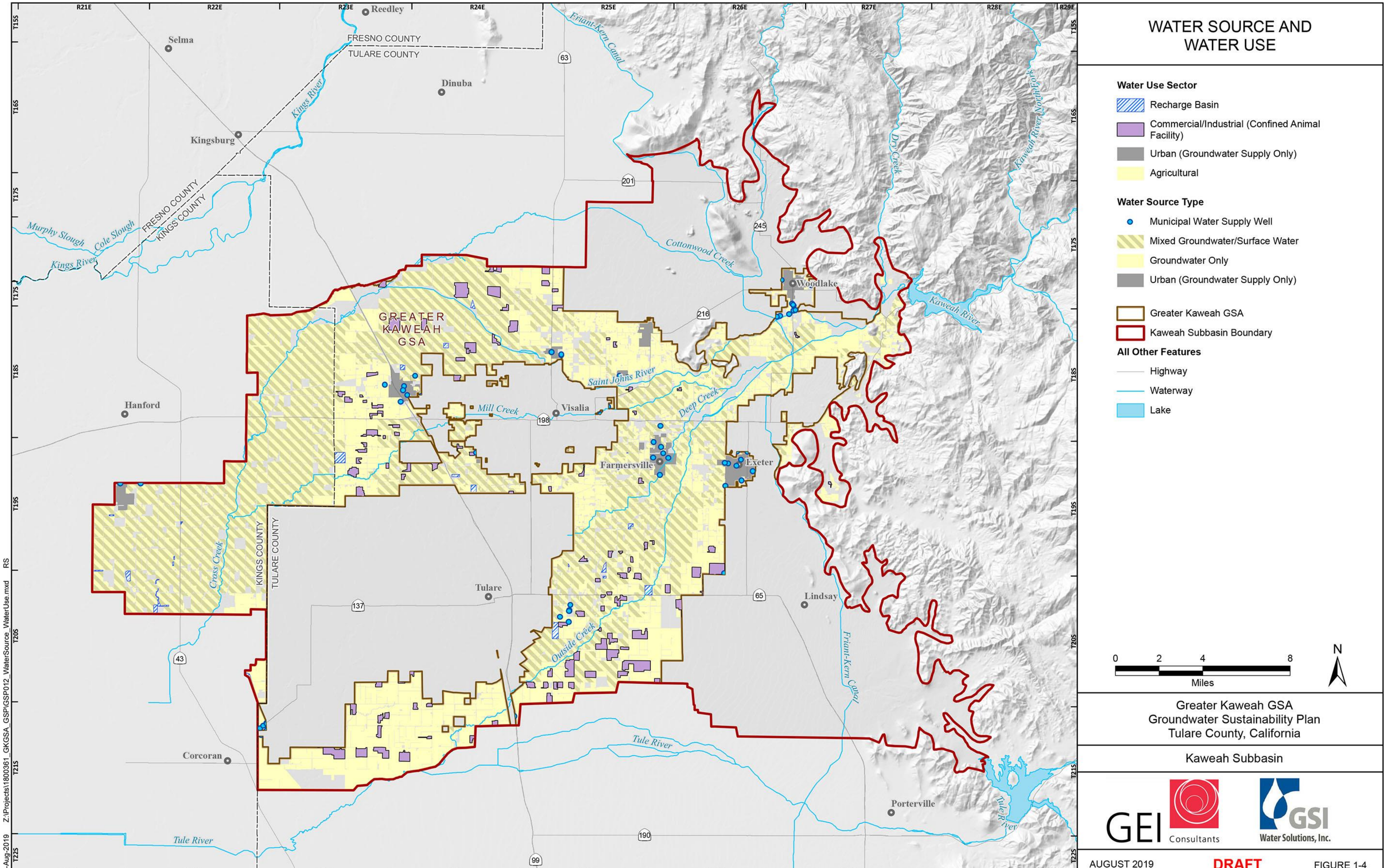


Figure 2-3: Water Source and Water Use

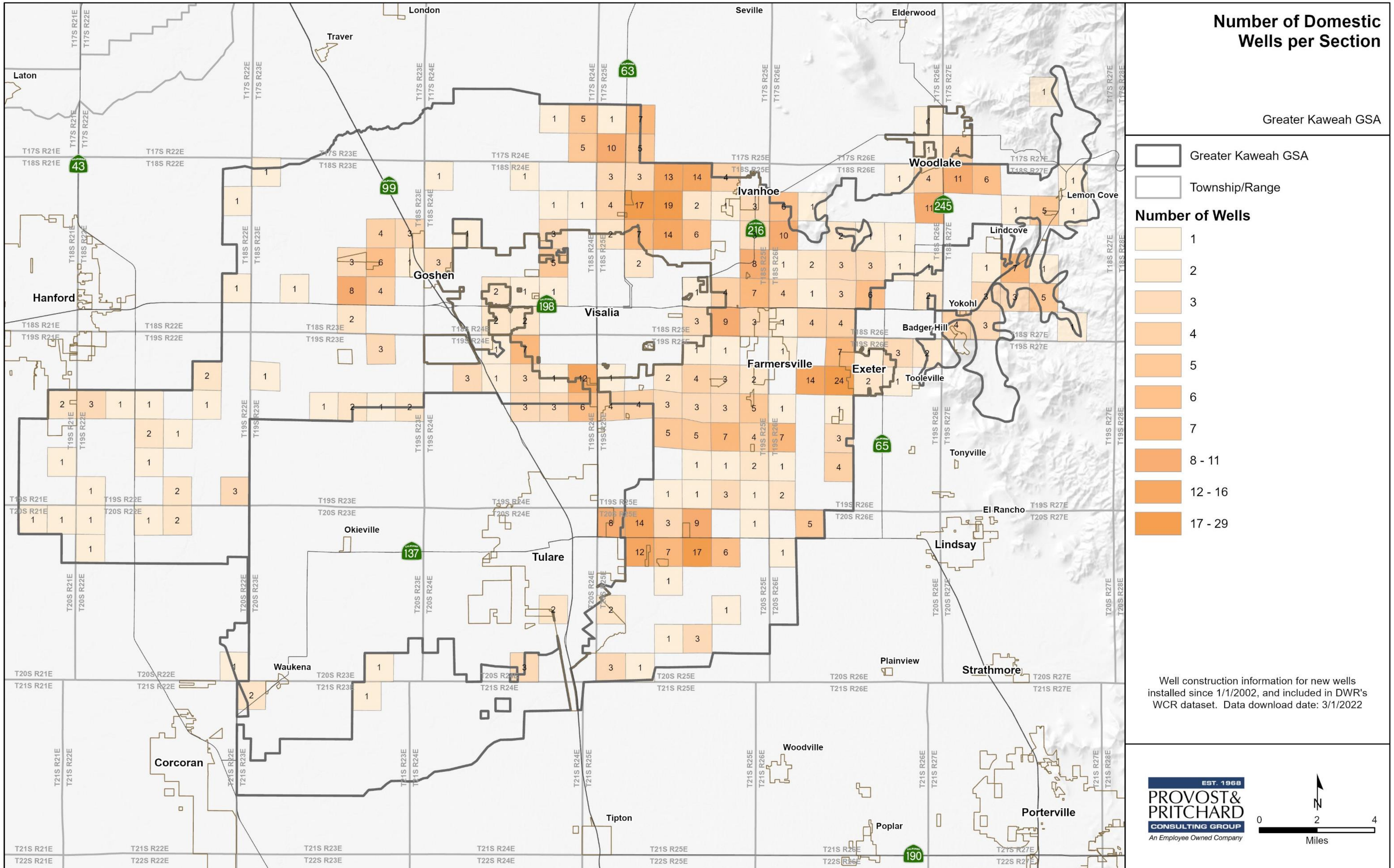


Figure 2-4: Well Density by Section (Domestic Wells)

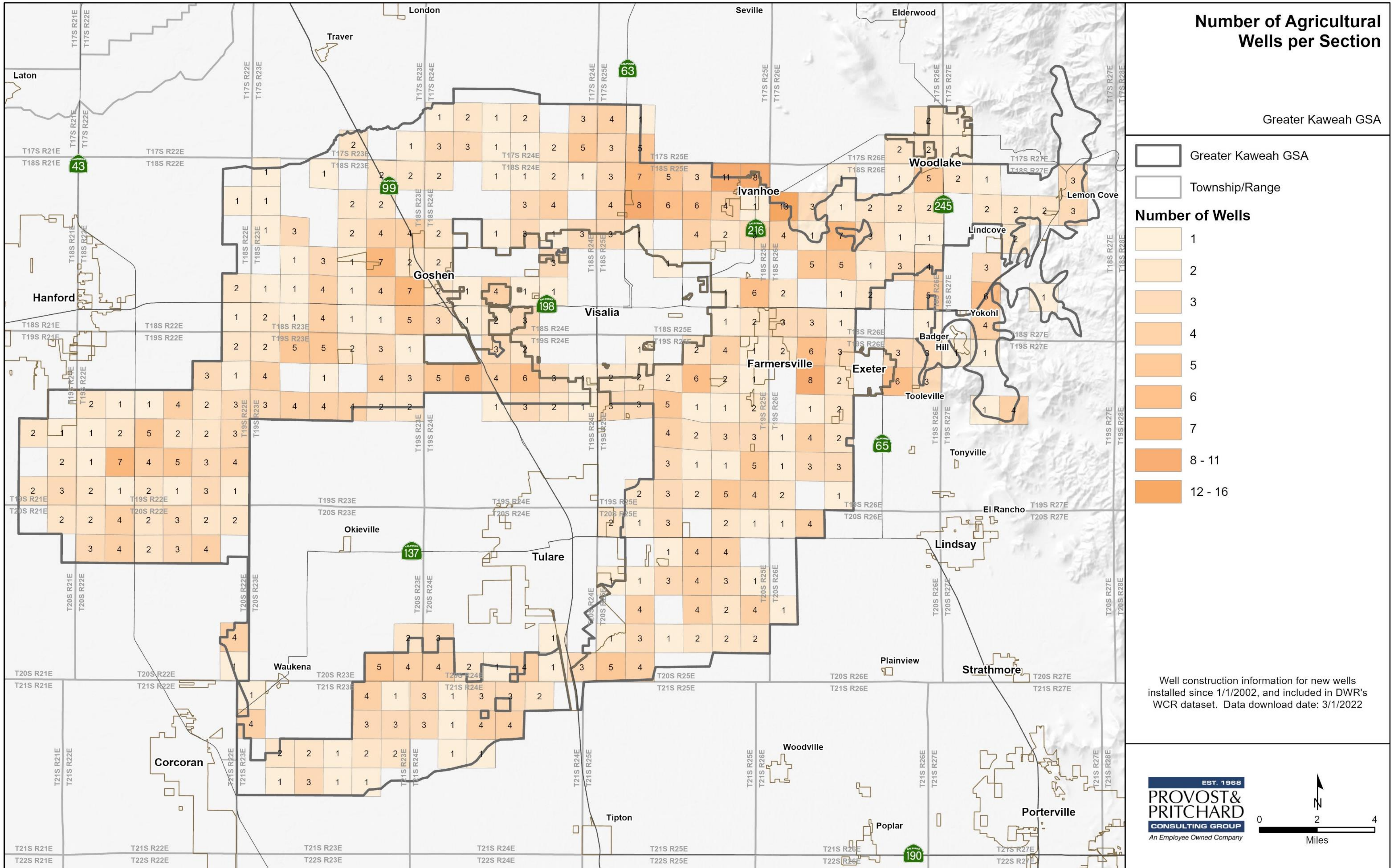


Figure 2-5: Well Density by Section (Production Wells)

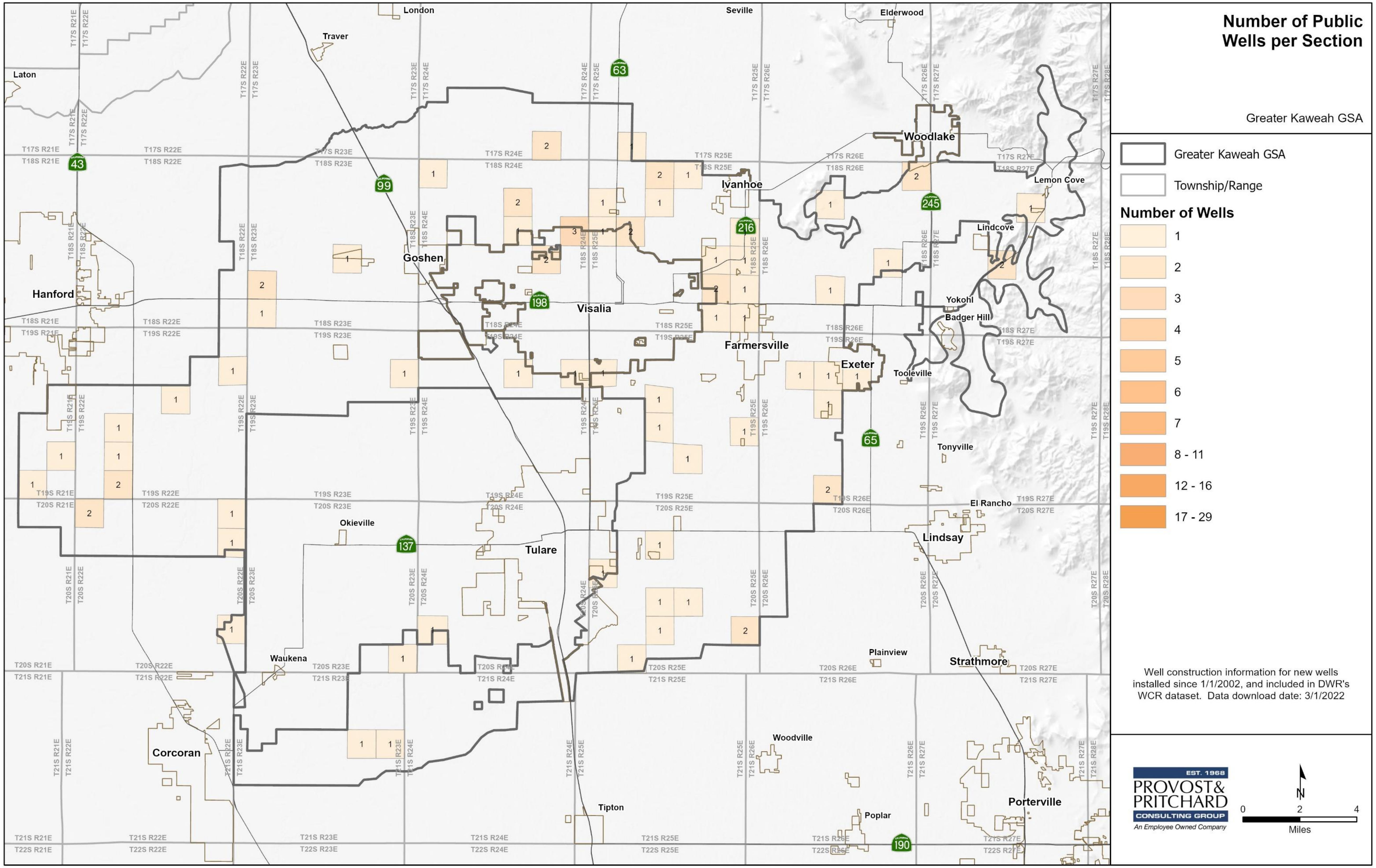


Figure 2-6. Well Density by Section (Public Wells)

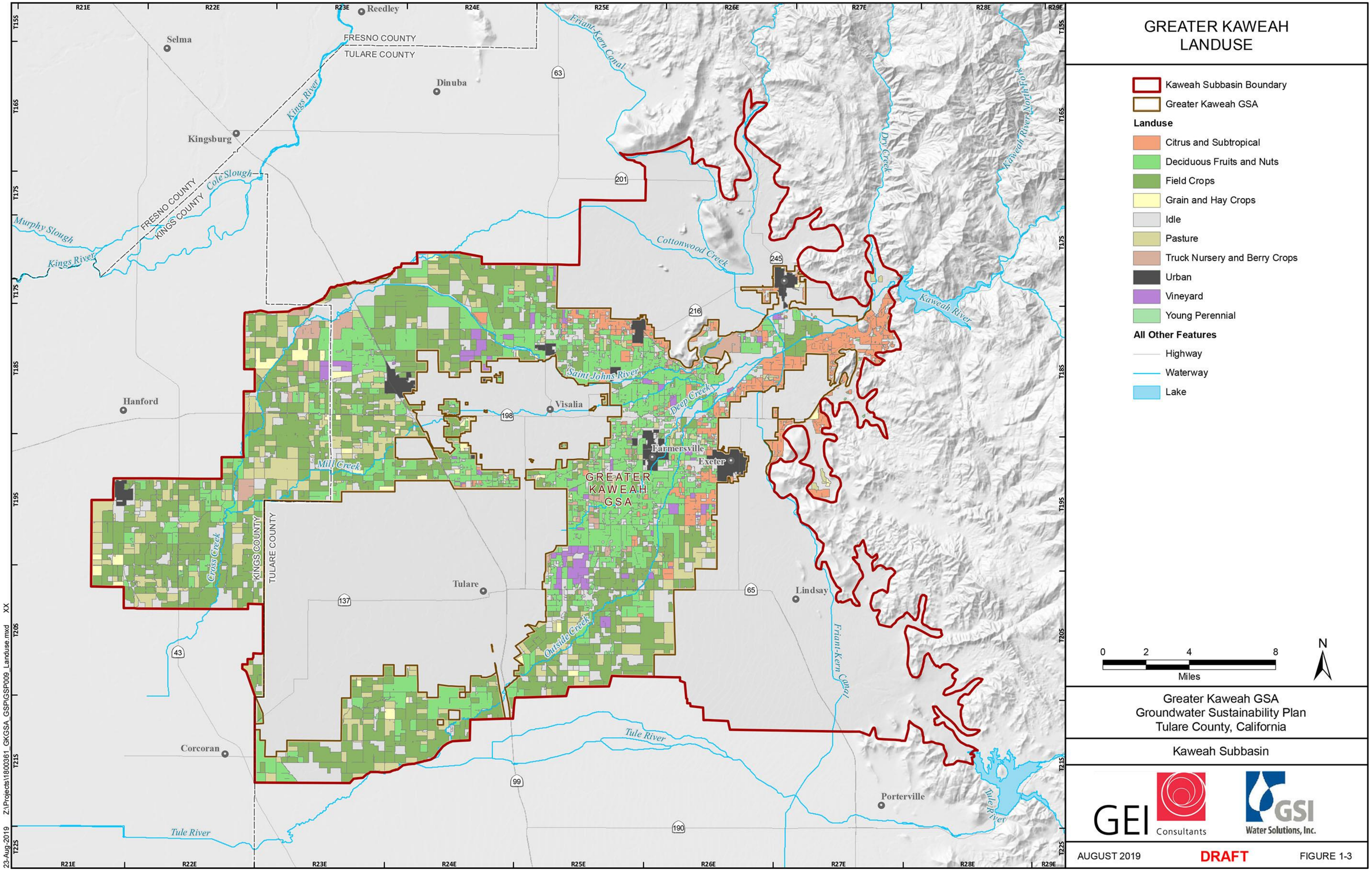


Figure 2-7: Greater Kaweah Land Use

3 BASIN SETTING [ARTICLE 5, SUBARTICLE 2]

3.1 Introduction to Basin Setting [§354.12]

§354.12 Introduction to Basin Setting. This Subarticle describes the information about the physical setting and characteristics of the basin and current conditions of the basin that shall be part of each Plan, including the identification of data gaps and levels of uncertainty, which comprise the basin setting that serves as the basis for defining and assessing reasonable sustainable management criteria and projects and management actions. Information provided pursuant to this Subarticle shall be prepared by or under the direction of a professional geologist or professional engineer.

As part of the 2020 GSP, the three GSAs in the Kaweah Subbasin have coordinated and jointly prepared a comprehensive Basin Setting Report which is included as **Appendix 3A** of this Plan. The process and work effort to prepare this document were in accordance with the "MOU for Cooperation and Coordination of the Kaweah Subbasin" executed by the GSAs in 2017 for the purposes of (a) retaining consultants to conduct the necessary technical work sufficient to support a Coordination Agreement and (b) to establish a committee structure and associated public vetting process leading to an acceptable Hydrogeologic Conceptual Model (HCM), which describes and depicts the groundwater conditions and water budgets within the Subbasin.

Building on the Kaweah Subbasin Basin Setting document provided in Appendix 3A**,** this section provides an overview of the basin setting followed by more detail on elements unique to the GKGSA, including:

- GKGSA Groundwater Level Trends
- GKGSA Land Subsidence
- GKGSA Interconnected Surface Water
- GKGSA Water Budget for Current Period

A description of management areas is also provided in this section.

The Kaweah Subbasin's sustainable yield has been re-estimated to be 550,000 AF per year. This revised sustainable yield represents the volume of groundwater extraction that can occur over the 2040-2070 period without causing undesirable results or long-term reductions in groundwater storage. This estimated sustainable yield will continue to be revised pursuant to the monitoring of sustainability indicators and avoidance of undesirable results.

Details regarding the hydrogeologic conditions in the GKGSA within the context of the entire Subbasin are provided in Appendix 3A.

3.2 Hydrogeologic Conceptual Model [§354.14]

§354.14 Hydrogeological Conceptual Model.

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

Below is a brief summary of the HCM. Please refer to Section 2.2 of Appendix 3A for the full HCM which includes the following subsections:

- Regional Setting
    - Subbasin Features
    - Regional Geology
    - Kaweah Subbasin Geology
- Geologic Features that Affect Groundwater Flow in the Kaweah Subbasin
- Lateral Boundaries of the Subbasin
- Bottom of the Subbasin
- Principal Aquifers and Aquitards of the Subbasin
    - Formation Names
    - Physical Characteristics
    - Structural Properties that Restrict Groundwater Flow
    - General Water Quality of Principal Aquifers
    - Primary Use of Aquifers
- Geologic Cross Sections
- Physical Characteristics
    - Sufficient Geology
    - Soil Recharge Characteristics Delineation of Recharge Areas, Potential Recharge Areas, and Discharge Areas, Including Spring Seeps and Wetlands
    - Surface Water Bodies
    - Source And Point of Delivery For Imported Water Supplies

The GKGSA is located within Kaweah Subbasin, bordering the EKGSA and the mountain front to the east, the Kings River Subbasin to the north, the Tulare Lake Subbasin to the west, and Tule River Subbasin to the south. The MKGSA is located within the central-western portions of the Kaweah Subbasin and is surrounded by the GKGSA, except for portions of its western boundary. Roughly, the western half of the GSA is underlain by the Corcoran Clay, which creates an upper and a lower aquifer system, as shown by Sections A-A', B-B', C-C', D-D', and E-E' (Figures 4 through 8 of the Basin Setting Report). A single aquifer system is present beneath the eastern portion of the GSA, all the way to the eastern boundary of the subbasin. The thickness of the fresh groundwater system varies from about 900 feet on the northeastern side of GKGSA where the St. Johns River enters the broad valley to about 1,600 feet along the western side of the subbasin. The thickness probably thins substantially eastward, up the river to the mountain front.

In general, groundwater flows across the GKGSA in a southwesterly direction and to local cones of depression during the irrigation season. The vertical flow gradient is from shallow to deep conditions. The majority of the groundwater quality data comes from the northern and central portions of the GKGSA and within the MKGSA. Several Constituents of Concern have been identified due to concentrations near Maximum Contaminant Levels (MCLs) or due to increasing trends in concentration: arsenic, nitrate, certain volatile organics, and 1,2,3-trichloropropane (1,2,3 TCP).

Land subsidence due to overpumping has occurred throughout much of the GKGSA area, and the Kaweah Subbasin in general, over the past 90 years, but data are limited in scale and frequency. The largest amounts of subsidence occurred along the western and southwestern portions of the GKGSA area. Greater amounts of subsidence are believed to have occurred beyond the Kaweah Subbasin to the west and south. According to the on-line DWR SGMA Data Viewer (2019), estimated subsidence between 1949 and 2005 has varied from about 1 foot or less to the north of Visalia to mostly 5 feet or less south of Farmersville and west of Visalia. Scattered areas of greater subsidence are present in these areas, between 5 and 10 feet. Along the southwestern corridor of GKGSA, the estimated subsidence mostly ranges between 10 and 15 feet with lesser areas ranging between 5 and 10 feet. In the westernmost GKGSA quadrangle, estimated subsidence ranges from 5 to 10 feet in the northwestern corner to between 15 and 20 feet in the southwestern corner. The pattern of these higher subsidence ranges is generally aligned in a northwest-southeast orientation. DWR did not provide subsidence estimates for the Farmersville, Ivanhoe, and areas further east. More recently, satellite radar technology (Interferometric Synthetic Aperture Radar or InSAR) has been used to identify subsidence for various time periods (January 2007 to December 2010, May 2015 to present), although this radar coverage is not complete across the basin. For the initial 4-year period, InSAR data are available for nine currently existing survey stations, including three stations with positive values (no subsidence) between 0.4 and 4.4 inches along the St. Johns River and six stations with negative values (subsidence) between -0.2 and -18.1 inches. The least amount of subsidence reported by DWR occurred on the east side of the GKGSA, south of Farmersville, while the greatest amounts of subsidence (-14.5 and -

18.1 inches) occurred on the western side of the GKGSA. For the most recent approximately 7-year InSAR period, subsidence data are available for 14 survey stations monitored by Kaweah Delta Water Conservation District in partnership with CalTrans and values have ranged between -1.6 to -17.1 inches. The least amount of subsidence (<3 inches) occurred in the seven stations on the northeast side of GKGSA while the highest value occurred on the western side.

While available date suggest the potential for groundwater dependent ecosystems along the upper reaches of the Kaweah River in the GKGSA, the data are limited at this time and additional work is necessary to determine the extent that groundwater sustains the plant communities and habitats and to what degree groundwater overdraft impacts them.

Within the GKGSA Plan area, the following data gaps in the HCM were identified:

- Accurate count of wells in GKGSA area, including well type (domestic, irrigation, etc.) and status (active, inactive, abandoned). A detailed reconnaissance survey is underway to verify location and operational status of wells within GKGSA's jurisdiction but was not yet complete to inform this plan).
- Construction details of wells, especially production/screen interval(s). This data gap is significant and limits a comprehensive understanding of depth-specific groundwater level and groundwater quality conditions.
- Expanded monitoring to gather information on the semi-confined aquifer east of the defined limit of the Corcoran Clay and the interaction between groundwater pumping and land subsidence
- Groundwater extraction records from direct measurement and locally generated estimates of groundwater use in rural areas of the GKGSA. This information will improve the water budget.
- Lithologic composition of aquifer, including geophysical logs at strategic locations. This information could then help with the interpretation of Airborne Electromagnetic (AEM) data available for the Subbasin.
- Hydraulic parameters of principal aquifers based on pumping tests.
- Water quality data for small rural community, domestic and irrigation wells.
- Measurements of subsidence within the GKGSA. The historical record of measured subsidence is limited and further data on the impact of depth-specific aquifer pumping on subsidence is needed. The correlation between subsidence and release of arsenic from clay mineralogy represents a data gap that needs to be filled through improved sampling and subsidence monitoring.

- Groundwater elevation monitoring in areas with shallower groundwater levels to confirm whether or not the potential interconnected surface water and/or GDEs are present.

The data gaps will be addressed as GKGSA implements the Management Actions designed to close such gaps.

3.3 Current and Historical Groundwater Conditions

3.3.1 Groundwater Level Trends

This section of the GSP provides more recent information on groundwater level trends throughout the GKGSA area since the initial 2020 GSP.

Interpreting trends in groundwater level requires understanding climatic conditions. Groundwater levels are influenced by precipitation, with drier years resulting in less natural and managed aquifer recharge, less surface water availability, and more groundwater extraction. Figure 3-1 illustrates changing hydrologic conditions within the Subbasin for rainfall recorded in Visalia from water year 1905 through 2023. Precipitation data prior to 1905 are available but excluded from the chart because the annual totals appeared incomplete.

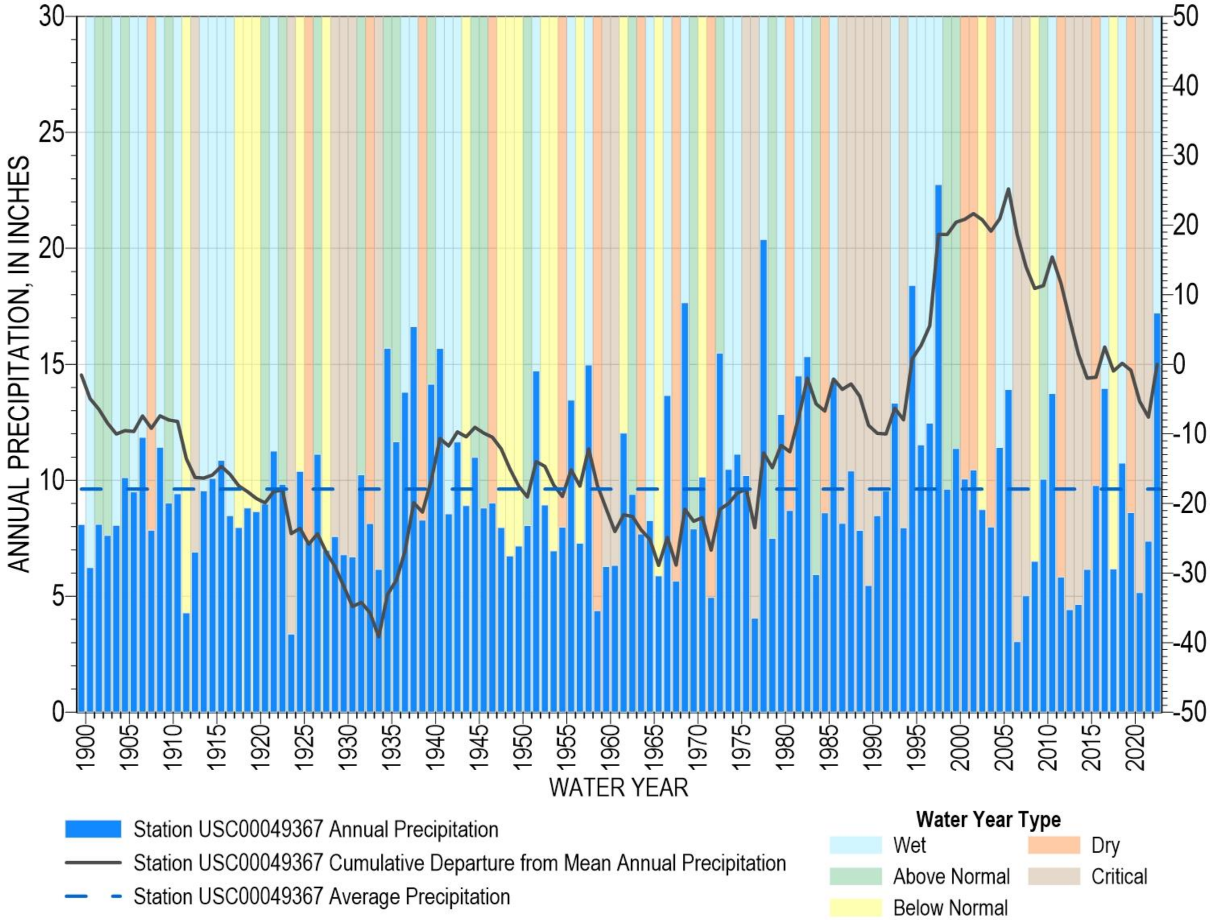


Figure 3-1. Cumulative Departure from Mean Annual Precipitation at the Visalia NOAA Station USC49367

Long-term average precipitation from 1905 through 2023 is 9.7 inches per year. The bottom half of the chart shows the annual precipitation as bars. The line on the chart represents climactic variability as cumulative departure from mean annual precipitation, such that upward trends represent wet periods and downward trends represent drought periods. The water year type for the southern San Joaquin Valley is color coded in the background of the chart.

Figure 3-1 and Table 3-1 emphasize the highly variable climatic cycles common to the southern San Joaquin Valley consisting of prolonged periods of modest drought punctuated by short, intense wet periods. Notable wet and dry cycles on **Error! Reference source not found.** include:

- A 23-year drought including water years 1946 through 1968 received below-average precipitation, when an average of 0.9 inches below normal fell each year.

- A wet period from 1978 through 1983 received an annual average precipitation of 3.5 inches above normal each year.
- A 9-year drought period between 1984 and 1992 received an average of 1 inch below normal precipitation each year.
- A wet period from 1993 through 1998 was recorded as wetter than the previous wet period. Annual rainfall averaged a full 4.7 inches above normal each year.

The most recent drought changed the long-term pattern of prolonged, but somewhat modest, droughts. For 10 years—during water years 2007 to 2016—the area received a total of 27.9 inches less rainfall than the long-term average, which is equal to an annual rainfall of 2.8 inches less than normal each year. The Subbasin received 29% less rainfall than the long-term average during this decade; the most severe drought on record. Hydrographs show groundwater level decline rates in the Subbasin increased over the 2007 – 2016 period.

Table 3-1. Kaweah Subbasin Historical Hydrologic Conditions

Period (Water Years)	Hydrologic Condition	Duration (No. of Years)	Precipitation Deviation (Inches)	Deviation Rate (Inches/year)
1905-1911	Variable	7	1.2	0.2
1912-1934	Drought	23	-32.9	-1.4
1935-1941	Wet	7	27.9	4.0
1942-1945	Variable	4	1.3	0.3
1946-1968	Drought	23	-21.7	-0.9
1969-1977	Variable	9	4.6	0.5
1978-1983	Wet	6	21.0	3.5
1984-1992	Drought	9	-8.8	-1.0
1993-1998	Wet	6	28.2	4.7
1999-2006	Variable	8	5.9	0.7
2007-2016	Drought	10	-27.9	-2.8
2017-2023	Variable	7	1.3	0.2

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.

Groundwater levels for the deeper confined aquifers found below the Corcoran Clay have similar downwards trends to the unconfined aquifers. Depth to groundwater in wells screened in the confined aquifer is deeper than in the unconfined aquifers. Depth to groundwater can be greater than 300 feet below ground surface.

Spring and Fall 2023 groundwater elevation contours for the Unconfined Aquifers are provided on Figure 3-2 and Figure 3-3, respectively. The contour maps both show a general groundwater gradient from the northeast to the southwest (Lake Kaweah towards Corcoran). Fall groundwater elevations are generally lower than Spring groundwater elevations reflecting seasonal irrigation pumping. The Fall contours highlight areas where higher intensity extraction creates pumping depressions. In the GKGSA area, pumping depressions are found in the southern GKGSA area east of Highway 99 and the western side of the GKGSA area. Groundwater flow at the Subbasin's southern boundary with the Tule Subbasin is generally perpendicular indicating balanced flows between the subbasins. This is likely influenced by flows in the Tule River just south of the Kaweah Subbasin's southern boundary. The western Kaweah-Tulare Lake Subbasins' boundary has more complexity due to the influence of multiple clay layers, surface water deliveries, and groundwater pumping. Contours show a mix of outflow from the Kaweah Subbasin into the Tulare Lake Subbasin and vice versa. In the far western extent of the Kaweah Subbasin, where the Tulare Lake Subbasin borders on three sides, there appears to be some flow from north to southwest.

Confined Aquifer groundwater elevation contours are not included because there are few monitoring locations perforated solely below the Corcoran Clay. As part of GSP implementation, the Subbasin GSAs have and will continue to add dedicated Confined Aquifer (also known as Lower Aquifer) monitoring wells to the monitoring network.

It is important to note that while much of the Subbasin experienced widespread water level declines, there are areas where water level declines have been less pronounced. 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.

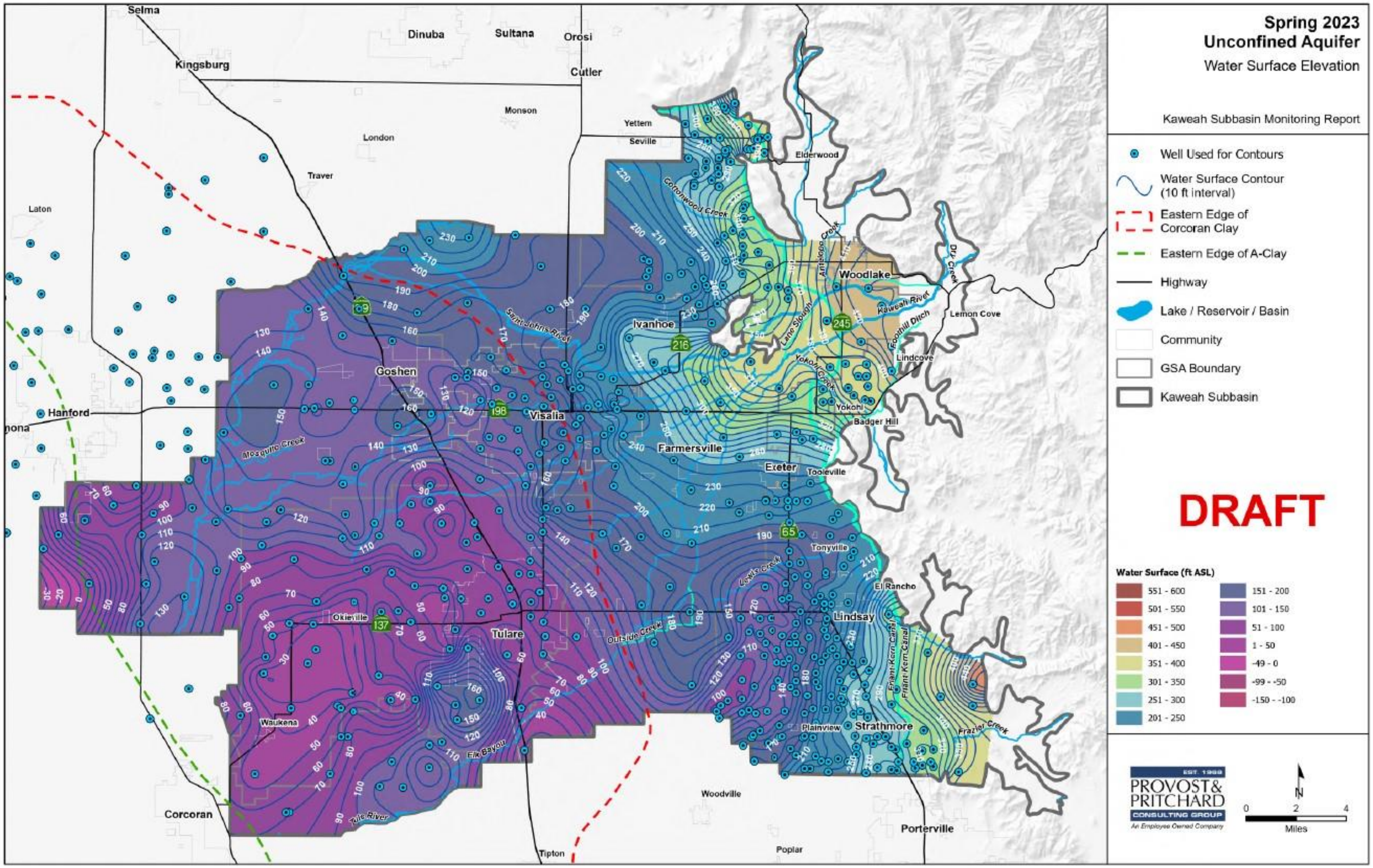


Figure 3-2. Spring 2023 Unconfined Aquifer Water Surface Elevation Map

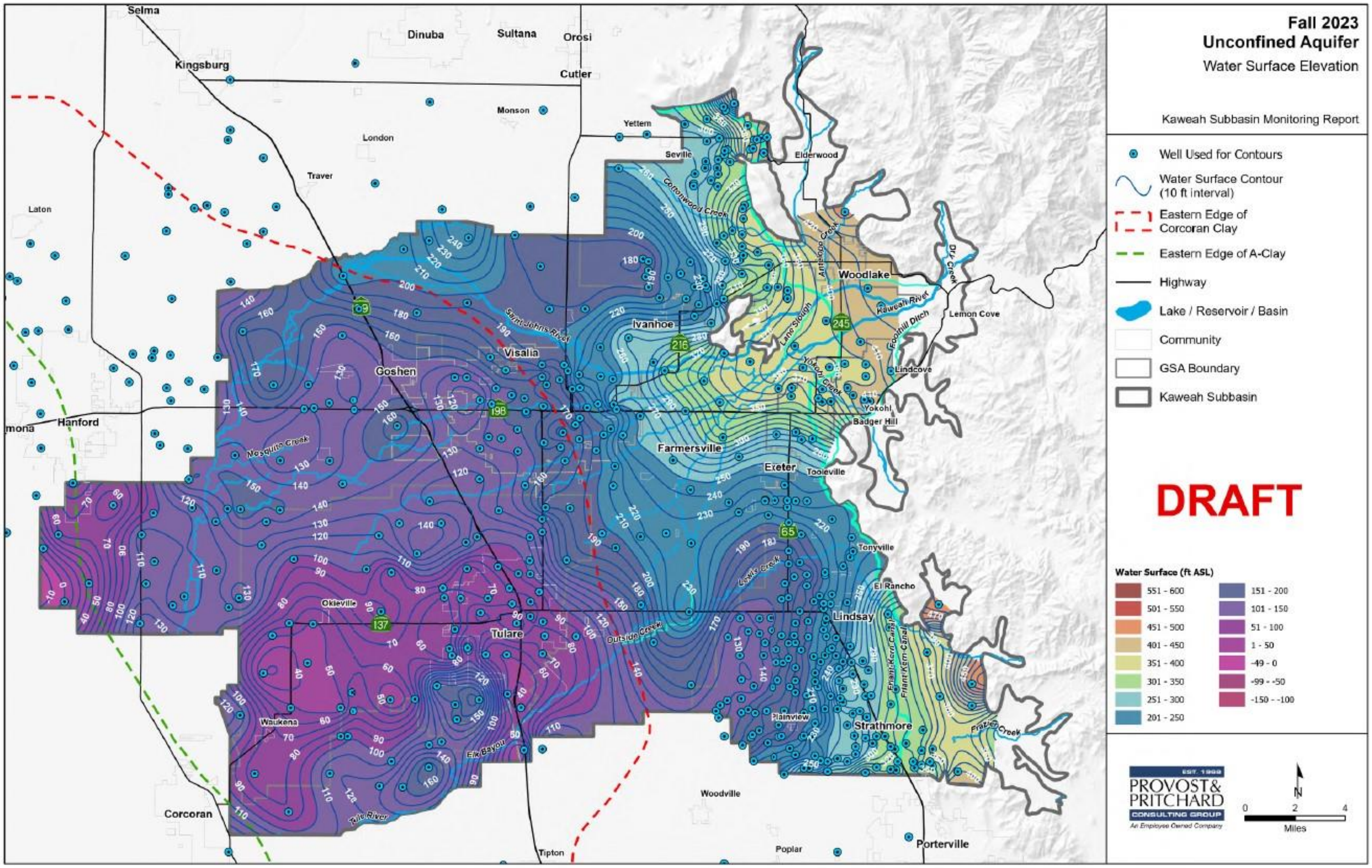


Figure 3-3. Fall 2023 Unconfined Aquifer Water Surface Elevation Map

3.3.2 Land Subsidence

Land subsidence due to overpumping has occurred throughout San Joaquin Valley over the past 90 years. The Corcoran Clay, which is the primary regional confining layer, and other fine-grained units within the Kaweah Subbasin's aquifer systems are susceptible to subsidence. When long-term groundwater overpumping occurs, the aquifer system can become depressurized, and water originally deposited within the fine-grained clay units can be released. This depressurization allows for the permanent collapse and rearrangement of the structure, or matrix, of particles in fine-grained layers that results in permanent or inelastic land subsidence.

The greatest subsidence in the Subbasin occurs along the western and southern boundaries of the GKGSA area. Based on historical land survey and radar technology supplemented with Interferometric Synthetic Aperture Radar (InSAR) data from 2015 onwards, it is estimated that since 1948, approximately 25 feet of total land subsidence has occurred in the southwestern part of the GKGSA area. The amount of subsidence decreases from southwest to northeast across the Subbasin. In northern Visalia, east of the Corcoran Clay, historical subsidence since 1949 is estimated to be 5 to 6 feet. The distribution of Subbasin-wide land subsidence obtained from InSAR over the available period of record from June 13, 2015 to January 1, 2024 is shown on Figure 3-4.

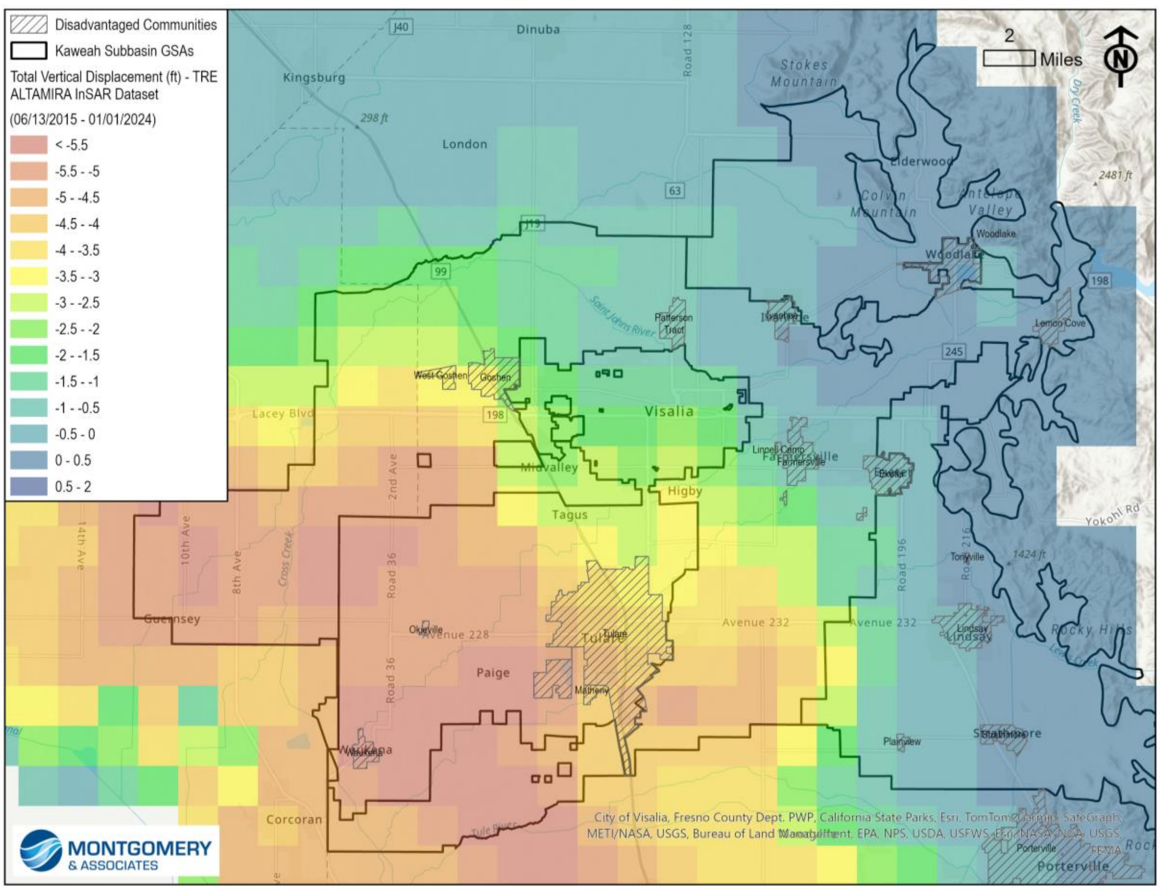


Figure 3-4. Kaweah Subbasin Total Land Subsidence from June 13, 2015 through January 1, 2024

3.3.3 Groundwater Quality

The Kaweah Subbasin Basin Setting document and groundwater conditions in Appendix 3B discuss in more detail the groundwater quality for the Kaweah Subbasin. Groundwater quality discussion specific to the GKGSA is included below. The primary source of data referenced for this characterization is from the SDWIS which collects sample results from all State regulated public water systems and Geotracker.

Appendix 3B contains maps showing Subbasin-wide distributions of median and maximum concentrations for constituents of concern from 2005 to 2015 (pre-SGMA) and 2016 to 2023 (post-SGMA) for the constituents of concern in this GSP.

3.3.3.1 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).

3.3.3.2 Data Sources

There are 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 are located throughout the Subbasin. In addition to SDWIS, GAMA GIS was searched to identify contaminant plumes, and the SWRCB’s Human Right to Water Portal was searched to identify contaminants commonly violating drinking water standards. A limited amount of data were available for private domestic wells within the Subbasin. For now, the Subbasin is referring to the SWRCB’s GAMA Domestic Well Project.

3.3.3.3 Overview of Groundwater Quality Conditions

While all regulated drinking water constituents were considered, findings from this evaluation show that the most common groundwater quality issues within the GKGSA boundaries are: arsenic, nitrate, sodium and chloride, perchlorate, dibromochloropropane (DBCP), 1,2,3 – trichloropropane (TCP), tetrachloroethylene (PCE), hexavalent chromium (Chromium VI), and uranium. The groundwater quality description below 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.

See Appendix 3B for Subbasin-wide maps depicting the spatial distribution of pre-SGMA concentrations of constituents of concern and post-SGMA enactment to current concentrations.

3.3.3.3.1 **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 Subbasin and GKGSA

The major source of arsenic in groundwater appears to be naturally occurring from erosion of natural deposits. In the Southeast San Joaquin Valley, arsenic is the constituent which most frequently occurs at concentrations above the drinking water standard (maximum contaminant level [MCL] = 10 µg/L) in the primary aquifers. Arsenic concentrations greater than 5 µg/L are primarily located within the western part of the Subbasin. Wells evaluated in the eastern portion of the Subbasin rarely have arsenic detections. However, wells that do have detections are at concentrations less than 5 µg/L. United States Geological Survey (USGS) reports indicate that wells constructed deeper than 250 feet tend to have higher arsenic levels; and these wells tend to be in the western portion of the Subbasin where wells are commonly deeper.

GAMA indicates there are 152 drinking water wells with arsenic detected in the GKGSA area. Of those wells, 5 are above MCL of 10 µg/L and the maximum concentration is 38 µg/L.

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 MCL of 10 µg/L and an Agricultural Water Quality Goal of 100 µg/L. 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 reported to the SWRCB and available publicly on GAMA. In addition to SWRCB DDW regulation, monitoring, and oversight, data on arsenic concentrations are available via the GAMA Priority Basin Project[5]. Arsenic is monitored as a constituent of concern within the Kaweah Subbasin.

3.3.3.3.2 Nitrate

Chemical Properties

The following chemical properties are summarized from the GAMA Program Groundwater Information sheet for nitrate. Nitrate (as NO_3), 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 concentrations of nitrate in drinking water are 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 Subbasin

Nitrate (as N, Nitrogen) is commonly detected throughout the Subbasin with concentrations commonly greater than 8 mg/L. Shallow wells have higher nitrate concentrations than wells deeper than 250 feet, because nitrate is a surface contaminant primarily impacting shallower groundwater. Overall, nitrate detections are prevalent throughout the Subbasin, with highest concentrations in the eastern portion where sediments are more permeable. GAMA indicates there are 1,281 drinking water wells with nitrate (as N) detected in the GKGSA area. Of those wells, 382 (29.8%) are above MCL of 10 mg/L and the maximum concentration is 92 mg/L.

Existing Regulatory Programs and Monitoring Efforts

Nitrate as Nitrogen (N) has an acute drinking water MCL of 10 mg/L. 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

[5] https://www.waterboards.ca.gov/gama/priority_basin_projects.html

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 Kaweah Basin Water Quality Association (KBWQA) also monitors 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 from 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.

3.3.3.3.3 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 GKGSA

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.

Slightly elevated sodium and chloride concentrations were detected in a small portion of the wells within the Subbasin (see Appendix 3A-Figure 81). Sodium concentrations above the drinking water Action Level of 50 mg/L were detected in 43 wells within the GKGSA, most of those being in the City of Tulare. Of those 43 wells, 24 wells were above the sodium Agricultural Water Quality Goal of 69 mg/L. Chloride concentrations above the Agricultural Water Quality Goal of 106 ppm were detected in 9 wells in the GKGSA area.

Existing Regulatory Programs and Monitoring

Based on drinking water standards, the recommended secondary maximum contaminant level (SMCL) for chloride is 250 mg/L with an upper limit of 500 mg/L. There is no drinking water standard for sodium, but it does have an Action Level of 50 mg/L. The Agricultural Water Quality Goal (AWQG) for sodium and chloride are 69 mg/L and 106 mg/L, 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 GKGSA, the Agricultural Water Quality Goals for sodium and chloride is used when evaluating water quality from agricultural wells.

3.3.3.3.4 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 GKGSA

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 µg/L have been detected in the GKGSA in two wells near the city of Exeter. Given the diffuse use of DBCP on agricultural lands throughout Tulare County, DBCP is expected to be widespread through the GKGSA without a predictable contaminant plume pattern. The lack of groundwater quality monitoring data for domestic and agricultural wells is why DBCP detection are only in the cities where groundwater quality monitoring occurs frequently. 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 as 20 years. This is consistent with the data that has been evaluated for this Subbasin since concentrations are generally decreasing.

Existing Regulatory Programs and Monitoring

DBCP is a synthetic organic contaminant with a drinking water MCL of 0.2 µg/L. 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 in 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 GeoTracker or by filing a public records request with DPR.

3.3.3.3.5 1,2,3-Trichloropropane (TCP)

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 GKGSA

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. DBCP contaminated with TCP was extensively used throughout Tulare County as a nematicide. TCP has also been used in solvents in the past. There are no known point sources of TCP from industrial or hazardous waste sites in the GKGSA.

GAMA shows 52 public supply wells with TCP detections. Of those wells, 42 wells in the cities of Visalia and Tulare have concentrations greater than the MCL with a maximum concentration 7 µg/L. Because public water supply wells regularly test and report water quality while irrigation wells do not, it appears the TCP distribution is only within the cities, It is more likely that the TCP distribution is diffuse with no specific contamination plume, similar to DBCP.

Existing Regulatory Programs and Monitoring

TCP has a primary drinking water MCL of 0.005 µg/L. There is no TCP Agricultural Water Quality Goal. 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.

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 µg/L PHG in 2009. In July 2017, the SWRCB DDW adopted the current MCL for TCP at 0.005 µg/L. All water systems have been required to test their wells quarterly beginning in January 2018.

3.3.3.3.6 **Tetrachloroethylene (PCE)**

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 GKGSA

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 GKGSA 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 large PCE plume located in the City of Visalia. A city-wide investigation, led by California Department of Toxic Substances Control (DTSC), began in 2007 to determine the responsible party and the extent of the PCE plume. Nine sites are involved in this ongoing investigation. Management actions are currently in place through the DTSC agreement with California Water Service (Cal Water) to limit these surface contaminants from spreading further in the aquifer.

Contamination sites continue to be monitored 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.

GAMA indicates there are 34 drinking water wells with detected levels of PCE. Most of those wells are in Visalia while three wells in Tulare and 1 near Paige also had detectable PCE concentrations. Only 7 of the 34 wells with PCE detects are above MCL of 10 µg/L.

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 GKGSA, 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 DTSC, its EnviroStor database provides data on groundwater quality at cleanup sites.

3.3.3.3.7 Hexavalent Chromium (Chromium VI)

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 GKGSA

Recent analyses have indicated that 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 by 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 µg/L in the Subbasin. During evaluation of historical Chromium VI concentrations, only one well exceeded 10 µg/L within the Subbasin but outside of the GKGSA area. Based on historical data in GAMA, Chromium VI is not considered to impact the groundwater in the GKGSA area. However, due to its potential human health impacts, Chromium VI will still be monitored within the GKGSA.

Existing Regulatory Programs and Monitoring

On April 27, 2024, the California SWRCB adopted a primary MCL of 10 µg/L. Public Water Systems (PWS) are required to comply with the regulation in accordance with the following specified timelines:

- PWS with 10,000 or more connections will be required to comply within two years after the MCL takes effect;
- PWS with 1,000 – 9,999 connections will be required to comply within three years after the MCL takes effect, and
- PWS with less than 1,000 connections will be required to comply within four years after the MCL takes effect.

3.3.3.3.8 Uranium

Chemical Properties

The following chemical properties are summarized from the SWRCB GAMA Program Groundwater Information sheet for radionuclides Radioactive forms of elements are called radionuclides. Radioactive decay is when a radioisotope transforms into another radioisotope; this process emits radiation in some form.

Uranium is a naturally occurring radioactive element in rocks, soil, water, plants, animals, and humans. There are three main isotopes of uranium (U-234, U-235, and U-238). U-238 is a weakly radioactive metal and contributes to low-level background radiation in the environment. U-238 has a very long half-life of 4.47 billion years. Enriched U-235 is used as fuel in nuclear reactors and in nuclear weapons. Depleted uranium, which is poor in U-235 but rich in U-238, is used by the military in tank armor, bullets, and missiles for its strength and density. Uranium is common in specific types of igneous, metamorphic, and sedimentary rocks.

Exposure to uranium can result in both chemical and radiological toxicity. Natural uranium consists primarily of the U-238, which is very weakly radioactive, and it is not a hazardous radioactive substance. However, uranium is a weak chemical poison that can seriously damage the kidneys at high blood concentrations. This damage is dosage dependent and somewhat reversible. The uranium ion (uranyl) can also deposit on bone surfaces and may be detected in the bone matrix for several years following exposure.

Sources and Spatial Distribution in the GKGSA

Some radionuclides, such as uranium, occur naturally in the environment, while others are man-made or produced as byproducts of nuclear reactions. Recent research indicates that increased concentrations of uranium in groundwater are caused by mobilization of uranium present in soil with irrigation waters containing bicarbonates. Also, nitrate can mobilize uranium through a series of bacterial and chemical reactions.

GAMA indicates there are 121 drinking water wells with uranium detections in the GKGSA area. Of these wells, only 9 are above MCL of 20 pCi/L. The Subbasin has a widespread distribution of detects but the majority of MCL exceedances are in the western portion of the Subbasin.

Existing Regulatory Programs and Monitoring

Uranium 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. Uranium has a primary drinking water MCL of 20 pCi/L but no Agricultural Water Quality Goal. To establish is uranium is present, public water systems are required by Title 22 §64442 to monitor quarterly. More frequent monitoring is required if uranium has been historically detected. Monitoring data from the public water systems is reported to the SWRCB and available publicly on GAMA. In addition to SWRCB DDW regulation, monitoring, and oversight, data on arsenic concentrations are available via the GAMA Priority Basin Project[6]. Arsenic is monitored as a constituent of concern within the Kaweah Subbasin.

3.3.4 Interconnected Surface Water

3.3.4.1 Available Data and Information to Evaluate Interconnected Streamflow

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 interconnected 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.

Local knowledge suggests the Kaweah River east of McKay's Point in GKGSA is interconnected. Two USGS stream gauges along the Kaweah River in this area have not gone dry throughout the history of measurements, even during droughts. However, anecdotal evidence suggests the River in this area did not have continuous flow east of McKay's Point during the 2015 drought. Local hydrogeologic experts, familiar with the hydrology and geology in the GSA believe the Kaweah River is generally a gaining stream in this area. However, there was still some water remaining in the channel. Well records show that wells in this area have a depth to groundwater of less than 30 feet, possibly substantiating the claims that there is interconnected surface water.

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. In addition to this baseline analysis, the presence of potential interconnected surface waters was further considered under historically wet conditions using Spring 2017 depth to groundwater information. The presence of interconnected surface waters can best be assessed when the depth to groundwater is at its shallowest. The 2017 water

[6] https://www.waterboards.ca.gov/gama/priority_basin_projects.html

year was a wet year in which groundwater elevations were generally elevated in the Kaweah Subbasin from the previous winter.

Interconnected surface water is a data gap as much of the groundwater pumping in this area is likely sourced by bedrock wells (not extracting from the alluvial aquifer that are within the GSAs jurisdiction). See **Section 6.7.7** Interconnected Surface Water Data Gap Workplan, which details the next steps to better understand potential interconnected surface water in the Kaweah Subbasin. Progress has been made on this workplan, including the installation of three new interconnected surface water representative monitoring sites. More information on these sites is available in **Section 4.9**.

3.3.4.2 Groundwater Dependent Ecosystems

There are locations near the foothills of the Sierra Nevada where groundwater levels are closer to the surface and may seasonally present conditions for potential groundwater-dependent ecosystems (GDEs). Areas where groundwater is within the reported rooting depth of phreatophytes present are primarily located along the Kaweah River (primarily in GKGSA), the Stone Corral ID area, and portions of Lewis Creek in the Lindsay-Strathmore ID area. The Kaweah Subbasin GSAs recognize that vegetative species can be opportunistic and adapt to deepening roots beyond what the reported rooting depth is for each species. Therefore, the GSAs are treating all potential GDEs identified by the Nature Conservancy as GDEs unless there are clear reasons to indicate that the site(s) were mischaracterized due to mapping errors or other erroneous causation.

This 2nd amended GSP includes improvements in the GDE and interconnected surface water evaluation through the following steps:

(1) Evaluate upper aquifer groundwater level conditions in a historically wet year.
(2) Review the Nature Conservancy's GDE Pulse 2.2 Tool, which was designed to be an update from the NC Dataset Viewer tool with greater accuracy and assesses the presence of potential GDEs through the 2014 -2023 period.
(3) Reviewing aerial imagery during the historically wet 2023 conditions to evaluate surface conditions at these potential GDE sites to validate the presence of potential GDEs.

More groundwater level data, well completion depth, groundwater extraction data, and stream flow data are necessary to understand the presence of interconnected surface water and GDEs. The Interconnected Surface Water Data Gap Workplan (**Section 6.7.12**) is intended to better understand potential interconnected surface waters and, consequently, GDEs. Progress has been made on this management action, including the installation of several new shallow monitoring wells adjacent to streams. This progress has allowed the GKGSA to include three new monitoring sites dedicated to interconnected surface water to the representative monitoring network, as described in **Section 4.9**.

3.3.5 Seawater Intrusion

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

3.4 Water Budgets [§354.18(a),(b)(1),(b)(2),(b)(3),(b)(4),(b)(6),(c)(1),(c)(2)(A),(c)(2)(B),(e), and (f)]

§354.18 Water Budget.

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

(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:
- (1) Total surface water entering and leaving a basin by water source type.
- (2) Inflow to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems.
- (3) Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.
- (4) The change in the annual volume of groundwater in storage between seasonal high conditions.
- (6) The water year type associated with the annual supply, demand, and change in groundwater stored.

(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.

(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)

This section summarizes the estimated water budgets for the Subbasin, including information required by the GSP Regulations and other information supporting development of an effective sustainability plan. In accordance with the GSP Regulations §354.18, the water budget provides an accounting and assessment of the total annual volume of surface water and groundwater entering and leaving the Subbasin and the change in the volume of groundwater in storage, including under historical, current, and projected water budget conditions. Water budgets specific to the GKGSA are also provided. Water budgets are reported in tabular formats, where applicable.

3.4.1 Overview of Water Budget Development

The GSP Regulations require the development of a subbasin-wide groundwater budget and a subbasin-wide surface water budget. In agricultural areas such as the Kaweah Subbasin, a land surface budget is an additional useful element to review to assess changes in water demands over time and evaluate the water demand versus water supply balance due to climatic variations and land use changes.

The water budget descriptions are divided into 3 subsections: (1) historical water budgets, (2) current water budgets, and (3) projected water budgets, with a groundwater budget and land surface budget presented within each. All subsections are described with a summary of key observations of trends over time and relative contribution to the water budget by different components, to emphasize what portions of the water budget have the most and least influence on the Subbasin's water resource conditions. A table summarizing the amount of water contributed by each component is provided on an annual basis. Each subsection follows the same format.

Water budgets are developed using the calibrated Kaweah Subbasin groundwater flow model constructed with version 2.3 of the MODFLOW-OWHM code (Boyce *et al.*, 2020). This code is a version of the USGS groundwater flow code MODFLOW that estimates agricultural supply and demand through the Farm Process. An overview of model refinements implemented for this GSP revision will be provided in the final GSP as an appendix.

Before presenting the water budgets, a brief overview of the Subbasin's inflows and outflows is provided.

3.4.1.1 Water Budget Area and Components

The water budget is an inventory of surface water and groundwater flows into and out of the Subbasin. Some water budget components can be measured, such as streamflow at a gaging station or municipal groundwater pumping from a metered well. Other components of the water budget are simulated by the model such as recharge from precipitation, agricultural groundwater pumping which is unmetered, and change of groundwater in storage. The change of groundwater in storage is calculated by the model from simulated inflows minus outflows and is associated with a change in groundwater levels.

The Kaweah Subbasin is bounded on its northern, southern, and western extents by surrounding subbasins. The eastern extent is bounded by the base of the Sierra Nevada Mountain range. The Subbasin's vertical boundary is defined by the bedrock or the bottom of the freshwater base.

The water budgets for the Subbasin are calculated within the following boundaries:

- Lateral: The perimeter of the Kaweah Subbasin in addition to a buffer region that extends into nearby Tule, Tulare Lake, and Kings Subbasins
- Bottom: The base of the model
- Top: Above the ground surface, to the extent that surface water is included in the water budge

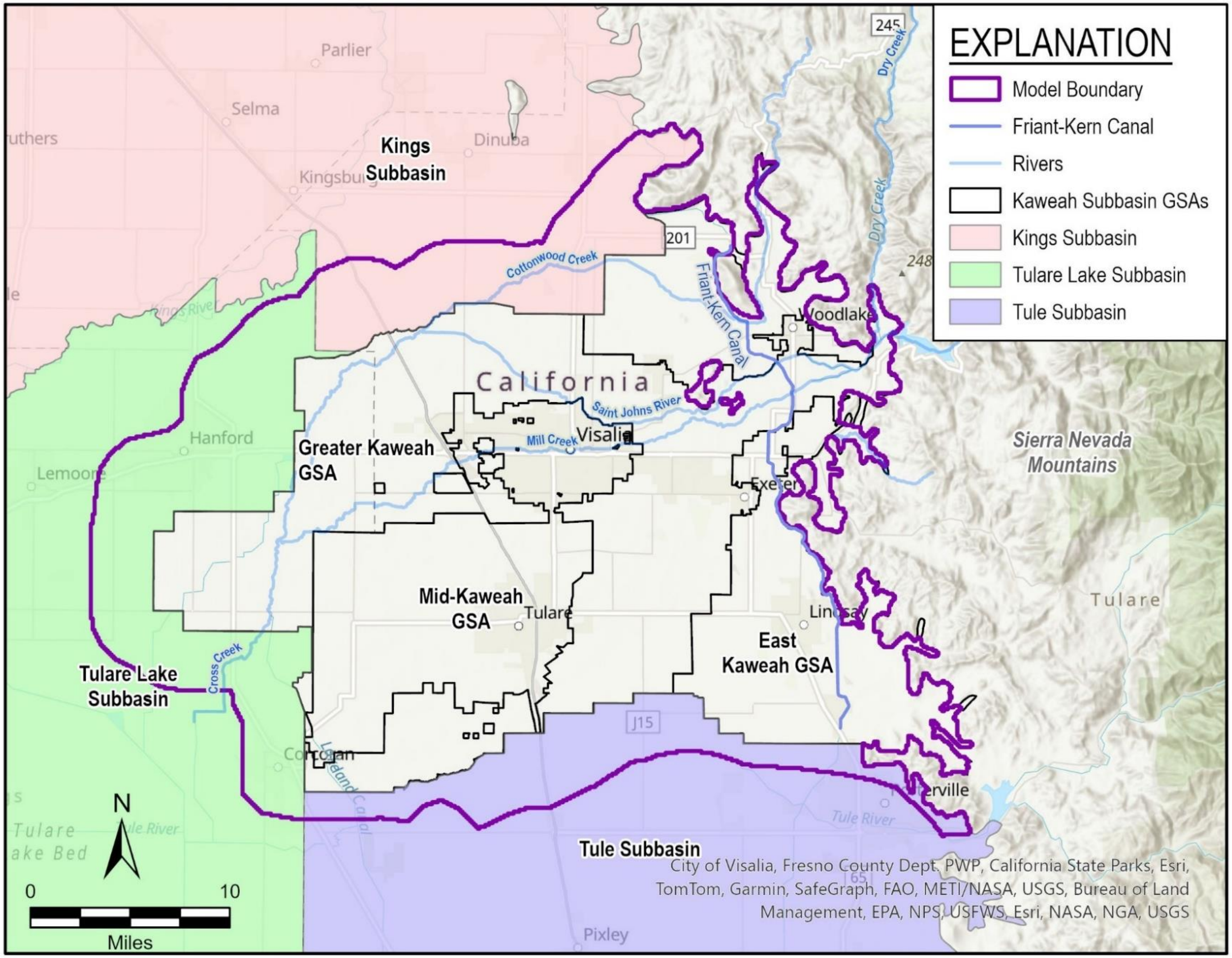
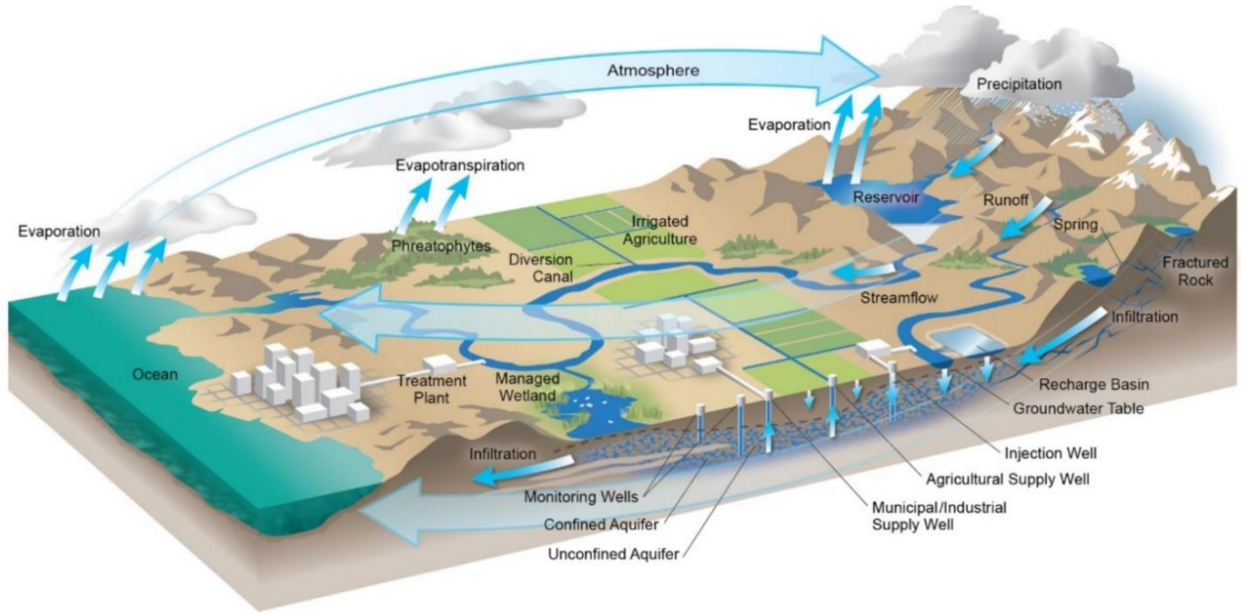


Figure 3-5. Kaweah Subbasin Water Budget Area

Figure 3-6 presents the general schematic diagram of the hydrologic cycle that is included in the water budget BMP (DWR, 2016c). Not all components represented in this graphic apply to the Kaweah Subbasin; specific components relevant to this GSP are presented in the subsections below.



(DWR, 2016c)

Figure 3-6. Schematic Hydrologic Cycle

The subsections below describe the Subbasin water budgets including the simulated inflow and outflow components.

3.4.1.1.1 Groundwater Budget Components

The groundwater budget represents the Subbasin's flow below the unsaturated zone and is developed by extracting groundwater budget components from the model over the Kaweah Subbasin zone budget area for the Kaweah Subbasin and each of the GSAs within the Subbasin (Figure 3-4). Evaluation of the groundwater budget provides an understanding of subbasin-wide trends in groundwater use, flows between subbasins, and groundwater-surface water connection.

Groundwater budget components applicable in the Subbasin are summarized below and illustrated on Figure 3-7.

Groundwater Inflows:

- **Subsurface Inflow** – Subsurface inflow consists of inter-aquifer flow from neighboring Subbasins into the Kaweah Subbasin.

- **Streambed Percolation** – Streambed percolation consists of flow which percolates to groundwater from stream channels.
- **Conveyance Losses** – Conveyance losses consists of flow which percolates to groundwater from unlined canals and ditches.
- **Mountain Front Recharge** –Mountain front recharge occurs on the eastern boundary from the Sierra Nevada Mountain range. The amount of mountain front recharge is based on estimates from other regional models and includes overland flow that becomes recharge as well as mountain block recharge from the crystalline bedrock into the shallow aquifer. Conveyance losses and mountain front recharge are grouped together in the water budget because they are simulated in the groundwater flow model's recharge package together.
- **Percolation of Recharge Basins –** Recharge basin percolation includes recharge from both surface water sources and wastewater treatment plant effluent.
- **Deep Percolation to Groundwater** – Deep percolation to groundwater includes percolation of irrigation water and percolation of precipitation.
- **Percolation of Irrigation Water** – Percolation of irrigation water includes recharge from irrigation water applied at surface that percolates to groundwater in the saturated zone. This also includes deep percolation from excess irrigation.
- **Percolation of Precipitation** – Percolation from precipitation consists of recharge from precipitation applied at surface that percolates to groundwater in the saturated zone.

Groundwater Outflows:

- **Subsurface Outflow –** Subsurface outflow consists of inter-aquifer flow from the Kaweah Subbasin to neighboring Subbasins
- **Municipal and Industrial Groundwater Pumping –** Pumping from municipal and industrial entities includes groundwater extracted from wells for urban use, small public water systems, dairies, nurseries, rural domestic, and golf courses.
- **Groundwater Pumping for Irrigated Agriculture –** This includes groundwater extracted from wells for use in agricultural irrigation.
- **Groundwater Discharge to Surface Water** – Groundwater discharge to surface water includes flow that discharges from groundwater into Kaweah River system channels.

The difference between groundwater inflows and outflows is equal to the change in storage. Total change in storage comprises the sum of aquifer and aquitard change in storage. Aquitard storage change is related compression of aquitards and land subsidence. Aquifer storage change is primarily referenced for comparison purposes in the text of this document, but both aquifer and aquitard storage are presented in associated tables.

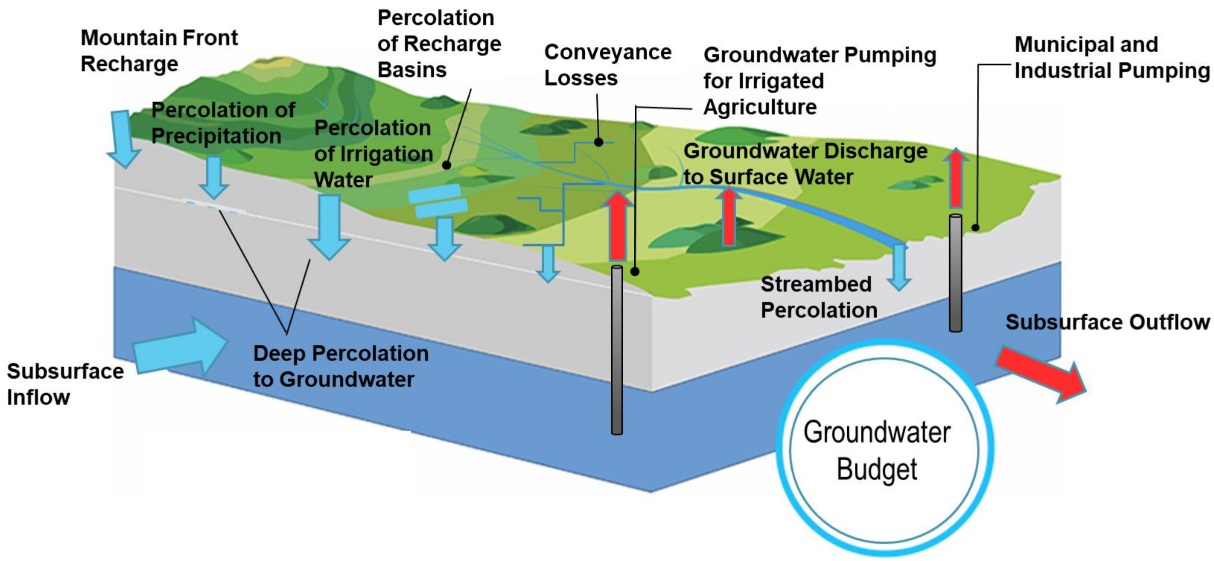


Figure 3-7.. Illustration of Groundwater Budget Components

3.4.1.1.2 Land Surface Budget Components

The land surface budget simulates the Subbasin's land surface system composed of the soil/land surface, root zone, and unsaturated zone. The land surface budget is developed by extracting land surface budget components from the historical model over the Kaweah Subbasin zone budget area for the Kaweah Subbasin and each of the GSAs within the Subbasin area (Figure 3-4). Evaluation of the land surface budget lends insight into trends in land and water use and the responsiveness of the surficial hydrologic system to inter-annual changes in precipitation.

Land surface budget components applicable in the Subbasin are summarized below and illustrated on Figure 3-8.

Land Surface Inflows:

- **Precipitation -** All precipitation that falls within the Subbasin
- **Applied Groundwater** - Water that is extracted from groundwater and applied to crops in the Subbasin
- **Applied Surface Water** - Water that is diverted from surface water bodies and canals (e.g. Kaweah River system and the Friant Kern Canal) and applied to crops in the Subbasin. This also includes treated wastewater from municipal Wastewater Treatment Plants (WWTPs) that is delivered for agricultural use.

- **Percolation of Recharge Basins** – Artificial recharge basins receive surface water, which percolates directly to groundwater. Surface water sources to recharge basins are from the Kaweah River diversions, the Friant Kern canal, and WWTP effluent diversions.

Land Surface Outflows:

- **Deep Percolation to Groundwater** – Deep percolation to groundwater includes percolation of irrigation water and percolation of precipitation.
- **Percolation of Irrigation Water** – Percolation of irrigation water is water recharged from applied surface water and applied groundwater that percolates to groundwater in the saturated zone. This also includes recharge from excess irrigation.
- **Percolation of Precipitation** – Percolation from precipitation consists of recharge from precipitation applied at surface that percolates to groundwater in the saturated zone.
- **Evapotranspiration** – Evapotranspiration includes water transpired by crops and native vegetation or evaporated into the atmosphere.
- **Percolation of Recharge Basins** - Artificial recharge basins receive surface water, which percolates directly to groundwater. Surface water sources to recharge basins are from the Kaweah River diversions, the Friant Kern canal, and WWTP effluent diversions.
- **Overland Flow** – Overland flow includes precipitation runoff, which is assumed to recharge due to the low slope profile of the basin; therefore, this term is reported together with percolation from precipitation.
- **Irrigation Return Flow** - Applied agricultural water that runs off the land surface into surface water bodies; all tail water is assumed to recharge and therefore this is accounted for in the water budgets as percolation from irrigation water.

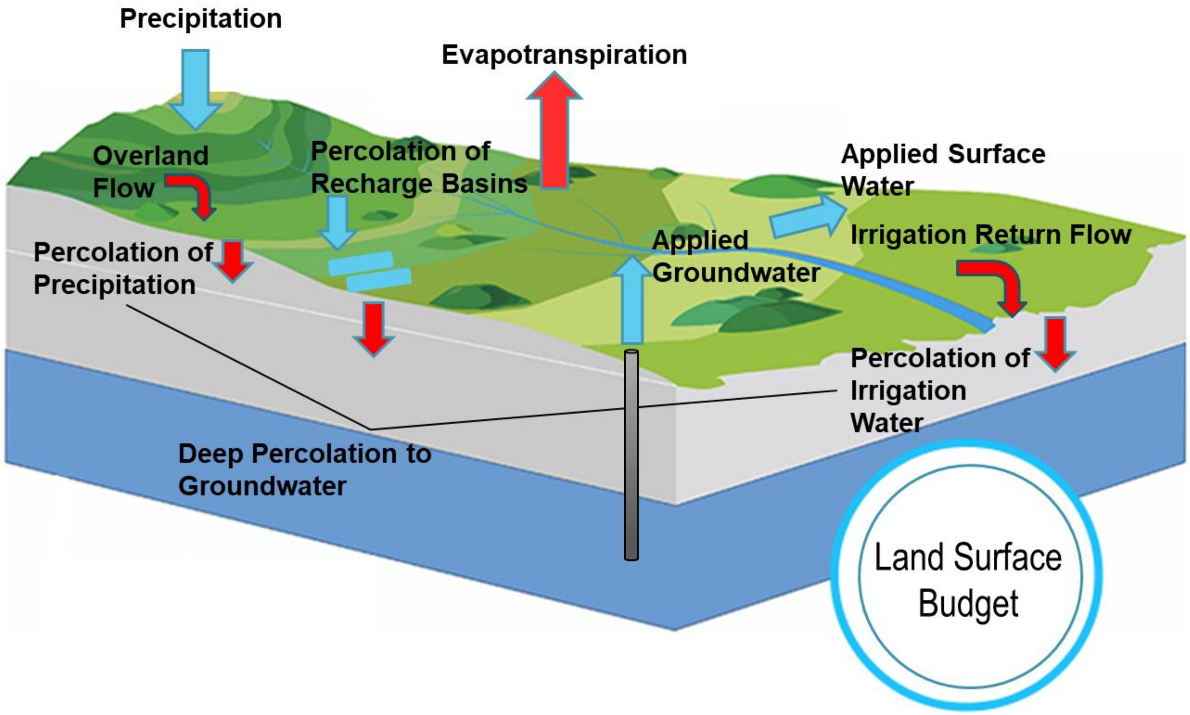


Figure 3-8. Illustration of Land Surface Budget Components

The difference between inflows and outflows is equal to the change in storage, which since there is no major surface water storage in the Subbasin, should be zero indicating a balanced land surface water budget.

3.4.1.1.3 Surface Water Budget Components

A Subbasin-wide surface water budget encompassing the surface water within the Subbasin is required in the GSP Regulations. The surface water budget is developed by extracting surface water budget components from model outputs for the Kaweah River System.

The Kaweah River splits at McKay Point, with the Upper Kaweah River upstream and the Lower Kaweah River and the Saint Johns River splitting downstream. The Saint Johns River converges with Cottonwood Creek and then feeds into Cross Creek. The Lower Kaweah River connects to Mill Creek and feeds into Cross Creek. Surface water diversions to agricultural lands occur along the Kaweah River System and only a small amount of water from the Kaweah River System leaves the Subbasin, usually during wet years. The Friant Kern Canal also brings in a substantial amount of imported surface water to the Subbasin which is diverted to the Kaweah River System and various agricultural districts in East Kaweah and Mid-Kaweah. However, because it is not a natural stream feature, it is not captured in the surface water budget where diversions come directly from the canal.

Evaluation of the surface water budget increases understanding of Subbasin-wide trends in groundwater-surface water connection, surface water use from local water sources, and the responsiveness of the surface water system to historical climatic variation.

Surface water budget components applicable in the Subbasin are summarized below.

Surface Water Inflows:

- **Kaweah River Upstream Inflow** - Surface water inflow to Kaweah River from below Terminus Dam
- **Friant Kern Canal -** Surface water inflow from the Friant Kern Canal to the Kaweah River and Saint John River
- **Small Tributaries** - Surface water inflow from minor streams outside of the Subbasin into the Subbasin's streams, which includes Dry Creek and Cottonwood Creek to the Kaweah River system
- **Groundwater Discharge -** Flow that discharges from groundwater into the Kaweah River system and the component of groundwater-surface water interaction where groundwater enters a stream under gaining conditions. This occurs upstream of McKay Point where bedrock is shallow.

Surface Water Outflows:

- **Kaweah River Outflow** - Surface water outflow from the Subbasin to Tulare Lake Subbasin via Cross Creek or Elk Bayou to the Tule Subbasin
- **Surface Water Diversions** - Water that is diverted from surface water bodies and applied to crops, directed to recharge basins, or percolated from canals/ditches as "losses" in the Subbasin
- **Streambed Percolation** - Flow that percolates down to groundwater from stream channels, also known as seepage from streambed. The component of groundwater-surface water interaction where streamflow percolates down to groundwater under losing conditions.
- **Riparian Evapotranspiration** – Evapotranspiration of surface water by plants along riparian corridor. This component was not explicitly modeled and assumed to be minimal.

3.4.1.2 Model Assumptions and Limitations for Water Budget Development

Data sources and limitations for the water budget components described above are presented in Table. The level of accuracy and certainty varies between water budget components, depending largely on the quality of model input data or available calibration data. Water budget uncertainty is expected to be reduced over time as GSP monitoring programs are implemented and the resulting data are used to check and improve the modeling tools and resulting water budgets.

Incorporating additional locally refined water budget information may also increase model simulation accuracy.

Table 3-2. Water Budget Components Data Sources and Limitations

Water Budget Component	Source of Model Input Data	Limitations
Land Surface Inflows		
Direct Precipitation	Historical precipitation data as provided by the AN81m/AN91m dataset from the PRISM	Precipitation is summarized over model element areas and may therefore not capture all variation over the element area.
Applied Groundwater	Simulated using land use water demands and surface water applications	Groundwater pumping is estimated from remaining crop water demand after natural sources and surface water deliveries are exhausted. Crop water demand estimates are developed at an model cell scale from estimated evapotranspiration data, irrigation methods, and soil type.
Applied Surface Water	Historical surface water diversion and delivery data	Derived from available historical records which are not always complete. Partitioning diversions to farm deliveries and losses is estimated.
Percolation of Recharge Basins	Historical recharge basin delivery data from surface water and WWTP effluent	Derived from available historical records which are not always complete.
Land Surface Outflows		
Percolation of Irrigation Water	Simulated by model	Estimated, limited data for calibration
Percolation of Precipitation	Simulated by model	Estimated, limited data for calibration
Evapotranspiration	Used estimated evapotranspiration arrays from Davids Engineering (simulated via soil water balance), or LandIQ in the Subbasin and OpenET (satellite-based) in the buffer area. Predictive simulations use LandIQ data.	Estimated evapotranspiration may be further limited by water supply in numerical model. Multiple datasets are necessary to cover model domain and simulation period. Inherent differences in estimated evapotranspiration between data sets were reconciled by applying scaling factors based on crop groups to better match the Davids Engineering and OpenET datasets with LandIQ. OWHM has the option to not meet the input ET arrays if it doesn't have enough water, therefore sometimes simulated ET could be less than actual ET.
Percolation of Recharge Basins	Historical recharge basin delivery data from surface water and WWTP effluent	Derived from available historical records which are not always complete.
Overland Flow	Simulated in model as percolation of precipitation	Limited data available
Irrigation Return Flow	Simulated in model as percolation of irrigation water	Limited data available
Surface Water Inflows		
Kaweah River Upstream Inflow	Simulated by model using historical streamflow measurements at stream headwaters	Subject to limitations in available streamflow measurements and estimates of stream inflows from and outflows to adjacent lands. These include diversions, precipitation, evaporation, runoff, return flows, gains from groundwater, and seepage to groundwater.
Friant Kern Canal	Simulated by model using historical gage data	Subject to limitations in available gage measurements.

Water Budget Component	Source of Model Input Data	Limitations
Small Tributaries	Simulated by model using historical streamflow gage data	Estimated, from limited gauge data for inflows to the Kaweah River system from the ephemeral streams discharging from upstream watersheds bordering the model
Groundwater Discharge	Simulated by model	Estimated, limited data for calibration
Surface Water Outflows		
Kaweah River Outflow	Simulated by model using historical streamflow measurements at stream headwaters and simulated surface water diversions and streambed percolation	Subject to limitations in available streamflow measurements and estimates of stream inflows from and outflows to adjacent lands. These include diversions, precipitation, evaporation, runoff, return flows, gains from groundwater, and seepage to groundwater
Surface Water Diversions	Historical surface water diversion and delivery data	Derived from available historical records which are not always complete
Streambed Percolation	Simulated by model	Estimated, limited data for calibration
Riparian Evapotranspiration	Not explicitly modeled	Assumed to be minimal; limited data available
Groundwater Inflows		
Subsurface Inflow	Simulated by model	Subject to uncertainty in simulated heads and aquifer hydraulic properties
Streambed Percolation	Simulated by model	Estimated, limited data for calibration
Conveyance Losses	Historical losses calculated as percentage of surface water diversion data	Subject to limitations of surface water diversions and gage measurements and assumptions of percentage of diversions applied as ditch and canal percolation
Mountain Front Recharge	Estimated based on review of regional models	Estimated, limited data for calibration
Percolation of Recharge Basins	Historical recharge basin data	Subject to limitations of diversion measurements or estimates provided
Percolation of Irrigation Water	Simulated by model	Estimated, limited data for calibration
Percolation of Precipitation	Simulated by model	Estimated, limited data for calibration
Groundwater Outflows		
Subsurface Outflow	Simulated by model	Subject to uncertainty in simulated heads and aquifer hydraulic properties
Municipal and Industrial Pumping	Used metered pumping where available and estimates based on population, service connections, etc. for historical period. Predictive period was simulated using projected urban water demands where available	Municipal pumping data was largely available, however small public water systems, rural domestic, and dairies were estimated. Predictive pumping assumes increased pumping as projected by Urban Water Management Plans, where available.
Groundwater Pumping for Irrigated Agriculture	Simulated using ETa, applied precipitation, and surface water deliveries	Groundwater pumping rates and depths are not derived from measured pumping data. They are estimated from crop acreages, crop water demand estimates and surface water delivery estimates
Groundwater Discharge to Surface Water	Simulated by model	Estimated, limited data for calibration

3.4.1.3 Water Budget Timeframes

The GSP Regulations require water budgets for 3 timeframes representing historical conditions, current conditions, and projected conditions. It is noted that the model and water budgets are calculated on a monthly basis but summarized by water year herein. All water budgets are developed for complete water years (WY).

In accordance with the GSP Regulation 23 CCR §354.18(c), the GSP quantifies a current, historical, and projected water budget for the Subbasin, as follows:

- The historical water budget is intended to evaluate how past water supply availability has affected aquifer conditions and the ability of groundwater users to operate sustainably. GSP Regulations require that the historical water budget include at least the most recent 10 years of water budget information (depending on data availability).
- The current water budget is intended to allow the GSAs and DWR to understand the existing supply, demand, and change in storage under the most recently available population, land use, and hydrologic conditions.
- The projected water budgets are intended to quantify the estimated future baseline conditions without implementation of GSP projects and management actions. Since overdraft currently exists in the Subbasin, a projected water budget without implementation of GSP projects and management actions would clearly result in ongoing overdraft and worsening conditions. Demand management and managed aquifer recharge are key to halting overdraft and associated land subsidence. The projected water budget therefore includes projects and management actions to demonstrate what is needed to achieve sustainability. The projected water budgets estimate conditions concerning hydrology, water demand, and surface water supply over a 50-year planning and implementation horizon. Historical trends in hydrologic conditions are used to project 50 years forward while considering projected climate change assumptions and projects and management actions by the GSAs.

Figure 3-8 summarizes the 3 timeframes for the water budgets developed for this GSP.

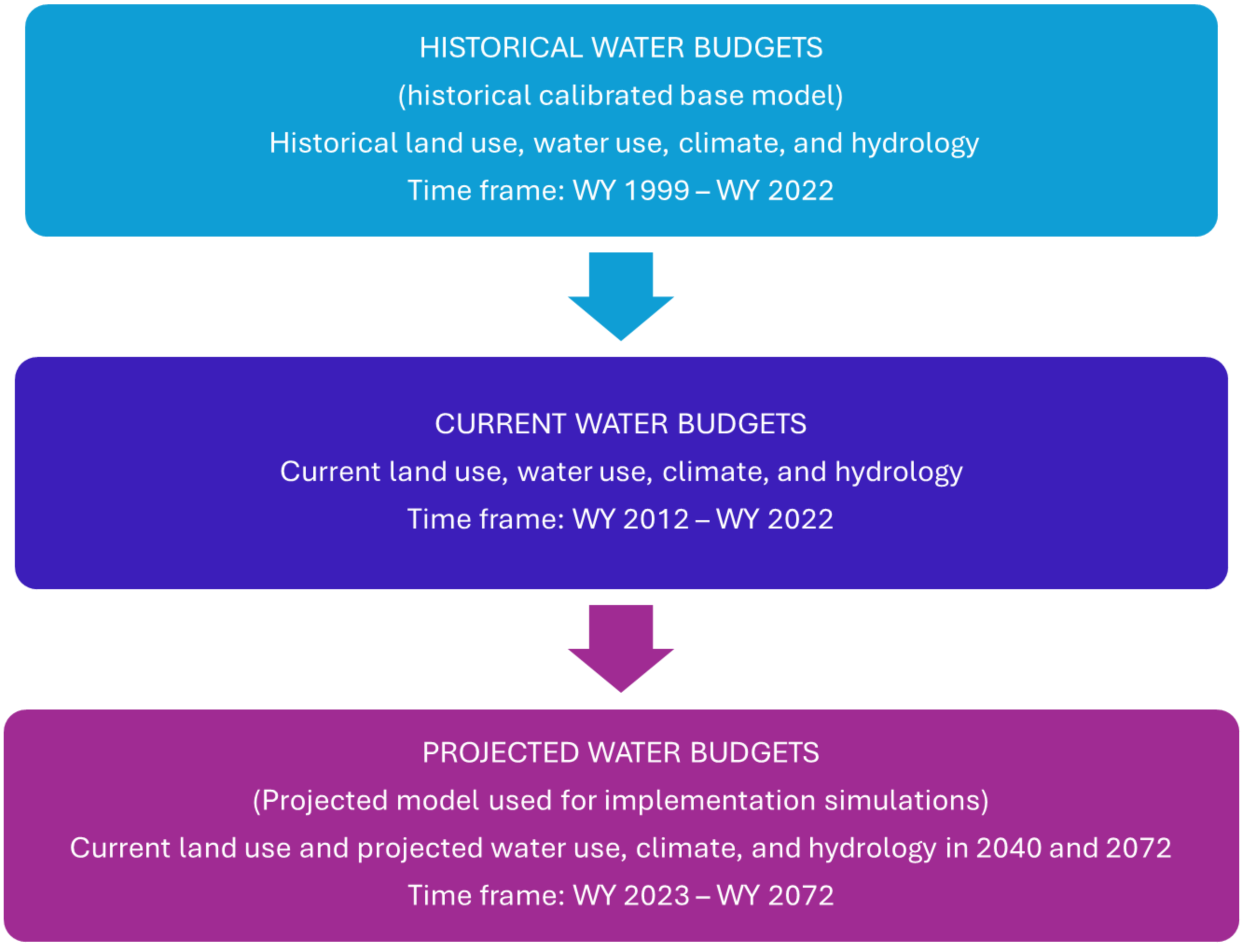


Figure 3-8. Summary of GSP-required Water Budget Time Frames

3.4.1.3.1 Historical Water Budgets

Historical conditions should go back to the most reliable historical data that are available for GSP development and water budget calculations. For this GSP, the historical timeframe is defined as WY 1999-2022 to align with the groundwater flow model period.

3.4.1.3.2 Current Water Budgets

The current water budget provides an understanding of the existing supply, demand, and change in storage under the most recent available population, land use, and hydrologic conditions. For this GSP, the current timeframe is defined as WY 2012-2022.

3.4.1.3.3 Future Projected Water Budgets

The projected water budget covers a 50-year time period from October 2022 through September 2072. Hydrologic conditions for the projected water budget are based on cycling the water year sequence from the 24-year historical period twice beginning in WY 2024, with WY 2017 used as a proxy year for WY 2023 (both wet years), and WY 1999 used as a proxy year for WY 2072. Future precipitation, reference evapotranspiration, and inflows to Lake Kaweah are adjusted from the historical period based on the central tendency climate change factor dataset provided by DWR (DWR, 2018) for the 2070 (late future) period.

In addition to comparing groundwater conditions to SMCs, projected water budgets are useful to evaluate if sustainability will be maintained over the 50-year planning and implementation horizon. Projected future baseline conditions are supplemented with simulated projects and management actions to ensure undesirable results to beneficial users and uses of groundwater do not occur.

3.4.1.4 Key Water Budget Findings

This GSP includes 2 types of water budgets (groundwater and land surface budgets) over 3 time periods: historical, current, and projected. Each water budget provides important information on the relative contribution of each component to the overall water budget. When comparing the results from each of the 3 time periods, potential trends in water budget gains and losses can be established for future Subbasin management.

Key findings of the detailed water budgets in the Subbasin can be summarized as follows:

- As simulated over the entire historical period, the Kaweah Subbasin has been subject to groundwater overdraft, demonstrated by a negative change of groundwater in storage due to groundwater outflows exceeding groundwater inflows.
- While the historical and current water budgets provide context for the recent conditions, the future water budgets are more instructive for GSP implementation; rather, it gives an understanding of past behavior and interactions of various flow components. Historical water budgets provide background information that is complementary to the Basin Setting.
- The groundwater budget provides key information such as total groundwater pumping and change in groundwater storage annually and cumulatively over the full simulation period. The land surface budget provides information on the total water demand and relative use of surface water versus groundwater. The surface water budget is primarily used to assess surface water for recharge availability operations, but is also used to assess interconnected surface water conditions. In this Subbasin, the Kaweah River system is generally a losing stream except for the uppermost reaches where there is shallow bedrock.
- Cumulative and average annual loss of storage is greater in the current water budget compared to the historical water budget; therefore, if water management strategies do not change, the Subbasin will experience ongoing groundwater level and storage declines, land subsidence, and overall worsening conditions compared to historical conditions.

- Average annual agricultural pumping increased by about 41,100 AF from the historical (692,300 AF/year) to the current water budget (733,400 AF/year). The simulated historical average annual change in aquifer storage is -139,300 AF and for the current period the average annual change in aquifer storage is -226,600 AF.

- In the future water budget, demand management is the primary action to transition the Subbasin from overdraft to sustainable conditions. Projected irrigation pumping in the GSP implementation scenario is expected to decrease to an annual average of 487,000 AF between WY 2023-2039 and 448,700 AF/year for WY 2040-2072. This results in an average annual change in aquifer storage to be 6,500 AF for WY 2023-2039 and 6,600 AF/year for WY 2040-2070.

- Groundwater conditions in neighboring subbasins impact projected water budgets and groundwater levels in the Kaweah Subbasin because they are hydrauliclly connected. Model assumptions, described in Section 3.4.4.1.6, are incorporated limit negative impacts to the Kaweah Subbasin from surrounding subbasins.

- Surface water inflows to the Kaweah River system decreases overall due to impacts from climate change, however during exceptionally wet years, additional water is available for recharge.

- The current and projected water budgets display increasingly less groundwater discharge to streams and more streambed recharge to groundwater, indicating that progressively lowered groundwater elevations in the future may draw more water from the Subbasin’s streams, and contribute less groundwater baseflow in return.

- Overall observations regarding historical, current, and future baseline groundwater budgets:

    - Historical: The Subbasin is in overdraft.

    - Current: The Subbasin is in overdraft. Overall a bit worse than historical.

    - Projected with management actions with climate change: The Subbasin’s implementation of projects and pumping reductions results in a shift of 226,600 AF/year of overdraft in the aquifer to a positive change in storage in the aquifer of 6,600 AF/year.

- The projected future water budget which incorporated changes in conditions as well as projects and management actions undertaken is what the GSP uses to evaluate SMC, and which helps define the sustainable yield of the Subbasin. This demonstrates that the Subbasin will operate sustainably during GSP implementation.

3.4.2 Historical and Current Groundwater Budgets

The historical and current annual groundwater budget for the Subbasin are summarized in Table 3-3. Historical and current annual groundwater budgets for the GKGSA area are summarized in Table 3-4.

3.4.2.1 Subbasin Historical Groundwater Budget

The historical groundwater budget is dominated by 6 primary components: percolation of irrigation water, percolation from precipitation, agricultural pumping, flow between groundwater and surface water, and inter-basin subsurface flow.

- Percolation from irrigation water and precipitation represents 51% of total groundwater inflow in an average year, though the total volume varies significantly with climate, ranging from 259,400 to 545,600 AF/year.
- Conveyance losses and mountain front recharge accounts for 16% of total groundwater inflow, with the total volume ranging from 24,300 to 283,800 AF/year.
- Percolation from recharge basins represents 8% of total groundwater inflow with total volumes ranging from 16,800 to 191,000 AF annually.
- Groundwater pumping constitutes 87% of groundwater outflow, 78% from agricultural pumping and 8% from municipal and industrial pumping. Agricultural pumping ranges from 428,300 to 959,000 AF/year with variation largely dependent on climate, land use, and surface water availability. Municipal and industrial pumping is less variable, ranging from 63,200 to 87,700 AF/year.
- Groundwater-surface water interaction occurs in both gaining and losing reaches across the Subbasin. Subbasin-wide streambed recharge comprises 12% of total groundwater inflows in an average year, while groundwater discharge to streams comprises 1% of total outflows in an average year. Subbasin-wide, an average of 82,700 AF of surface water percolates along the channels of the Kaweah River System and an average volume of 8,100 AF of groundwater discharges into the Subbasin's streams annually.
- Subsurface flows constitute 12% of total groundwater inflows and 12% of total groundwater outflows in an average year. On average there is annually more subsurface outflows than inflows, for a net outflow of 24,908 AF. On a net basis, groundwater flows into the Subbasin from Kings and Lower Tule Subbasins and out of the Subbasin to the Tulare Lake Subbasin. The location of subsurface inflows and outflows are largely due to regional groundwater gradients that direct groundwater from northeast to southwest. Subsurface flows are also impacted by seasonal groundwater pumping occurring in agricultural areas.

- Historical wet periods result in increased deep percolation to groundwater and reduced groundwater pumping due to associated increases in surface water use and reduced irrigation demands. Likewise, the Subbasin is highly responsive to extended dry periods largely driven by decreases in deep percolation to groundwater and increased reliance on groundwater extraction. The annual change of groundwater in storage fluctuates between a loss of 714,800 and a gain of 629,300 AF, with an annual average loss of 190,000 AF, which substantiates the Subbasin's historical overdraft. The Subbasin displays a cumulative groundwater storage loss of 4,559,400 AF over the historical water budget period.

3.4.2.2 Subbasin Current Groundwater Budget

The current groundwater budget is summarized in Table 3-3. Major differences between the historical groundwater budget and the current groundwater budget include the following:

- A 44,400 AF decrease in average annual deep percolation to groundwater caused primarily by decreases in precipitation percolation
- A 20,300 AF decrease in average annual conveyance losses
- A 14,300 AF decrease in average annual streambed recharge, and a 200 AF average annual increase in groundwater discharge to streams
- A 41,100 AF increase in average annual agricultural pumping driven by decreased surface water applications
- A 108,200 AF decrease in average annual change of groundwater in storage; 87,400 AF from the change in storage in the aquifer and 20,800 AF from change in storage in the aquitard

These results suggest current land use and water use trends are unsustainable, even without considering climate change impacts.

3.4.2.3 GKGSA Historical Groundwater Budget

The historical groundwater budget for the GKGSA is dominated by the same primary water budget components as the overall Subbasin but with different percentage distributions (Table 3-4).

- Percolation from irrigation water and precipitation represents 10% of total groundwater inflow in an average year, though the total volume varies significantly with climate, ranging from 8,800 to 145,100 AF/year.
- Conveyance losses accounts for 9% of total groundwater inflow, with the total volume ranging from 110,100 to 151,600 AF/year.

- Percolation from recharge basins represents 4% of total groundwater inflow with total volume ranging from 5,900 to 71,400 AF/year.
- Streambed percolation represents 10% of total groundwater inflow with total volumes ranging from 16,200 to 133,000 AF/year.
- Groundwater pumping constitutes 64% of groundwater outflow, 61% agricultural pumping and 3% municipal and industrial groundwater pumping. Agricultural pumping ranges from 278,500 to 552,400 AF/year with variation largely dependent on climate, land use, and surface water use. Municipal and industrial pumping is less variable, ranging from 15,500 to 27,400 AF/year. Irrigated agriculture in the GKGSA pumps 63% of Subbasin-wide irrigation pumping and 3% of Subbasin pumping for M&I.
- Discharge to surface water to stream channels is approximately 1% of groundwater outflows with total volumes ranging from 3,200 to 11,900 AF/yr.
- Subsurface flows constitute 48% of total groundwater inflows and 35% of total groundwater outflows in an average year. Overall, there is greater subsurface outflow than inflow.

The annual change of aquifer storage fluctuates between a loss of 308,900 and a gain of 364,300 AF/year with an annual average loss of 74,300 AF/year. Annual aquitard storage change ranges from a gain of 8,300 to a loss of 67,900 AF/year with an average annual loss of 27,700 AF/year. GKGSA has a cumulative groundwater storage loss of 2,447,400 AF over the historical period (1999 – 2022).

3.4.2.4 GKGSA Current Groundwater Budget

The current groundwater budget for GKGSA is summarized at the bottom of Table 3-4. The largest differences between the historical groundwater budget and the current groundwater budget include the following:

- A 14,400 AF decrease in average annual deep percolation to groundwater caused primarily by decreases in percolation of precipitation.
- A 11,100 AF decrease in average annual conveyance losses.
- A 10,200 AF decrease in average annual streambed percolation.
- A 17,400 AF increase in average annual agricultural pumping driven by decreased surface water applications.
- A 54,400 AF increase in average annual loss of groundwater in storage; 43,600 AF from the change in storage in the aquifer, and 10,800 AF from change in storage in the aquitard.

Table 3-3. Historical and Current Annual Groundwater Budget Summary for the Kaweah Subbasin (WY 1999 – WY 2022)

Kaweah Subbasin Model Simulated Groundwater Inflows, Outflows and Change in Storage for WY 1999 through WY 2022

Values in 1,000s Acre-Feet

	Water Year	Rainfall		Components of Inflow						Components of Outflow									
										Groundwater Pumpage									
		Inches	% of Average	Subsurface Inflow	Steambed Percolation	Conveyance Losses (Canal and Ditch Recharge) and MFR Recharge	Percolation of Recharge Basins	Percolation of Irrigation Water	Percolation of Precipitation (Crop and Non-Ag Land)	M & I GW Pumping	GW Pumping for Irrigated Agriculture	Discharge to Surface Water	Subsurface Outflow	*Total Inflow*	*Total Outflow*	Aquitard Storage Change	Aquifer Storage Change	Change in Storage	Cumulative Change in Storage
	1999	9.5	102%	106.0	82.6	104.1	67.0	226.6	134.0	67.8	584.8	3.7	54.5	*720.3*	*710.9*	*20.0*	*-10.6*	*9.4*	*9.4*
	2000	10.9	117%	85.4	90.0	117.9	56.4	243.0	172.6	65.9	618.6	4.5	81.8	*765.2*	*770.7*	*-2.7*	*-2.8*	*-5.5*	*3.9*
	2001	9.2	99%	78.4	57.4	89.4	22.0	245.4	124.9	71.9	729.1	6.0	106.7	*617.6*	*913.7*	*-30.8*	*-265.3*	*-296.1*	*-292.2*
	2002	9.5	102%	79.2	75.0	92.5	28.6	258.9	136.8	74.5	772.9	6.0	109.4	*671.0*	*962.9*	*-40.9*	*-250.9*	*-291.9*	*-584.0*
	2003	9.3	100%	76.3	93.1	118.8	72.8	240.6	101.7	75.0	644.9	6.7	118.0	*703.2*	*844.6*	*-35.0*	*-106.4*	*-141.4*	*-725.5*
	2004	7.4	80%	74.9	61.0	63.8	20.8	264.2	121.4	81.7	832.3	5.8	111.4	*606.2*	*1,031.2*	*-62.6*	*-362.4*	*-425.0*	*-1,150.5*
	2005	14.0	151%	79.9	142.8	206.4	129.0	219.3	187.7	71.2	447.8	8.3	111.4	*965.2*	*638.7*	*-14.4*	*340.9*	*326.5*	*-824.0*
	2006	14.4	155%	73.2	146.1	213.7	86.7	225.3	241.3	74.5	467.7	13.1	108.4	*986.3*	*663.8*	*-0.7*	*323.2*	*322.5*	*-501.4*
	2007	5.3	57%	73.9	44.6	43.8	25.8	253.9	45.6	87.7	889.6	7.9	127.9	*487.8*	*1,113.1*	*-54.9*	*-570.3*	*-625.2*	*-1,126.7*
	2008	7.8	84%	76.5	72.3	94.2	22.6	258.9	126.9	85.7	775.7	7.2	177.6	*651.4*	*1,046.1*	*-73.8*	*-321.0*	*-394.7*	*-1,521.4*
	2009	6.8	74%	76.5	70.5	97.4	24.7	261.0	72.1	83.8	796.4	6.5	176.1	*602.2*	*1,062.7*	*-86.6*	*-373.8*	*-460.5*	*-1,981.9*
	2010	11.3	122%	77.7	125.7	195.5	99.8	238.9	168.1	76.0	533.1	10.0	152.8	*905.8*	*771.9*	*-44.5*	*178.4*	*133.9*	*-1,848.0*
	2011	16.8	181%	94.7	171.6	242.7	167.3	230.4	315.3	71.4	455.3	17.2	109.5	*1,221.9*	*653.5*	*-3.2*	*571.6*	*568.4*	*-1,279.5*
	2012	7.9	85%	94.0	62.2	66.4	41.7	236.2	48.5	81.7	758.5	10.3	109.5	*549.0*	*960.0*	*-35.5*	*-375.5*	*-411.0*	*-1,690.5*
	2013	5.4	59%	91.0	46.7	33.7	26.0	253.5	53.5	81.2	913.9	6.8	125.9	*504.4*	*1,127.8*	*-73.8*	*-549.6*	*-623.4*	*-2,314.0*
	2014	4.4	48%	91.4	24.7	31.3	18.7	250.9	17.8	75.3	959.0	4.4	110.9	*434.8*	*1,149.6*	*-110.1*	*-604.7*	*-714.8*	*-3,028.8*
	2015	7.1	77%	88.8	24.6	25.4	17.6	239.6	93.1	65.8	923.8	4.5	95.8	*489.1*	*1,089.8*	*-123.4*	*-477.3*	*-600.7*	*-3,629.5*
	2016	11.6	125%	74.6	80.5	103.7	38.9	179.7	142.2	67.7	573.5	6.5	105.2	*619.6*	*752.9*	*-94.8*	*-38.6*	*-133.3*	*-3,762.8*
	2017	14.6	158%	80.7	187.7	283.8	191.0	224.7	266.0	63.2	428.3	13.9	99.3	*1,234.0*	*604.7*	*-37.0*	*666.3*	*629.3*	*-3,133.5*
	2018	6.2	67%	76.9	70.4	82.7	47.2	203.0	56.4	72.7	641.2	9.5	84.2	*536.6*	*807.6*	*-47.1*	*-223.8*	*-270.9*	*-3,404.4*
	2019	12.3	133%	87.7	142.2	257.4	131.1	201.7	132.6	68.3	459.5	14.2	87.6	*952.7*	*629.5*	*-27.3*	*350.5*	*323.2*	*-3,081.2*
	2020	8.7	94%	79.6	50.0	55.3	26.2	200.2	60.1	69.2	699.4	9.1	89.8	*471.3*	*867.5*	*-49.1*	*-347.2*	*-396.2*	*-3,477.5*
	2021	4.5	49%	93.7	17.6	24.3	16.8	225.1	38.8	72.5	921.2	5.9	81.2	*416.3*	*1,080.9*	*-90.1*	*-574.5*	*-664.6*	*-4,142.1*
	2022	7.7	83%	104.3	45.4	44.1	25.9	206.8	97.0	68.1	789.1	5.5	78.2	*523.5*	*940.8*	*-98.6*	*-318.7*	*-417.3*	*-4,559.4*
Historical 1999-2022	Maximum	16.8	181%	106.0	187.7	283.8	191.0	264.2	315.3	87.7	959.0	17.2	177.6	1,234.0	1,149.6	20.0	666.3	629.3	
	Minimum	4.4	48%	73.2	17.6	24.3	16.8	179.7	17.8	63.2	428.3	3.7	54.5	416.3	604.7	-123.4	-604.7	-714.8	
	Average	**9.3**	**100%**	**84.0**	**82.7**	**112.0**	**58.5**	**232.8**	**123.1**	**73.9**	**692.3**	**8.1**	**108.9**	**693.1**	**883.1**	**-50.7**	**-139.3**	**-190.0**	
	% of Total			12%	12%	16%	8%	34%	18%	8%	78%	1%	12%						
Current 2012 - 2022	Maximum	14.6	158%	104.3	187.7	283.8	191.0	253.5	266.0	81.7	959.0	14.2	125.9	1,234.0	1,149.6	-27.3	666.3	629.3	
	Minimum	4.4	48%	74.6	17.6	24.3	16.8	179.7	17.8	63.2	428.3	4.4	78.2	416.3	604.7	-123.4	-604.7	-714.8	
	Average	**8.2**	**89%**	**87.5**	**68.4**	**91.7**	**52.8**	**220.1**	**91.4**	**71.4**	**733.4**	**8.2**	**97.1**	**611.9**	**910.1**	**-71.5**	**-226.6**	**-298.2**	
	% of Total			14%	11%	15%	9%	36%	15%	8%	81%	1%	11%						

Table 3-4. Historical and Current Annual Groundwater Budget Summary for Greater Kaweah Groundwater Sustainability Agency (WY 1999 – WY 2022)

Greater Kaweah Model Simulated Groundwater Inflows, Outflows and Change in Storage for WY 1999 through WY 2022

Values in 1,000s Acre Feet

		Rainfall		Components of Inflow						Components of Outflow									
										Groundwater Pumpage									
	Water Year	Inches	% of Average	Subsurface Inflow	Steambed Percolation	Conveyance Losses (Canal and Ditch Recharge) and MFR Recharge	Percolation of Recharge Basins	Percolation of Irrigation Water	Percolation of Precipitation (Crop and Non-Ag Land)	M & I GW Pumping	GW Pumping for Irrigated Agriculture	Discharge to Surface Water	Subsurface Outflow	*Total Inflow*	*Total Outflow*	Aquitard Storage Change	Aquifer Storage Change	Change in Storage	Cumulative Change in Storage
	1999	9.1	101%	253.8	61.8	55.8	33.8	130.1	61.3	17.4	398.4	3.5	164.3	*596.7*	*583.7*	8.3	*4.7*	*13.0*	*13.0*
	2000	10.6	118%	241.2	65.3	58.4	27.5	138.7	81.7	20.3	402.8	3.7	189.9	*612.8*	*616.7*	*-2.7*	*-1.2*	*-3.9*	*9.1*
	2001	9.1	102%	234.7	39.9	44.2	9.7	139.6	61.0	24.0	434.2	5.1	219.8	*529.1*	*683.1*	*-15.9*	*-138.1*	*-154.0*	*-144.9*
	2002	8.6	97%	241.6	54.3	45.0	12.6	147.6	65.9	22.9	467.6	5.0	226.5	*566.9*	*721.9*	*-21.6*	*-133.4*	*-155.0*	*-299.9*
	2003	8.9	99%	245.0	66.8	61.5	36.4	137.8	45.3	22.2	407.5	5.4	238.4	*592.7*	*673.6*	*-19.5*	*-61.4*	*-80.9*	*-380.8*
	2004	7.3	81%	239.9	43.2	32.8	8.5	151.6	59.4	23.7	505.2	4.6	230.7	*535.4*	*764.2*	*-33.6*	*-195.2*	*-228.8*	*-609.6*
	2005	13.8	154%	255.3	101.8	103.2	65.5	126.6	90.3	16.8	286.4	6.6	245.2	*742.7*	*555.0*	*-7.5*	*195.3*	*187.8*	*-421.9*
	2006	14.2	159%	246.3	107.0	104.1	41.5	128.3	114.2	17.0	288.1	10.5	258.0	*741.4*	*573.6*	*-0.1*	*167.9*	*167.8*	*-254.1*
	2007	5.0	56%	249.2	31.7	18.4	10.3	146.4	20.9	27.4	531.5	6.4	270.2	*477.0*	*835.6*	*-30.0*	*-328.6*	*-358.6*	*-612.7*
	2008	7.5	83%	272.2	49.8	50.1	8.8	148.5	58.7	27.0	459.3	5.7	312.5	*588.1*	*804.6*	*-42.4*	*-174.0*	*-216.4*	*-829.1*
	2009	6.6	73%	276.2	49.8	48.2	10.2	150.1	32.6	24.8	482.2	5.1	307.3	*567.2*	*819.4*	*-49.1*	*-203.2*	*-252.2*	*-1,081.3*
	2010	10.9	122%	285.6	86.8	80.2	30.8	137.3	76.7	20.8	339.7	7.9	282.4	*697.5*	*650.8*	*-26.2*	*72.8*	*46.7*	*-1,034.7*
	2011	16.2	181%	293.6	120.7	125.1	66.5	131.1	145.1	17.3	278.5	14.1	265.1	*882.0*	*575.0*	*-1.4*	*308.5*	*307.0*	*-727.6*
	2012	7.5	83%	272.8	42.7	33.6	13.2	135.4	20.1	25.7	442.4	8.5	265.9	*517.8*	*742.5*	*-19.1*	*-205.6*	*-224.6*	*-952.3*
	2013	5.2	58%	273.6	33.4	15.4	8.0	144.8	24.4	24.1	542.8	5.6	265.8	*499.5*	*838.3*	*-40.8*	*-298.0*	*-338.7*	*-1,291.0*
	2014	4.3	48%	263.0	19.2	10.2	6.9	143.5	8.8	20.9	552.4	3.2	237.6	*451.5*	*814.1*	*-60.0*	*-302.5*	*-362.6*	*-1,653.6*
	2015	6.9	77%	248.1	19.2	10.4	6.3	138.6	44.2	19.1	536.9	3.3	213.2	*466.8*	*772.4*	*-67.9*	*-237.8*	*-305.7*	*-1,959.3*
	2016	11.1	124%	238.4	58.2	46.7	8.2	110.1	65.8	20.9	347.5	5.0	215.3	*527.5*	*588.7*	*-52.0*	*-9.2*	*-61.2*	*-2,020.5*
	2017	14.1	158%	289.8	133.0	140.4	71.4	128.8	124.1	15.5	280.8	11.2	234.7	*887.6*	*542.2*	*-19.0*	*364.3*	*345.3*	*-1,675.1*
	2018	6.1	68%	249.4	47.9	40.3	12.1	121.6	28.1	21.8	403.5	7.8	224.6	*499.4*	*657.7*	*-24.7*	*-133.6*	*-158.2*	*-1,833.4*
	2019	11.9	133%	279.4	96.2	119.4	49.2	122.2	64.2	18.3	296.6	11.9	236.3	*730.5*	*563.1*	*-14.3*	*181.7*	*167.5*	*-1,665.9*
	2020	8.3	93%	242.8	36.2	27.4	7.1	122.0	30.0	18.6	418.2	7.5	241.9	*465.6*	*686.2*	*-26.3*	*-194.3*	*-220.6*	*-1,886.5*
	2021	4.5	50%	243.0	16.2	8.3	5.9	137.9	21.9	18.8	545.6	4.7	220.4	*433.2*	*789.5*	*-47.5*	*-308.9*	*-356.3*	*-2,242.8*
	2022	7.3	81%	243.1	34.0	21.1	8.1	125.5	48.1	17.3	455.3	4.3	207.6	*479.9*	*684.4*	*-51.7*	*-152.8*	*-204.6*	*-2,447.4*
Historical 1999-2022	Maximum	16.2	181%	293.6	133.0	140.4	71.4	151.6	145.1	27.4	552.4	14.1	312.5	887.6	838.3	8.3	364.3	345.3	
	Minimum	4.3	48%	234.7	16.2	8.3	5.9	110.1	8.8	15.5	278.5	3.2	164.3	433.2	542.2	-67.9	-328.6	-362.6	
	Average	**8.9**	**100%**	**257.4**	**59.0**	**54.2**	**23.3**	**135.2**	**58.0**	**20.9**	**421.0**	**6.5**	**240.6**	**587.0**	**689.0**	**-27.7**	**-74.3**	**-102.0**	
	% of Total			44%	10%	9%	4%	23%	10%	3%	61%	1%	35%						
Current 2012 - 2022	Maximum	14.1	158%	289.8	133.0	140.4	71.4	144.8	124.1	25.7	552.4	11.9	265.9	887.6	838.3	-14.3	364.3	345.3	
	Minimum	4.3	48%	238.4	16.2	8.3	5.9	110.1	8.8	15.5	280.8	3.2	207.6	433.2	542.2	-67.9	-308.9	-362.6	
	Average	**7.9**	**88%**	**258.5**	**48.7**	**43.0**	**17.9**	**130.0**	**43.6**	**20.1**	**438.4**	**6.6**	**233.0**	**541.8**	**698.1**	**-38.5**	**-117.9**	**-156.3**	
	% of Total			48%	9%	8%	3%	24%	8%	3%	63%	1%	33%						

3.4.3 Historical and Current Land Surface Budgets for Kaweah Subbasin

The historical and current annual land surface budget for the Kaweah Subbasin is summarized in Table 3-5.

3.4.3.1 Subbasin Historical Land Surface Budget

Inflow to the land surface system is dominated by applied groundwater (51%) with applied surface water (23%), and precipitation (21%) having lesser inflows. Outflow from the land surface system is primarily from evapotranspiration (69%) and deep percolation to groundwater from precipitation and percolation of irrigation water (17%). The land surface system is highly dependent on annual precipitation, with total flow correlating strongly with climate classification. Applied groundwater increases in dry years and decreases in wet years, related to increased groundwater demand during dry years. Applied surface water and irrigation return flows to streams generally display the opposite trend, associated with surface water use increasing in wet years and decreasing in dry years.

3.4.3.2 Subbasin Current Land Surface Budget

Major differences between the historical land surface budget and the current land surface budget include the following:

- A 41,100 AF increase in average annual applied groundwater
- A 81,900 AF decrease in average annual applied surface water
- A 44,400 AF decrease in average annual deep percolation to groundwater attributed to lower volumes of total applied water

Overall, the current land surface budget compared to historical reflects a system with increased applied groundwater, decreased surface water application and less overall applied water and decreased deep percolation to groundwater.

Table 3-5. Historical and Current Annual Land Surface Budget for the Kaweah Subbasin

Kaweah Subbasin Model Simulated Land Surface Water Budget for WY 1999 through WY 2022

Values in 1,000s Acre-Feet

	Water Year	Rainfall		Components of Inflow				Components of Outflow				Total Inflow	Total Outflow
		Inches	% of Average	Precipitation	Applied Groundwater	Applied Surface Water	Percolation of Recharge Basins	Percolation of Irrigation Water	Percolation of Precipitation (Crop and Non-Ag Land)	Evapotranspiration	Percolation of Recharge Basins		
	1999	9.5	102%	313.7	584.8	365.4	67.0	226.6	134.0	903.3	67.0	*1,330.9*	*1,330.9*
	2000	10.9	117%	358.6	618.6	409.2	56.4	243.0	172.6	970.9	56.4	*1,442.8*	*1,442.8*
	2001	9.2	99%	305.4	729.1	314.0	22.0	245.4	124.9	978.2	22.0	*1,370.6*	*1,370.6*
	2002	9.5	102%	291.2	772.9	327.7	28.6	258.9	136.8	996.2	28.6	*1,420.5*	*1,420.5*
	2003	9.3	100%	304.4	644.9	382.9	72.8	240.6	101.7	989.9	72.8	*1,404.9*	*1,404.9*
	2004	7.4	80%	242.6	832.3	296.9	20.8	264.2	121.4	986.2	20.8	*1,392.7*	*1,392.7*
	2005	14.0	151%	458.8	447.8	490.8	129.0	219.3	187.7	990.3	129.0	*1,526.4*	*1,526.4*
	2006	14.4	155%	472.5	467.7	502.2	86.7	225.3	241.3	975.9	86.7	*1,529.2*	*1,529.2*
	2007	5.3	57%	170.3	889.6	199.0	25.8	253.9	45.6	959.3	25.8	*1,284.7*	*1,284.7*
	2008	7.8	84%	255.8	775.7	335.7	22.6	258.9	126.9	981.3	22.6	*1,389.8*	*1,389.8*
	2009	6.8	74%	223.8	796.4	327.9	24.7	261.0	72.1	1,015.0	24.7	*1,372.8*	*1,372.8*
	2010	11.3	122%	371.7	533.1	495.6	99.8	238.9	168.1	993.3	99.8	*1,500.2*	*1,500.2*
	2011	16.8	181%	550.7	455.3	539.0	167.3	230.4	315.3	999.4	167.3	*1,712.3*	*1,712.3*
	2012	7.9	85%	255.8	758.5	256.2	41.7	236.2	48.5	985.8	41.7	*1,312.2*	*1,312.2*
	2013	5.4	59%	177.2	913.9	175.8	26.0	253.5	53.5	959.9	26.0	*1,292.8*	*1,292.8*
	2014	4.4	48%	144.5	959.0	122.5	18.7	250.9	17.8	957.2	18.7	*1,244.6*	*1,244.6*
	2015	7.1	77%	233.7	923.8	106.2	17.6	239.6	93.1	931.0	17.6	*1,281.3*	*1,281.3*
	2016	11.6	125%	329.8	573.5	237.2	38.9	179.7	142.2	818.6	38.9	*1,179.4*	*1,179.4*
	2017	14.6	158%	448.2	428.3	537.8	191.0	224.7	266.0	923.6	191.0	*1,605.4*	*1,605.4*
	2018	6.2	67%	161.6	641.2	266.3	47.2	203.0	56.4	809.7	47.2	*1,116.3*	*1,116.3*
	2019	12.3	133%	318.9	459.5	445.2	131.1	201.7	132.6	889.2	131.1	*1,354.6*	*1,354.6*
	2020	8.7	94%	226.2	699.4	195.5	26.2	200.2	60.1	860.9	26.2	*1,147.4*	*1,147.4*
	2021	4.5	49%	114.3	921.2	79.6	16.8	225.1	38.8	851.3	16.8	*1,132.0*	*1,132.0*
	2022	7.7	83%	191.6	789.1	133.7	25.9	206.8	97.0	810.5	25.9	*1,140.2*	*1,140.2*
Historical	Maximum	16.8	181%	550.7	959.0	539.0	191.0	264.2	315.3	1,015.0	191.0	1,712.3	1,712.3
1999-2022	Minimum	4.4	48%	114.3	428.3	79.6	16.8	179.7	17.8	809.7	16.8	1,116.3	1,116.3
	Average	**9.29**	**100%**	**288.4**	**692.3**	**314.3**	**58.5**	**232.8**	**123.1**	**939.0**	**58.5**	**1,353.5**	**1,353.5**
	% of Total			21%	51%	23%	4%	17%	9%	69%	4%		
Current	Maximum	14.6	158%	448.2	959.0	537.8	191.0	253.5	266.0	985.8	191.0	1,605.4	1,605.4
2012 - 2022	Minimum	4.4	48%	114.3	428.3	79.6	16.8	179.7	17.8	809.7	16.8	1,116.3	1,116.3
	Average	**8.2**	**89%**	**236.5**	**733.4**	**232.4**	**52.8**	**220.1**	**91.4**	**890.7**	**52.8**	**1,255.1**	**1,255.1**
	% of Total			19%	58%	19%	4%	18%	7%	71%	4%		

3.4.4 Projected Water Budgets

Methodology and assumptions used to develop projected water budgets are discussed in the subsections below. A summary of the average annual current water budget along with the projected water budget for WY 2023-2039 and WY 2040-2070 are shown in Table 3-6. The projected annual groundwater budget for the Subbasin is summarized in Table 3-7. The projected annual groundwater budget for the GKGSA is summarized in Table 3-8.

3.4.4.1 Method and Assumptions Used to Develop Projected Water Budgets

The projected water budget was developed based on predictive modeling with the calibrated Kaweah Subbasin groundwater flow model. Predictive modeling was conducted with monthly stress periods, consistent with the historical and current period model.

The projected water budget covers a 50-year time period from October 2022 through September 2072. Hydrologic conditions for the projected water budget are based on cycling the water year sequence from the 24-year historical period twice beginning in WY 2024, with WY 2017 used as a proxy year for WY 2023, and WY 1999 used as a proxy year for WY 2072. Future precipitation, reference evapotranspiration, and inflows to Lake Kaweah are adjusted from the historical period based on the central tendency climate change factor dataset provided by DWR (DWR, 2018) for the 2070 (late future) period.

3.4.4.2 Projected Surface Water Deliveries

Projected surface water diversions at each major point along the Kaweah River are calculated as a percentage of projected total annual inflow to Lake Kaweah, with the monthly diversion percentages derived based on historical data. Projected CVP water deliveries are assigned as estimated by the Friant Water Authority (FWA, 2018) based on the 2070.c scenario (central tendency climate change scenario with the full San Joaquin River Restoration Scenario and Full Access Water Management Goal). The 2070.c scenario was adjusted to include additional deliveries of CVP water during wet years based on the FWA January 2023 Reconnaissance Study (FWA, 2023) that evaluated the capacity of each Friant Contractor’s managed aquifer recharge facilities to absorb additional spill deliveries during wet years.

3.4.4.3 Projected Groundwater Pumping

Projected municipal groundwater use by the City of Visalia and City of Tulare was developed based on each city’s 2020 Urban Water Management Plan. The disposition of recycled water from each city as either deliveries to irrigators (in-lieu recharge) or deliveries to recharge basins was carried forward during the future period based on 2022-2023 recycled water management.

Projected groundwater pumping for irrigation was developed based on projected crop consumptive use. Projected crop consumptive use is established from 2022 cropping patterns and estimated evapotranspiration derived from LandIQ crop consumptive use analyses (LandIQ, 2022). To avoid chronic lowering of groundwater level undesirable results, the 2022 crop consumptive use was adjusted to account for future climate and reductions in crop consumptive use planned across all 3 GSAs in the Kaweah Subbasin. Projected groundwater extraction for irrigation was calculated by the groundwater flow model as the remaining crop irrigation requirement after accounting for effective precipitation and deliveries of surface water and recycled water to irrigators.

In addition to the reduction in overall groundwater pumping for irrigation, MKGSA and GKGSA plan to support landowners to transition their irrigation pumping from the lower aquifer to the upper aquifer. Predictive modeling for the future projected water budget assumes that the pumping transition will occur over a 12-year implementation period, with:

- 25% of lower aquifer pumping shifted to the upper aquifer during years 1-3 of GSP implementation
- 50% of lower aquifer pumping shifted to the upper aquifer during years 4-6 of GSP implementation
- 75% of lower aquifer pumping shifted to the upper aquifer during years 7-9 of GSP implementation
- 100% of lower aquifer pumping shifted to the upper aquifer during years 10-12 of GSP implementation

These measures do not impact projected volumes of irrigation pumping, but instead are planned in order to avoid undesirable results for land subsidence, which is due to unsustainable groundwater pumping from the lower aquifer.

3.4.4.3.1 Projects within MKGSA

In addition to existing recharge facilities within MKGSA that were operational during the current period (2012–2022), the projected water budget incorporates the following MKGSA projects that were either completed since 2022 or are in advanced stages of implementation or planning:

- Okieville Recharge Basin
- Linear Recharge Projects along Packwood Creek and Cameron Creek
- MKGSA Water Banking Operation

MKGSA projects are described in Chapter 6.

3.4.4.3.2 Projects within GKGSA

The projected water budget incorporates the following GKGSA projects that were either completed since 2022 or are in advanced stages of implementation or planning:

- Paregien Basin Expansion and Paregien Basin Phase II
- Mathews Ditch Basin
- Ritchie Basin
- Peoples 1A Basin Expansion
- Kaweah Oaks Preserve Recharge Basin
- King Basin
- Johnson Slough Basin
- Kaweah Subbasin Multi-Benefit Recharge Facility (in association with MKGSA)

GKGSA projects are described in Chapter 6 of the GKGSA GSP.

3.4.4.3.3 Projects within EKGSA

The projected water budget incorporates the following EKGSA projects that were either completed since 2022 or are in advanced stages of implementation or planning:

- Mariposa Basin
- 1st Avenue Basin
- 5th Avenue Basin
- Hirabayashi Recharge Basin
- Recharge of imported CVP water along Lower Lewis Creek

EKGSA projects are described in Chapter 6 of the EKGSA GSP.

3.4.4.3.4 Assumed Conditions within Neighboring Subbasins

Groundwater underflow between the Kaweah Subbasin and neighboring subbasins is dependent on groundwater conditions in both the Kaweah Subbasin and neighboring subbasins. For the purposes of the projected water budget, conditions in all 3 neighboring Subbasins – Kings, Tulare Lake, and Tule – are based on projected groundwater pumping and groundwater levels assumptions as assigned for the historical and current water budgets:

- Groundwater levels at the groundwater model boundary within each neighboring Subbasin are assigned based on:
    - 2022 conditions for model layer 1 (representing the upper aquifer in areas where the Corcoran Clay is present)

  - An assumed recovery of 25 feet from 2022 conditions in model layers 3 and 4 (representing the lower aquifer in areas where the Corcoran Clay is present)

- Irrigation pumping within the groundwater model domain and in neighboring subbasins outside of the Corcoran Irrigation District (CID) wellfield is projected using a similar methodology for irrigation pumping inside the Subbasin, based on projected crop demands and surface water availability. The following assumptions are made regarding future demand management in portions of the neighboring subbasins that fall within the domain of the Kaweah Subbasin groundwater model:
  - Alta Irrigation District: 15% reduction in crop consumptive use by 2040
  - Mid-Kings River GSA: 26% reduction in crop consumptive use by 2040
  - Lower Tule River Irrigation District: 31% reduction in crop consumptive use by 2040

  The assumed reductions in crop consumptive use as listed above are assigned based on the reduction in crop consumptive use—and therefore, irrigation pumping—within nearby areas of the Kaweah Subbasin. This assumes that neighboring subbasins would be undertaking groundwater demand management actions similar to those planned for the Kaweah Subbasin.

- Groundwater pumping in the portion of the CID wellfield that falls within the groundwater model domain is assigned as 50% of the 1999-2022 average pumping. This reflects an assumption that CID wellfield pumping will need to be curtailed in order to achieve sustainability within the El Rico GSA in the Tulare Lake Subbasin.

- Groundwater pumping for agricultural irrigation is shifted from the lower aquifer to the upper aquifer on the same schedule as detailed in Section 1.4.1.2.

Groundwater conditions in neighboring subbasins is a recognized source of uncertainty that has a material impact on the projected water budget in the Kaweah Subbasin. The approach used for the projected water budget in this GSP is neutral to slightly optimistic. These assumptions are adopted in the future projected water budgets based on the expectation that demand management in neighboring subbasins will be comparable in magnitude to the demand management measures planned within the Kaweah Subbasin, and included in the future projected water budget for this GSP.

Finally, it should be recognized that both the projected groundwater underflow from and to neighboring subbasins and the projected change in groundwater storage are intrinsically uncertain and dependent not only on assumptions within the Subbasin, but also upon assumed conditions in neighboring subbasins.

3.4.4.4 Subbasin Projected Groundwater Budget

Major differences between the current groundwater budget and the projected groundwater budgets incorporating climate change include the following on an annual average basis:

- There is a projected average annual decrease of 247,500 AF in agricultural pumping for WY 2023-2039, and an average annual decrease of 289,200 AF for WY 2040-2070 from the current period. Agricultural pumping decreases are driven largely by simulated decreased evapotranspiration (ET) to account for planned management actions to reduce groundwater pumping. As surface water applications are constant across all scenarios, decreased ET reduces crop water demand and results in reduced groundwater extraction as part of the groundwater allocation and accounting program management action.
- For municipal and industrial pumping there is an average annual increase from the current period of 11,500 AF for WY 2023-2039 (116% of current) and an average annual increase of 21,000 AF for WY 2040-2070 (129% of current). This is largely due to increased urban demand projections in Urban Water Management Plans for the cities of Visalia and Tulare.
- As a result of decreased ET there is reduced percolation of irrigation water; for WY 2023-2039 there is an annual average decrease of 52,700 AF and for WY 2040-2070 there is an annual average decrease of 66,7000 AF.
- Table reports overall changes in groundwater storage both within the permeable aquifer system and within clay interbeds. Projected average annual groundwater storage change in the aquifer is about +6,600 AFY over 2040-2070, meaning that a modest increase in overall groundwater storage is projected for the aquifer system over this time period.
- At the same time, the projected average annual groundwater storage change in the clay interbeds is about -9,900 AFY over 2040-2070 as a result of lagged depressurization within the clay interbeds. The persistence of groundwater storage changes in the clay interbeds is due to their low permeability and represents the effects of groundwater pumping from the lower aquifer that occurred prior to the GSP implementation period. As such, it is reasonable to expect some continued loss of groundwater storage within the clay interbeds even with the demand management measures planned by all 3 GSAs.

Table 3-6. Current and Projected Groundwater Budget Average Annual Summary and Comparison for the Kaweah Subbasin

Values in 1,000s Acre Feet

Groundwater Budget Component	Current Period	Projected Period		Comparison	
	2012-2022	2023-2039	2040-2070	2023-2039 Change from Current	2040-2070 Change from Current
Subsurface Inflow	*87.5*	*86.1*	*95.7*	*-1.4*	*8.2*
Streambed Percolation	*68.4*	*89.5*	*82.6*	*21.2*	*14.2*
Conveyance Losses (Canal and Ditch Recharge) and MFR Recharge	*91.7*	*103.3*	*96.0*	*11.6*	*4.3*
Percolation of Recharge Basins	*52.8*	*70.5*	*69.5*	*17.7*	*16.7*
Percolation of Irrigation Water	*220.1*	*167.4*	*153.4*	*-52.7*	*-66.7*
Percolation of Precipitation (Crop and Non-Ag Land)	*91.4*	*121.4*	*120.5*	*30.0*	*29.0*
M & I GW Pumping	*71.4*	*82.9*	*92.4*	*11.5*	*21.0*
GW Pumping for Irrigated Agriculture	*733.4*	*487.0*	*448.7*	*-246.4*	*-284.7*
Discharge to Surface Water	*8.2*	*12.8*	*13.0*	*4.6*	*4.8*
Subsurface Outflow	*97.1*	*79.9*	*66.7*	*-17.2*	*-30.3*
Total Inflow	*611.9*	*638.3*	*617.6*	*26.3*	*5.6*
Total Outflow	*910.1*	*662.6*	*620.9*	*-247.5*	*-289.2*
Clay Interbed Storage Change	*-71.5*	*-30.8*	*-9.9*	*40.7*	*61.7*
Aquifer Storage Change	*-226.6*	*6.5*	*6.6*	*233.1*	*233.2*
Change in Storage	*-298.2*	*-24.4*	*-3.3*	*273.8*	*294.9*

3.4.4.5 GKGSA Projected Groundwater Budget

- Major differences between the current groundwater budget and the projected groundwater budgets incorporating climate change include the following:Average annual irrigated agricultural pumping is projected to decrease from 438,400 AF/year in the current period, to 294,500 AF/year between WY 2023 and 2039, and then to 250,300 AF/year for WY 2040 to 2070. Agricultural pumping decreases are driven largely by simulated decreased ET to account for planned management actions to reduce groundwater pumping. As surface water applications are constant across all scenarios, decreased ET reduces crop water demand, and results in reductions to groundwater extraction as part of the groundwater extraction allocation implementation management action.
- Average annual municipal and industrial pumping is projected to remain approximately the same, from 20,100 AF/year in the current period to 19,500 AF/year in the future period.
- As a result of decreased ET demand and applied water from irrigated agriculture, there is reduced percolation of irrigation water of 31,200 AF/year from the current period to WY 2023-2039 and a further reduction of 14,000 AF/year for the WY 2040-2070.

Table 3-7. Projected Groundwater Budgets Summary for the Kaweah Subbasin (WY2023 – WY2072)

Values in 1,000s Acre Feet

	Water Year	Rainfall		Components of Inflow						Components of Outflow				Total Inflow	Total Outflow	Clay Interbed Storage Change	Aquifer Storage Change	Change in Storage	Cumulative Change in Storage
										Groundwater Pumpage									
		Inches	% of Historical Average	Subsurface Inflow	Streambed Percolation	Conveyance Losses (Canal and Ditch Recharge) and MFR Recharge	Percolation of Recharge Basins	Percolation of Irrigation Water	Percolation of Precipitation (Crop and Non-Ag Land)	M & I GW Pumping	GW Pumping for Irrigated Agriculture	Discharge to Surface Water	Subsurface Outflow						
	2023	15.1	163%	103.8	210.5	308.6	314.8	181.2	244.8	75.1	376.4	29.3	98.5	1,363.9	579.3	-83.6	868.2	784.6	784.6
	2024	9.5	102%	76.2	90.9	62.4	21.5	168.8	108.5	76.1	515.7	10.5	89.6	528.2	692.0	-49.6	-114.2	-163.8	620.8
	2025	11.0	118%	80.5	97.9	100.8	32.2	178.3	147.5	76.8	506.2	9.2	82.7	637.1	674.8	-49.1	11.4	-37.7	583.1
	2026	10.0	107%	80.1	57.4	64.1	19.2	170.5	120.3	77.4	567.4	10.0	84.4	511.5	739.2	-43.4	-184.3	-227.8	355.4
	2027	8.3	89%	84.1	63.3	62.0	18.7	181.9	108.3	78.1	588.5	8.8	76.6	518.2	752.1	-52.9	-181.1	-233.9	121.5
	2028	9.0	97%	88.9	79.8	92.2	29.5	173.9	71.7	78.9	489.2	7.6	73.1	536.1	648.8	-48.4	-64.2	-112.7	8.8
	2029	7.5	81%	88.3	54.7	58.6	20.8	188.6	103.4	79.4	598.4	7.3	74.0	514.4	759.1	-44.6	-200.0	-244.6	-235.8
	2030	13.9	150%	88.0	119.9	159.0	148.0	150.8	170.6	80.1	289.9	9.7	79.7	836.4	459.4	-21.3	398.3	377.0	141.2
	2031	14.5	156%	84.4	161.6	209.1	212.6	155.3	209.5	81.1	355.6	32.9	86.9	1,032.6	556.5	0.2	475.8	476.1	617.3
	2032	5.5	60%	76.3	44.1	37.3	15.5	168.9	38.4	88.5	587.7	8.8	88.6	380.5	773.6	-12.0	-381.1	-393.1	224.1
	2033	8.0	86%	84.0	73.0	79.9	24.8	173.6	119.1	89.1	553.9	7.5	79.3	554.4	729.9	-19.8	-155.7	-175.5	48.7
	2034	6.5	71%	87.9	57.9	62.9	20.9	175.4	70.5	89.7	563.4	7.3	73.8	475.5	734.2	-27.5	-231.2	-258.7	-210.0
	2035	11.7	126%	93.9	103.2	132.9	52.5	157.1	160.1	84.4	425.3	10.5	71.0	699.7	591.2	-21.3	129.7	108.5	-101.6
	2036	16.9	182%	89.5	166.1	202.8	213.5	147.7	280.2	85.8	267.0	35.2	79.8	1,099.8	467.8	5.1	627.0	632.1	530.5
	2037	7.0	76%	78.9	68.1	52.2	22.2	154.0	45.4	89.1	475.0	10.4	81.1	420.7	655.7	-5.3	-229.6	-234.9	295.5
	2038	5.2	56%	84.6	48.4	40.7	16.7	158.4	45.0	89.8	541.9	7.5	73.2	393.8	712.4	-18.8	-299.9	-318.6	-23.1
	2039	4.6	49%	94.2	25.0	30.8	15.1	162.1	20.5	90.3	577.9	5.1	65.4	347.8	738.7	-31.7	-359.2	-390.9	-414.0
	2040	6.9	74%	102.8	29.9	35.6	15.4	155.5	82.2	90.8	553.4	4.6	59.6	421.3	708.5	-43.7	-243.4	-287.1	-701.1
	2041	11.0	119%	106.4	52.0	64.8	20.6	148.6	149.6	90.9	459.8	7.3	57.4	542.1	615.4	-39.7	-33.6	-73.3	-774.4
	2042	15.1	163%	115.7	210.8	308.6	319.3	148.7	253.7	89.3	265.0	36.7	66.8	1,356.9	457.8	1.6	897.6	899.2	124.8
	2043	6.6	71%	87.2	73.7	71.5	27.9	168.6	81.9	96.9	476.4	10.3	70.6	510.7	654.2	-0.6	-142.9	-143.4	-18.6
	2044	11.8	127%	90.5	148.2	199.3	195.1	156.9	151.4	91.7	340.7	29.5	73.3	941.5	535.2	8.4	397.9	406.3	387.6
	2045	8.6	93%	81.9	52.5	38.1	17.3	146.4	89.2	92.2	526.2	9.2	75.0	425.3	702.6	-3.2	-274.1	-277.3	110.4
	2046	5.3	57%	90.3	24.8	26.3	15.5	166.4	56.1	91.8	612.5	5.5	68.5	379.4	778.3	-19.2	-379.8	-399.0	-288.6
	2047	7.4	80%	98.9	46.9	38.6	17.6	164.2	98.8	91.4	563.0	5.0	63.3	465.1	722.7	-24.8	-232.8	-257.6	-546.2
	2048	9.5	102%	101.3	90.5	62.4	24.5	139.8	115.6	91.2	397.6	6.8	61.6	534.1	557.3	-23.3	0.0	-23.2	-569.5
	2049	11.0	118%	101.7	98.6	100.8	34.8	149.5	155.2	90.9	392.7	8.0	61.8	640.7	553.4	-17.0	104.3	87.3	-482.2
	2050	10.0	107%	99.2	57.3	64.1	21.7	144.7	129.9	90.9	463.8	9.6	62.6	516.9	626.9	-16.9	-93.2	-110.1	-592.3
	2051	8.3	89%	100.4	63.6	62.0	21.1	156.4	114.5	90.6	483.0	8.9	60.9	518.0	643.4	-21.5	-103.9	-125.4	-717.6
	2052	9.0	97%	103.8	80.0	92.2	31.9	150.5	79.9	90.6	396.4	7.7	58.9	538.2	553.7	-21.2	5.7	-15.4	-733.0
	2053	7.5	81%	101.9	54.9	58.6	23.0	166.4	109.4	90.3	505.8	7.5	59.0	514.1	662.6	-23.1	-125.4	-148.5	-881.5
	2054	13.9	150%	100.0	120.4	159.0	150.1	134.0	182.0	90.6	227.2	10.1	63.0	845.5	390.8	-6.0	460.7	454.7	-426.8
	2055	14.5	156%	92.9	162.9	209.1	214.6	140.3	220.3	91.4	300.4	33.4	73.5	1,040.1	498.8	15.6	525.8	541.4	114.6
	2056	5.5	60%	84.1	44.3	37.3	17.3	152.7	42.0	96.3	521.8	9.3	74.0	377.6	701.4	-1.2	-322.6	-323.8	-209.2
	2057	8.0	86%	90.7	73.1	79.9	26.5	159.4	122.9	95.9	497.8	7.9	67.8	552.4	669.4	-7.1	-109.9	-117.0	-326.2
	2058	6.5	71%	93.3	58.0	62.9	22.4	163.1	73.9	95.6	514.9	7.7	65.1	473.5	683.2	-13.5	-196.2	-209.7	-535.9
	2059	11.7	126%	97.9	103.2	132.9	53.9	147.7	163.7	91.1	389.3	11.0	64.4	699.3	555.8	-6.7	150.1	143.4	-392.5
	2060	16.9	182%	91.7	166.5	202.8	214.7	140.7	284.1	91.8	241.2	36.5	75.0	1,100.5	444.5	17.8	638.2	656.0	263.5
	2061	7.0	76%	80.1	68.4	52.2	23.2	148.4	47.7	94.6	451.7	11.1	78.2	420.1	635.5	4.4	-219.9	-215.5	48.0
	2062	5.2	56%	85.5	48.6	40.7	17.6	154.6	45.7	94.4	525.7	8.0	72.1	392.8	700.1	-9.5	-297.8	-307.3	-259.3
	2063	4.6	49%	94.4	25.1	30.8	15.8	160.2	20.9	93.9	569.3	5.3	65.2	347.3	733.7	-19.7	-366.6	-386.3	-645.6
	2064	6.9	74%	102.5	30.0	35.6	16.0	155.5	82.2	93.5	552.9	4.8	60.3	421.8	711.6	-26.9	-262.9	-289.9	-935.5
	2065	11.0	119%	106.0	52.2	64.8	21.1	148.6	149.6	92.8	459.4	7.6	58.1	542.3	618.0	-27.9	-47.7	-75.7	-1,011.1
	2066	15.1	163%	115.5	211.0	308.6	319.7	148.7	253.7	90.7	264.8	37.0	67.2	1,357.3	459.6	10.0	887.7	897.7	-113.4
	2067	6.6	71%	86.9	73.8	71.5	28.1	168.9	81.8	97.8	477.4	10.5	70.5	511.0	656.2	5.8	-151.0	-145.2	-258.6
	2068	11.8	127%	90.4	156.6	199.3	195.3	156.9	151.4	92.1	340.6	30.5	72.8	949.9	536.0	14.7	399.2	413.9	155.3
	2069	8.6	93%	81.9	55.0	38.1	17.3	146.4	89.2	92.1	526.2	9.7	74.5	427.8	702.4	2.3	-276.9	-274.6	-119.3
	2070	5.3	57%	90.4	26.4	26.3	15.5	166.4	56.1	91.7	612.5	5.8	67.8	381.0	777.8	-13.9	-382.9	-396.7	-516.0
	2071	7.4	80%	99.3	48.5	38.6	17.6	164.2	98.8	91.2	563.0	5.3	62.3	467.0	721.9	-18.2	-236.7	-254.9	-770.9
	2072	5.3	57%	102.0	93.0	62.4	24.5	139.8	115.6	91.0	397.6	7.4	60.5	537.2	556.5	-15.1	-4.2	-19.3	-790.2
2023-2039	Maximum	16.9	182%	103.8	210.5	308.6	314.8	188.6	280.2	90.3	598.4	35.2	98.5	1,363.9	773.6	5.1	868.2	784.6	
	Minimum	4.6	49%	76.2	25.0	30.8	15.1	147.7	20.5	75.1	267.0	5.1	65.4	347.8	459.4	-83.6	-381.1	-393.1	
	Average	**9.6**	**104%**	**86.1**	**89.5**	**103.3**	**70.5**	**167.4**	**121.4**	**82.9**	**487.0**	**12.8**	**79.9**	**638.3**	**662.6**	**-30.8**	**6.5**	**-24.4**	
	% of Total			13%	14%	16%	11%	26%	19%	13%	73%	2%	12%						
2040-2070	Maximum	16.9	182%	115.7	211.0	308.6	319.7	168.9	284.1	97.8	612.5	37.0	78.2	1,357.3	778.3	17.8	897.6	899.2	
	Minimum	4.6	49%	80.1	24.8	26.3	15.4	134.0	20.9	89.3	227.2	4.6	57.4	347.3	390.8	-43.7	-382.9	-399.0	
	Average	**9.3**	**100%**	**95.7**	**82.6**	**96.0**	**69.5**	**153.4**	**120.5**	**92.4**	**448.7**	**13.0**	**66.7**	**617.6**	**620.9**	**-9.9**	**6.6**	**-3.3**	
	% of Total			15%	13%	16%	11%	25%	20%	15%	72%	2%	11%						

Table 3-8. Projected Annual Groundwater Budget Summary for the Greater Kaweah Groundwater Sustainability Agency (WY2023–WY2072)

Values in 1,000s Acre Feet

	Water Year	Rainfall		Components of Inflow						Components of Outflow									
										Groundwater Pumpage									
		Inches	% of Historical Average	Subsurface Inflow	Streambed Percolation	Conveyance Losses (Canal and Ditch Recharge) and MFR Recharge	Percolation of Recharge Basins	Percolation of Irrigation Water	Percolation of Precipitation (Crop and Non-Ag Land)	M & I GW Pumping	GW Pumping for Irrigated Agriculture	Discharge to Surface Water	Subsurface Outflow	*Total Inflow*	*Total Outflow*	Clay Interbed Storage Change	Aquifer Storage Change	Change in Storage	Cumulative Change in Storage
	2023	14.6	164%	279.0	143.8	150.9	174.7	109.4	121.1	17.7	222.1	27.4	253.7	*979.0*	*520.9*	*-44.8*	*502.9*	*458.1*	*458.1*
	2024	9.1	101%	233.0	64.8	33.9	11.0	102.8	53.0	17.7	334.1	8.9	241.8	*498.5*	*602.5*	*-26.9*	*-77.0*	*-103.9*	*-103.9*
	2025	10.6	119%	231.9	67.5	50.2	15.1	106.9	74.8	17.6	320.3	7.6	226.7	*546.4*	*572.2*	*-25.5*	*-0.3*	*-25.8*	*-25.8*
	2026	9.9	111%	221.0	40.0	36.9	10.1	105.6	62.6	17.6	338.2	8.6	224.7	*476.2*	*589.1*	*-22.4*	*-90.6*	*-113.0*	*-113.0*
	2027	8.2	91%	223.2	46.6	31.2	8.8	110.8	58.1	17.7	374.5	7.5	210.6	*478.8*	*610.3*	*-27.4*	*-104.1*	*-131.4*	*-131.4*
	2028	8.6	96%	221.4	56.1	50.5	15.0	102.1	35.8	17.8	295.3	6.3	208.1	*480.9*	*527.5*	*-23.7*	*-22.9*	*-46.5*	*-46.5*
	2029	7.4	83%	217.0	40.2	28.3	9.3	113.5	55.0	17.7	384.9	6.0	200.3	*463.3*	*609.0*	*-23.4*	*-122.3*	*-145.7*	*-145.7*
	2030	13.7	153%	230.6	81.6	66.6	61.0	87.7	93.5	17.8	202.2	8.1	215.3	*621.0*	*443.4*	*-10.9*	*188.5*	*177.6*	*177.6*
	2031	14.3	160%	251.2	107.0	95.6	114.1	88.1	109.4	17.8	201.4	31.0	249.1	*765.5*	*499.3*	*1.3*	*264.8*	*266.1*	*266.1*
	2032	5.3	59%	223.8	31.4	20.6	6.9	103.5	18.9	24.2	363.5	7.6	232.4	*405.2*	*627.7*	*-6.9*	*-215.6*	*-222.4*	*-222.4*
	2033	7.6	85%	220.6	50.8	43.4	12.8	105.1	59.5	24.1	319.7	6.3	216.6	*492.2*	*566.7*	*-10.1*	*-64.4*	*-74.5*	*-74.5*
	2034	6.3	70%	215.6	43.3	32.2	10.2	103.8	37.9	24.1	343.4	6.1	207.8	*443.0*	*581.3*	*-14.0*	*-124.3*	*-138.3*	*-138.3*
	2035	11.2	125%	218.7	70.0	65.7	33.2	87.4	80.7	18.0	213.8	8.8	218.1	*555.7*	*458.6*	*-9.0*	*106.0*	*97.1*	*97.1*
	2036	16.3	182%	243.4	108.5	93.4	114.1	81.4	145.9	18.0	166.0	32.9	255.7	*786.7*	*472.6*	*4.8*	*309.3*	*314.1*	*314.1*
	2037	6.6	74%	219.6	47.9	30.3	11.5	86.1	23.5	20.6	264.0	9.0	241.7	*418.9*	*535.2*	*-2.3*	*-114.0*	*-116.3*	*-116.3*
	2038	5.0	56%	212.6	34.9	20.6	7.3	90.5	23.2	20.7	314.1	6.4	221.1	*389.2*	*562.3*	*-9.7*	*-163.4*	*-173.1*	*-173.1*
	2039	4.5	50%	212.1	19.4	13.2	6.2	95.0	12.3	20.7	349.3	4.2	199.4	*358.2*	*573.6*	*-16.2*	*-199.2*	*-215.4*	*-215.4*
	2040	6.7	75%	212.2	22.8	15.5	6.4	88.9	44.8	20.8	325.7	3.8	186.2	*390.5*	*536.4*	*-22.0*	*-123.9*	*-145.9*	*-145.9*
	2041	10.5	117%	211.4	39.1	31.8	9.6	80.7	78.7	20.8	253.2	6.3	186.7	*451.3*	*466.9*	*-18.8*	*3.2*	*-15.6*	*-15.6*
	2042	14.6	164%	264.6	142.8	150.9	177.3	76.9	130.0	18.2	113.0	34.6	246.4	*942.6*	*412.2*	*5.6*	*524.7*	*530.3*	*530.3*
	2043	6.5	72%	213.1	49.2	38.4	13.4	91.5	46.0	24.6	266.8	8.9	240.7	*451.6*	*541.0*	*1.6*	*-91.1*	*-89.4*	*-89.4*
	2044	11.4	128%	233.9	98.5	92.9	102.7	82.8	82.5	18.3	181.1	27.9	255.4	*693.3*	*482.7*	*6.2*	*204.4*	*210.6*	*210.6*
	2045	8.3	93%	213.3	37.4	22.1	8.0	86.1	46.4	18.3	286.7	8.0	243.3	*413.4*	*556.2*	*-1.3*	*-141.6*	*-142.8*	*-142.8*
	2046	5.3	59%	211.1	19.9	11.3	6.3	99.5	31.3	18.3	377.8	4.6	216.4	*379.4*	*617.1*	*-10.5*	*-227.2*	*-237.7*	*-237.7*
	2047	7.0	78%	213.8	34.2	19.7	7.7	95.1	49.4	18.3	333.0	4.2	200.5	*420.0*	*556.1*	*-13.0*	*-123.1*	*-136.1*	*-136.1*
	2048	9.1	101%	211.1	67.6	33.9	12.2	73.2	60.2	18.3	216.6	5.8	202.7	*458.3*	*443.4*	*-10.7*	*25.6*	*14.9*	*14.9*
	2049	10.6	119%	211.4	69.4	50.2	16.2	78.0	82.6	18.3	209.3	6.8	211.4	*507.8*	*445.7*	*-6.4*	*68.5*	*62.1*	*62.1*
	2050	9.9	111%	204.7	40.4	36.9	11.2	79.1	72.3	18.3	234.1	8.4	217.4	*444.5*	*478.2*	*-6.4*	*-27.3*	*-33.7*	*-33.7*
	2051	8.2	91%	205.3	47.2	31.2	9.8	85.0	64.4	18.3	270.0	7.6	212.4	*443.0*	*508.2*	*-8.7*	*-56.5*	*-65.2*	*-65.2*
	2052	8.6	96%	206.5	56.4	50.5	16.0	78.5	43.9	18.3	204.9	6.5	212.8	*451.8*	*442.5*	*-7.9*	*17.3*	*9.4*	*9.4*
	2053	7.4	83%	204.8	40.3	28.3	10.2	91.0	61.0	18.3	293.2	6.3	208.0	*435.5*	*525.8*	*-10.0*	*-80.3*	*-90.3*	*-90.3*
	2054	13.7	153%	219.7	81.9	66.6	61.9	70.7	104.7	18.3	141.1	8.5	221.9	*605.5*	*389.8*	*-1.3*	*216.9*	*215.7*	*215.7*
	2055	14.3	160%	237.9	108.2	95.6	114.9	72.9	120.1	18.3	148.0	31.5	254.3	*749.6*	*452.1*	*10.1*	*287.5*	*297.5*	*297.5*
	2056	5.3	59%	211.4	31.5	20.6	7.7	87.0	22.5	22.7	295.9	8.0	238.3	*380.7*	*564.9*	*-0.3*	*-183.8*	*-184.1*	*-184.1*
	2057	7.6	85%	209.4	50.4	43.4	13.5	90.8	63.3	22.6	262.9	6.6	225.0	*470.8*	*517.1*	*-2.9*	*-43.4*	*-46.3*	*-46.3*
	2058	6.3	70%	206.0	43.1	32.2	10.9	91.2	41.3	22.6	293.3	6.4	218.3	*424.7*	*540.6*	*-6.5*	*-109.3*	*-115.9*	*-115.9*
	2059	11.2	125%	211.2	69.7	65.7	33.8	77.8	84.3	18.3	179.3	9.3	229.5	*542.5*	*436.3*	*-1.6*	*107.8*	*106.2*	*106.2*
	2060	16.3	182%	237.7	108.6	93.4	114.6	74.3	149.7	18.3	141.1	34.1	266.6	*778.3*	*460.2*	*10.8*	*307.3*	*318.1*	*318.1*
	2061	6.6	74%	212.7	48.1	30.3	11.9	80.4	25.9	20.9	241.6	9.6	251.0	*409.3*	*523.1*	*2.5*	*-116.4*	*-113.9*	*-113.9*
	2062	5.0	56%	207.5	35.0	20.6	7.7	86.4	24.0	20.9	297.5	6.8	230.8	*381.3*	*556.0*	*-5.4*	*-169.3*	*-174.7*	*-174.7*
	2063	4.5	50%	208.4	19.4	13.2	6.5	92.6	12.8	20.9	339.9	4.4	209.2	*352.9*	*574.4*	*-11.2*	*-210.3*	*-221.4*	*-221.4*
	2064	6.7	75%	210.2	22.8	15.5	6.7	88.8	44.7	20.9	325.7	4.0	195.6	*388.7*	*546.2*	*-14.6*	*-142.9*	*-157.5*	*-157.5*
	2065	10.5	117%	210.4	39.2	31.8	9.8	80.6	78.7	20.9	253.2	6.5	194.7	*450.5*	*475.3*	*-13.9*	*-10.9*	*-24.7*	*-24.7*
	2066	14.6	164%	263.3	143.0	150.9	177.4	76.9	130.0	18.3	113.0	34.9	252.0	*941.5*	*418.2*	*9.0*	*514.3*	*523.3*	*523.3*
	2067	6.5	72%	211.4	49.2	38.4	13.5	91.5	45.9	24.6	266.8	9.1	244.5	*450.0*	*545.1*	*4.2*	*-99.3*	*-95.1*	*-95.1*
	2068	11.4	128%	234.2	101.9	92.9	102.7	82.8	82.5	18.3	181.1	28.8	258.8	*697.0*	*487.1*	*8.7*	*201.3*	*210.0*	*210.0*
	2069	8.3	93%	213.9	38.6	22.1	8.0	86.1	46.4	18.3	286.7	8.4	246.4	*415.2*	*559.8*	*0.9*	*-145.5*	*-144.6*	*-144.6*
	2070	5.3	59%	211.6	21.4	11.3	6.3	99.5	31.3	18.3	377.8	4.9	219.3	*381.4*	*620.3*	*-8.6*	*-230.3*	*-238.9*	*-238.9*
	2071	7.0	78%	215.0	34.7	19.7	7.7	95.1	49.4	18.3	333.0	4.5	203.3	*421.6*	*559.1*	*-10.5*	*-127.0*	*-137.5*	*-137.5*
	2072	9.1	101%	212.6	69.2	33.9	12.2	73.2	60.2	18.3	216.6	6.2	205.5	*461.4*	*446.7*	*-7.7*	*22.3*	*14.7*	*14.7*
2023-2039	Maximum	16.3	182%	279.0	143.8	150.9	174.7	113.5	145.9	24.2	384.9	32.9	255.7	979.0	627.7	4.8	502.9	458.1	
	Minimum	4.5	50%	212.1	19.4	13.2	6.2	81.4	12.3	17.6	166.0	4.2	199.4	358.2	443.4	-44.8	-215.6	-222.4	
	Average	**9.4**	**105%**	**227.9**	**62.0**	**50.8**	**36.6**	**98.8**	**62.7**	**19.4**	**294.5**	**11.3**	**224.9**	**538.7**	**550.1**	**-15.7**	**4.3**	**-11.4**	
	% of Total			42%	12%	9%	7%	18%	12%	4%	54%	2%	41%						
2040-2070	Maximum	16.3	182%	264.6	143.0	150.9	177.4	99.5	149.7	24.6	377.8	34.9	266.6	942.6	620.3	10.8	524.7	530.3	
	Minimum	4.5	50%	204.7	19.4	11.3	6.3	70.7	12.8	18.2	113.0	3.8	186.2	352.9	389.8	-22.0	-230.3	-238.9	
	Average	**9.0**	**100%**	**217.2**	**57.3**	**47.0**	**36.0**	**84.4**	**64.6**	**19.7**	**248.7**	**11.7**	**225.7**	**506.5**	**505.8**	**-4.0**	**4.7**	**0.8**	
	% of Total			43%	11%	9%	7%	17%	13%	4%	49%	2%	45%						

3.4.4.6 Projected Land Surface Budgets

The projected land surface budgets are summarized in Table 3-9.

Major differences between the current land surface budget and the projected land surface budgets incorporating climate change include the following:

- Applied groundwater is projected to decrease by an average annual volume of 270,400 AF for WY 2023-2039, and 284,700 AF for WY 2040-2070.
- Evapotranspiration is projected to decrease by an average annual volume of 242,100 AF for WY 2023-2039 and 262,900 AF for WY 2040-2070.
- Precipitation is projected to decrease by 1,200 AF for WY 2023-2039 and 4,200 AF for WY 2040-2070.
- Percolation from recharge basins is projected to increase by an average annual volume of 15,100 AF for WY 2023-2039 and 16,700 AF for WY 2040-2070.

Implementation of management actions to reduce groundwater pumping results in reduced ET, applied groundwater, and percolation of applied water. Implementation of additional recharge basin projects results in increased percolation to groundwater.

Table 3-9. Projected Land Surface Budgets Summary for Kaweah Subbasin (WY 2023 – WY 2072)

Values in 1,000s Acre-Feet

Water Year	Rainfall		Components of Inflow				Components of Outflow				Total Inflow	Total Outflow
	Inches	% of Historical Average	Precipitation	Applied Groundwater	Applied Surface Water	Percolation of Recharge Basins	Percolation of Irrigation Water	Percolation of Precipitation (Crop and Non-Ag Land)	Evapotranspiration	Percolation of Recharge Basins		
2023	15.1	163%	376.5	376.4	436.6	314.8	181.2	244.8	763.5	314.8	*1,504.4*	*1,504.4*
2024	9.5	102%	237.4	515.7	238.4	21.5	168.8	108.5	714.2	21.5	*1,013.0*	*1,013.0*
2025	11.0	118%	274.0	506.2	291.6	32.2	178.3	147.5	745.9	32.2	*1,103.9*	*1,103.9*
2026	10.0	107%	250.4	567.4	193.1	19.2	170.5	120.3	720.2	19.2	*1,030.2*	*1,030.2*
2027	8.3	89%	206.8	588.5	222.4	18.7	181.9	108.3	727.6	18.7	*1,036.4*	*1,036.4*
2028	9.0	97%	225.0	489.2	288.3	29.5	173.9	71.7	756.9	29.5	*1,032.0*	*1,032.0*
2029	7.5	81%	190.2	598.4	243.0	20.8	188.6	103.4	739.7	20.8	*1,052.5*	*1,052.5*
2030	13.9	149%	351.8	289.9	388.3	148.0	150.8	170.6	708.6	148.0	*1,178.0*	*1,178.0*
2031	14.5	156%	364.9	355.6	346.2	212.6	155.3	209.5	701.9	212.6	*1,279.4*	*1,279.4*
2032	5.5	59%	137.5	587.7	162.7	15.5	168.9	38.4	680.5	15.5	*903.3*	*903.3*
2033	8.0	86%	199.8	553.9	214.8	24.8	173.6	119.1	675.9	24.8	*993.4*	*993.4*
2034	6.5	70%	163.4	563.4	220.0	20.9	175.4	70.5	701.0	20.9	*967.8*	*967.8*
2035	11.7	126%	292.1	425.3	282.3	52.5	157.1	160.1	682.5	52.5	*1,052.3*	*1,052.3*
2036	16.9	182%	427.4	267.0	403.2	213.5	147.7	280.2	669.6	213.5	*1,311.0*	*1,311.0*
2037	7.0	76%	175.1	475.0	217.6	22.2	154.0	45.4	668.3	22.2	*889.9*	*889.9*
2038	5.2	56%	130.3	541.9	167.5	16.7	158.4	45.0	636.4	16.7	*856.4*	*856.4*
2039	4.6	49%	114.6	577.9	144.4	15.1	162.1	20.5	654.3	15.1	*852.0*	*852.0*
2040	6.9	74%	173.2	553.4	142.5	15.4	155.5	82.2	631.4	15.4	*884.4*	*884.4*
2041	11.0	118%	274.6	459.8	211.8	20.6	148.6	149.6	648.0	20.6	*966.8*	*966.8*
2042	15.1	163%	376.5	265.0	411.2	319.3	148.7	253.7	650.3	319.3	*1,372.1*	*1,372.1*
2043	6.6	71%	164.8	476.4	282.2	27.9	168.6	81.9	673.0	27.9	*951.3*	*951.3*
2044	11.8	127%	296.5	340.7	369.3	195.1	156.9	151.4	698.2	195.1	*1,201.6*	*1,201.6*
2045	8.6	93%	218.2	526.2	126.6	17.3	146.4	89.2	635.3	17.3	*888.2*	*888.2*
2046	5.3	57%	133.9	612.5	128.3	15.5	166.4	56.1	652.2	15.5	*890.2*	*890.2*
2047	7.4	80%	186.2	563.0	171.6	17.6	164.2	98.8	657.9	17.6	*938.5*	*938.5*
2048	9.5	102%	237.4	397.6	235.4	24.5	139.8	115.6	615.1	24.5	*894.9*	*894.9*
2049	11.0	118%	274.0	392.7	284.7	34.8	149.5	155.2	646.7	34.8	*986.3*	*986.3*
2050	10.0	107%	250.4	463.8	189.4	21.7	144.7	129.9	629.1	21.7	*925.4*	*925.4*
2051	8.3	89%	206.8	483.0	221.7	21.1	156.4	114.5	640.6	21.1	*932.7*	*932.7*
2052	9.0	97%	225.0	396.4	283.1	31.9	150.5	79.9	674.2	31.9	*936.4*	*936.4*
2053	7.5	81%	190.2	505.8	242.9	23.0	166.4	109.4	663.2	23.0	*962.0*	*962.0*
2054	13.9	149%	351.8	227.2	380.8	150.1	134.0	182.0	643.7	150.1	*1,109.9*	*1,109.9*
2055	14.5	156%	364.9	300.4	338.1	214.6	140.3	220.3	642.8	214.6	*1,218.0*	*1,218.0*
2056	5.5	59%	137.5	521.8	161.3	17.3	152.7	42.0	625.9	17.3	*837.8*	*837.8*
2057	8.0	86%	199.8	497.8	211.6	26.5	159.4	122.9	627.0	26.5	*935.7*	*935.7*
2058	6.5	70%	163.4	514.9	217.4	22.4	163.1	73.9	658.7	22.4	*918.1*	*918.1*
2059	11.7	126%	292.1	389.3	278.7	53.9	147.7	163.7	648.8	53.9	*1,014.0*	*1,014.0*
2060	16.9	182%	427.4	241.2	399.4	214.7	140.7	284.1	643.2	214.7	*1,282.7*	*1,282.7*
2061	7.0	76%	175.1	451.7	217.4	23.2	148.4	47.7	648.1	23.2	*867.4*	*867.4*
2062	5.2	56%	130.3	525.7	168.2	17.6	154.6	45.7	623.9	17.6	*841.9*	*841.9*
2063	4.6	49%	114.6	569.3	145.1	15.8	160.2	20.9	647.8	15.8	*844.8*	*844.8*
2064	6.9	74%	173.2	552.9	142.9	16.0	155.5	82.2	631.4	16.0	*885.0*	*885.0*
2065	11.0	118%	274.6	459.4	212.1	21.1	148.6	149.6	648.0	21.1	*967.3*	*967.3*
2066	15.1	163%	376.5	264.8	411.4	319.7	148.7	253.7	650.3	319.7	*1,372.4*	*1,372.4*
2067	6.6	71%	164.8	477.4	282.5	28.1	168.9	81.8	674.0	28.1	*952.8*	*952.8*
2068	11.8	127%	296.5	340.6	369.4	195.3	156.9	151.4	698.2	195.3	*1,201.8*	*1,201.8*
2069	8.6	93%	218.2	526.2	126.6	17.3	146.4	89.2	635.3	17.3	*888.2*	*888.2*
2070	5.3	57%	133.9	612.5	128.3	15.5	166.4	56.1	652.2	15.5	*890.2*	*890.2*
2071	7.4	80%	186.2	563.0	171.6	17.6	164.2	98.8	657.9	17.6	*938.5*	*938.5*
2072	5.3	57%	237.4	397.6	235.4	24.5	139.8	115.6	615.1	24.5	*894.9*	*894.9*
2023-2039 Maximum	16.9	182%	427.4	598.4	436.6	314.8	188.6	280.2	763.5	314.8	1,504.4	1,504.4
Minimum	4.6	49%	114.6	267.0	144.4	15.1	147.7	20.5	636.4	15.1	852.0	852.0
Average	**9.6**	**100%**	**234.9**	**463.0**	**247.2**	**67.9**	**158.1**	**120.3**	**666.7**	**67.9**	**1,013.0**	**1,013.0**
% of Total			23%	46%	24%	7%	16%	12%	66%	7%		
2040-2070 Maximum	16.9	182%	427.4	612.5	411.4	319.7	168.9	284.1	698.2	319.7	1,372.4	1,372.4
Minimum	4.6	49%	114.6	227.2	126.6	15.4	134.0	20.9	615.1	15.4	837.8	837.8
Average	**9.3**	**100%**	**232.3**	**448.7**	**241.7**	**69.5**	**153.4**	**120.5**	**648.8**	**69.5**	**992.2**	**992.2**
% of Total			23%	45%	24%	7%	15%	12%	65%	7%		

3.4.4.7 Uncertainties in Projected Water Budget Simulations

While significant uncertainty exists regarding the prediction of climatic conditions, the 2030 and 2070 central tendency scenarios provided by DWR are considered best available science at the time the GSP was developed and can be used to adequately describe likely future conditions for SGMA planning and implementation (DWR, 2018b). As described by DWR, there is an approximately equal likelihood that actual future conditions will be more stressful or less stressful than those described by the recommended scenarios, therefore these conditions provide a solid middle ground on which to examine future groundwater sustainability with climate change. Further specifics regarding uncertainty in projected water budget simulations are described in the climate change guidance released by DWR (DWR, 2018b). As climate change science improves and newer data becomes available, DWR will release revised projected climate change datasets to be used in future GSP updates.

3.4.5 Sustainable Yield

The sustainable yield of the Subbasin is an estimate of the quantity of groundwater that can be pumped on a long-term average annual basis without causing undesirable results. Basin-wide pumping within the sustainable yield estimate is neither a measure, nor proof of, sustainability. Sustainability under SGMA is only demonstrated by avoiding undesirable results for the applicable sustainability indicators. However, estimates of sustainable yield using the current and projected simulations may prove useful in estimating the need for projects and management actions to help achieve and maintain sustainability.

The role of sustainable yield estimates in SGMA, as described in the Sustainable Management Criteria (SMC) BMP (DWR, 2017), are as follows:

> *"In general, the sustainable yield of a basin is the amount of groundwater that can be withdrawn annually without causing undesirable results. Sustainable yield is referenced in SGMA as part of the estimated basin-wide water budget and as the outcome of avoiding undesirable results.*
>
> *Sustainable yield estimates are part of SGMA's required basin-wide water budget. Section 354.18(b)(7) of the GSP Regulations requires that an estimate of the basin's sustainable yield be provided in the GSP (or in the coordination agreement for basins with multiple GSPs). A single value of sustainable yield must be calculated basin-wide. This sustainable yield estimate can be helpful for estimating the projects and programs needed to achieve sustainability."*

Groundwater elevations simulated in the projected GSP implementation model scenario through 2070 compared to MTs, indicate undesirable results are unlikely. Therefore, average annual pumping in the GSP implementation scenario can be used as an estimate of sustainable yield for the Subbasin. However, the projected groundwater budget indicates an average annual increase in groundwater storage of 6,600 AF. Accordingly, this number is added to average annual projected pumping to arrive at a sustainable yield of 550,000 AF of groundwater pumping per year.

3.5 Management Areas

GKGSA has, and may still, consider establishing Management Areas (MAs) within the GSA boundaries, as appropriate to facilitate the compliance with sustainability goals. New MAs will be included in future revisions of the GSP.

4 MONITORING NETWORKS [§354.32 [ARTICLE 5, SUBARTICLE 4]]

§354.32 Introduction to Monitoring Networks. 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.

The following section describes both the existing groundwater monitoring within the GKGSA area, and the representative monitoring required by SGMA. In areas where existing monitoring does not meet the SGMA requirements, this section identifies the data gaps and proposed measures to address these data gaps during the SGMA implementation period, so the monitoring improves with time. Any such improvement will be implemented as recognized and the results will be evaluated during the 5-year updates.

4.1 Existing Monitoring Networks and Programs § 354.34 (a)

§ 354.34. Monitoring Network.
(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.

Monitoring programs—a fundamental component of groundwater management and also required for SGMA compliance—help measure progress toward groundwater sustainability. Monitoring programs are needed that monitor impacts to beneficial users and uses, such as groundwater level, land subsidence, and groundwater quality monitoring. Existing monitoring programs, included in this subsection, contain a description of their SGMA compliance and history and adequacy for the GKGSA Monitoring Network. Additional information is also available in the Kaweah Subbasin Setting document in Appendix 3A. In general, groundwater levels have been monitored at least semi-annually and groundwater quality has been monitored annually. Where viable, these existing monitoring networks have been incorporated into the GSP monitoring networks to comply with monitoring network requirements for SGMA.

4.1.1 Existing Groundwater Level Monitoring § 354.34 (a)

Groundwater elevations are monitored by local agencies (water conservation districts, irrigation districts, and others) and regional agencies. **Table 4-1** presents a summary of the groundwater monitoring in the GKGSA. The interpretation of these data is described in the Kaweah Subbasin Basin Setting Report (Appendix 3A).

Table 4-1: Existing Groundwater Level Monitoring Summary

Agency	Frequency of Monitoring	Period of Record for Monitoring	Types of Wells Monitored	Number of Wells (Approx.)	Known Completion of Wells Monitored	Number of Dual Completion Wells
Alta ID	Monthly to bi-annually	1921 – 2011	Agriculture / Domestic	5	None	None
Bureau of Reclamation	Monthly to bi-annually	1924 – 2008	Unknown	118	15	Unknown
Cal Water (City of Visalia)	Monthly	1971 – 2018	Municipal	104	None	Unknown
Dept of Water Resources	Bi-annually	1930 – 2016	Various	182	7	Unknown
Exeter ID	Bi-annually	1963 – 2016	Agricultural	40	None	Unknown
KDWCD	Monthly to Bi-Annually	1919 – 2018	Agricultural	425	30	4
Kings County Water District	Bi-annually	2011 – 2018	Agricultural	6	3	Unknown
Lakeside IWD	Bi-annually	2012 – 2017	Agricultural	33	2	Unknown

In addition to the local agency monitoring, the KDWCD participates in the California Statewide Groundwater Elevation Monitoring (CASGEM) Program in a coordinated effort with overlapping jurisdictions (LIWD, KCWD, others). CASGEM was established by the DWR in 2009 and is used to track seasonal and long-term groundwater elevation trends in groundwater basins statewide, in collaboration with local monitoring entities. Tulare Irrigation District (TID) is the other CASGEM reporting entity for the Kaweah Subbasin. Within GKGSA, data are shared through coordinated efforts in overlapping jurisdictional boundaries (KDWCD, LIWD, KCWD, and others).

4.1.2 Existing Land Subsidence Monitoring § 354.34 (a)

As described in Section 2.3.3 of the Basin Setting Report (Appendix 3A), land subsidence monitoring includes both the monitoring of land elevation changes and groundwater level changes. Land elevation survey monitoring includes NGS benchmark repeat level surveys, remote sensing by InSAR, and in-situ compaction monitoring by an extensometer south of the Kaweah Subbasin. The existing groundwater level monitoring network is described in Section 4.1.1 of this section and Section 2.3.1 of the Basin Setting Report (Appendix 3A). **Table 4-2** below is a summary of historic and recent land subsidence monitoring programs in the GKGSA and the Kaweah Subbasin, at large.

Table 4-2: Historical and Recent Subsidence Monitoring

Category	Monitoring Entity (Entities)	Period of Record
Historical Monitoring	National Geodetic Survey of benchmarks (repeat level surveys)	1926 – 1970
Recent Monitoring	National Geodetic Survey of benchmarks (repeat level surveys). Installation and measurement of Deer Creek extensometer (8.5 miles south of Kaweah Subbasin in the Tule Subbasin)	1970 to present
	KDWCD Land Surface Elevation Monitoring (local benchmark monitoring network)	2016 to present
	UNAVCO and CVSRN CGPS stations: P056, P566, CRCN, LEMA, and RAPT	2006 to present (depending on station)
	NASA JPL, USGS, and others (InSAR and UAVSAR programs)	2007 – 2010 2015 to present

4.1.3 Existing Groundwater Quality Monitoring § 354.34 (a)

Groundwater quality monitoring and reporting is currently conducted through numerous public agencies for the Kaweah Subbasin. The agencies and programs are summarized in **Table 4-3** for the GKGSA, and these programs are also described in the Kaweah Subbasin Basin Setting Report (Appendix 3A). **Figure 4-1** explains the relationship between GKGSA and ILRP.

Table 4-3: Existing Groundwater Quality Monitoring Programs

Water Quality Monitoring Program	Participating Agencies	Constituents	Frequency
AB 3030 and SB 1938	Exeter ID, KDWCD, Lakeside ID	Agricultural suitability analysis (limited suite of general minerals)	Annually to Once Every 3 Years
State of California – Drinking Water Program	City of Exeter, City of Farmersville, Ivanhoe Public Utility District, City of Woodlake	All Title 22 regulated constituents	Title 22 General Minerals & Metals, every 3 years. Nitrates, annually (quarterly if ≥ 5 ppm). VOCs and SOCs, every 3 years Uranium, dependent on historical sampling and varies between every 3 years when ≥ 10 pCi/L, 6 years when < 10 pCi/L or 9 years when not detected

Water Quality Monitoring Program	Participating Agencies	Constituents	Frequency
Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS)		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	
Department of Pesticide Regulation (DPR)	City of Exeter, City of Farmersville, Ivanhoe Public Utility District, City of Woodlake	Pesticides	Annual
Groundwater Ambient Monitoring and Assessment (GAMA)	United States Geological Survey (USGS), State Water Resources Control Board (SWRCB), Central Valley Regional Water Quality Control Board (RWQCB), Department of Water Resources (DWR), DPR, National Water Information System (NWIS), Lawrence Livermore National Laboratory (LLNL)	USGS established the original program with SWRCB. GAMA database is now derived from a variety of sources Constituents vary by program objectives. The Priority Basin Project performed baseline and trend assessments, sampling 2,900 public and domestic wells statewide. The Domestic Well Project sampled over 180 wells in Tulare County (29 wells were in the Kaweah Subbasin).	Variable depending on project objectives.
Geotracker and Envirostor Databases	SWRCB, Central Valley RWQCB	Many contaminants of concern - organic and inorganic	Dependent on program or conditions of permits (monthly, quarterly, semiannually, annually, etc.)
Irrigated Lands Regulatory Program (IRLP)	Kaweah Basin Water Quality Association	Temperature, pH, electrical conductance, nitrate as nitrogen, dissolved oxygen, General Minerals suite	Annually for the five constituents, every 5 years for General Minerals (First sampling occurred during fall 2018)

Water Quality Monitoring Program	Participating Agencies	Constituents	Frequency
USGS California Water Science Center	USGS	Multiple Groundwater Quality studies in Kaweah Subbasin	Studies used for Basin Setting: 2017 - Groundwater Quality in the Shallow Aquifer • 2012 - Status and Understanding • 2012 - Groundwater Quality in Southeast San Joaquin Valley (SESJ) • 2008 - Groundwater Quality Data in the SESJ • 1998 - Environmental Setting

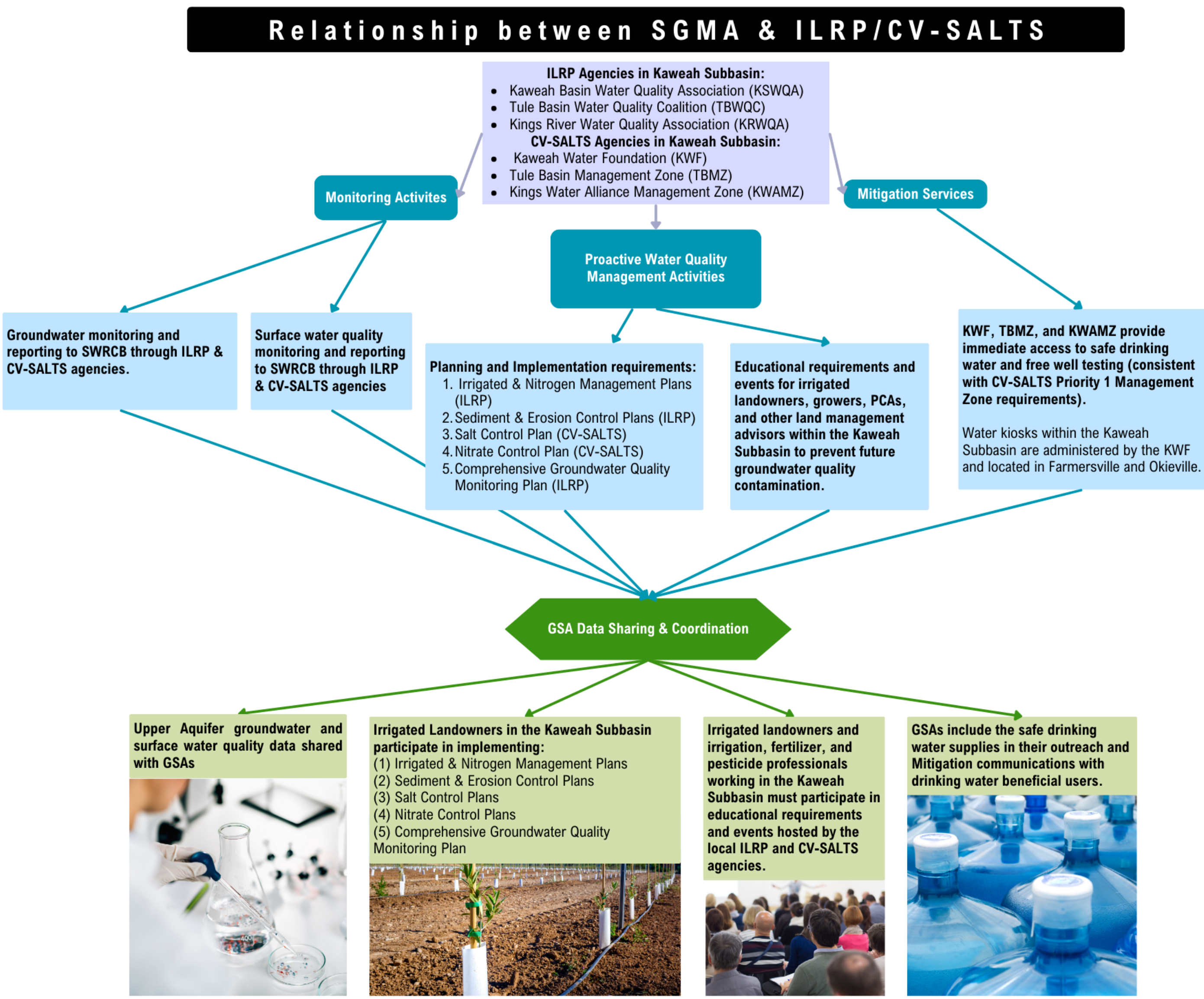


Figure 4-1 Relationship Between SGMA and ILRP/CV-SALTS in the Kaweah Subbasin

4.1.3.1 Irrigated Lands Regulatory Program

The Irrigated Lands Regulatory Program (ILRP) addresses discharge of wastes (e.g., sediments, pesticides, nitrates) from commercial irrigated lands. The goal of the ILRP is to protect surface water and groundwater and reduce impacts of irrigated agricultural discharges to waters of the State. In 1999, the California Legislature passed Senate Bill 390, which eliminated a blanket waiver for agricultural waste discharges. The Bill required the Regional Water Quality Control Board (RWQCB) to develop a program to regulate agricultural lands under the Porter-Cologne Water Quality Control Act. In 2003, the Central Valley Water Board adopted a conditional Waiver of Waste Discharge Requirements (WDRs) to regulate agricultural discharges to surface waters. In September 2013, the RWQCB adopted the WDR governing the Tulare Lake Region, of which the Kaweah Subbasin is a part, that address discharges to both surface water and groundwater, thus requiring ILRP enrollment for all commercial irrigated agricultural operations. **Figure 4-1** explains the relationship between the Subbasin and ILRP.

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 GKGSA 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.

4.1.3.2 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

4.1.3.3 Geotracker and EnviroStor Database

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.

4.1.3.4 California State Drinking Water Information System (SDWIS)

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

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

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

4.1.3.5 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.

4.1.3.6 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.

4.1.3.7 Central Valley-Salinity Alternatives for Long-Term Sustainability

CV-SALTS is a collaborative stakeholder driven and managed program to develop sustainable salinity and nitrate management planning for the Central Valley. The program objective is intended to facilitate the salt and nitrate implementation strategies recommended in the Salt and Nitrate Management Plan (SNMP) developed in 2017. They are designed to address both legacy and ongoing salt and nitrate accumulation issues in surface and groundwater. The overarching management goals and priorities of the control are: 1) ensure safe drinking water supply; 2) achieve balanced salt and nitrate loading; and 3) implement long-term, managed restoration of impaired water bodies. The program is phased with the primary focus of early actions on nitrate impacts to groundwater drinking water supplies and established specific implementation activities. The Kaweah Subbasin is a Priority 1 basin for nitrate management. The nitrate control program schedule began in 2019, following State Board adoption of the Salt and Nitrate Control Program basin plan. **Figure 4-1** explains the relationship between EKGSA and ILRP.

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.

4.1.4 Existing Interconnected Surface Water Monitoring § 354.34 (a) and § 354.38 (d)

> ***§354.38 Assessment and Improvement of Monitoring Network**.*
> (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.

KDWCD holds a permanent contract with the US Bureau of Reclamation (USBR) which entitles it to certain quantities of surface water from Millerton Lake, which is delivered via the Friant-Kern Canal. KCWD and Lakeside IWD, while not long-term contractors, have historically purchased surplus CVP water, when available. The Kaweah River is fully appropriated, pre-1914 rights, and water is delivered via agreements with water rights holders of the Kaweah and St. Johns River Association. **Figure 4-2** shows the locations of surface water monitoring stations (headgates). Water rights are administered through the Watermaster in accordance with historic agreements and associated measurement locations. Additionally, KDWCD and KSJRA works with the Army Corps of Engineers in the operation of Terminus Dam to coordinate releases from the dam for flood releases as well as delivery to appropriators. Seasonal streams originating in the eastern portion of the Kaweah Subbasin, such as Yokohl, Lewis, Cottonwood, and Dry Creeks, also contribute to the surface water inflow to GKGSA.

The GKGSA is currently evaluating the incorporation of six shallow monitoring wells located along the Kaweah River east of McKay's Point for incorporation into an interconnected surface water monitoring system. The monitoring wells were originally constructed as part an evaluation of the site's suitability for a groundwater recharge facility. This study not only gave insight to the existing interconnection between surface water and groundwater at the eastern edge of the GKGSA and Kaweah Subbasin, but may serve as a model for how unique monitoring protocols can be effective at identifying groundwater behavior in areas where there is a direct connection of surface water and groundwater.

4.1.5 Existing Weather and Precipitation Monitoring

For the Kaweah Subbasin, several weather stations are used for the measurement of precipitation. These stations, which are part of the CIMIS and NOAA networks, are listed in **Table 4-4** below.

Table 4-4: CIMIS Stations in and around Kaweah Subbasin

Source	Station Number	Station Name
CIMIS	43747	Hanford
CIMIS	42012	Corcoran
CIMIS	49367	Visalia
CIMIS	44957	Lindsay
CIMIS	44890	Lemon Cove
CIMIS	48917	Three Rivers Edison
NOAA	04-0204	Angiola
NOAA	04-2012	Corcoran Irrigation District
NOAA	04-2922	Exeter Fauver Ranch
NOAA	04-3747	Hanford 1 S
NOAA	72-0040	Lake Kaweah Weather
NOAA	04-4890	Lemon Cove
NOAA	04-4957	Lindsay
NOAA	04-7077	Porterville
NOAA	04-9367	Visalia

4.2 Kaweah Subbasin Monitoring Network Objectives [§354.34 (b)(1),(b)(2),(b)(3),(b)4)]

§354.34 Monitoring Network.

(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.

According to GSP Regulations § 354.34(b), each GSA is required to develop a monitoring network that, when implemented, shall accomplish the following objectives:

1. Demonstrate progress toward achieving interim milestones and 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
5. Monitor changes for the following pertinent sustainability indicators

The minimum thresholds and measurable objectives for the Kaweah Subbasin account for the following sustainability indicators: interconnected streams, groundwater levels, groundwater storage, groundwater quality, and land subsidence. While they are listed in SGMA, seawater intrusion is not considered in this Plan because they do not apply to the GKGSA area. As described in the Subbasin Basin Setting Report (Appendix 3A), the location of the Kaweah Subbasin precludes the possibility of seawater intrusion.

4.2.1 Kaweah Subbasin Monitoring Objectives

The monitoring networks will maintain data quality to meet the Measurable Objectives of this GSP. As described in the 2016 DWR best management practice (BMP) document for monitoring (*Groundwater Monitoring Protocols, Standards, and Sites BMP*), the processes for maintaining quality control and quality assurance are iterative and will be evaluated every five years for effectiveness. The monitoring networks implemented with this GSP will produce acceptable data to monitor the Sustainability Indicators against Minimum Thresholds and Interim Milestones. Where necessary, revisions will be made every five years.

4.2.2 Kaweah Subbasin Temporal Monitoring

The monitoring network will be capable of collecting sufficient data to demonstrate seasonal, short-term (1 to 5 years), and long-term (5 to 10 years) trends in groundwater and related surface conditions, in addition to yielding representative information about groundwater conditions necessary to evaluate Plan implementation. The frequency at which data will be collected for each network is described in the following sections.

4.2.3 Kaweah Subbasin Representative Monitoring

As referenced in Regulation §354.36, representative monitoring sites may be designated where site results reflect the general conditions in the area, and where quantitative values are defined for Minimum Thresholds and Interim Milestones.

Representative monitoring will include the use of groundwater elevations as proxy measurements for groundwater storage. The USGS and DWR have utilized changes in groundwater elevations to estimate changes in groundwater storage and have demonstrated a correlation between declining groundwater elevations and increased subsidence, however a strong correlation was not identified for this plan area. A reasonable margin of operational flexibility with groundwater elevations will be taken to avoid undesirable results for the other sustainability indicators.

4.2.4 Monitoring Rationales

As discussed in the Basin Setting Report (**Appendix 3A**), the overall trend for groundwater levels is declining in the Kaweah Subbasin for the Hydrologic Base Period and groundwater storage is commensurately less. Inelastic subsidence also tends to trend with declining groundwater levels in areas interbedded with clay layers or with a significant confining layer(s). Seawater Intrusion, due to the distance to the Pacific Ocean, is not considered to be a Sustainability Indicator (Section 3: Sustainability Goal). Due to limited data, a work plan has been developed to fill data gaps related to Interconnected Surface Waters in the GKGSA. More monitoring locations such as shallow monitoring wells and stream gauges are likely to be installed in gap areas as part of this work plan. More detail on the work plan is provided in Section 7.7.12.

Groundwater level monitoring is the key parameter that will inform progress made by the GKGSA in meeting the Interim Milestones and Measurable Objectives set in this Plan. The other Sustainability Indicators will be monitored using the existing monitoring systems and programs and will be evaluated concurrently groundwater levels. Data collected from the monitoring networks will be used to refine water budget components for future planning and subbasin modeling. Additional stream flow data will also enhance the water budget for an updated Subbasin model. The following sections (4.3 through 4.8) describe how GKGSA will monitor each Sustainability Indicator.

4.3 GKGSA Groundwater Level Monitoring Network [§354.34 and §354.36]

§354.34 Monitoring Network.
(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.
(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.

(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:

(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 monitoring 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.

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

(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.
(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.
(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.

(g) Each Plan shall describe the following information about the monitoring network:

(1) Scientific rationale for the monitoring site selection process.
(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.
(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.

(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.
(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.
(j) 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 a monitoring network related to those sustainability indicators.
§354.36 Representative Monitoring. Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:
(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.

Groundwater-level monitoring has been carried out for most of the past century. Existing groundwater wells with long monitoring histories make the best data sources for continued monitoring. These wells are rare, and when they exist, they typically have poor data quality. Data quality issues include wells that have an incomplete time-series or lack of well construction details. There is no recourse for historic data gaps, but the frequency of future measurements in these wells can be obtained by adding wells with a long history of measurements, combined with construction details to the monitoring network.

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 GKGSA. Among the current records, data inconsistencies may arise because 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 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 effected 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 GKGSA will attempt to drill new monitoring wells in locations minimally affected by pumping, however, this is an aspect that cannot be directly controlled.

4.3.1 Groundwater Level Monitoring Management Areas

A Management Area (MA) refers to an area within the subbasin or GSA for which a GSP has identified different Minimum Thresholds, Measurable Objectives, monitoring, or Projects and Management Actions, based on unique local conditions for water use, water source, geology, aquifer characteristics, or other factors. MAs serve to preserve groundwater management practices and implement additional requirements set forth in this GSP. The GKGSA has not designated any MAs at this time but may elect to establish MAs in future updates to address different conditions (e.g. surface-water lands versus groundwater-only lands).

4.3.2 Groundwater Level Monitoring Frequency

At a minimum, groundwater level monitoring will occur twice each year, typically in March and October. January has been a historic period of measurement because irrigation pumping is minimal during the winter rainy season when runoff is higher and groundwater recharge has begun. October is a typical period of measurement because the harvest is complete, and the irrigation season is generally over. March is a common period of measurement, but in drier years irrigation pumping has started by this time of the year, which reduces groundwater levels and dampens the recognition of groundwater level recovery. This frequency of monitoring is more than sufficient to demonstrate seasonal, short-term (1 to 5 years) and long-term (5 to 10 years) trends in groundwater and related surface conditions and yield representative information about groundwater conditions.

4.3.3 Groundwater Level Monitoring Network

Figure 4-3 provides the current distribution of wells with available data throughout the GKGSA portion of the Kaweah Subbasin, including data from CASGEM, local and regional agencies, and MAs. **Figure 4-4** shows the groundwater wells in the GKGSA that will be used for monitoring of groundwater levels and water quality. Most of these wells are upper or single aquifer wells. Based on the BMP for monitoring networks, the well density goal is 4 to 10 wells per 100 square miles (DWR, 2017). The GKGSA area is approximately 340 square miles. Based on the BMP, the GKGSA monitoring network will require between 14 and 34 monitoring wells.

4.3.4 Groundwater Level Representative Monitoring Network §354.36(a),(b)(1),(b)(2),(c)

§354.36 Representative Monitoring

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

(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.

(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.

(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.

The GKGSA Representative Monitoring Network is a subset of the Monitoring Network which is made up of monitoring sites deemed representative of nearby conditions in which they are dedicated to monitoring. Quantitative metrics to assess progress towards the sustainability goal are assigned at each representative monitoring site, which is explained in detail in **Section 5**. Supplemental data from the larger Monitoring Network (made up of sites from existing monitoring programs) are used to support technical analyses, such as groundwater elevation contours, cross-boundary relationships, and model development and interpretation. A map of the GKGSA Representative Monitoring Network for groundwater levels is available in **Figure 4-4.**

Appendix B of the Basin Setting Report tabulates known well construction information while construction information was not available for many wells during the development of this initial GSP. Table 4 of the Basin Setting Report (**Appendix 3A**) lists the monitoring entity and the frequency of measurement for groundwater levels.

Access agreements are pending for the monitoring wells for the collection and reporting of groundwater level data at the time of publication of this public review draft and these agreements, as well as a Standard Operating Procedure (SOP) for data collection will be prepared per DWR's BMP "*Monitoring Protocols, Standards, and Sites.*"

4.3.5 Groundwater Level Monitoring Protocols

The Kaweah Subbasin GSAs are required to monitor seasonal high (spring) and seasonal low (fall) upper aquifer groundwater levels and report results to DWR through their SGMA Data Portal on a bi-annual basis. The groundwater levels are monitored following industry standards, and the results are reported publicly through the Annual Reports submitted every April 1st from 2020 through the implementation period (2040).

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 4D** for a copy of the BMP. The EKGSA may develop standard monitoring forms in the future.

As referenced in Regulation § 352.4, "monitoring protocols shall be developed according to best management practices. Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan and modified as necessary."

Per the DWR's Monitoring Protocol BMP:

- All groundwater levels in a basin will be collected within as short a time as possible, preferably within a 1 to 2-week period.
- Depth to groundwater will be measured at an established Reference Point (RP) on the well casing. The RP will be identified with a permanent marker, paint spot, or a notch in the lip of the well casing. By convention in open casing monitoring wells, the RP is located on the north side of the well casing. If no mark is apparent, the person performing the measurement should measure the depth to groundwater from the north side of the top of the well casing.
- The sampler will remove the appropriate cap, lid, or plug that covers the monitoring access point listening for pressure release. If a release is evident, the measurement will be delayed for a short period of time to allow the water level to equilibrate.

- Measurements of depth to groundwater and land surface will be measured and reported in feet to an accuracy of at least 0.1 feet relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement will be noted on the record (i.e. electric sounder, steel tape, transducer, acoustic sounder or airline).
- The water level probe should be cleaned after measuring each well.
- To assure that the same well is being measured each time, the GSA will create a Well Identification Sheet for each well site, which will be used to track each well during monitoring. The following information will be recorded on each Well Identification Sheet: well number, date of survey, latitude and longitude, RP elevation, location description and map, well type and use, well completion type and, if available, total depth, screened intervals and well completion report number.
- The sampler will replace any well caps or plugs and lock any well buildings or covers.
- All data will be entered into the data management system (DMS) as soon as possible. Care will be taken to avoid data entry errors and the entries will be checked by a second person for accuracy.
- The GKGSA relies on the monitoring plan implemented by the KDWCD in collecting groundwater elevation data for local groundwater management and for reporting to DWR as required by SGMA. A copy of KDWCD's groundwater level monitoring plan is attached as Appendix 4B.

4.3.5.1 Pressure Transducers

Per the DWR Monitoring Protocols BMP, groundwater levels may be measured using pressure transducers installed in monitoring wells and recorded by data loggers, along with calculated groundwater elevations. When relying on pressure transducers and data loggers, manual measurements of groundwater levels will be taken during installation to synchronize the transducer system and periodically (quarterly) to ensure monitoring equipment does not allow a 'drift' in the actual values.

The following protocols will be followed when installing a pressure transducer in a monitoring well:

- The sampler will use an electronic sounder or chalked steel tape to measure the depth to groundwater level from the RP. The groundwater elevation will be calculated by subtracting the depth to groundwater from the RP elevation. These values will be used as references to synchronize the transducer system in the monitoring well.
- The sampler will record the well identifier, the associated transducer serial number, transducer range, transducer accuracy, and other pertinent information in the log.
- Transducers will be able to record groundwater levels with an accuracy of at least 0.1 foot. Various factors will be considered in the selection of the transducer system,

including battery life, data storage capacity, range of groundwater level fluctuations, and natural pressure drift of the transducers.

- The sampler will record whether the pressure transducer uses a vented or non- vented cable for barometric compensation. Vented cables are preferred, but non- vented cables are acceptable if the transducer data are properly corrected for natural fluctuations in barometric pressure changes, which requires the commensurate logging of barometric pressures.
- Follow manufacturer specifications for installation, calibration, battery life preservation, correction procedure (for non-vented cables), and anticipated life expectancy to ensure optimal use of the equipment.
- Secure the cable to the well head with a well dock or another reliable method. Mark the cable at the elevation of the reference point with tape or an indelible marker to allow estimates of future cable slippage.
- The transducer data will be checked periodically against hand measured groundwater levels to monitor electronic drift or cable movement. This check will not occur during routine site visits, but at least annually.
- The data will be downloaded regularly to ensure data are not lost. Upon reviewing and accepting the data according to the QA/QC program, the data will be uploaded into the DMS. Data from non-vented cables will be corrected for barometric pressure fluctuations, as appropriate. After ensuring the transducer data have been downloaded and stored in the DMS, the data will be deleted from the data logger to ensure that adequate data logger memory remains for future measurements.

4.4 GKGSA Land Subsidence Monitoring Network [§354.34 and §354.36]

§354.34 Monitoring Network.
(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.
(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.

(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:

(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.

(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.
(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.
(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.

(g) Each Plan shall describe the following information about the monitoring network:

(1) Scientific rationale for the monitoring site selection process.
(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.
(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.

(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.
(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.
(j) 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 a monitoring network related to those sustainability indicators.
§354.36 Representative Monitoring. Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:
(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.
(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.

(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.

4.4.1 Land Subsidence Management Areas

For the purpose of this Plan, the GKGSA will not designate separate Management Areas to evaluate subsidence. The Sustainability Indicator for subsidence will be evaluated with SGMA implementation to determine the necessity to specify Management Areas for subsidence monitoring.

4.4.2 Land Subsidence Monitoring Frequency

Land subsidence is monitored in the Subbasin using remote sensing (InSAR) and subsidence benchmark surveys. InSAR data are collected by DWR at a monthly frequency and reported quarterly. Subsidence station elevations are and will continue to be monitored annually by the GSAs and partner agencies to supplement InSAR data.

4.4.3 Land Subsidence Monitoring Network

To provide better coverage than the previous monitoring network, land subsidence is monitored using InSAR data provided as technical support by DWR. InSAR data covers the entire Subbasin on a roughly 302-foot by 302-foot grid. This subsidence dataset represents the best available science for the GSP area and is therefore used as the subsidence monitoring network. InSAR data will be confirmed as necessary using benchmark survey data collected by the Kaweah Delta Water Conservation District (KDWCD). KDWCD monitors 9 stations within the GKGSA area using GPS methods.

4.4.4 Land Subsidence Representative Monitoring Network §354.36(a),(b)(1),(b)(2),(c)

§354.34 Representative Monitoring

(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.

(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.

(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.

The land subsidence representative monitoring network for the Subbasin (96 sites) and GKGSA area (44 sites) are shown on Figure 4-5 and Figure 4-6, respectively. The 44 GKGSA sites are listed in Table 4-5. InSAR data will be interpolated to each site in the representative monitoring network, and subsidence at each site will be tracked and compared to the subsidence SMC for that site.

The monitoring network locations are co-located with several existing benchmarks, GPS stations, and wells, with additional locations based on historical subsidence observations and locations of critical infrastructure. The following locations make up the RMS subsidence monitoring network in the GKGSA area:

- Three lower aquifer groundwater level RMS
- Eleven other shallow and composite (i.e. screened across Corcoran Clay) groundwater level RMS
- Eleven existing KDCWD subsidence GPS stations
- 17 locations without prior monitoring where subsidence is observed in InSAR data between 2015 and 2022, areas along basin boundaries with no existing monitoring locations, or near critical infrastructure such as local conveyance systems

InSAR data will be interpolated to each site in the representative monitoring network, and subsidence at each site will be tracked and compared to the subsidence SMC for that site.

The monitoring network locations are co-located with several existing benchmarks, GPS stations, and wells, with additional locations based on historical subsidence observations and locations of critical infrastructure. The following locations make up the RMS subsidence monitoring network in the GKGSA area:

- Three lower aquifer groundwater level RMSs
- Eleven other shallow and composite (i.e. screened across Corcoran Clay) groundwater level RMS
- Twelve of the existing KDCWD subsidence GPS stations
- Seventeen locations without prior monitoring where subsidence is observed in InSAR data between 2015 and 2022, areas along basin boundaries with no other existing monitoring locations, and near critical infrastructure such as local conveyance systems.

Table 4-5. Summary of GKGSA Subsidence Monitoring Locations

Representative Monitoring Site	Network Category
36.1056_-119.4518	Data Gap Area
36.1033_-119.4150	Data Gap Area
36.1354_-119.4589	Data Gap Area
36.3224_-119.4399	Data Gap Area
36.0878_-119.5028	Data Gap Area
36.2950_-119.4810	Data Gap Area
36.1519_-119.2592	Data Gap Area

Representative Monitoring Site	Network Category
36.1920_-119.2811	Data Gap Area
36.4143_-119.4149	Data Gap Area
36.3499_-119.4450	Data Gap Area
36.3047_-119.5360	Data Gap Area
36.2611_-119.6612	Data Gap Area
36.2272_-119.5781	Data Gap Area
36.1537_-119.3043	Data Gap Area
36.1303_-119.4196	Data Gap Area
36.3940_-119.4880	Data Gap Area
36.3570_-119.4864	Data Gap Area
Kaweah River Check	FKC Check
KSB-0905	Lower Aquifer GWL RMS
GK-1	Lower Aquifer GWL RMS
GK-2	Lower Aquifer GWL RMS
KSB-1535	Other shallow and composite monitoring wells
KSB-1259	Other shallow and composite monitoring wells
KSB-2114	Other shallow and composite monitoring wells
KSB-0550	Other shallow and composite monitoring wells
KSB-2203	Other shallow and composite monitoring wells
KSB-0531	Other shallow and composite monitoring wells
KSB-0856	Other shallow and composite monitoring wells
KSB-2058	Other shallow and composite monitoring wells
KSB-1580	Other shallow and composite monitoring wells
KSB-2095	Other shallow and composite monitoring wells
KSB-2017	Other shallow and composite monitoring wells
K001	Subsidence GPS Station
K003	Subsidence GPS Station
DH6686	Subsidence GPS Station
DH6739	Subsidence GPS Station
K012	Subsidence GPS Station
K015	Subsidence GPS Station
K015X	Subsidence GPS Station
K016	Subsidence GPS Station
K1081	Subsidence GPS Station
S228	Subsidence GPS Station
P566	Subsidence GPS Station
K02A1	Subsidence GPS Station

4.4.5 Land Subsidence Monitoring Protocols

Land subsidence InSAR monitoring protocols are the same protocols used by DWR, who adapted their methods to measure subsidence on hard surfaces only and interpolate between them. This minimizes the change in land surface elevation captures in soft surfaces that are likely not true subsidence. The cell size of the interpolated surface is 302 feet by 302 feet. The InSAR monitoring protocols are consistent with data and reporting standards described in GSP Regulations § 352.4.

According to the KDWCD Land Surface Elevation Monitoring Plan, the following protocols are used for data collection and processing.

4.4.5.1 Static Occupation Protocols for GPS Stations

The protocols listed below will be followed for collection of the land surface elevation data:

- Static occupation strategies may necessarily vary by point but will in every case remain consistent with National Geodetic Survey recommendations. The observer will use a dual-frequency (L1/L2) survey grade GPS receiver to continuously occupy each station for no fewer than 2.0 hours per measurement period. Lower root-mean square error (RMSE) correlates directly with longer duration of observation.
- The preferred outcome at each station is to acquire one 4.0+ hour autonomous dataset from 1 setup. The average of two 2.0+ hour autonomous datasets from 2 independent setups separated by not more than 24 hours is an acceptable alternative. Occasionally, one 2.0+ hour autonomous dataset may meet the Vertical RMSE (VRMSE) standard.
- Although L-band receivers are 24-hour, all-weather capable, operations will be limited to daylight hours. Modern receivers are resistant to moisture infiltration but will not be exposed to heavy or sustained precipitation. Fog, haze, overcast, clouds, light rain, and dust should not be problematic. Operations will cease in cases where environmental elements—such as high winds or blowing debris—or man-made conditions threaten observer safety, equipment functionality, or data integrity, and will begin again only when practicable for at least 2 hours.
- Prior to initiating each collection period, at 30-minute intervals during each period and at cessation, observers will complete a schedule of system checks in the station field notes. Logging will be enabled during instrument configuration; however, observers shall remain aware and engaged throughout each collection period and be ready to take appropriate action.

4.4.5.2 Data Processing Protocols for GPS Data

After the land surface elevation data are collected, the protocols listed below will be followed in the processing of the data:

- All original datasets will be preserved in a permanent stand-alone database. Copies of the datasets will be examined for coherence and continuity. Errors and deficiencies will be corrected additively or proportionally wherever possible. Unusable datasets will be set aside, and stations with inadequate data will be occupied again. Further data will not be eliminated unless irreparable defects are revealed by subsequent analysis. Station coordinates will be computed from the quality-checked copies with rigorous relative and absolute adjustment strategies.
- Relative coordinate solutions will be computed by the Online Positioning User Service (OPUS), an NGS differential GPS (DGPS) internet application. OPUS solutions are the primary program deliverables. Primary solutions are given in terms of the computational reference frame on the observation epoch date and of the standard datum on the current standard epoch date.
- Absolute coordinate solutions will be computed by the Automatic Precise Positioning Service (APPS), a National Aeronautics and Space Administration (NASA) – Jet Propulsion Laboratory (JPL) – California Institute of Technology (CIT) precise point positioning (PPP) internet application. APPS solutions are secondary program deliverables. Secondary solutions are rendered in terms of the computational reference frame on the observation epoch date and may be transformed to the standard datum adjusted to the current standard epoch date.
- Uncertainty is associated with every observation. Every measurement contains some degree of error. GPS coordinates are characteristically less accurate in the vertical than in the horizontal. NGS and NASA employ sophisticated strategies to detect and correct systematic error. While many conventions are observed, no single comprehensive adjustment computation protocol exists.
- Corrections can be performed in-office with local instrument software and continuously operating reference station (CORS) data obtained online from NGS, or absolutely with archived ephemerides and the Global Navigation Satellite System (GNSS)- Inferred Positioning System and Orbital Analysis Simulation Software (GIPSY-OASIS) site package. These options should be considered if OPUS and APPS become problematic.

4.5 GKGSA Groundwater Storage Monitoring Network [§354.36 (b)(1)]

§354.36 Representative Monitoring

(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.

Change in groundwater storage is correlated with the change in groundwater levels. Therefore, the GKGSA will use groundwater levels as a proxy for the change in groundwater storage.

Groundwater storage changes will be calculated by evaluating the volumetric difference between changes in groundwater surfaces created based on groundwater level data collected in the spring of each year.

Because groundwater levels will be used as a proxy for groundwater storage changes, the sub-level discussions such as management areas, monitoring frequency, spatial density, etc., are not deemed necessary, since this information is provided for groundwater level data collection above.

4.6 GKGSA Groundwater Quality Monitoring Network [§354.34 and §354.36]

§354.34 Monitoring Network.

(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.

(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.

(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:

(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.

(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.

(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

(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.

(g) Each Plan shall describe the following information about the monitoring network:

(1) Scientific rationale for the monitoring site selection process.
(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.
(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.

(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.

(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.

(j) 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 a monitoring network related to those sustainability indicators.

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

(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.

(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.

4.6.1 Groundwater Quality Management Areas

The GKGSA has not designated any MAs at this time but may elect to establish MAs in future updates to address different groundwater quality conditions.

4.6.2 Groundwater Quality Monitoring Frequency

The monitoring network will be capable of collecting sufficient data to demonstrate seasonal, short-term (1 to 5 years) and long-term (5 to 10 years) trends in groundwater and related surface conditions and yield representative information about groundwater conditions as necessary to evaluate Plan implementation. In general, water quality monitoring will be seasonal to evaluate water quality during spring groundwater levels (seasonal high prior to summer irrigation demands) and fall groundwater levels (seasonal low after the summer irrigation demands).

Municipal wells are monitored according to a schedule determined by the Division of Drinking Water of the State Water Resources Control Board. Schedules are provided at https://sdwis.waterboards.ca.gov/PDWW/

Groundwater from the multi-level monitoring wells is analyzed annually for the agricultural suitability suite of constituents.

4.6.3 Groundwater Quality Monitoring Network

The spatial distribution must be adequate to map or supplement mapping of known regional water quality trends as identified in the Basin Setting (Chapter 3). The subbasin will coordinate with municipal water suppliers, ILRP, and CV-SALTS to share infrastructure. **Figure 4-7** shows the locations of existing groundwater quality sampling sites for public supply.

4.6.4 Groundwater Quality Representative Monitoring Network §354.36(a),(b)(1),(b)(2), (c)

The GKGSA groundwater quality representative monitoring network is as shown on **Figure 4-7.** The current monitoring frequency is on a semi-annual or quarterly basis and/or more or less frequently based on existing safe drinking water monitoring standards that these public supply wells are beholden to.

The GKGSA does not include any agricultural wells as being included in the representative monitoring network, as the most limiting groundwater quality standards are established for drinking water criteria. However, chlorine and sodium’s agricultural water quality goals are more limiting for agriculture than for the secondary MCL for chlorine, and there is no drinking water MCL for sodium. However, supplemental data is evaluated on an annual basis from agricultural wells via the ILRP and CV-SALTS programs. There are data privacy limitations on the ability to include these wells in the GKGSA representative monitoring network at this time.

4.6.5 Groundwater Quality Monitoring Protocols

The monitoring protocols will follow, at a minimum, the sampling guidelines as provided in DWR's *Groundwater Monitoring Protocols, Standards, and Sites BMP* (2016). Groundwater quality sampling protocols should ensure that:

- Groundwater quality data are taken from the correct location,
- Groundwater quality data are accurate and reproducible,
- Data are loaded into the DMS in a timely manner and handled in a way that ensures data integrity.

4.7 GKGSA Interconnected Surface Water Monitoring Network [§ 354.34 and §354.36]

§354.34 Monitoring Network.
(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.
(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.
(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:
(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.
(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.
(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.
(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.
(g) Each Plan shall describe the following information about the monitoring network:
(1) Scientific rationale for the monitoring site selection process.
(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.
(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.
(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.
(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.
(j) 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 a monitoring network related to those sustainability indicators.
§354.36 Representative Monitoring. Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:
(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.
(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 GKGSA has identified interconnected surface water as a data gap and has begun implementation of the Interconnected Surface Water Data Gap Workplan (Section 6.7.12) to address this data gap. As a result of this management action, the Kaweah Subbasin now has 3 new shallow RMS wells near Lewis Creek and Cottonwood Creek dedicated to evaluating the groundwater level conditions and six shallow monitoring wells near the Kaweah River upstream of McKay Point that are being evaluated for this purpose.

It is important to clarify that groundwater levels are not a substitute for depletions of interconnected surface water; however, establishing protective groundwater level SMC adjacent to these potentially interconnected waterbodies is intended to avoid significant and unreasonable impacts by keeping potential interconnection present.

SGMA requires GSAs to develop and enforce groundwater management policies that avoid significant and undesirable results. This is especially challenging for the interconnected surface water sustainability indicator. The ability to assess the relationship between groundwater pumping and depletions of interconnected surface water can be hindered by many other variables that influence depletions and flow stage, such as snowpack declines, snowmelt variability, upstream vegetative conditions, landscape changes (such as indirect influence from seasonal fires, or such as landslides), and many other variables that are unrelated to anthropogenic groundwater management.

To be protective and without certainty of true interconnection of several of the potentially interconnected waterbodies in the Kaweah Subbasin, new interconnected surface water RMS and SMC have been established in the interim and are in alignment with the upper aquifer groundwater level monitoring network. At this time, this is the best available resource to monitor for interconnected surface water. However, streamflow monitoring will be necessary to fill data gaps, as explained in **Section 4.9**.

At the time of publishing this 2nd Amended GSP, the DWR BMP on establishing monitoring and SMC for depletions of interconnected surface water was not made available. Once the BMP is available, the Kaweah Subbasin will evaluate the suggested best practices and revisit interconnected surface water identification, monitoring, and SMC.

4.7.1 Interconnected Surface Water Management Areas

The GKGSA has not designated any MAs at this time but may elect to establish MAs in future updates to address interconnected surface water conditions.

4.7.2 Interconnected Surface Water Monitoring Frequency

The monitoring frequency for the potential six interconnected monitoring wells will initially be consistent with the Upper Aquifer Groundwater Level Monitoring Network during seasonal high (March-April) and seasonal low (September-October) periods. The monitoring frequency may be adjusted with further implementation of the Interconnected Surface Water Data Gap Workplan (**Section 6.7.12**).

4.7.3 Interconnected Surface Water Monitoring Network

The interconnected surface water monitoring network remains a data gap. Potential monitoring wells have been identified but their suitability for this purpose has not been confirmed. See **Section 6.7.12** for more information on the plan to fill this data gap through the Interconnected Surface Water Data Gap Workplan.

4.7.4 Interconnected Surface Water Representative Monitoring Network [§354.36(a),(b)(1),(b)(2),(c)]

§354.36 Representative Monitoring
Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:
(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.
(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.
(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.

The interconnected surface water monitoring network remains a data gap and RMS have not been identified. Potential monitoring wells have been identified but their suitability for this purpose has not been confirmed. See **Section 6.7.12** for more information on the plan to fill this data gap through the Interconnected Surface Water Data Gap Workplan.

4.7.5 Interconnected Surface Water Monitoring Protocols

The monitoring protocols for interconnected surface water are consistent with the monitoring protocols for groundwater level monitoring. See **Section 4.3** for more information on those protocols.

4.8 Seawater Intrusion Monitoring [§354.34(j)]

§354.34 Monitoring Network.
(j) 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 a monitoring network related to those sustainability indicators.

The Kaweah Subbasin being in the interior part of the state is far removed from any seawater body. Furthermore, deep connate water exhibiting high TDS is beyond the reach of producing wells in the Subbasin and is considered isolated from the freshwater aquifers above. The Subbasin GSAs have determined that seawater intrusion is not present and is not likely to physically occur. No monitoring for seawater intrusion is conducted by Subbasin GSAs.

4.9 Monitoring Data Gaps [§354.38 and §354.40]

§354.38 Assessment and Improvement of Monitoring Network.
(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.
(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.
(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.
(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.
(e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:
  (1) Minimum threshold exceedances.
  (2) Highly variable spatial or temporal conditions.
  (3) Adverse impacts to beneficial uses and users of groundwater.
  (4) The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.

§354.40 Reporting Monitoring Data to the Department. 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 following section describes data gaps for groundwater elevations, groundwater quality, and land subsidence.

4.9.1 Groundwater Level and Storage Monitoring Data Gaps

As referenced in Regulation §352.4, “If an Agency relies on wells that lack casing perforations, borehole depth, or total well depth information to monitor groundwater conditions as part of a Plan, the Agency shall describe a schedule for acquiring monitoring wells with the necessary information, or demonstrate to the Department that such information is not necessary to understand and manage groundwater in the basin.”

Well types and construction details will need to be determined to improve the monitoring network. Downhole well surveys and desktop surveys will be utilized for existing wells to fill in the well construction details gap (see **Section 6.7.13**). New dedicated monitoring wells and converted production wells will be utilized to fill in the monitoring network spatial extent and density. Improvement will occur during the initial few years of the implementation period, prior to the first 5-year update.

4.9.2 Groundwater Quality Monitoring Data Gaps

Groundwater quality data are mostly available from the reoccurring sampling requirements for public water systems, primarily the Cities of Exeter, Farmersville, and Woodlake, but also for smaller systems within the GKGSA. Additional groundwater quality data will be available from the IRLP program and the upcoming CV-SALTS program and will provide further coverage in agricultural and rural areas. DWR will construct two new nested monitoring wells for the GKGSA as part of the Technical Services Support program. In addition, inactive production wells will be converted to monitoring wells to improve the spatial extent and density of the monitoring network. Improvement will occur during the initial few years of the implementation period, prior to the first 5-year review.

4.9.3 Interconnected Surface Water Monitoring Data Gaps

The GKGSA acknowledges that confidence in the presence of interconnected surface water is limited until shallow, near-stream groundwater level and surface water flow data have been collected for several years. This data gap will be addressed via the implementation of the Interconnected Surface Water Data Gap Work Plan (**Section 6.7.7**). Progress has been made on this management action, including the identification of potential new interconnected surface water RMS wells, as described above, to fill data gaps. See **Figure 4-8** for a map of the data gap areas in the Kaweah Subbasin, including the data gap areas of the Kaweah River.

4.9.4 Land Subsidence Monitoring Data Gaps

With the availability of InSAR data, the current subsidence monitoring network is believed to sufficiently cover the GKGSA. The continued implementation of the KDWCD Land Surface Elevation Monitoring Plan will provide ongoing data on future subsidence at 12 locations within GKGSA and seven locations with MKGSA plus eight locations outside the Kaweah Subbasin. The EKGSA established subsidence monitoring locations along the Friant-Kern Canal. The GKGSA and EKGSA will be coordinating to evaluate the subsidence monitoring along this critical infrastructure. The GKGSA will coordinate with adjacent subbasins, especially in the southwestern portion of the subbasin where subsidence is greatest and could affect surface infrastructure. The GKGSA will modify its subsidence monitoring program as more information about potential for subsidence impacts on infrastructure are collected.

4.9.5 Plan to Fill Data Gaps

GKGSA is in the process of filling data gaps and is embracing new technologies to improve the Kaweah Subbasin's understanding of groundwater conditions affecting beneficial users, uses, and property interests. Improving certainty results in better groundwater management planning; therefore, filling data gaps is considered a top priority for GKGSA. New management actions have been added with the aim of improving data gaps and community trust building to access private data and information that is currently inaccessible.

4.9.5.1 Plan to Fill Groundwater Level Data Gaps

The GKGSA 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. The GKGSA will need to locate accessible private wells or drill new wells. Four new monitoring well locations have been identified for construction of new monitoring wells in the GKGSA. Over time, the GKGSA will transition to utilizing dedicated monitoring wells in its monitoring network.

To address data quality gaps related to unknown construction information, the GKGSA will employ 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. Because of the way data are 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. 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. Acquiring this information will be pursued through the GKGSA Well Registration management action discussed in **Section 6.7.13**.
- **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 re-install a pump to obtain access in production wells. There would also be additional costs for administration and outreach to landowners. The GKGSA would need to enter into private agreements with individual well owners for the use of these wells; as an incentive for participation the GKGSA would cover the cost of the well video assessment.

- **Abandoned Wells**. The GKGSA 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 they 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 groundwater level reading.
- **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 GKGSA 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 sidestep the expense of drilling new wells but would still be subject to availability and limitations arising from the missing historical record.
- **Implement a Well Registration Program**. Construction, groundwater level, and groundwater quality data from wells not currently in the GKGSA database are expected to be better understood through this management action. This management action fills data gaps by accessing existing and future data from domestic, small community, and agricultural wells. More information on this management action is available in **Section 6.7.13**.
- **Implement a Well Mitigation Program**. Through the mitigation program, groundwater level and quality data is to be better understood at impacted domestic well sites across the Subbasin. Following completion of long-term mitigation services, the GSA will request these landowners consider allowing the GSA access to the well for future monitoring and inclusion in the representative monitoring networks for groundwater quality and groundwater levels. More information on this management action is available in **Section 6.9.7**.

4.9.5.2 Plan to Fill Groundwater Storage Data Gaps

Storage data gaps will be filled by 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 Subbasin scale was performed through AEM, the findings of which have been incorporated into the Kaweah Subbasin Groundwater Flow Model

Update for use in planning groundwater management into the future and for annual reporting and periodic evaluations.

4.9.5.3 Plan to Fill Groundwater Quality Data Gaps

GKGSA recognizes the addition of private domestic wells in the representative monitoring network would be helpful; however, there is generally hesitation among private landowners with sharing their data with a public agency. Two new management actions have been added, which are anticipated to improve the understanding of domestic groundwater quality in GKGSA and the Kaweah Subbasin:

- **Well Registration Program**. Construction, groundwater level, and groundwater quality data from wells not currently in the GKGSA database are expected to be better understood through this management action. By enrolling in the Well Registration Program (and participating in the representative monitoring network), the GSAs would receive the information necessary to notify the owners of wells at risk of groundwater quality, level, or subsidence impacts. This management action fills data gaps by accessing existing and future data from domestic and small community wells. More information on this management action is available in Section 6.7.6.
- **Mitigation Program**. The Subbasin Mitigation Program will help us better understand groundwater level and quality data at impacted domestic well sites across the Subbasin. Following completion of long-term mitigation services, the GSA will request these landowners consider allowing the GSA access to the well for future monitoring and inclusion in the representative monitoring networks for groundwater quality and groundwater levels. More information on this management action is available in **Appendix 6A**.

In addition to the new Well Registration Program and Mitigation Program, several new recharge facilities include groundwater quality monitoring to assess the relationship between the recharged water and the underlying groundwater quality. More information on these recharge basins and the Well Registration Program is available in Chapter 6.

The GKGSA’s commitment to monitor constituents of concern 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 5 years of implementation should provide more insight on groundwater quality (location, trends, etc.) in the GKGSA. The GKGSA will also collaborate, where appropriate and feasible, with other agencies tasked with tracking and/or improving groundwater quality for additional assistance with data gaps.

4.9.5.4 Plan to Fill Land Subsidence Data Gaps

With the addition of survey points to critical infrastructure, and utilizing the InSAR data, the current subsidence monitoring network is believed to sufficiently cover the GKGSA.

4.9.5.5 Interconnected Surface Streams

Section 6.7.7 describes the GKGSA's plan to fill the interconnected surface water data gap through the Interconnected Surface Water Data Gap Work Plan.

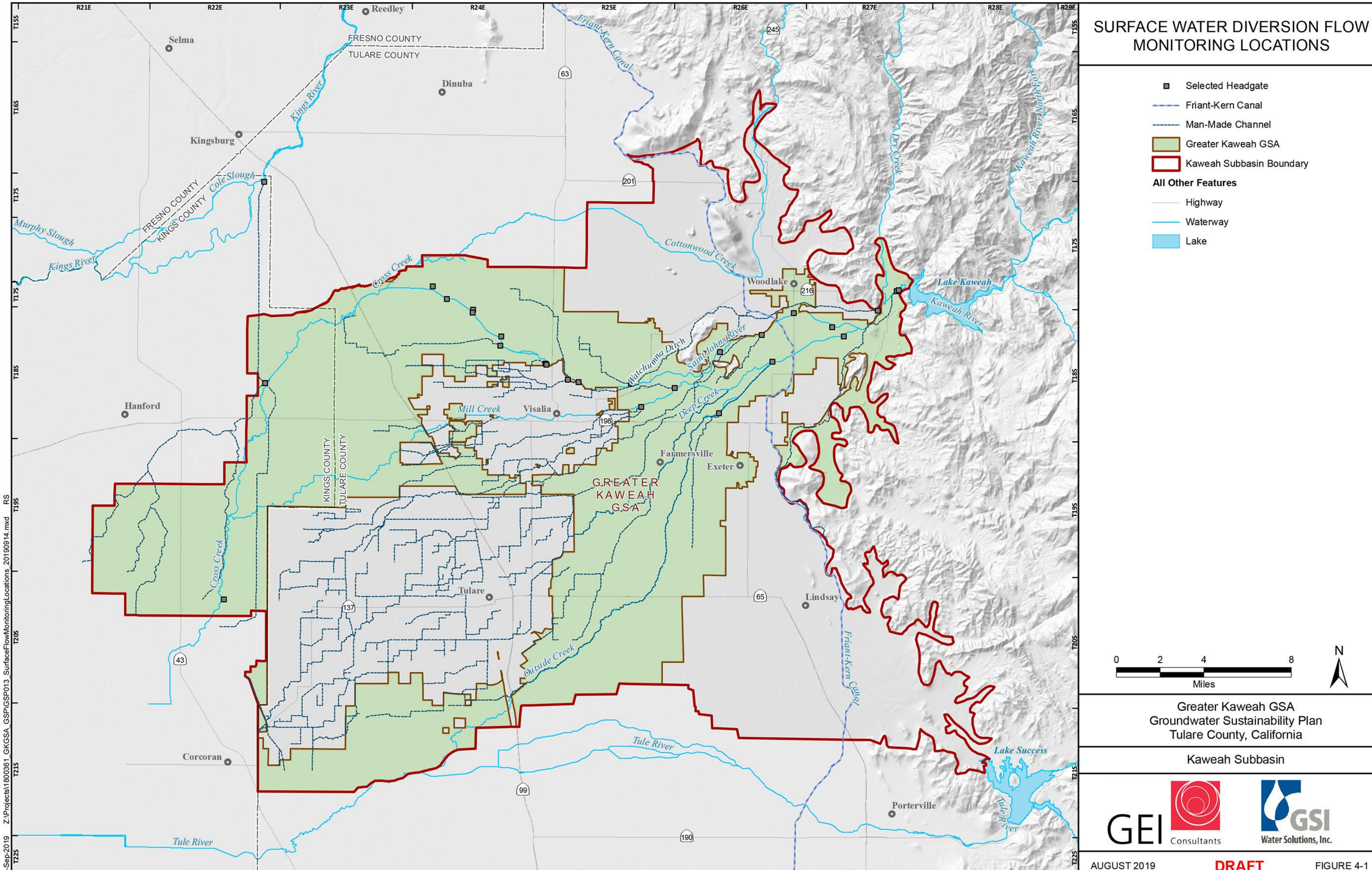


Figure 4-2: Surface Water Diversion Flow Monitoring Locations

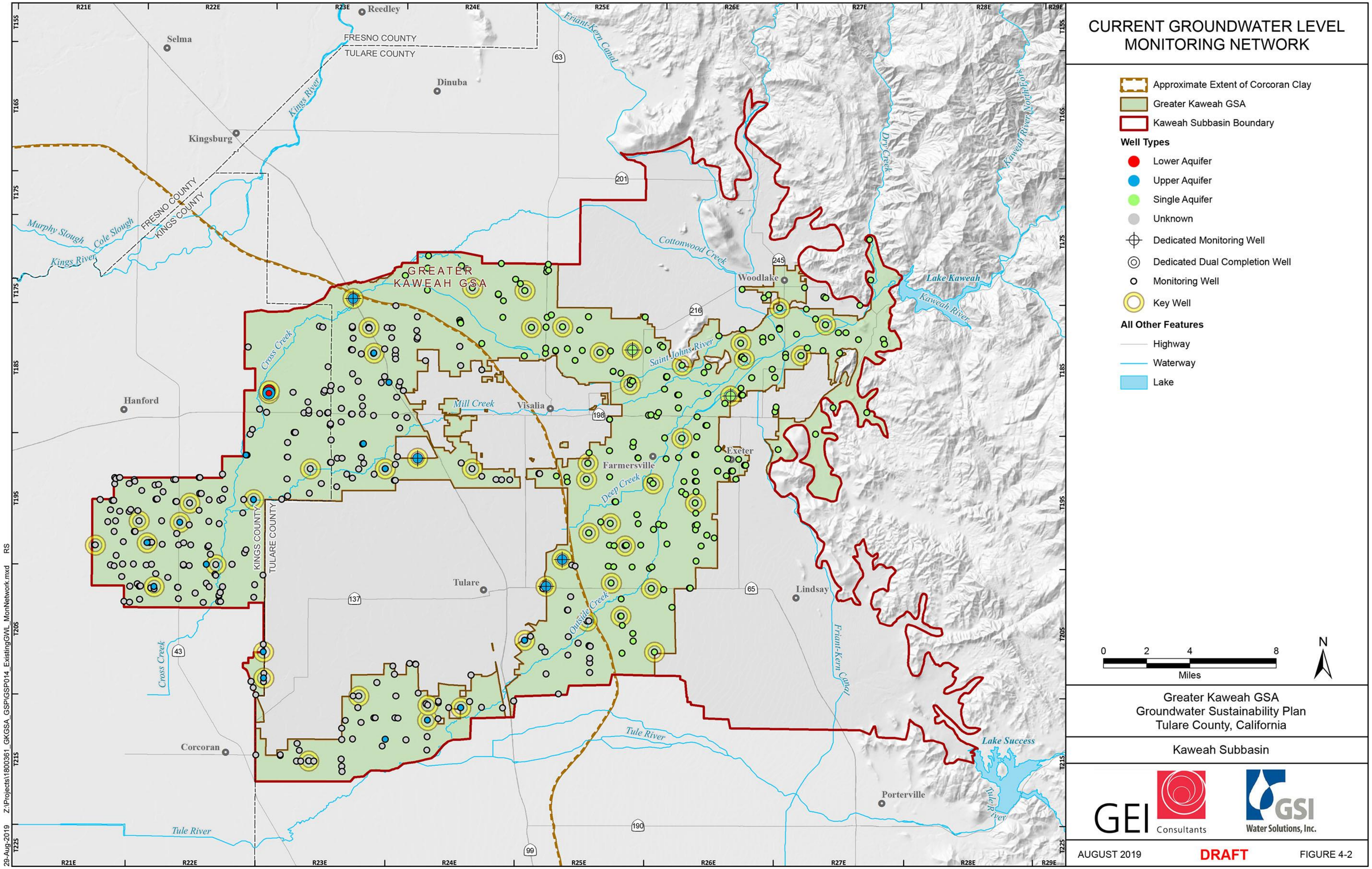


Figure 4-3: Current Groundwater Level Monitoring Network in the Kaweah Subbasin

Figure 4-4: Representative Monitoring Site for Groundwater Level Monitoring Network

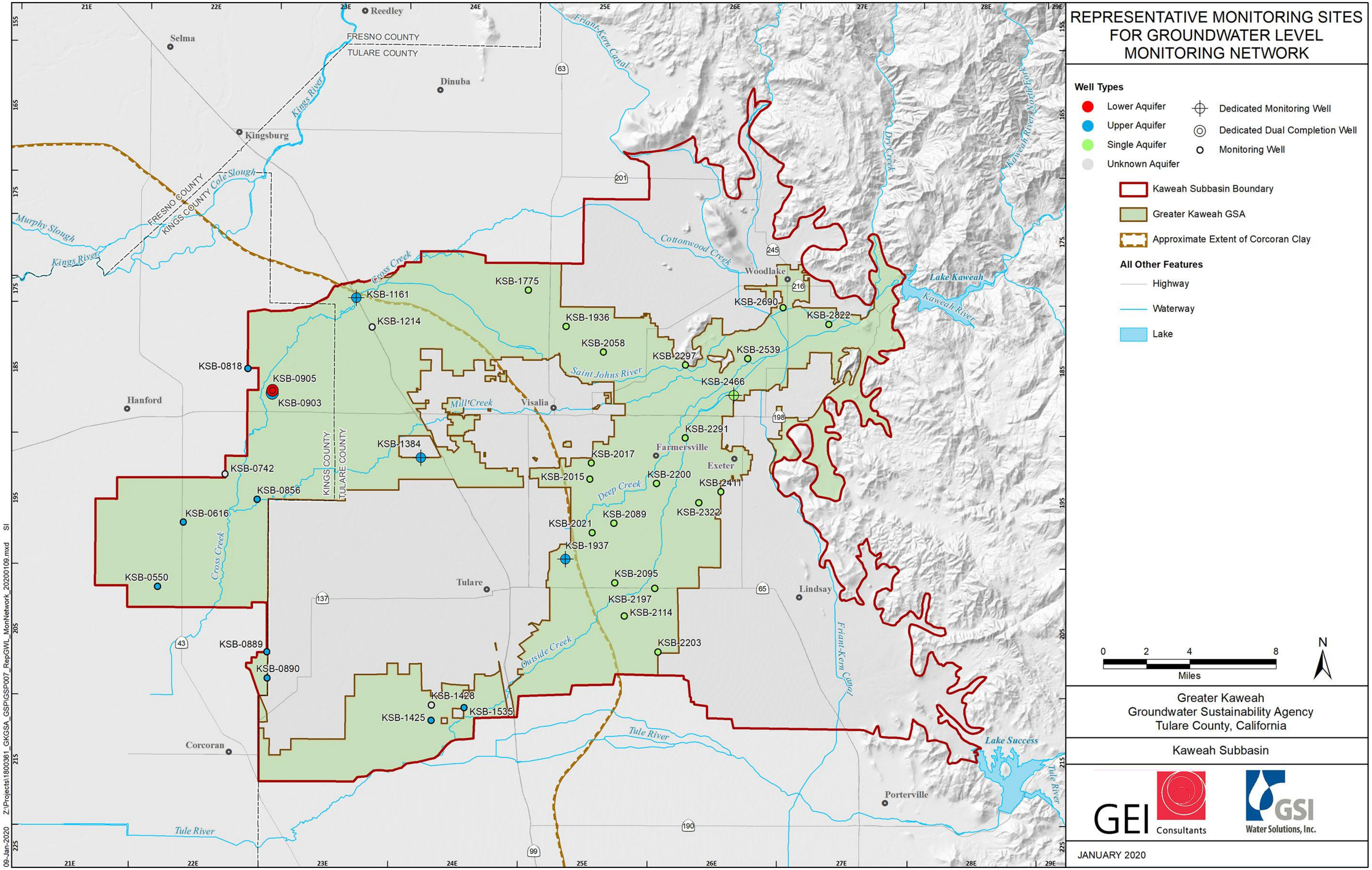
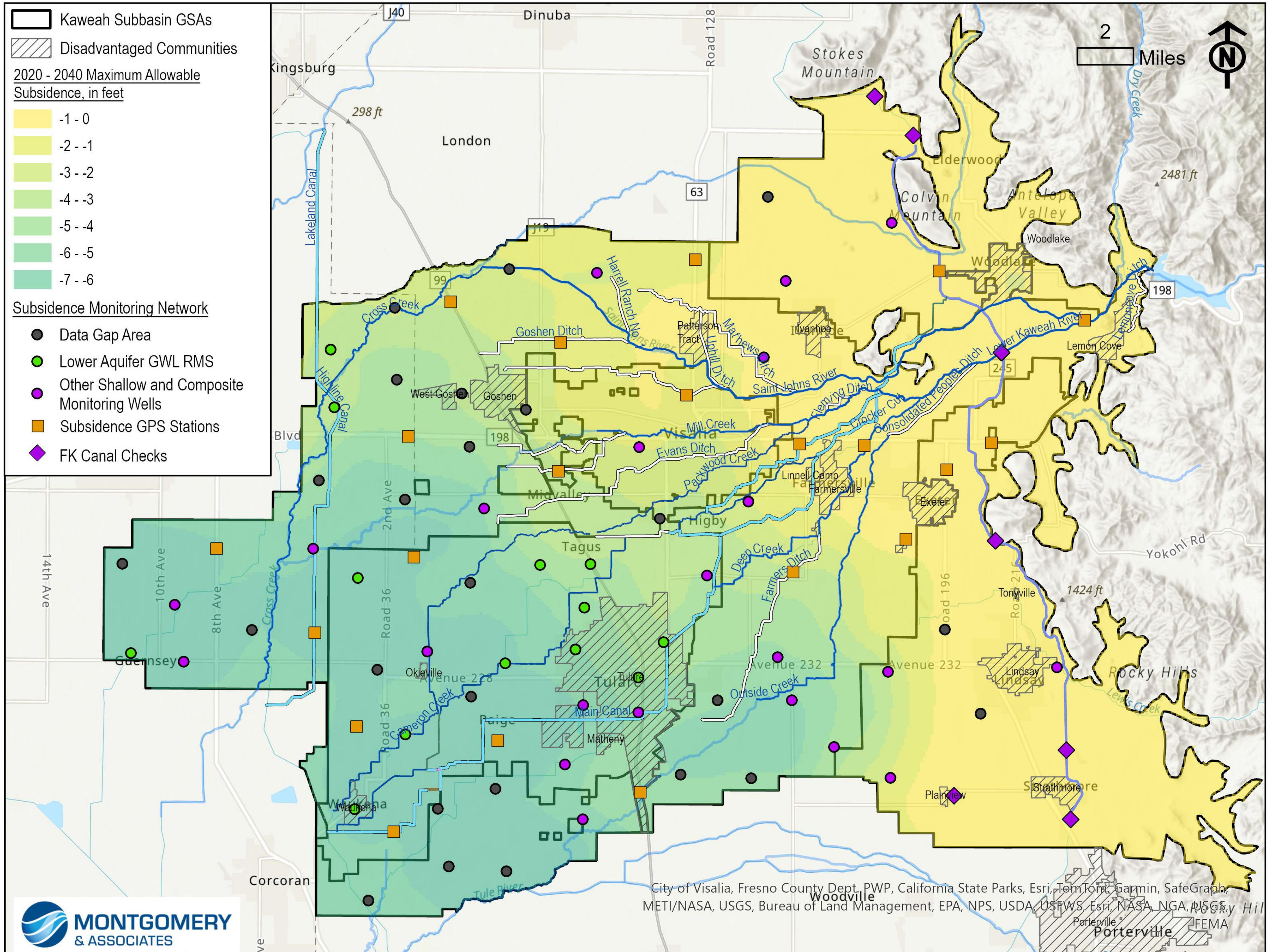


Figure 4-5: Kaweah Subbasin Subsidence Monitoring Network



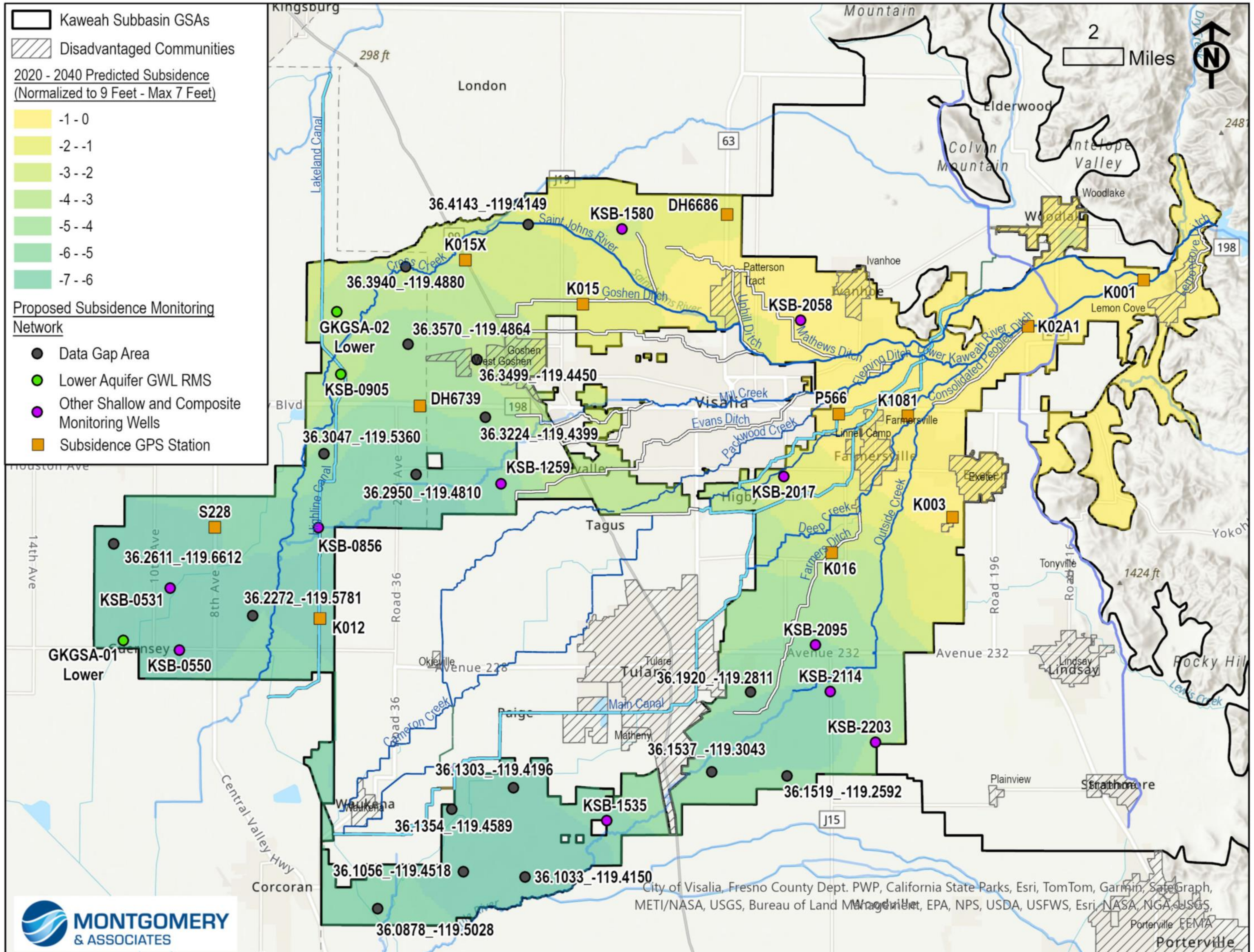


Figure 4-6: Greater Kaweah GSA Subbasin Subsidence Representative Monitoring Network

Figure 4-7: Public Water System Water Quality Monitoring Network

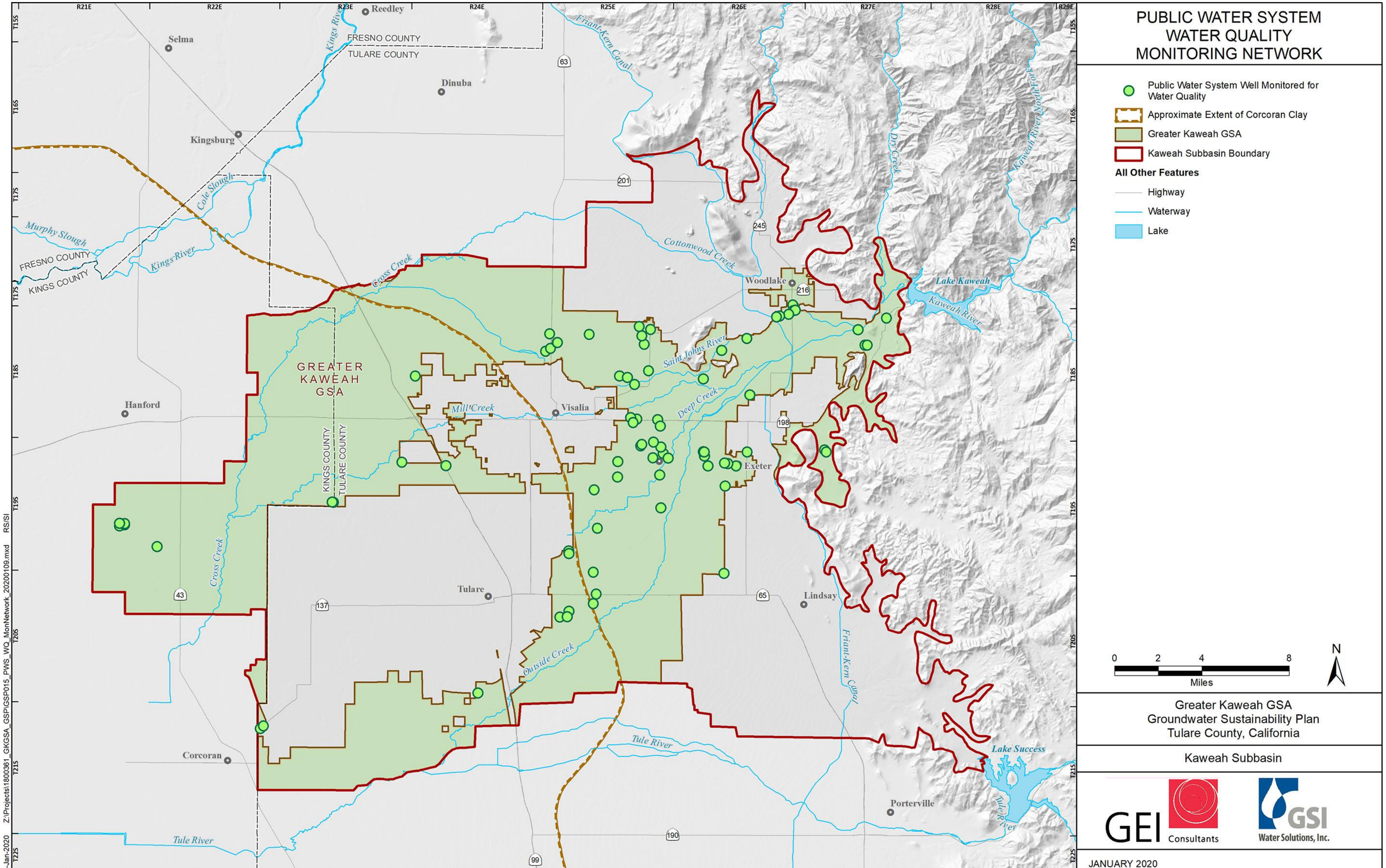
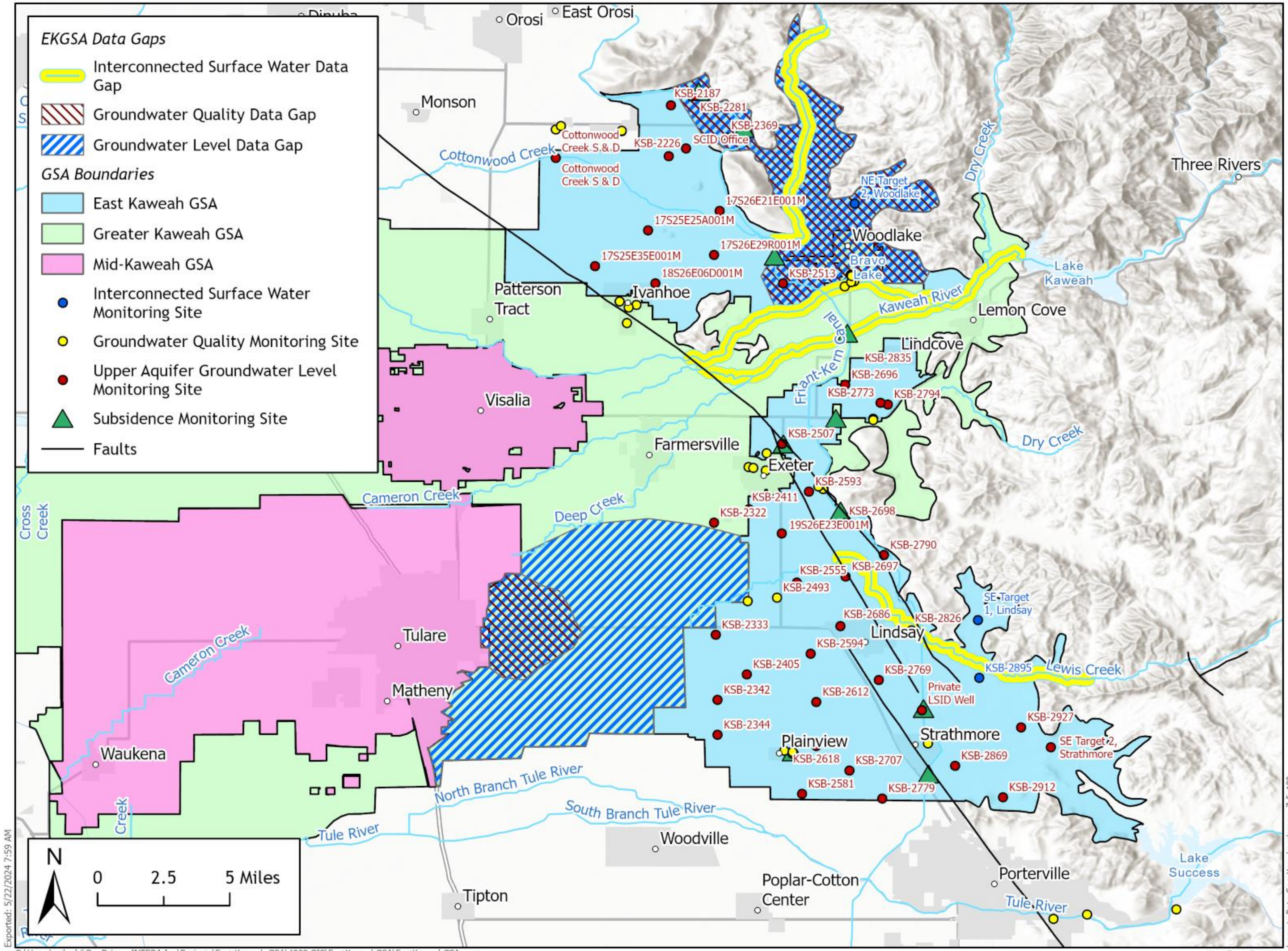


Figure 4-8: Greater Kaweah Groundwater Sustainability Agency Monitoring Data Gaps



5 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.

This section provides location-specific sustainable management criteria (SMC) for the five applicable sustainability indicators, including the definition of undesirable results (URs), minimum thresholds (MTs), interim milestones (IMs), and MOs (MOs). This section builds from the Kaweah Subbasin's sustainability goal described in Section 5.2 and is consistent with Appendix 6 of the Coordination Agreement (Appendix 1B).

The overall goal of SGMA is to achieve sustainable management of groundwater basins. To meet this goal, the Kaweah Subbasin GSAs have established SMC to reach sustainability by 2040. Demonstration of the absence of URs 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 URs within the initial 20-year implementation period does not by itself, indicate that the Subbasin is not being managed sustainably.

The Kaweah Subbasin's strategy is to manage, through the implementation of management actions and projects, to the MO to achieve the sustainability goal. More information on this strategy and confidence in achieving it is the specific demand management policies, projects, and other proactive measures are available in Chapter 6 of the 2nd Amended GSPs.

5.1 Introduction [§354.22]

§354.22 Introduction to Sustainable Management Criteria.

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 URs. Thus, the avoidance of URs, defined later in this chapter, is vital to the success of this GSP. The purpose of this section is to define various SMC by stating the sustainability goal for the Kaweah Subbasin, defining URs, and establishing the MTs, IMs, and MOs for each applicable sustainability indicator. A thorough understanding of the historical, current and future groundwater conditions of the Subbasin is necessary to properly define SMC, therefore, development of the criteria is dependent on basin information presented in the hydrogeologic conceptual model, groundwater conditions, and water budget sections of the GKGSA GSP (Chapter 3).

The SMC methodology and approach are shown in Figure 5-1 and a summary of the definitions and qualitative and quantitative functions of the SMC is available in Figure 5-2.

Seven appendices contain supplemental information on the process, analyses, and results that informed the revisions to the SMC for chronic lowering of groundwater levels and land subsidence for this 2nd Amended GSP. These appendices are considered extensions of Chapter 5:

1. **Appendix 5A** – Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage SMC Technical Memorandum
2. **Appendix 5B** – Land Subsidence and Lower Aquifer Chronic Lowering of Groundwater Level SMC Development Process for the Kaweah Subbasin
3. **Appendix 5C** – Groundwater Level SMC Hydrographs
4. **Appendix 5D** – Development and Use of A One-Dimensional Land Subsidence Model for the Kaweah Subbasin Technical Memorandum
5. **Appendix 5E** - Projected Conditions Hydrographs
6. **Appendix 5F** – Development of the Relationship Between Modeled Aquifer Storage and Regional Groundwater Elevations

The process and analyses vary for each sustainability indicator's SMC development; however, the general methodology remains consistent with the goal of avoiding significant and unreasonable effects to beneficial uses and users of groundwater in the subbasin (Figure 5-1).

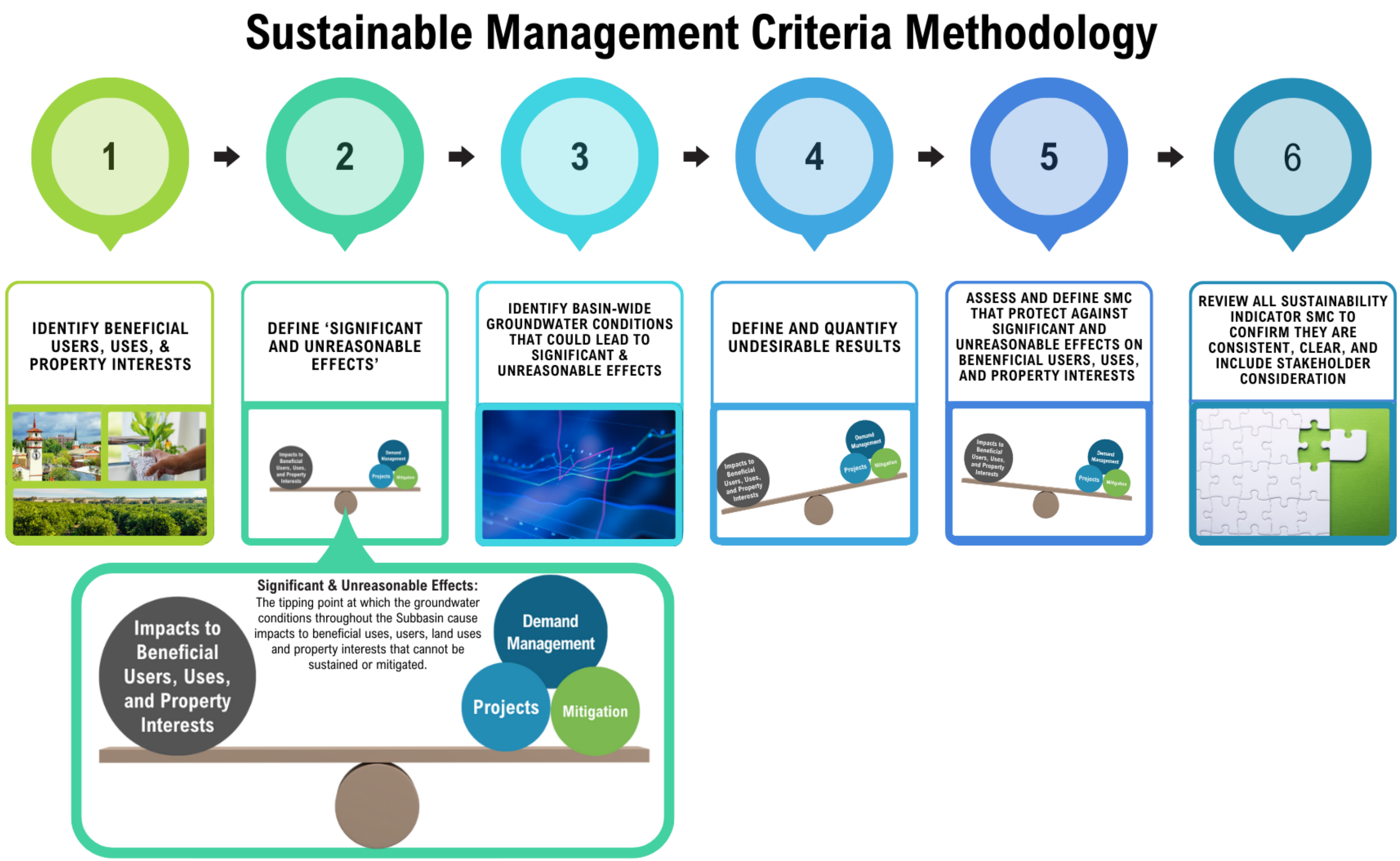


Figure 5-1 SMC Methodology and Approach

5.1.1 General Description of Undesirable Result

The Kaweah Subbasin carefully considered and determined the groundwater conditions at which each of the five applicable sustainability indicators exhibit significant and unreasonable effects. URs are considered to occur when any of the five applicable sustainability indicators exceed a combination of MTs. All UR descriptions presented in this chapter are consistent with those presented within the Kaweah Subbasin Coordination Agreement (Appendix 1B). Further subsections describe the data and rationale used as justification for determining significant and unreasonable conditions which lead to URs 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, URs impacting beneficial uses and users in the subbasin;
- Criteria used to define when and where the effects of groundwater conditions cause URs;
- Quantification of URs via localized MT exceedances; and,
- Description of the potential effects of the UR on beneficial uses or users.

5.1.2 General Description of Minimum Thresholds [§354.28]

§354.30 Measurable Objectives.

(a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 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.
(g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for a finding of inadequacy of the Plan.

In addition to a qualitative description, each UR must also be substantiated using a quantitative combination of MT exceedances. A MT is a quantitative value that represents the groundwater conditions at a RMS that, when exceeded individually or in combination with MTs at other RMS, may cause UR(s) in the Subbasin. When setting the MT for each sustainability indicator, potential impacts to the relevant beneficial uses and users of groundwater were considered. In addition, the Kaweah Subbasin MTs were set at levels that do not impede adjacent GSAs or subbasins from avoiding their MTs or achieving their sustainability goals.

The following components are presented in each sustainability indicators' relevant MT section:

(1) The information and criteria relied upon to establish and justify the MTs for each sustainability indicator. The justification for the MT 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 MTs for each sustainability indicator, including an explanation of how the Kaweah Subbasin has determined that conditions for levels at each MT will avoid URs.
(3) How MTs have been selected to avoid causing URs in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.
(4) How MTs may potentially impact 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 MT differs from other regulatory standards, the Kaweah Subbasin GSAs will explain the nature and basis for the difference.
(6) How each MT will be quantitatively measured, consistent with monitoring network requirements.
(7) How SMC for one sustainability indicator may be used as a proxy for another sustainability indicator.
(8) Each of the sustainability indicators must be monitored for MT exceedances. However, based on the strong relationship between groundwater levels and changes in aquifer storage (i.e., rising groundwater levels indicate an increase in groundwater storage and vice versa), land subsidence (Lees et al., 2022)[7], and potentially, depletions of interconnected surface water, whichever indicator is the most sensitive to groundwater level reduction will be the limiting MT for groundwater conditions in that threshold region. Given the specific hydrogeology of the GKGSA and limited data for interconnected surface water depletions, groundwater levels are determined at this time to be the most sensitive to potential MT exceedances and therefore, are the primary metric for determining URs within the Subbasin. In general, based on currently known information, groundwater level MT exceedances would be triggered prior to URs being experienced from surface water depletions, aquifer storage reductions, or land subsidence. Nonetheless, in addition to monitoring groundwater levels, the groundwater quality, potential interconnected surface water depletion rates, and land subsidence sustainability indicators will also be monitored separately.

5.1.3 General Description of Measurable Objectives

MOs are quantitative goals that reflect the desired groundwater conditions and allow the Kaweah Subbasin to achieve the sustainability goal within 20 years. MOs are set to allow for a reasonable

[7] Lees, M., Knight, R., Smith, R. (2022). Development and Application of a 1D Compaction Model to Understand 65 Years of Subsidence in the San Joaquin Valley. Water Resources Research. e2021WR031390. https://doi.org/10.1029/2021WR031390

margin of operational flexibility relative to the MT that provides accommodation for extended droughts, climate change factors, conjunctive use operations, and other groundwater management activities. The Kaweah Subbasin and GKGSA has developed a set of management actions and projects outlined in Chapter 6 that are intended to achieve sustainability in 2040 at the MO. Adjustment to the management actions and projects will be made accordingly during the implementation period to achieve sustainability in 2040 at the MO.

5.1.4 General Description of Interim Milestones

Five-year IMs for the GKGSA implementation timeline were designed to allow the GKGSA to track progress over time toward the sustainability goal and are presented for each sustainability indicator. Consistent with the Coordination Agreement (Appendix 1B), A summary of the URs, MTs, MOs, and IMs for each sustainability indicator is available in the below subsections.

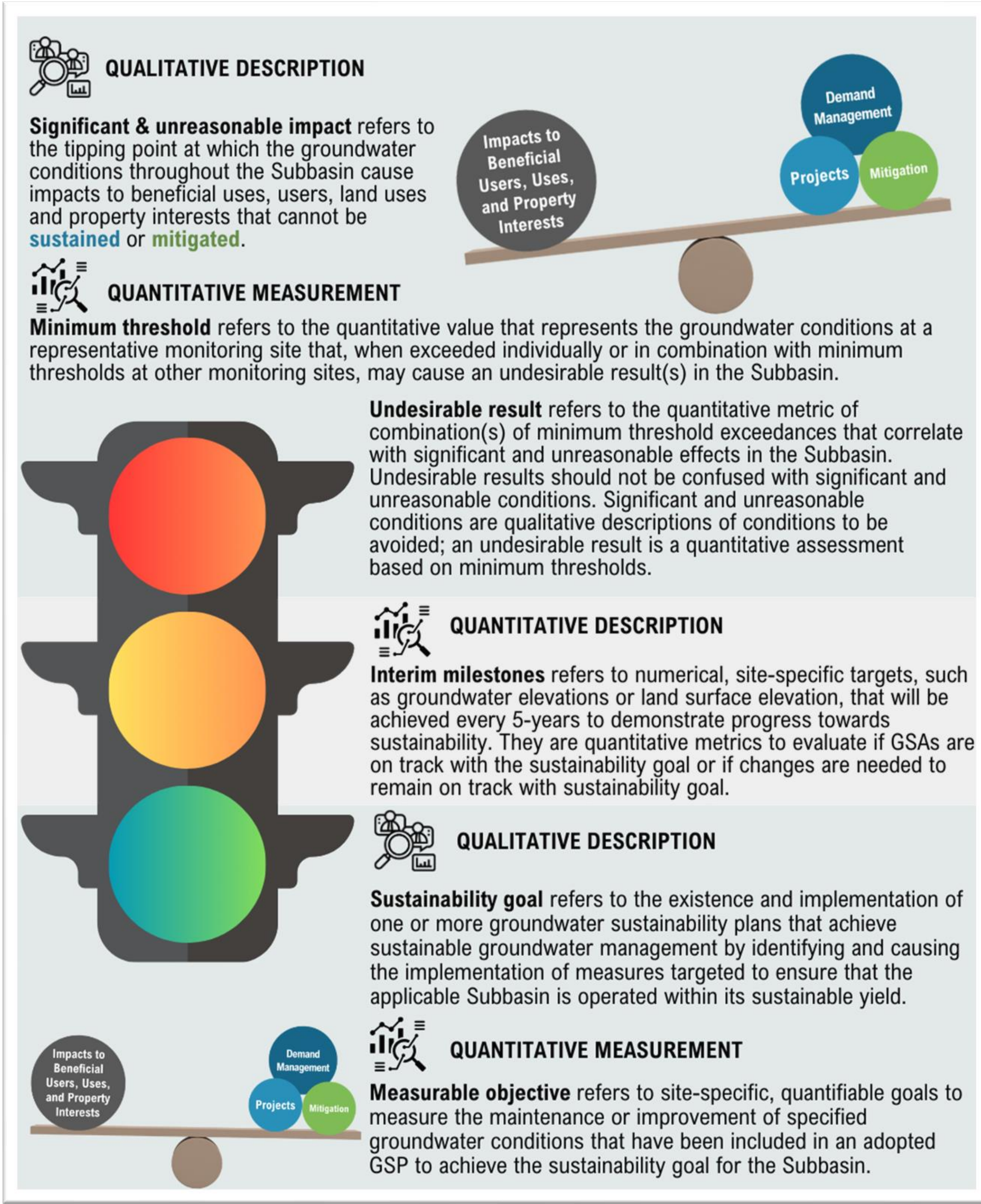


Figure 5-2 SMC Definitions & Functions

5.1.5 Sustainability Indicators Applicable in the Kaweah Subbasin

The applicability of sustainability indicators is described in Chapter 4 – Monitoring Network and summarized in Figure 5-3.

Figure 5-3 SGMA Sustainability Indicators

5.1.6 Potential Effects on Beneficial Users, Uses, and Property Interests by Sustainability Indicator

Figure 5-4 summarizes potential effects on beneficial uses, users, and property interests that are considered when establishing SMCs for the five applicable sustainability indicators.

5.1.7 Management Areas

Descriptions of each Management Area and their rationale for their formation are available in Section 3.6. The Management Areas in the Kaweah Subbasin do not have different SMC approaches and will not be operated to different MTs and MOs objectives than the Subbasin at large. Additionally, URs are defined consistently throughout the Subbasin.

Figure 5-4 Potential Effects on Beneficial Users, Uses, and Property Interests in the Kaweah Subbasin by Sustainability Indicator

5.2 Sustainability Goal [§354.24]

§354.24 Sustainability Goal.

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 Subbasin that culminates in the sustainable management of groundwater resources through the absence of URs within 20 years. The sustainability goal and bases for SMCs were coordinated across the Kaweah Subbasin GSAs. Consistent with the Coordination Agreement (Appendix 1B), and compliant with §354.24 of the Regulations and 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 [the Kaweah Subbasin area within] Tulare County and within portions of Kings County.

The sustainability goal will be achieved by:

- The implementation of the EKGSA, GKGSA and MKGSA GSPs which are designed to identify phased measures (projects and management actions) targeted to ensure that the groundwater resources of the Kaweah Subbasin are managed to avoid URs and achieve MOs by 2040.
- Collaboration with other agencies and entities to prevent chronic lowering of groundwater levels and reduction of groundwater storage, minimize land subsidence where significant and unreasonable, and address the degradation of water quality to protect the local beneficial uses and users of groundwater.
- Assessments of progress towards implementation via evaluation of Ims and benefits from implemented projects and management actions during annual reporting and each 5-year GSP update pursuant to SGMA.
- Continued implementation of projects and management actions by the three GSAs as appropriate through the planning and implementation horizon.

In order to achieve the sustainability goal, a combination of projects and management actions will be implemented over the course of the next 20 years. Understanding that projects take time and funding to construct, interim assessments at 5, 10, and 15 years were set to evaluate progress on the path for reaching the sustainability goal by 2040. As much of the overdraft as possible will be avoided by demand management derived from allocation policies as well as increased supply via projects. Any impacts to beneficial uses and users of groundwater that may occur on the path towards the sustainability goal are addressed via the Kaweah Subbasin Mitigation Program and GKGSA Mitigation Plan (see Chapter 6). GKGSA is managing to achieve the sustainability goal, as evidenced by the Water Accounting Framework (Section 6.7), and significant investments in groundwater sustainability and resiliency infrastructure (see Chapter 7, Table 7-1).

The key factor for the Kaweah Subbasin to meet the sustainability goal is to avoid URs. Significant and unreasonable effects that lead to URs are further discussed in the next section. Within the GKGSA, notable correlation has been developed between the chronic lowering of groundwater levels and the significant and unreasonable effects from reduction of groundwater in storage, and land subsidence sustainability indicators. Therefore, maintaining groundwater levels at the defined SMC is the primary mechanism to avoid URs and sustainability will be achieved by eliminating overdraft through pumping restrictions (i.e., allocations), storing more groundwater (via managed recharge projects), and establishing new water banking facilities.

5.3 General Process for Establishing Sustainable Management Criteria [§354.26(a)]

> §354.26 Undesirable Results.
>
> (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.

5.3.1 SMC Revision Priorities

The SMC presented in this GSP have been revised from previous versions of GSPs to meet regulatory requirements under SGMA.

Preparation of this 2nd Amended GSP and its supporting analyses and documentation was conducted in 2023 and early 2024, before the draft Staff Report released in May 2024. Even though the draft Staff Report was released before publication of this document, given the completion rate of the GSP and the lack of a final Staff Report, publication of the GSPs continued without incorporating the comments from the draft Staff. Therefore, the only deficiencies and recommendations that the Kaweah Subbasins have available and are directed to address are DWR's deficiencies. The Kaweah Subbasin GSAs will collaborate with the SWRCB to address any additional supplemental recommendations from the SWRCB staff in accordance with the stakeholder feedback process described in Section 5.3.2.

Priorities for establishing the revised SMC are summarized in Figure 5-6 and more information on the general process to establish revised SMC is available in Figure 5-1.

Figure 5-5 Kaweah Subbasin SMC Revision Priority Considerations

5.3.2 Stakeholder Feedback Process

In general, SMC for each sustainability indicator are determined using a data-informed, Subbasin-wide coordinated, and stakeholder-inclusive progress. Specifically, the GKGSA Technical Advisory Committee (TAC), Kaweah Subbasin Technical Team, "Core Teams", and Board of Directors (Board) carefully considered when the five sustainability indicators applicable to the GKGSA would reach levels that were "significant and unreasonable" conditions and what conditions would be sustainable based upon the quantitative data presented in the investigative analyses on impacts to beneficial users and uses. **Figure 5-** includes a chart that summarizes the stakeholder and technical process nexus.

The GSA Board, in combination with stakeholder input, TAC, Advisory Committee, and Core Team expertise ultimately determined the definition of URs based upon the relative levels that would have a significant and unreasonable negative impact to communities with the Kaweah Subbasin, historical and biological quality of life, and that would also severely threaten regional agricultural economy and impact the world's food chain supply.

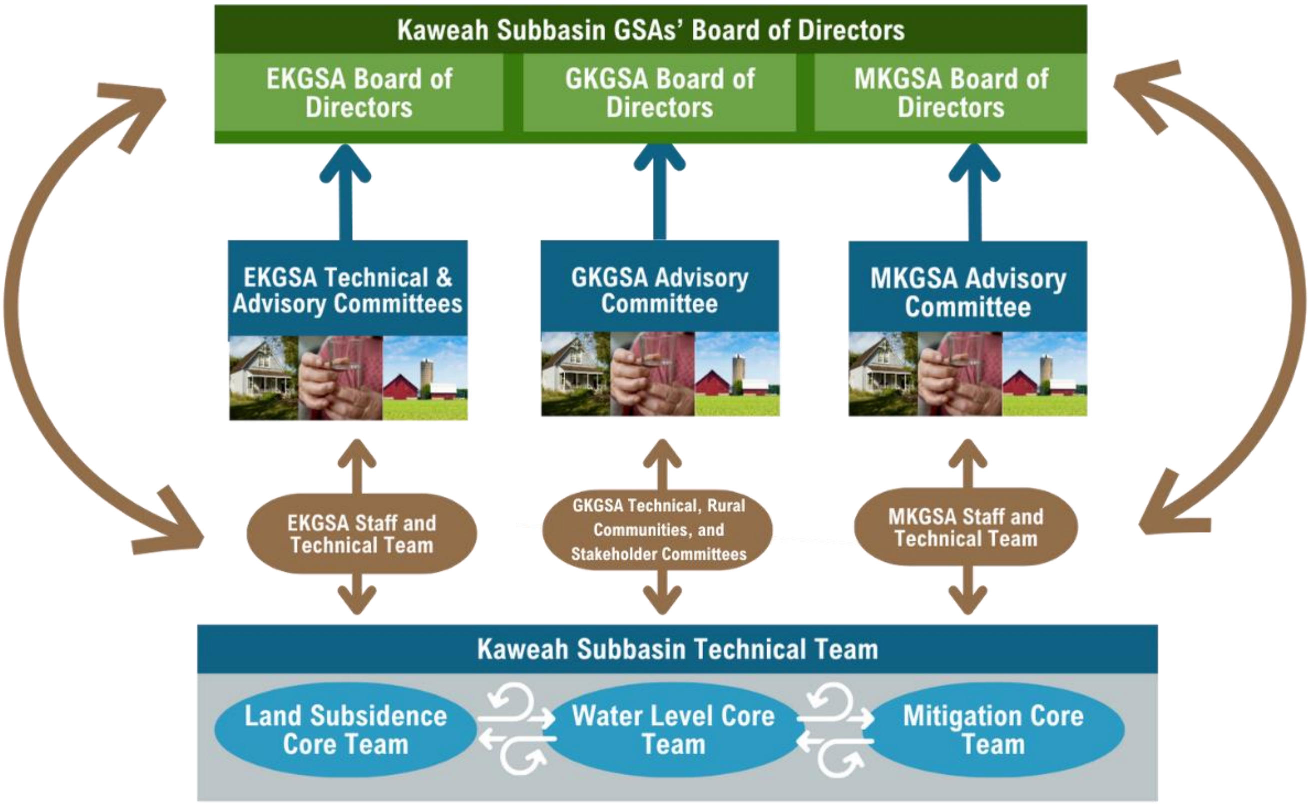


Figure 5-6 Kaweah Subbasin Stakeholder & Technical Feedback to Revise SMC

5.4 Sustainable Management Criteria Summary [§354.26(b)(1),(2),(3)]

§354.26 Undesirable Results.

(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.

Table 5-1 provides a summary of the SMC for each of the applicable sustainability indicators. This GSP is designed to avoid URs by achieving the sustainability goal within 20 years, along with progress toward reaching IMs every 5 years. Management actions and projects provide sufficient options for reaching MOs within 20 years and maintaining those conditions for 30 years for all applicable sustainability indicators. The rationale and background for developing these criteria are provided in detail in the following sections.

The SMC presented in Table 5-1 are part of the Kaweah Subbasin's 50-year management plan: SGMA allows for 20 years to reach sustainability and requires the Subbasin have no URs for the subsequent 30 years. Note, the SMC presented in this GSP have been developed using the best available data and science and may require revision in the future as more data are collected and the Kaweah Subbasin Groundwater Flow Model can be used to improve the understanding of the groundwater conditions under different climate scenarios and operational conditions (see Section 5.5.5)

Use of Proxy SMC

- There is a significant correlation between groundwater levels and aquifer storage. The Kaweah Subbasin is utilizing groundwater levels as a proxy metric for aquifer storage.

- For land subsidence, the Kaweah Subbasin is using a rate of land subsidence that avoids impacts to critical infrastructure. Lower aquifer groundwater management is directly correlated with land subsidence; therefore, lower aquifer SMC are established as the groundwater elevation that is consistent with SMC for land subsidence.

- In the future, interconnected surface water will be evaluated using a rate of surface water depletion in interconnected channels; however, surface water flow data is limited and is a data gap that the Kaweah Subbasin GSAs are actively working to fill. In the interim, groundwater level data is being collected near potentially interconnected streams in EKGSA and monitored in conjunction with the upper aquifer groundwater level monitoring. The DWR determination letter sent to the Kaweah Subbasin in March 2023 included deficiencies and the Department's recommendations on how to address them. In the case of interconnected surface water, the GSAs were advised to utilize the depletions of interconnected surface water Guidance Document when it becomes available. At this time, the Guidance Document has not been released by DWR. In the interim, groundwater levels are not used as a proxy for establishing SMC for depletions of interconnected surface water; however, this may be considered in the future pending recommendations from DWR's Guidance Document.

Table 5-1 Kaweah Subbasin SMC General Summary

	Chronic Lowering of Groundwater Levels	Reduction in Groundwater Storage	Degraded Groundwater Quality	Land Subsidence	Depletions of Interconnected Surface Water
Measurement	Groundwater elevations derived from measured depth to groundwater at RMS	Groundwater levels are used as a proxy for the reduction in groundwater storage.	Groundwater quality analysis from samples collected by the GSA or other public agencies	Total subsidence measured at RMS using DWR provided InSAR data	Groundwater elevations from measured depth, available surface water presence and flow data, aerial imagery. *interconnected surface water monitoring remains a data gap, see more information on the Interconnected Surface Water Data Gap Workplan in Section 6.
UR	**Upper Aquifer:** 1. If more than 20 RMS wells in the Kaweah Subbasin exceed their minimum threshold in any given year; AND 2. More than 30 domestic wells in the Kaweah Subbasin are impacted by overdraft and require mitigation in any given year. OR 3. If a GSA is unable to meet mitigation needs. **Lower Aquifer:** A single groundwater level MT is exceeded AND The corresponding subsidence MT (cumulative OR rate) is exceeded at any RMS in the Kaweah Subbasin	Since groundwater levels are used as a proxy for storage, the URs for Reduction in Groundwater Storage match those for Chronic Lowering of Groundwater Levels	**Important Note:** SMCs for groundwater quality are in process of being revised in response to the SWRCB Draft Staff Report's new deficiencies received during the publishing process of this Public Draft GSP. Significant and unreasonable degraded water quality, including the migration of contaminant plumes caused by the management of groundwater resources which impair water supplies	When the cumulative subsidence MT is exceeded at any single RMS location.	**Important Note:** SMCs for interconnected surface are in process of being revised in response to the SWRCB Draft Staff Report's new deficiencies received during the publishing process of this Public Draft GSP. The Kaweah Subbasin GSAs are awaiting the Interconnected Surface Water Guidance Document from DWR to further inform revisions. Undefined currently due to data gaps. In the interim, the Kaweah Subbasin GSAs are evaluating GDE health from 2015 to the current conditions on an annual basis to assess potential for significant and unreasonable impacts via GDE Pulse 2.2, reviewing aerial imagery of annual conditions compared to baseline 2015 conditions, installing new monitoring wells, and further implementing the Interconnected Surface Water Data Gap Workplan.
MT	**Upper Aquifer:** MTs are set at a groundwater elevation at each RMS that is based on the GSAs collective ability to maintain groundwater supplies either through protective local supplies or through interim mitigation measures	Groundwater levels are used as a proxy for groundwater storage MTs	MCL or Agricultural WQO, whichever is applicable based on the predominant land use around the RMS	Maximum subsidence limited to 7 feet, Average subsidence = 3.1 feet to be	MO rationale varies by GSA based on (1) the presence of potential ISWs and (2) what data and information is available for the potentially interconnected waterways (with consideration for the significant surface water flow data gap). Efforts are being made by EKGSA and GKGSA

	(when necessary) during the implementation period. **Lower Aquifer:** MTs are based on the groundwater elevation that correlates with the subsidence MT at each specific RMS. These MTs are also protective of groundwater supplies in the lower aquifer.			protective of beneficial users, uses, and land uses (varies by RMS location)	(where potential interconnected waterways are present) to implement the Interconnected Surface Water Data Gap Workplan to form more meaningful MT in the future.
MO	**Upper Aquifer:** Established to allow reasonable operational flexibility and to be consistent with groundwater conditions necessary to achieve the conditions described in the Kaweah Subbasin's sustainability goal. In areas with limited saturated thickness due to shallow bedrock (against the mountain front), the MOs were set at Spring 2017 groundwater levels. The groundwater levels west of this region were set at half the decline rate used for the basis of the minimum threshold. Between these areas, a multi-mile transitional area is included to smooth the gradient between the two water level criteria to provide hydrogeological plausible gradients from east to west. This is expected to be updated with the Groundwater Flow Model, when available. **Lower Aquifer:** MOs are based on pre-SGMA Fall 2012 lower aquifer groundwater levels.	Groundwater levels are used as a proxy for groundwater storage MOs	75% of the MT	0 feet per year of subsidence.	MO rationale varies by GSA based on (1) the presence of potential ISWs and (2) what data and information is available for the potentially interconnected waterways (with consideration for the significant surface water flow data gap). Efforts are being made by EKGSA and GKGSA (where potential interconnected waterways are present) to implement the Interconnected Surface Water Data Gap Workplan to form more meaningful MT in the future.

5.5 Chronic Lowering of Groundwater Levels SMC [§354.28(c)(1)(A), (c)(1)(B),(C)(2)]

§354.28 Minimum Thresholds.

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:

(1) Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following: .

(A) The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.

(B) Potential effects on other sustainability indicators.

(2) Reduction of Groundwater Storage. The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.

Revised chronic lowering of groundwater levels are developed based on the best available science, input collected during the stakeholder process (Figure 5-6), coordination amongst the three GSAs' technical experts, and discussions with the SWRCB Staff.

The revised SMC methodology began by identifying all beneficial users, uses, and property interests of groundwater in the Kaweah Subbasin, then the risk of potentially impacting these users via a Dry Well Susceptibility Analysis (DWSA) was evaluated. The DWSA evaluated the potential risk of impairing domestic wells, agricultural wells, small community wells, and municipal wells' function under various groundwater level scenarios. More information on the DWSA, SMC methodology, and rationale for SMC are available in the subsections below and in Table 5-2.

Table 5-2 Groundwater Level and Storage SMC Appendices

Appendix 5A	Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage SMC Technical Memorandum	Describes the considerations, approach, analyses, and results involved in the establishment of upper aquifer SMC for the chronic lowering of groundwater level and reduction of groundwater storage sustainability indicators
Appendix 5B	Land Subsidence and Lower Aquifer Chronic Lowering of Groundwater Level SMC Development Process for the Kaweah Subbasin	Describes the land subsidence critical infrastructure impact analysis and correlated groundwater levels that are the basis of the lower aquifer SMC for the chronic lowering of groundwater level and reduction of groundwater storage sustainability indicators.

Appendix 5C	Groundwater Level SMC Hydrographs	Includes annotated hydrographs for all groundwater level RMS with the MTs, MOs and IMs.
Appendix 5D	Development and Use of A 1-D Land Subsidence Model for the Kaweah Subbasin	Describes the land subsidence critical infrastructure impact analysis used to inform the land subsidence SMC.
Appendix 5E	Groundwater Levels and Water Quality Correlation Analysis	Describes and presents results of an analysis assessing the relationship between groundwater levels and groundwater quality
Appendix 5F	Projected Hydrographs	Includes annotated hydrographs for all RMS projected through 2070.
Appendix 5G	Development of the Relationship Between Modeled Aquifer Storage and Regional Groundwater Elevations	Presents an analysis of groundwater levels with modeled basin groundwater storage for the unconfined aquifer, to help understand the range of the relationship between groundwater storage and average water levels

5.5.1 Groundwater Beneficial Uses and Users [§354.26(b)(3)]

The first step of the SMC approach (Figure 5-1) is to identify beneficial users, uses, and property interests. Beneficial uses, users, and property interests are identified in Section 2.7.1. Potential effects on beneficial uses induced by chronic lowering of groundwater levels and reduction in groundwater storage are summarized in Figure 5-4. GKGSA is managing to avoid these potential effects through significant changes in groundwater management, including allocations (groundwater pumping restrictions) limited to native yield and recharge activities (described more in Chapter 6).

In evaluating the potential effects of impacts related to chronic lowering of groundwater levels, it was determined that domestic drinking water wells are the most vulnerable beneficial user in the upper aquifer and single aquifer. The single aquifer area is defined as the area in which there is no aquifer separation by the Corcoran Clay. For simplification purposes, both the single aquifer and upper aquifer are referred to as “upper aquifer” herein this section. Based upon the determination of domestic wells being the most vulnerable beneficial user in the upper aquifer, the Kaweah Subbasin Technical Team and the WLCT developed a dry well susceptibility analysis DWSA, which formed the basis for defining upper aquifer groundwater level MTs.

During ongoing work, it was also identified that the lower aquifer in the Kaweah Subbasin would need to be evaluated independently of the upper aquifer in the Kaweah Subbasin. The lower aquifer MTs (which are based on land subsidence MTs) were also evaluated to ensure there were no potential impacts to domestic wells. The beneficial users, uses, and property interests most vulnerable to the chronic lowering of groundwater levels include those critical infrastructure and their users listed for land subsidence under Section 5.6.1.

5.5.2 Chronic Lowering of Groundwater Level Undesirable Results [§354.28(c)(2)]

As depicted in Figure 5-1, defining beneficial users, significant and unreasonable effects, and URs are critical first steps to establishing effective SMC.

5.5.2.1 Subbasin Defined Significant and Unreasonable Chronic Decline in Groundwater Levels [§354.26(b)(2)]

To locally define significant and unreasonable effects due to the chronic lowering of groundwater levels sustainability indicator, transparency with and involvement of stakeholders was critical in the development of the methodology and multiple iterations of the technical analyses involved (see Figure 5-6).

It is important to distinguish the role of SGMA in evaluating subbasin-wide challenges. Subbasins and their GSAs are asked to evaluate impacts on a subbasin-wide level to determine what constitutes significant and unreasonable effects that could lead to URs. The Kaweah Subbasin GSAs recognize the importance of also addressing localized, individual impacts that may occur as the Subbasin is working towards achieving and maintaining sustainability. The Kaweah Subbasin developed a Mitigation Program and GSA-specific Mitigation Plans which are intended to address these individual impacts on the path to achieving sustainability.

The undesirable result is a quantitative reflection of significant and unreasonable effects occurring subbasin-wide. The Kaweah Subbasin has defined significant and unreasonable effects as:

The tipping point at which groundwater conditions across the Kaweah Subbasin, cause impacts to beneficial users, uses, and property interests, that cannot be sustained or mitigated.

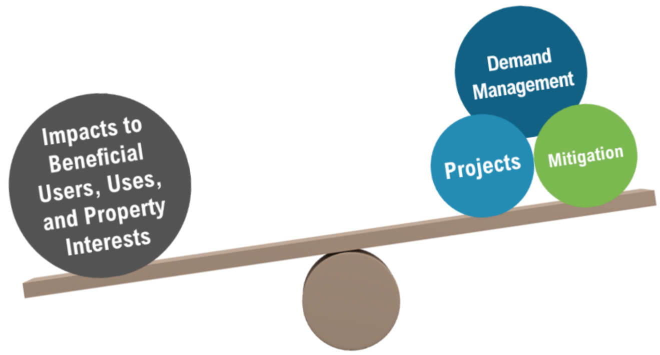


Figure 5-7 Analogy Diagram of Significant and Unreasonable Effects

In the case of chronic lowering of groundwater levels and reduction in storage, this may include the number of domestic wells impacted which exceeds the GSAs' mitigation budgets, community water systems unable to meet their supplies, or supply wells in areas of limited saturated thickness that are unable to meet demands or cannot drill deeper with technical assistance awarded via the GSA's Mitigation Plan. As stated, the Kaweah Subbasin's revised SMC in this 2nd Amended GSP and recent changes in demand management policies are designed to achieve the sustainability goal and avoid URs. The prevention of significant and unreasonable effects is a correlated outcome of this strategy.

5.5.2.2 Significant and Unreasonable Impacts on the Most Sensitive Beneficial Uses and Users

Kaweah Subbasin's beneficial uses, users, and property interests are listed in Section 2.7.1. The vulnerability of these groups to the potential impacts from chronic lowering of groundwater levels and reduction in groundwater storage varies based on the depths at which the wells are constructed. In the Kaweah Subbasin, domestic wells are often drilled to more shallow depths than agricultural wells. Therefore, as groundwater levels are lowered, the first wells to be impacted are the shallower domestic wells. GKGSA will continue to closely monitor the potential risks of impacts to shallow domestic wells and is committed to improving the capabilities of appropriately notifying landowners of well impacts through the Well Registration Program. This Program is intended to gather well construction information and contact information needed to meaningfully evaluate well-specific risks and notify the landowner when appropriate (see description in Chapter 6). In addition to supporting early notification, all the gathered information on domestic wells and their potential risks will be evaluated by the GSA to annually reassess the SMC, demand management policies, and available options to avoid localized, individual impacts. The GSAs have an ethical and financial interest in this reassessment protocol – it is more affordable for the GSA to be proactive and avoid the need for mitigation than to retroactively mitigate. Significant and unreasonable effects on the beneficial uses, users and property interests include:

- Individual Impact: any domestic well unable to supply safe drinking water to a household due to lowering of groundwater levels/reduction in groundwater storage.
- Significant and Unreasonable Effect: the number of impacted domestic wells exceeds the GSA's mitigation budget's capacity.
- Individual Impact: A small community groundwater production system is unable to supply safe drinking water to connected households due to the lowering of groundwater levels/reduction in groundwater storage.
  - Significant and Unreasonable Effect: the proactive measures, technical assistance, and groundwater management policies initiated by the GSA in accordance with the Mitigation Program are not sufficient to avoid impairments in production for a small community systems.

5.5.2.3 Significant and Unreasonable Impacts on Other Beneficial Uses and Users

In the case of other beneficial users, uses, and property interests, including agricultural, industrial, municipal, commercial, and other production well types, these wells are generally drilled deeper than domestic and small community wells in the Kaweah Subbasin. Therefore, they are less vulnerable to impacts from the lowering of groundwater levels than those discussed in **SECTION 5.5.1**. Significant and unreasonable effects on these beneficial uses, users and property interests include:

- Individual Impact: An agricultural well is unable to meet intended demand due to the lowering of groundwater levels/reduction in groundwater storage.
  - Significant and Unreasonable Effect: the count of impacted agricultural wells exceeds the GSA Mitigation Plan's technical assistance budget's capacity.
- Individual Impact: A municipal or commercial well is unable to supply drinking water to connected households due to the lowering of groundwater levels/reduction in groundwater storage and is unable to use their backup well(s) to supply drinking water.
  - Significant and Unreasonable Effect: the proactive measures, technical assistance, and groundwater management policies initiated by the GSA in accordance with the Mitigation Program are not sufficient to avoid or mitigate impairments in production for municipal/commercial supplies.

- Individual Impact: An industrial well is unable to meet intended demand due to the lowering of groundwater levels/reduction in groundwater storage.
    - Significant and Unreasonable Effect: the count of impacted industrial wells exceeds the GSA Mitigation Plan's technical assistance budget's capacity.

It is important to note that if these agricultural, industrial, municipal, or commercial wells are pumping more than their pro rata share of the native yield, then they are contributing to overdraft and will not qualify for mitigation support. Each GSA may evaluate extending mitigation support and/or technical assistance for non-qualifying claims on a case-by-case basis. The reason for this distinction is to avoid the need to drill deeper and/or reward unsustainable groundwater use.

5.5.2.4 Significant and Unreasonable Impacts on Neighboring Subbasins

The Kaweah Subbasin has coordinated with neighboring subbasins' draft revised SMC to avoid inconsistencies and interbasin groundwater management challenges. Significant and unreasonable effects induced by Kaweah Subbasin groundwater management on neighboring subbasins include:

- Individual Impact: any drinking water well in a neighboring subbasin unable to supply safe drinking water to a household due to the lowering of groundwater levels/reduction in groundwater storage induced by Kaweah Subbasin groundwater management.
    - Significant and Unreasonable Effect: the number of drinking water wells in an adjacent subbasin impacted by Kaweah Subbasin groundwater management exceeds the neighboring subbasins mitigation budget's capacity.

5.5.2.5 Summary of Significant and Unreasonable Effects

The individual impacts and significant and unreasonable effects by beneficial user are summarized in Table 5-3.

Table 5-3 Summary of Individual Impacts vs. Significant and Unreasonable Chronic Lowering of Groundwater Level Impacts

Beneficial User	Individual Impact	Significant & Unreasonable Impact
Domestic Wells	Any domestic unable to supply safe drinking water to a household due to the lowering of groundwater levels/reduction in groundwater storage.	The number of impacted domestic wells exceeds the GSA's mitigation budget's capacity.
Small Community Wells	Small community groundwater production system unable to supply safe drinking water to connected households due to the lowering of groundwater levels/reduction in groundwater storage.	The proactive measures, technical assistance, and groundwater management policies initiated by the GSA in accordance with the Mitigation Program are not sufficient to avoid or mitigate impairments in production for a small community system.
Agricultural Wells	An agricultural well is unable to meet the intended demand due to the lowering of groundwater levels/reduction in groundwater storage.	The number of impacted agricultural wells exceeds the GSA Mitigation Plan's technical assistance budget's capacity.
Industrial	An industrial well is unable to meet the intended demand due to the lowering of groundwater levels/reduction in groundwater storage.	the number of impacted industrial wells exceeds the GSA Mitigation Plan's technical assistance budget's capacity.
Municipal/ Commercial Wells	A municipal or commercial well is unable to supply drinking water to connected households due to the lowering of groundwater levels/reduction in groundwater storage and is unable to use their backup well(s) to supply drinking water.	The proactive measures, technical assistance, and groundwater management policies initiated by the GSA in accordance with the Mitigation Program are not sufficient to avoid impairments in production for municipal/commercial supplies.

5.5.2.6 Criteria for Defining Chronic Lowering of Groundwater Levels Undesirable Results

By regulation, the undesirable result for the chronic lowering of groundwater levels is a quantitative combination of groundwater level MT exceedances. As per California Water Code 354.26I, multiple combinations of potential MTs were evaluated to assess whether undesirable results would occur based on different groundwater conditions. See the MTs subsection of this memorandum that details the methodology, analysis, and results associated with MT determinations. The primary criteria and metric to determine if undesirable results occur in the Subbasin is if the count of impacted domestic wells exceed the GSAs' ability to mitigate those impacts. Domestic wells are the most vulnerable to groundwater level impacts because they are generally drilled shallower than other well types in the Kaweah Subbasin. Also, the loss of water in domestic wells results in homes that do not have potable water leaving homeowners without reliable water supplies. Therefore, by defining undesirable results to be protective of impacts to domestic wells, other beneficial users, uses, and property interests are also protected. An undesirable result in the Kaweah Subbasin's upper aquifer has been defined to be multi-layers to ensure protection of the most vulnerable groundwater users:

UR#1. If more than 17 upper aquifer RMS wells (17%) in the Kaweah Subbasin exceed their minimum threshold in any given year;

AND

UR#2. More than 30 domestic wells in the Kaweah Subbasin are impacted due to overdraft and require mitigation in any given year. If 30 wells require mitigation for multiple years, no more than 350 wells shall be impacted cumulatively by 2040;

OR

UR#3. If a GSA is unable to meet mitigation needs.

For **UR #1** above, the first metric of 17 RMS wells exceeding the MT spatially correlates on average to the number of potentially impacted domestic wells that a GSA can afford to mitigate in a single water year (i.e., approximately 60, based on the DWSA costing). The number of potentially impacted domestic wells per RMS, if groundwater levels are at the MT, is approximately 3, based on the spatial distribution of wells with available depth information (i.e., there are 102 RMS wells that have been designated for the upper aquifer (Table 5-4), and the DWSA determined that there are 350 potentially impacted domestic wells if groundwater levels reach the MT; hence, 350÷102=3.4); therefore, 60 potentially impacted domestic wells divided by 3.4 wells per RMS equals 17.6 RMS (i.e., greater than 17). At the time of developing this technical memorandum, 17 upper aquifer RMS wells equate to 17 percent of RMS wells in the Kaweah Subbasin's upper aquifer groundwater level representative monitoring network.

For **UR #2** above, the annual number of impacted domestic wells able to be mitigated is approximately 60; however, coordination of the GSAs and technical teams determined that a 50% safety factor should be applied for domestic impacts for an added level of security; therefore, 30 (50% of 60) impacted domestic wells was selected as a second quantitative measure for undesirable results. In summary, if both metrics in #1 are exceeded, it would indicate that sustainability planning and implementation is not sufficient and, therefore, is a UR. Alternatively, more than 17 RMS MT exceedances could also result in very few domestic well impacts; hence, the additional metric of 30 impacted domestic wells was included. A cumulative limit of 350 domestic well impacts during the plan implementation period (2024-2040) is included to ensure no more than 10% of the total domestic wells identified within the subbasin (3,543) are impacted. Undesirable result #2 was included to override #1 in the event that the available mitigation costs are exceeded if #1 does not occur.

UR #3 was included further protect the beneficial users by requiring the UR reflect a clear condition of significant and unreasonable effects in the Kaweah Subbasin. This undesirable result #3 was specifically included to serve as a protective measure in the event data uncertainty results in the projected potential impacts being undercounted. This circumstance is expected to be avoided via several protective assumptions built into the mitigation cost estimate, such as assuming maximum mitigation award for all claims and assuming all potentially impacted wells are/will be indeed impacted.

The metrics for undesirable results are intended to become more stringent over time, since after 2040 when the sustainability goal is reached, the need for mitigation is projected to be reduced to zero.

The definition of undesirable results, and all other SMC, may be revised in the future as lessons are learned through implementation of this 2nd Amended GSP and the Mitigation Program.

5.5.2.7 Potential Causes of Undesirable Results

Potential causes of URs related to the chronic lowering of groundwater levels includes the following:

- Prolonged periods of extracting groundwater in excess of the sustainable yield can lead to regional declines in groundwater levels in the Subbasin.
- Localized over pumping of groundwater can lead to declining groundwater levels in a subarea of the Subbasin, even if regional pumping is maintained within the sustainable yield. For example, a cluster (or pumping center) of high-capacity wells may cause excessive localized drawdown leading to significant and unreasonable effects to neighboring wells.
- Extreme drought (such as the 5-year drought observed in 2012-2016) and associated impacts on groundwater conditions due to a) curtailments of imported surface water supplies, b) reduction in natural recharge, and c) increased pumping to meet demands can lead to excessively low groundwater elevations and undesirable results. This becomes especially significant if groundwater levels do not rebound after the drought period is over or excessive subsidence occurs.
- Unsustainable groundwater management from neighboring subbasins leading to excessive underflow losses.

5.5.2.8 Effects on Beneficial Users and Uses

URs occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the Subbasin. The primary significant and unreasonable effects related to chronic lowering of groundwater levels on beneficial users includes significant loss of well capacity, increased costs due to higher pumping lifts, lack of groundwater extraction due to the groundwater levels declining below the pump setting depth or the bottom of the well, drying of domestic wells, significant reductions in GDEs as a result of declines in interconnected surface water due to nearby pumping, or subsidence impacts on well structures and above ground infrastructure (in the case of lower aquifer groundwater level decline). A breakdown of potential effects to beneficial uses and users in the Kaweah Subbasin by sustainability indicator is available in Figure 5-5.

5.5.3 Chronic Lowering of Groundwater Level MTs [§354.28(c)(1)(A)]

The MTs for the chronic lowering of groundwater level sustainability indicator are quantified as groundwater elevations at each RMS well dedicated to groundwater level monitoring (Chapter 4). Table 5-4 lists the SMC at each RMS well. Figures 5-8 and 5-10 are maps showing MTs at each representative monitoring site for the upper and lower aquifers, respectively.

The function of MTs is to provide a quantitative metric representative of significant and unreasonable effects that can be used by the GSAs to evaluate the potential for URs. The Kaweah Subbasin GSAs have established management policies that aim for groundwater levels to recover to the MO; however, the GSAs are prepared to mitigate impacts in the event they occur during prolonged drought conditions (which are reflected in the exceedance of MT(s). See Appendix 5A for more details on the process used to develop the SMC for the upper aquifer. Appendix 5B provides details on the process used to develop SMC for the land subsidence sustainability indicator which is the basis for the lower aquifer SMC.

Hydrographs for each RMS their respective SMC are provided in Appendix 5C.

Table 5-4 Chronic Lowering of Groundwater Levels MTs, MOs, and IMs

Representative Monitoring Site ID	GSA	Aquifer Designation	MT (WSE in feet)	MO (WSE in feet)	Operational Flexibility (feet)	IM 2025 (WSE in feet)	IM 2030 (WSE in feet)	IM 2035 (WSE in feet)
KSB-2107	East Kaweah	Single	159	212	53	165	197	207
KSB-2187	East Kaweah	Single	258	291	33	265	282	288
KSB-2196	East Kaweah	Single	222	255	33	229	246	252
KSB-2216	East Kaweah	Single	191	255	64	191	234	248
KSB-2226	East Kaweah	Single	214	285	71	264	278	282
KSB-2281	East Kaweah	Single	325	362	37	325	349	358
KSB-2327	East Kaweah	Single	274	326	53	309	321	325
KSB-2333	East Kaweah	Single	80	168	88	108	148	161
KSB-2342	East Kaweah	Single	69	173	104	101	149	165
KSB-2344	East Kaweah	Single	54	156	102	92	135	149

Representative Monitoring Site ID	GSA	Aquifer Designation	MT (WSE in feet)	MO (WSE in feet)	Operational Flexibility (feet)	IM 2025 (WSE in feet)	IM 2030 (WSE in feet)	IM 2035 (WSE in feet)
KSB-2354	East Kaweah	Single	321	348	27	321	339	345
KSB-2369	East Kaweah	Single	316	387	71	316	363	379
KSB-2405	East Kaweah	Single	77	187	110	120	165	179
KSB-2493	East Kaweah	Single	112	199	87	139	179	192
KSB-2507	East Kaweah	Upper	254	303	49	265	290	299
KSB-2510	East Kaweah	Single	162	201	38	174	192	198
KSB-2513	East Kaweah	Single	338	350	12	338	346	349
KSB-2555	East Kaweah	Single	129	211	82	145	189	204
KSB-2581	East Kaweah	Single	193	218	26	228	222	220
KSB-2593	East Kaweah	Single	219	246	27	219	237	243
KSB-2594	East Kaweah	Single	140	230	90	156	205	222
KSB-2612	East Kaweah	Single	147	246	99	165	219	237
KSB-2618	East Kaweah	Single	162	232	71	171	212	226
KSB-2686	East Kaweah	Single	159	250	90	173	224	241
KSB-2696	East Kaweah	Single	336	374	38	348	365	371
KSB-2697	East Kaweah	Single	170	241	71	170	217	233
KSB-2698	East Kaweah	Single	184	239	55	184	221	233
KSB-2707	East Kaweah	Single	200	232	32	227	230	231
KSB-2769	East Kaweah	Single	211	290	79	211	264	281
KSB-2773	East Kaweah	Single	336	379	42	358	372	376
KSB-2779	East Kaweah	Single	235	265	30	263	264	264
KSB-2790	East Kaweah	Single	183	276	93	189	247	267
KSB-2794	East Kaweah	Single	341	383	42	366	378	381
KSB-2826	East Kaweah	Single	246	336	90	246	306	326
KSB-2835	East Kaweah	Single	396	420	24	396	412	417
KSB-2869	East Kaweah	Single	305	337	32	313	329	334
KSB-2895	East Kaweah	Single	363	396	33	363	385	392
KSB-2912	East Kaweah	Single	346	400	55	346	382	394
KSB-2927	East Kaweah	Single	427	444	17	427	438	442
Private LSID Well	East Kaweah	Upper	277	335	57	277	316	329
SCID Office	East Kaweah	Single	250	298	48	269	289	295
GKGSA-01	Greater Kaweah	Lower	-60	-50	10	-60	-53	-51
GKGSA-02	Greater Kaweah	Lower	80	116	36	80	104	112
KSB-0531	Greater Kaweah	Upper	-39	-12	27	78	18	-2
KSB-0550	Greater Kaweah	Upper	-19	16	36	66	33	22
KSB-0616	Greater Kaweah	Upper	39	76	37	86	79	77
KSB-0742	Greater Kaweah	Upper	60	81	21	94	86	83
KSB-0818	Greater Kaweah	Upper	77	92	15	103	96	93
KSB-0856	Greater Kaweah	Upper	81	100	19	90	97	99

Representative Monitoring Site ID	GSA	Aquifer Designation	MT (WSE in feet)	MO (WSE in feet)	Operational Flexibility (feet)	IM 2025 (WSE in feet)	IM 2030 (WSE in feet)	IM 2035 (WSE in feet)
KSB-0889	Greater Kaweah	Upper	-4	16	20	37	23	18
KSB-0903	Greater Kaweah	Upper	126	140	14	126	135	138
KSB-0905	Greater Kaweah	Lower	20	58	38	20	45	54
KSB-1161	Greater Kaweah	Upper	129	144	15	149	146	144
KSB-1214	Greater Kaweah	Upper	135	154	18	140	149	152
KSB-1222	Greater Kaweah	Upper	116	131	15	134	132	131
KSB-1428	Greater Kaweah	Upper	45	75	31	65	72	74
KSB-1580	Greater Kaweah	Single	150	158	8	151	156	157
KSB-1775	Greater Kaweah	Single	139	155	17	148	153	155
KSB-1783	Greater Kaweah	Upper	1	25	24	54	35	29
KSB-1936	Greater Kaweah	Single	155	174	19	163	170	173
KSB-1937	Greater Kaweah	Upper	92	115	23	101	110	113
KSB-2015	Greater Kaweah	Single	133	164	31	172	166	165
KSB-2017	Greater Kaweah	Single	140	168	28	186	174	170
KSB-2021	Greater Kaweah	Single	112	134	22	144	137	135
KSB-2058	Greater Kaweah	Single	228	243	15	228	238	242
KSB-2089	Greater Kaweah	Single	131	156	26	156	156	156
KSB-2095	Greater Kaweah	Single	86	111	25	115	112	111
KSB-2114	Greater Kaweah	Single	80	104	24	106	105	104
KSB-2139	Greater Kaweah	Single	124	150	25	143	148	149
KSB-2147	Greater Kaweah	Single	233	248	15	233	243	246
KSB-2197	Greater Kaweah	Single	113	133	21	121	129	132
KSB-2200	Greater Kaweah	Single	179	199	21	211	203	201
KSB-2203	Greater Kaweah	Single	103	124	21	129	126	125
KSB-2291	Greater Kaweah	Single	244	270	26	244	261	267
KSB-2297	Greater Kaweah	Single	282	336	54	282	318	330
KSB-2322	Greater Kaweah	Single	162	181	19	188	184	182
KSB-2411	Greater Kaweah	Single	174	201	27	193	199	200
KSB-2466	Greater Kaweah	Single	356	373	17	356	367	371
KSB-2539	Greater Kaweah	Upper	375	389	13	375	384	387
KSB-2690	Greater Kaweah	Single	381	406	25	381	398	404
KSB-2822	Greater Kaweah	Single	419	435	16	419	429	433
KSB-0922	Mid-Kaweah	Upper	-15	11	26	23	15	13
KSB-0946	Mid-Kaweah	Upper	55	70	14	76	72	70
KSB-0948	Mid-Kaweah	Upper	-9	8	17	49	22	13
KSB-0976	Mid-Kaweah	Upper	-20	5	25	32	14	8
KSB-0994	Mid-Kaweah	Upper	93	104	11	94	101	103
KSB-1071	Mid-Kaweah	Upper	-10	10	20	51	24	15
KSB-1168	Mid-Kaweah	Upper	100	123	23	100	116	121
KSB-1206	Mid-Kaweah	Upper	-35	-4	30	48	13	1

Representative Monitoring Site ID	GSA	Aquifer Designation	MT (WSE in feet)	MO (WSE in feet)	Operational Flexibility (feet)	IM 2025 (WSE in feet)	IM 2030 (WSE in feet)	IM 2035 (WSE in feet)
KSB-1226	Mid-Kaweah	Upper	32	53	21	85	64	57
KSB-1320d	Mid-Kaweah	Lower	50	95	45	50	80	90
KSB-1320s	Mid-Kaweah	Upper	30	32	2	69	44	36
KSB-1408d	Mid-Kaweah	Lower	69	145	76	69	120	137
KSB-1408s	Mid-Kaweah	Upper	52	71	19	87	76	73
KSB-1427	Mid-Kaweah	Upper	87	101	14	110	104	102
KSB-1431	Mid-Kaweah	Upper	51	75	24	97	82	77
KSB-1477	Mid-Kaweah	Upper	72	105	32	72	94	101
KSB-1506	Mid-Kaweah	Lower	48	109	61	48	89	102
KSB-1526	Mid-Kaweah	Upper	88	112	24	123	115	113
KSB-1536d	Mid-Kaweah	Lower	54	132	78	54	106	123
KSB-1536s	Mid-Kaweah	Upper	31	55	24	55	55	55
KSB-1545d	Mid-Kaweah	Lower	75	155	80	75	128	146
KSB-1545s	Mid-Kaweah	Upper	42	57	15	69	61	59
KSB-1628	Mid-Kaweah	Upper	7	33	27	47	38	35
KSB-1695	Mid-Kaweah	Lower	54	112	58	54	93	106
KSB-1696	Mid-Kaweah	Upper	79	94	15	94	94	94
KSB-1699	Mid-Kaweah	Upper	91	110	19	119	113	111
KSB-1770	Mid-Kaweah	Lower	68	155	87	68	126	145
KSB-1884	Mid-Kaweah	Single	146	175	29	183	178	176
KSB-1903	Mid-Kaweah	Upper	101	129	27	106	121	126
KSB-1905	Mid-Kaweah	Upper	96	125	29	123	124	125
KSB-1977	Mid-Kaweah	Single	167	183	16	205	190	185
MKGSA-01	Mid-Kaweah	Lower	20	30	10	20	27	29
MKGSA-02	Mid-Kaweah	Lower	30	39	9	30	36	38
WK-1	Mid-Kaweah	Lower	-70	-26	44	-70	-41	-31

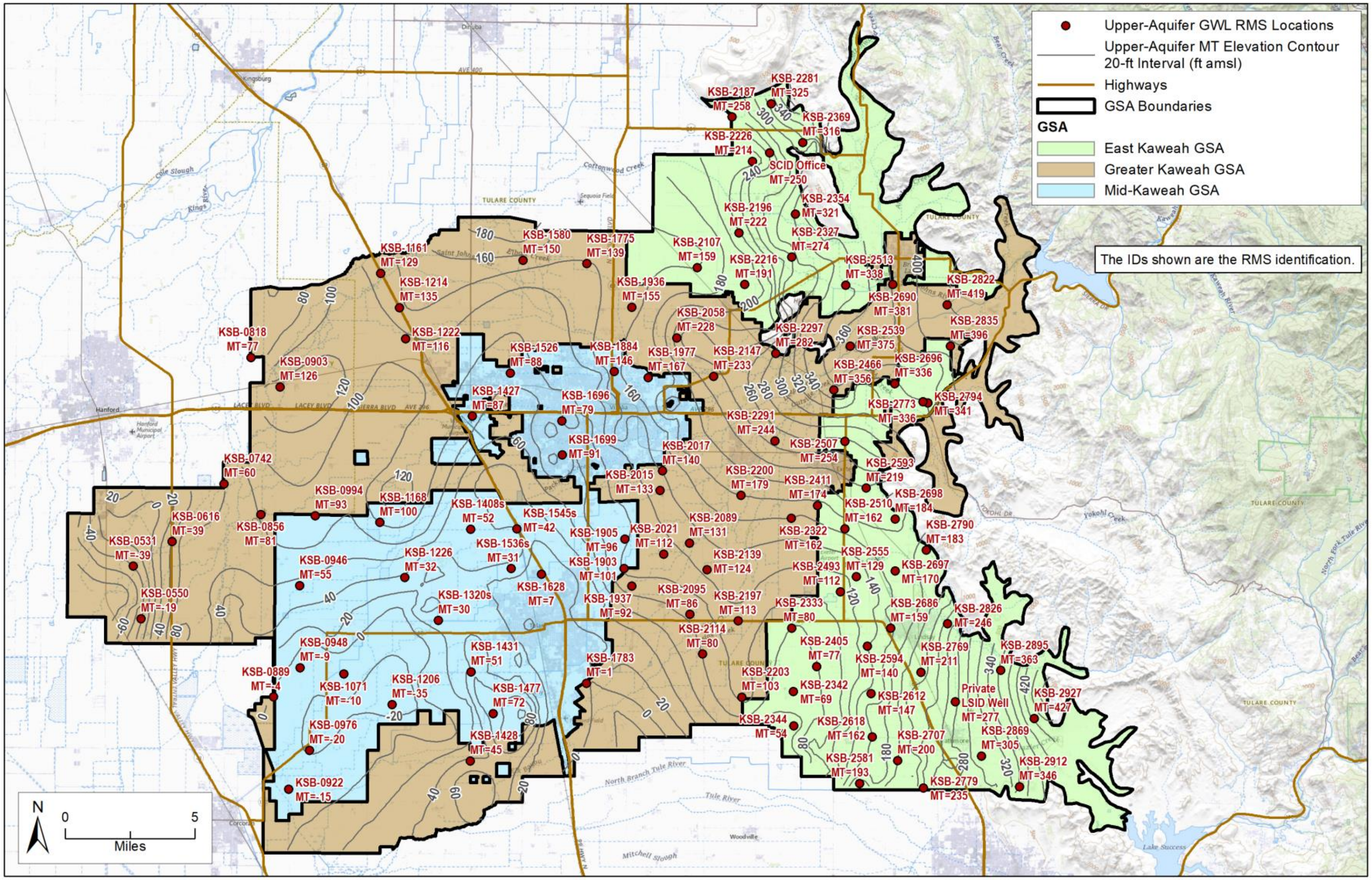


Figure 5-6 Map of Upper Aquifer Groundwater Level MTs

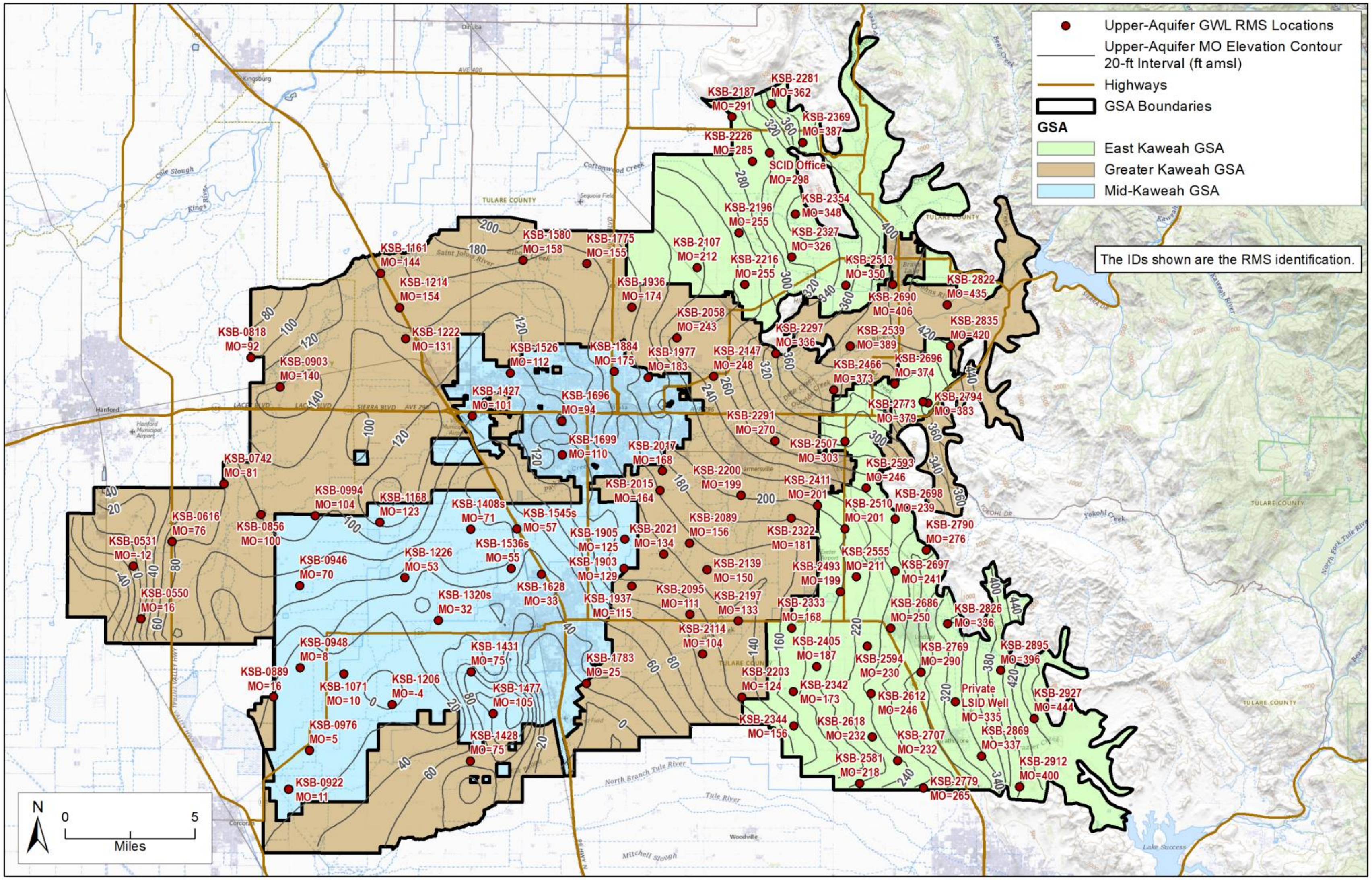


Figure 5-7 Map of Upper Aquifer Groundwater Level MOs

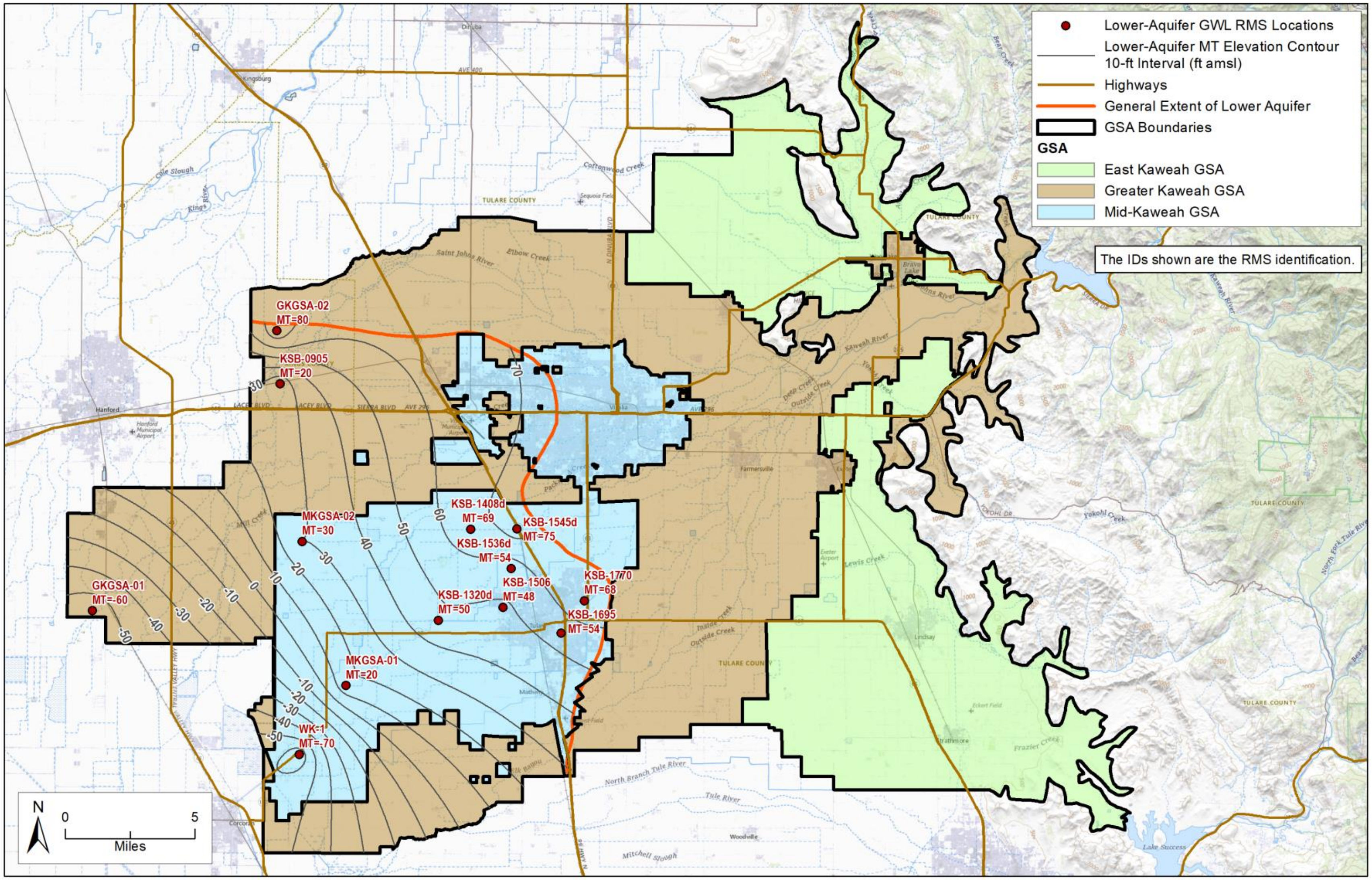


Figure 5-8 Map of Lower Aquifer Groundwater Level MTs

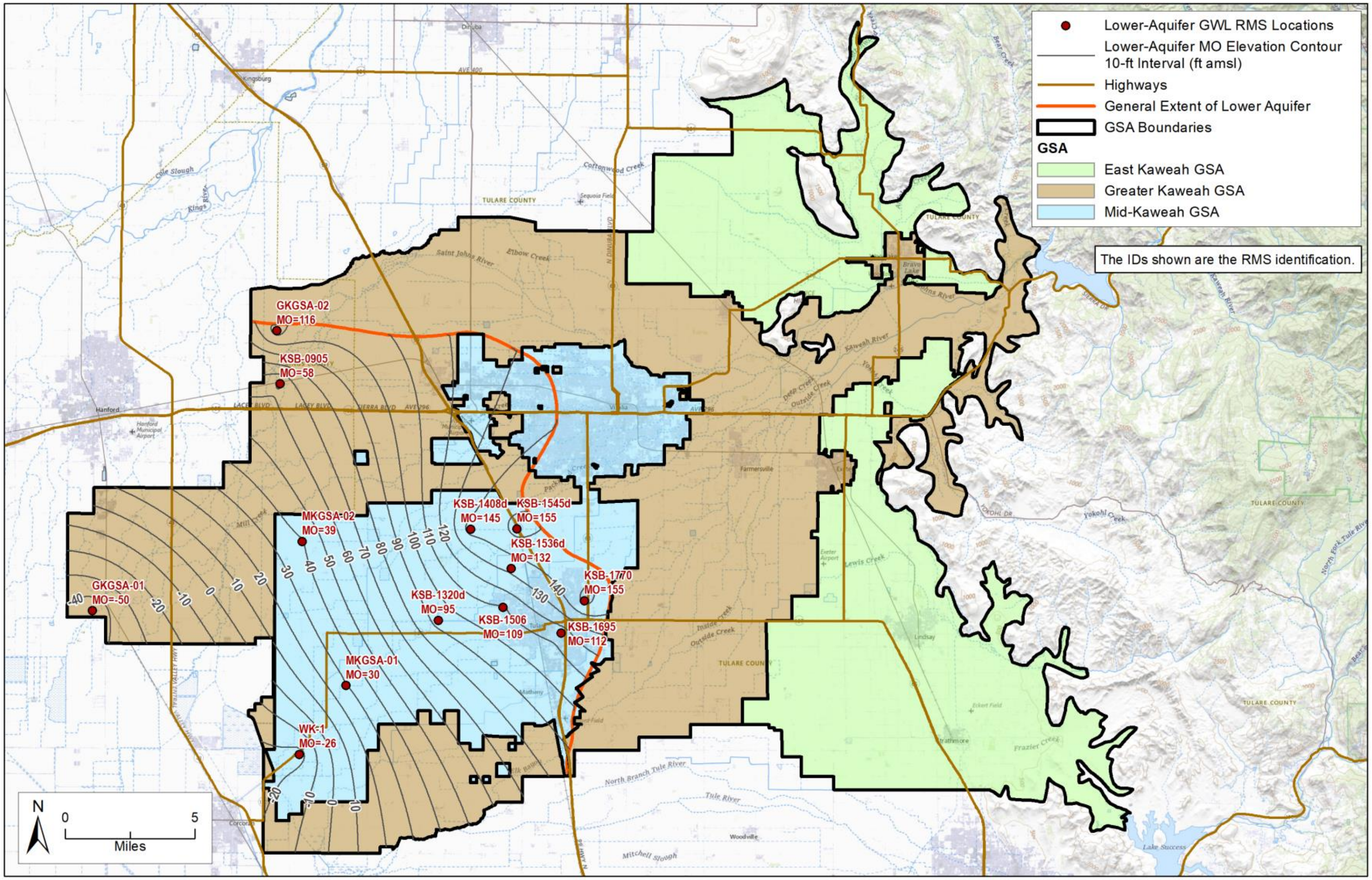


Figure 5-9 Map of Lower Aquifer Groundwater Level MOs

5.5.3.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

The methodology to establish MT for groundwater levels (and all other SMC) is depicted in Figure 5-1. A more granular summary of analyses and methodologies is available in Appendices A, B and C.

In the case of groundwater level SMC, over 100 stakeholder engagement meetings (Table 5-5) were held to refine the methodology, assumptions, datasets, and logistics to determine which groundwater level conditions under the projected declines were considered significant and unreasonable, and MTs were then proposed and reviewed until agreement and coordination between the GSAs was reached. Ultimately, the ability for each GSA to sustain groundwater levels and/or mitigate potential impacts to domestic wells under projected dry conditions was the primary determining factor for selecting the final groundwater level to assign as the MT for the upper aquifer of the Kaweah Subbasin (Appendix 5A). The lower aquifer MTs are based on the land subsidence SMC (Appendix 5B)) and are listed along with the upper aquifer RMS locations on Table 5-4 and shown on Figure 5-10. As an additional check, the lower aquifer SMC were also evaluated to ensure there were no potential impacts to domestic wells.

Ultimately, the ability for each GSA to sustain groundwater levels and/or mitigate potential impacts to domestic wells under projected dry conditions was the primary determining factor in selecting the upper aquifer groundwater level MT. A summary of the number of potential impacts, generated from the Dry Well Susceptibility Analysis and explained in more detail in Appendix 5A is available in Figure 5-12. The annual mitigation cost estimates, which include both the costs to physically mitigate and the costs to administer the program, sample for groundwater quality, and technically evaluate claims, are summarized by GSA in Figure 5-13.

Table 5-5 Stakeholder Coordination Meetings Addressing Groundwater Level SMC Revisions for 2nd Amended GSP

Stakeholder Meeting Type	Count of meetings[1]	Stakeholder Groups Represented/Present
EKGSA Technical Advisory Committee	16	Drinking Water Advocacy Groups (NGO), Environmental/Conservation Groups, Groundwater-Dependent Growers, Conjunctive Use Growers, Small Family Farmers, Tulare County, Local Community & City Representatives
EKGSA Advisory Committee	9	
EKGSA Board of Directors	11	
GKGSA Advisory Committee	6	
GKGSA Board of Directors	13	
GKGSA Stakeholder & Rural Communities Committee	9	
GKGSA Outreach Events	7	
MKGSA Advisory Committee	16	Drinking Water Advocacy Groups (NGO) Groundwater-Dependent Growers
MKGSA Board of Directors	14	GSA Staff & Technical Support
MKGSA Mitigation Workshop	1	
Community Well Mitigation Workshop with SHE	1	Self-Help Enterprises (SHE)
Dry Well Susceptibility Analysis Workshop	3	Drinking Water Advocacy Groups (NGO) Groundwater-Dependent Growers
Total	**106**	

[1] Meetings listed include only those in which revisions to groundwater level SMC updates (for the 2nd Amended GSPs) were presented and discussed

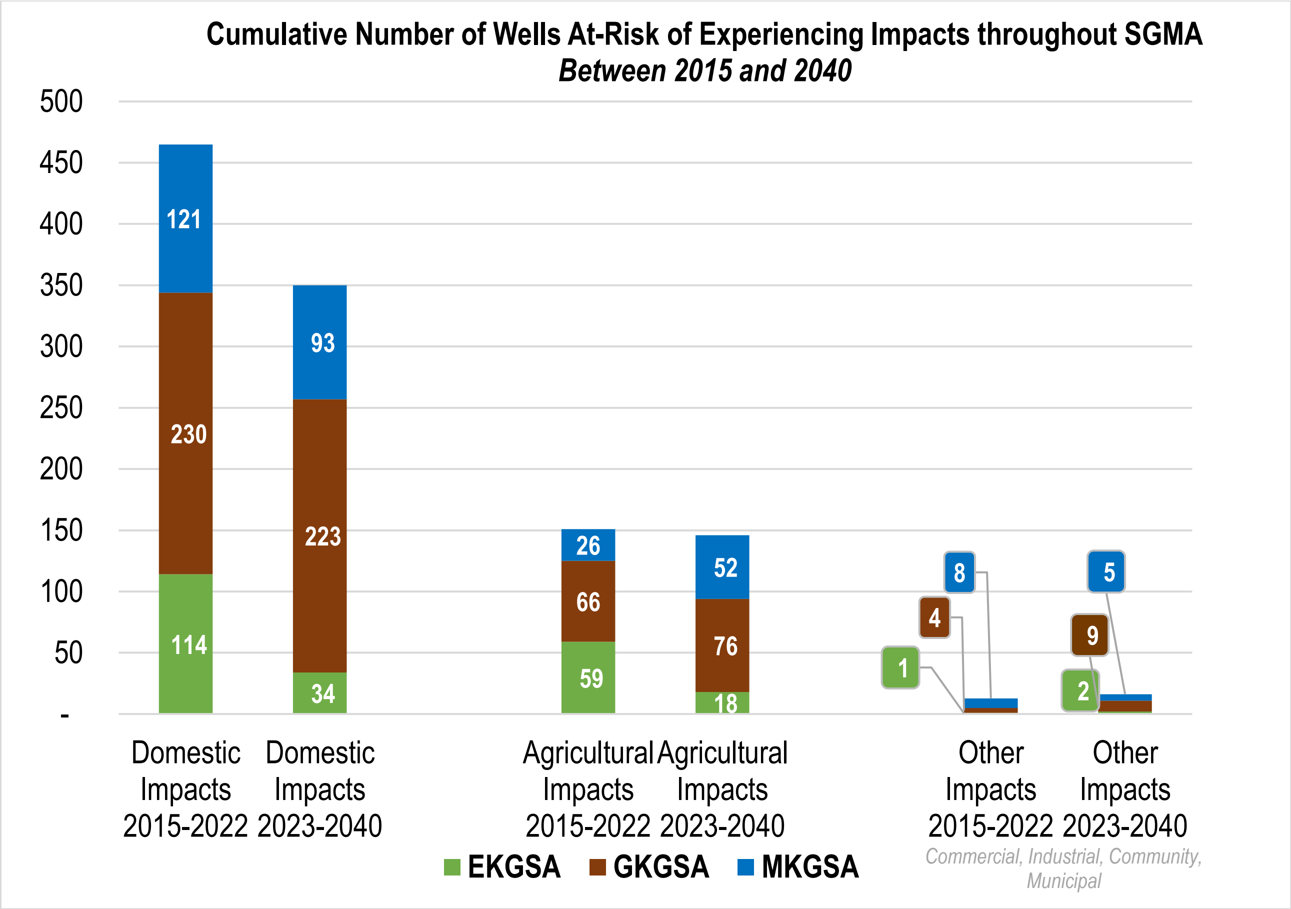


Figure 5-10 Count of Potentially Impacted Wells Based on MT Scenario[8]

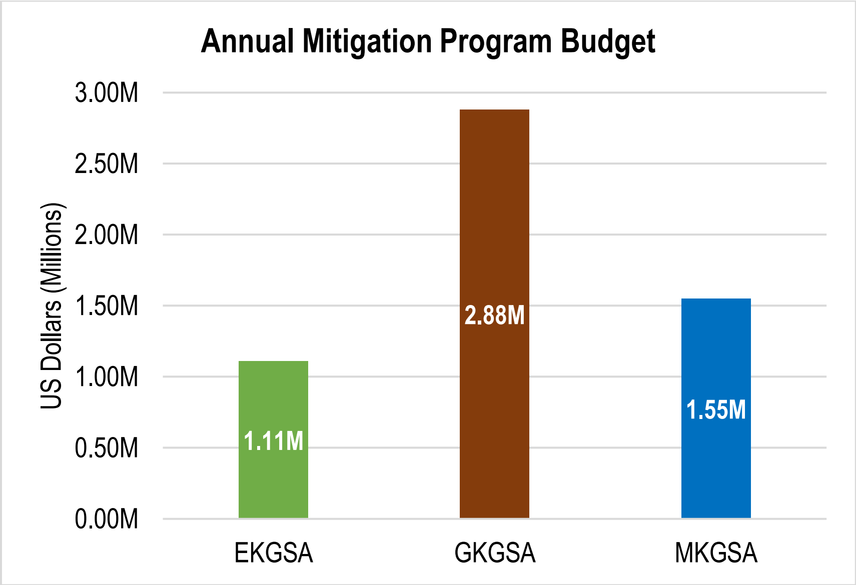


Figure 5-11 Annual Cost to Implement Kaweah Subbasin Mitigation Program

5.5.3.2 Minimum Threshold Extent

The lateral extent of MTs for the upper aquifer covers the entire Subbasin. The presence of the aquitard between the upper and lower aquifers (i.e., the Corcoran Clay) is limited to the western half of the Subbasin, which delineates the extent of the lower aquifer.

The vertical extent also varies across the Subbasin for both upper and lower aquifers are reflected in the MTs identified at each RMS site in Figure 5-8 and Figure 5-10.

5.5.3.3 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

The upper aquifer groundwater level MTs were developed using current and historical groundwater level measurements across the Subbasin, based on the best available data and science. The groundwater level data were evaluated to ensure hydrogeologic plausibility and reasonable continuity of MT values between RMS locations for other sustainability indicators. For the lower aquifer, the subsidence analysis was used to inform MTs.

- **Land subsidence.** The MTs for the land subsidence sustainability indicator were used to define the lower aquifer MTs (SECTION 5.6). Therefore, the land subsidence and lower aquifer groundwater level MTs are aligned, and there is no impact of one on the other.

  Further geologic investigation may demonstrate that there is gradually increasing aquifer confinement with depth in parts of the single aquifer system (i.e., east of the Corcoran Clay). In this case, the deeper portion of the single aquifer may exhibit different groundwater levels than the shallower portion. A recent nested monitoring well installation in the Tule Subbasin suggests this might be the case in the southern portion of the Kaweah Subbasin. See GKGSA's new management action regarding the installation of new dual nested monitoring wells in this area to fill this data gap in Section 6 of the GKGSA GSP. If future investigations suggest delineation of upper and lower aquifers within areas of the aquifer currently characterized as a single aquifer system, limits on the deeper aquifer groundwater levels may be necessary to avoid URs from land subsidence.
- **Reduction in groundwater storage.** The reduction of groundwater storage sustainability indicator minimum thresholds are identical to those developed for the chronic lowering of groundwater levels sustainability indicator, since groundwater levels are used as a proxy for the reduction of groundwater storage SMC (Section 5.7 and Appendix 5F).

[8] Note: this count of wells assumes all minimum thresholds are exceeded across the Kaweah Subbasin, which theoretically cannot happen due to our definition of Undesirable Results. This is considered highly unlikely, and the Kaweah Subbasin is committed to demand management, recharge, water banking, and other projects to manage to the sustainability goal and Measurable Objective.

Groundwater storage is the measure of the volume of groundwater stored within the aquifer. Therefore, more groundwater is available in the aquifer during periods with higher groundwater levels and vice versa. Although a significant relationship between groundwater levels and storage within the unconfined aquifer has been established, the strength of this relationship may vary according to the depth to the base of the aquifer (i.e., saturated thickness). An equal volume of groundwater lost due to the lowering of groundwater levels in an area with a very shallow depth to the base of the aquifer will have vastly different consequences for beneficial users than an area with a much deeper base of the aquifer. The remaining amount of storage within the aquifer was a limiting factor for defining MTs in the eastern regions that have a shallower depth to the base of the aquifer due to the presence of bedrock. This limitation was included in the process of establishing groundwater level MTs in the easternmost portion of the Subbasin.

- **Degraded water quality.** Legacy and natural groundwater quality issues are present in the Kaweah Subbasin. SGMA requires GSAs to account for the degradation of groundwater quality induced by a GSA's management of groundwater. This may include degradation of groundwater quality or migration of contaminant plumes caused by recharge activities or changes in groundwater levels and flow directions induced by overdraft pumping. Existing programs require changes in fertilizer use, reporting, and water quality impact avoidance planning to limit or avoid additional groundwater quality impacts related to agricultural activities (see **SECTION 4.1.3**). At this time, there are no instances of degradation of groundwater quality induced by groundwater management activities since SGMA was enacted; however, the Kaweah Subbasin GSAs are committed to expanding the groundwater quality monitoring network, especially near areas with domestic wells, community groundwater supply systems, and adjacent to groundwater recharge facilities. The Kaweah Subbasin GSAs have also included new management actions which may aid in filling data gaps related to groundwater quality (particularly pertaining to domestic wells) throughout the Subbasin. See Section 4.9 for more information.
- **Depletion of interconnected surface water.** In the future, interconnected surface water will be evaluated using a rate of surface water depletion in interconnected channels; however, surface water flow data is limited and is a data gap that the Kaweah Subbasin GSAs are actively working to fill. In the interim, groundwater level data is being collected near potentially interconnected streams in EKGSA and monitored in conjunction with the upper aquifer groundwater level monitoring. The DWR determination letter sent to the Kaweah Subbasin in March 2023 included deficiencies and the Department's recommendations on how to address them. In the case of interconnected surface water, the GSAs were advised to utilize the depletions of interconnected surface water Guidance Document when it becomes available. At this time, the Guidance Document has not been released by DWR. In the interim,

groundwater levels are not used as a proxy for establishing SMC for depletions of interconnected surface water; however, this may be considered in the future pending recommendations from DWR's Guidance Document.

5.5.3.4 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

Three subbasins of the San Joaquin Valley Basin adjoin the Kaweah Subbasin:

- Kings Subbasin, to the north
- Tule Subbasin, to the south
- Tulare Lake Subbasin, to the west

The Kaweah Subbasin GSAs have coordinated with neighboring Subbasins to compare the revised MTs for water levels and land subsidence and are generally consistent across GSA Boundaries. In the case of the Kaweah Subbasin, the upper aquifer groundwater level MTs and MOs appear generally higher than the neighboring Subbasin in the eastern region of the Kaweah Subbasin. The regular monitoring and review of results for annual reporting will provide more information on whether interbasin policies are needed to avoid impacts to beneficial uses and users of groundwater. Because land subsidence SMC are the limiting factor for assigning lower aquifer groundwater level SMC, it is expected that the lower aquifer MTs will be at or above the lower aquifer MTs in neighboring GSAs (more on this in Section 5.6.3).

Potential effects on beneficial users, uses, and property interests are depicted in Figure 5-4. The beneficial users identified in Figure 5-4 generally occur throughout the subbasin, with domestic wells primarily drilled in the upper aquifer and irrigation wells drilled in both aquifer systems, where the Corcoran Clay extent is present. More information on the causation of impacts and their effects on beneficial users, uses, and property interests is available in Section 5.5.5.3. The MTs for the chronic lowering of groundwater level sustainability indicator seek to prevent significant and unreasonable effects on groundwater supply wells. The GSAs will monitor to ensure the Subbasin is trending towards sustainability as planned, or if further projects and management actions are needed in areas where groundwater level trends are towards the MTs. The key to sustainability in the Kaweah Subbasin is the implementation of groundwater allocation and pumping caps. GSAs intend to actively monitor and allocate groundwater utilization based on achieving sustainability at our MOs. Although the Subbasin GSAs' strategy involves groundwater pumping restrictions and elevated SMC, individual well impacts may still occur during prolonged drought periods. In addition, individual impacts on beneficial users, uses, and property interests could occur in areas where groundwater levels are within the range of operational flexibility (**Section 5.5.4.4**). These individual impacts are addressed via the Kaweah Subbasin Mitigation Program and GSA specific Mitigation Plans. Additionally, the land subsidence MTs were explicitly set to prevent significant and unreasonable impacts on groundwater levels.

5.5.3.5 Relevant Federal, State, or Local Standards

There are no federal, state, or local regulations related to groundwater levels outside of SGMA.

5.5.3.6 Method for Quantitative Measurement of Minimum Thresholds

Groundwater level measurements will be assessed annually using the monitoring network described in Section 4, and will be evaluated to determine their relation to MTs. Groundwater level monitoring will be conducted in accordance with the monitoring plan outlined in **CHAPTER 4**. The dense network of RMS wells spans the various geologic conditions in the Subbasin. Groundwater level data will be collected at the RMS sites bi-annually to capture the seasonal high (spring) and seasonal low (fall) water table conditions. This data will be reported to DWR bi-annually via the SGMA Data Portal and reported in the Annual Reports, as has been completed since the submittal of the first GSP in 2020. During Annual Report development, the GSAs and their respective stakeholder committees review monitoring results and consider if management and policy changes are needed to steer the subbasin on the sustainability track, or if progress is trending as expected.

5.5.4 Chronic Lowering of Groundwater Levels Measurable Objectives and Interim Milestones [§354.30(a)(b)(c)(d)(e)(f)(g)]

§354.30 Measurable Objectives.

(a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 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.
(g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for a finding of inadequacy of the Plan.

The MO for the chronic lowering of groundwater level sustainability indicator represents a target groundwater surface elevation that acts as a quantitative measure of the sustainability goal. MOs were developed by applying the concept of providing a reasonable margin of operational flexibility under adverse conditions (GSP Emergency Regulations §354.30(c)). IMs were developed to illustrate a reasonable path to achieve the sustainability goal for the Subbasin within 20 years of Plan implementation.

5.5.4.1 Methodology for Setting Measurable Objectives and Interim Milestones

The MOs for the upper aquifer RMS were developed following the establishment of MTs. The MO methodology utilized the same Annual Allowable Rate of Decline (AARD) surface that was evaluated for establishing MTs. This methodology is described in more detail in Appendix 5A. Several technical meetings with the stakeholders, GSA staff, and SMC Core Teams were held to coordinate an agreed upon approach for establishing MOs. The MO for the Subbasin upper aquifer was established to maintain sufficient operational flexibility and sustain sufficient saturated thickness in the areas with shallow depth to bedrock along the mountainfront (Sierra Nevada foothills). MO was determined to be representative of the Kaweah Subbasin sustainability goal, and reasonable for the Subbasin to achieve through demand management policies and project benefits. The easternmost area required a reduced margin of operational flexibility, due to the reduced thickness of the aquifer where the depth to bedrock is much shallower. Therefore, a different rationale was established for the easternmost area of the Subbasin with shallow depth to bedrock as compared to the area west of this region.

For the easternmost area (where shallow depth to bedrock is prevalent), the spring 2017 groundwater levels were selected as the measurable objectives based on stakeholder feedback and to allow sufficient storage for future drought resiliency. West of this region in the Kaweah Subbasin, the MOS are informed by the projected AARD scenarios from the DWSA. The rate of decline that is 50% the difference between the Fall 2022 and MT groundwater level elevations which is representative of the operational flexibility and minimizes dry well impacts aligned with the qualitative definition of MO, the sustainability goal.

Because the spring 2017 groundwater level surface is much higher in elevation than the MO of the easternmost region, a transition between the surfaces was required for the hydrogeologic plausibility of the measurable objective groundwater level surface. The gradient of the transition between the east and west portions of the Subbasin was compared to observed historical gradients in past groundwater level datasets to ensure it did not unreasonably exceed gradients that have been measured in the area. A transition zone with too steep of a gradient could potentially induce more flow toward the west, lowering groundwater levels and reducing storage the areas where the aquifer thickness is limited, hindering the ability to maintain groundwater levels at the MO.

The Subbasin numerical groundwater model was used to verify the analyses to ensure the groundwater conditions evaluated to develop the SMC are hydrogeologically plausible. The MOs for the upper aquifer are shown for each of the RMS in Table 5-4 and in Figure 5-9. The lower aquifer MOs are established based on the land subsidence SMC methodology, described in **APPENDIX 5B** and are also presented in **TABLE 5-4** and **FIGURE 5-11**.

The interim milestones (IMs) represent target groundwater levels at the RMS to demonstrate progress towards the MOs, and are based on incrementally (net) decreasing groundwater level changes over time based on the following:

- 2025 IM– extend the 2014-2022 rate of groundwater level decline (see Section 5.5.3.1) to 2025
- 2030 IM –elevation at two-thirds of the elevation difference between the 2025 interim milestone and the MO
- 2035 IM – elevation at two-thirds of the elevation difference between the 2030 interim milestone and the MO

The method for setting IMs is also illustrated on Figure 5-14 Groundwater elevations representing MOs for each of the RMS are shown in Table 5-4. Figure 5-15 through Figure 5-17 include an example projected groundwater level hydrographs with the RMS well's SMC for each respective GSA.

Additional SMC hydrographs are available in Appendix 3C.

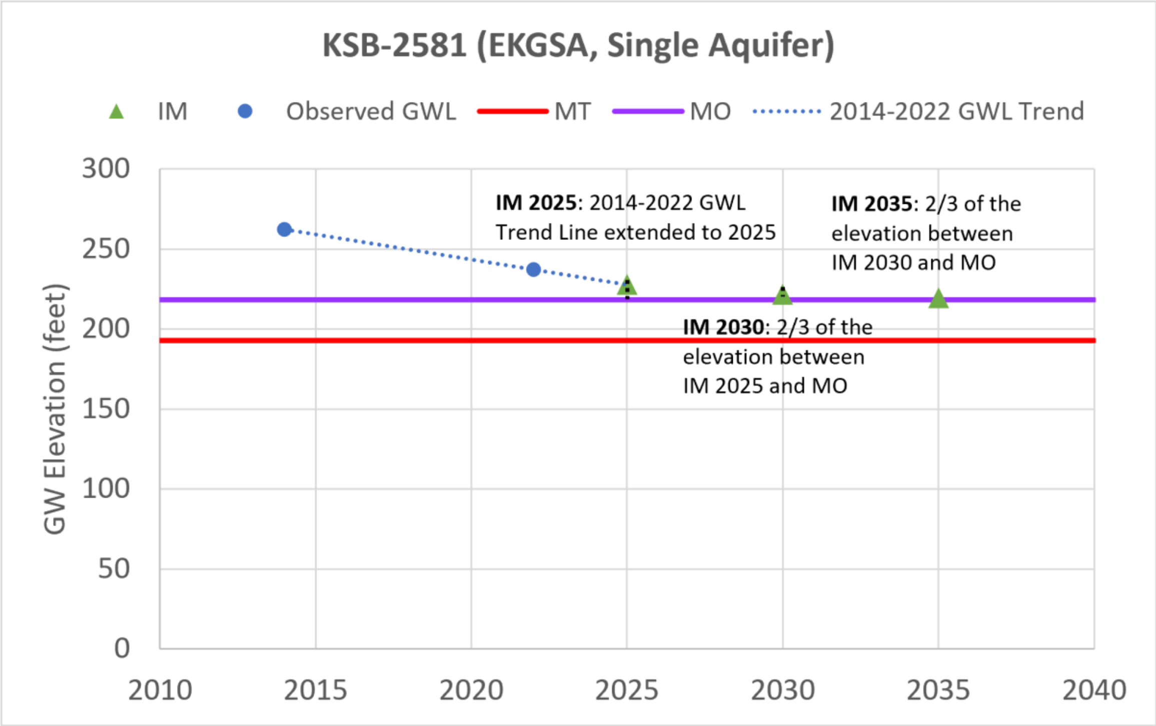


Figure 5-12 Example of IM Method for Groundwater Level SMCs

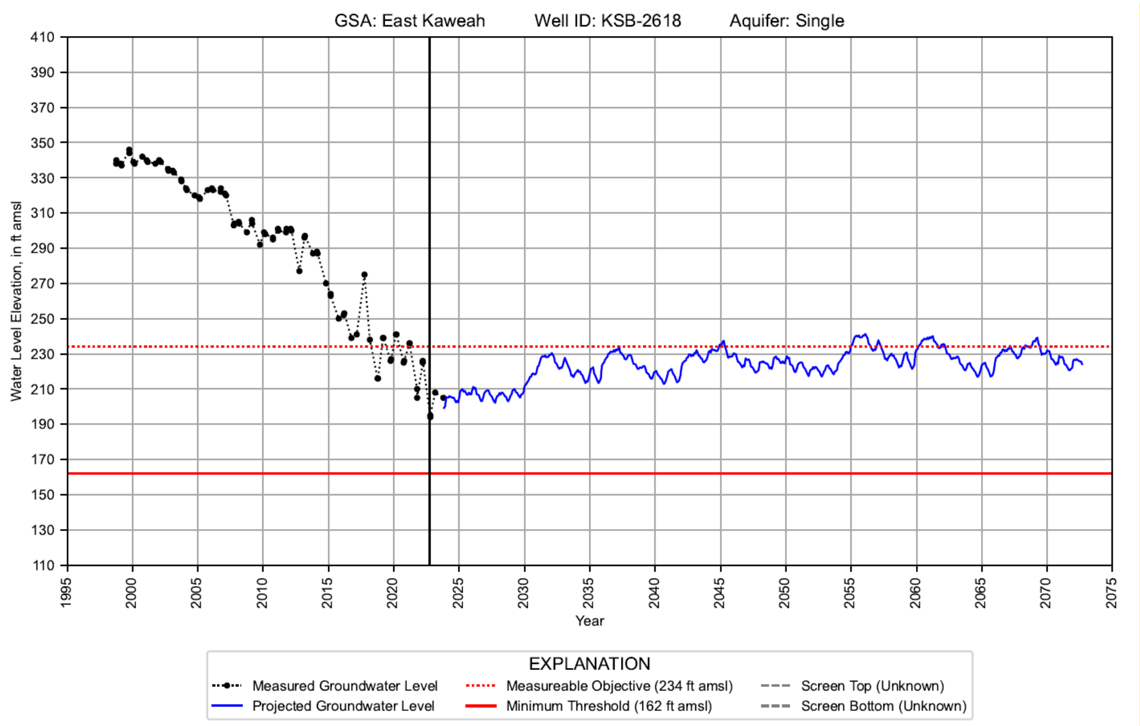


Figure 5-13 Projected RMS Hydrograph with SMC (EKGSA)

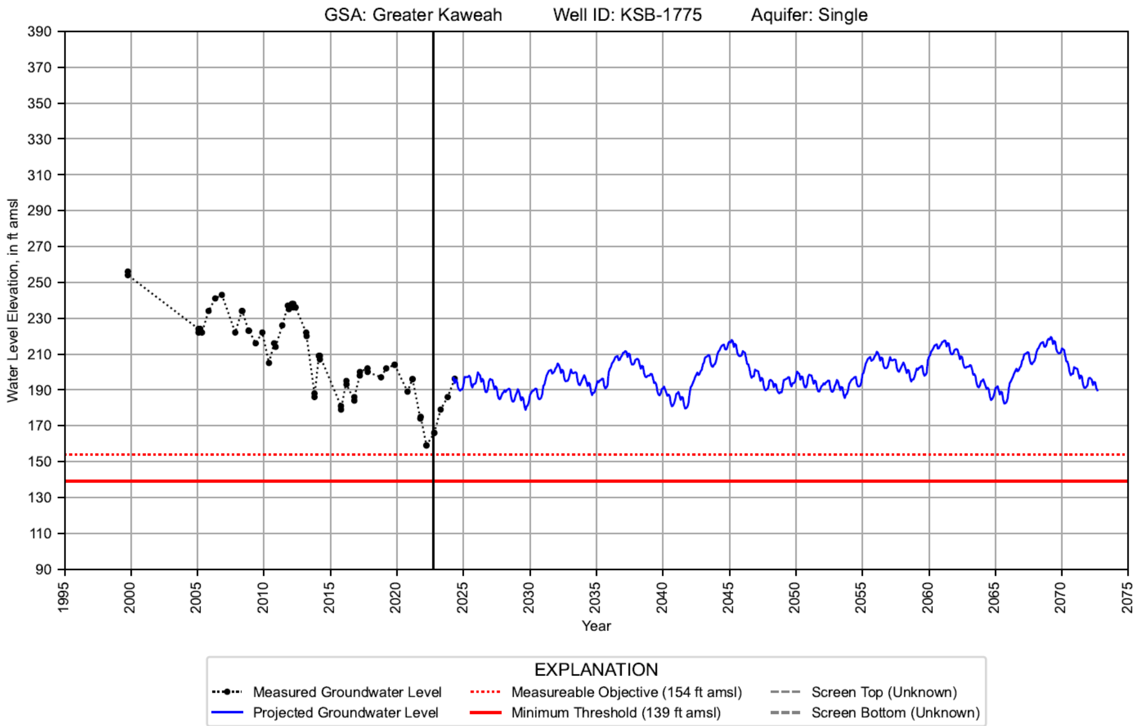


Figure 5-14 Projected RMS Hydrograph with SMC (GKGSA)

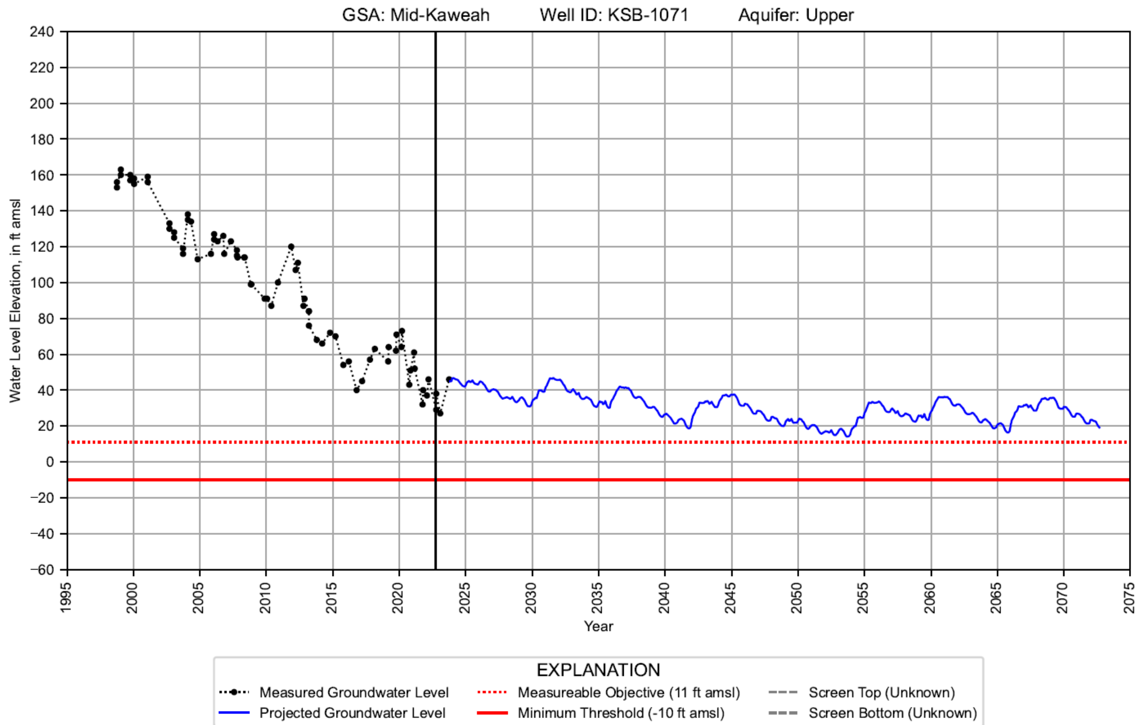


Figure 5-15 Projected RMS Hydrograph with SMC (MKGSA)

More information on the methodology, analyses, and considerations that informed the MOs are available in Appendix 5A for upper aquifer groundwater levels and Appendix 5B for lower aquifer groundwater levels.

5.5.4.2 Operational Flexibility

Operational flexibility is defined as the water level difference between MTs and MOs. In general, areas with a higher projected rate of decline have more operational flexibility; however, much greater operational flexibility is in the easternmost portion of the EKGSA, where the aquifer thickness is limited due to the presence of bedrock. Table 5-4 lists the operational flexibility at each RMS.

5.5.5 Future Improvements to Sustainable Management Criteria

The SMC established herein is developed using the best available data, information, and science. Data gaps and uncertainties, along with strategies to fill them, are summarized in **SECTION 4.9**. At this time, the revision of the SMC for the 2nd Amended GSP has been prioritized to address DWR-identified deficiencies. The potential to meet SMC goals has been informed through a preliminary analysis using an updated and recalibrated Kaweah Subbasin Groundwater Flow Model. The Kaweah Subbasin Groundwater Flow Model has served as a useful tool in updating groundwater budgets and assessing the ability to achieve sustainability in the future with climactic influences and different operational conditions. Preliminary analysis using the model has shown that the projects and management actions identified in Section 6 will enable the GSAs to meet their sustainability goals. As new data are collected and analyzed, it may be necessary or appropriate to adjust projects and management actions or SMC to better reflect conditions.

In the future, the model will also serve as a useful tool in reassessing and verifying projects and management actions needed to meet SMC, impact attribution analyses, and supplemental impact risk assessments. The timeline to develop, analyze, and engage with stakeholders to establish SMC revisions is highly variable and contingent on receptiveness of approach and results by stakeholders, SWRCB, DWR, and other interested parties. It is important for the Kaweah Subbasin GSAs and Technical Team to remain transparent on the methods and analyses used and the technical basis for all GSP revisions to minimize delays in schedule and continue to build and retain trust with the community and regulatory agencies.

5.6 Land Subsidence SMC [§354.28(c)(5)(A),(c)(5)(B)]

§354.28 Minimum Thresholds.

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:

(5) Land Subsidence. The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with the surface land uses and may lead to undesirable results. Minimum thresholds for land subsidence shall be supported by the following:

(A) Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including an explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects.

(B) Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.

Land subsidence SMC—based on input collected during stakeholder and Advisory Committee meetings and discussions with SWRCB and GSA staff—addresses total cumulative subsidence, differential subsidence, and an annual subsidence rate. The land subsidence SMC methodology is as follows:

1. Identify infrastructure potentially impacted by subsidence
2. Identify the total amount of subsidence that is acceptable without causing significant and unreasonable impacts to infrastructure
3. Compare acceptable subsidence to current subsidence rates and adjust them as needed
4. Estimate groundwater levels that avoid unacceptable subsidence, and assign groundwater level MTs protective of unacceptable subsidence

While Appendix 5B presents an assessment and analysis of land subsidence impacts and SMC for the entire Kaweah Subbasin, this section presents only the subset of the analysis and SMC relevant to the area covered by this GSP. The land subsidence SMC of all three of the Subbasin's GSPs are coordinated and based on the unified analysis in Appendix 5B.

5.6.1 Land Surface Beneficial Uses and Users[§354.26(b)(3)]

The Kaweah Subbasin GSAs reviewed all critical infrastructure that could be impacted by subsidence. The assessment of significant and unreasonable impacts was informed by outreach to agencies or stakeholders that manage critical infrastructure in the Kaweah Subbasin. The review is discussed in Appendix 5B.

Table 5-7 summarizes the beneficial land surface uses that are found in the GSP area, along with an assessment of whether data exist to quantify significant and unreasonable impacts from subsidence. Table 5-7 does not imply that subsidence impacts to infrastructure lacking historical data on impacts will not be addressed or mitigated by the GSA. The GSA will monitor subsidence impacts on all infrastructure listed in Table 5-7 and address mitigation of critical infrastructure as outlined in the mitigation program.

This analysis acknowledges that the relationship between subsidence and infrastructure impacts is incomplete. Future data may offer an updated understanding of infrastructure impacts, allowing subsequent GSP updates to better quantify subsidence impacts on all infrastructure.

Table 5-7. Summary of Beneficial Uses and Users (Critical Infrastructure) Potentially Impacted by Land Subsidence

Infrastructure / Beneficial Use	Significant & Unreasonable Impact	Quantifiable Impacts?	Agency or Group Contacted Regarding Historical Subsidence Impacts
Flood Control	Capacity loss from reduced land slope leading to increased risk of flooding	No historical quantifiable impacts. Neighboring subbasins are limiting subsidence based on quantifiable flood mitigation costs.	Tulare County Flood Control District Kaweah Delta WCD Tule Subbasin GSAs Tulare Lake Subbasin GSAs Tulare Irrigation District
Local Canals	Capacity loss from reduced canal slope and cracks	Possible based on historical impacts to beneficial users	Tulare Irrigation District Kaweah Delta WCD Other local private ditch companies
Supply Wells	Collapse of deep wells that prevents use and requires repair or replacement	Based on well design. Not enough historical information to correlate collapse with subsidence	Self-Help Enterprise Local drillers Local landowners with wells
Roads and Bridges	Uneven settlement that requires repairs or replacement	No historical quantifiable impacts	Tulare County Resources Management Agency – Road Department
Electrical Power Lines	Stretch or harm	No historical quantifiable impacts	
Sanitary Sewers	Cracks or loss of capacity	No historical quantifiable impacts	
Gas and Water Pipelines	Cracks or loss of capacity	No historical quantifiable impacts	
Railroad Tracks	Uneven settlement that requires repairs or replacement	No historical quantifiable impacts	California High Speed Rail Authority

5.6.2 Subsidence Undesirable Results

As depicted in Figure 5-14, defining beneficial users, significant and unreasonable effects, and URs are critical first steps to establishing effective SMC.

5.6.2.1 Subbasin Defined Significant and Unreasonable Land Subsidence

Based on the review of existing data summarized in Table 5-7, impacts were quantified for the infrastructure that had adequate, quantifiable information. Details of the quantification are in Appendix 5B.

5.6.2.1.1 Significant and Unreasonable Impacts on Local Canals

> *Differential subsidence that reduces the slope of a canal by 1 foot over 1.5 miles is significant and unreasonable.*

The differential subsidence that results in significant and unreasonable impacts was established by looking at historical impacts on local canals and the mitigation required to deliver surface water to growers. An inability to deliver adequate surface water could result in increased groundwater pumping to make up for reduced surface water deliveries. Appendix 5B includes an analysis of data that substantiates the 1 foot over 1.5 miles criterion.

5.6.2.1.2 Significant and Unreasonable Impacts on Water Supply Wells

> *Subsidence of greater than 9 feet may result in significant and unreasonable harm to deep water supply wells.*

The analysis included in Appendix 5B shows that deep irrigation wells can be designed to absorb between 9 and 14 feet of subsidence when installed with mechanical compression sleeves. The Kaweah Subbasin GSAs adopted the more conservative 9 feet of subsidence as the maximum allowable to protect deep water supply wells in the 2022 Amended GSPs.

5.6.2.1.3 Significant and Unreasonable Impacts on Flood Control/Neighboring Subbasins

> *Subsidence of greater than 7 feet may result in significant and unreasonable harm to flood control infrastructure that cannot be mitigated, as established in coordination with neighboring subbasins.*

The neighboring Tule Subbasin has established a maximum subsidence limit of 7 feet, based on the cost of mitigating flood control levees along the Tule River. The Tule Subbasin effectively limits the maximum subsidence in the Kaweah subbasin to 7 feet. Adopting the Tule Subbasin’s limit of 7 feet of subsidence along the Tule River ensures subsidence management coordination between the adjoining subbasins.

5.6.2.1.4 Summary of Significant and Unreasonable Impacts

The significant and unreasonable subsidence impacts relevant to the area covered by this GSP are summarized in Table 5-8. Other critical infrastructure not listed on Table 5--8 that might be impacted by subsidence are eligible for mitigation funds under the GSP Mitigation Program. However, these other critical infrastructures lack data required to quantify levels of significance and establish numerical SMC.

Table 5-8. Summary of Significant and Unreasonable Subsidence Impacts

Critical Infrastructure	Absolute Subsidence Impact?	Differential Subsidence Impact?	Value
Domestic and Small System Wells	X		Any collapse
Local Canals		X	1 foot of subsidence over 1.5 miles
Water Supply Wells (non-drinking water)	X		9 feet of subsidence
Flood Control Structures	X		7 feet of subsidence

5.6.2.1.5 Significant and Unreasonable Impacts on the Most Sensitive Beneficial Uses and Users

> *Any domestic or small water system well collapse due to subsidence is significant and unreasonable.*

Domestic well owners and small water systems could suffer significant hardships if wells collapse due to subsidence.

5.6.2.2 Criteria for Defining Land Subsidence Undesirable Results

By regulation, the land surface subsidence undesirable result is a quantitative combination of subsidence MT exceedances. The primary criteria and metric to determine if land subsidence undesirable results are occurring in the Subbasin will be the cumulative subsidence at each RMS. Reflecting the GSA's commitment to minimizing subsidence, any single MT exceedance is undesirable. The statement of undesirable results is:

> *An Undesirable Result will occur in the Subbasin if the cumulative subsidence minimum threshold is exceeded at any single RMS location.*

An undesirable result does not occur if the subsidence MT rate is exceeded since the rate is not tied to significant and unreasonable impacts. If the subsidence MT rate is exceeded at any location, the GSA will expedite management actions before subsidence undesirable results occur.

5.6.2.3 Potential Causes of Undesirable Results

Undesirable results associated with subsidence are caused by overpumping or reduced groundwater recharge during drought periods, and may occur due to groundwater levels falling and remaining below previous lows in the confined aquifers. Overpumping and lack of recharge is area specific, and some areas have historically experienced greater subsidence than others despite similar groundwater level trends. Subsidence impacts may occur in the Subbasin even if groundwater levels stabilize, as residual subsidence from past overdraft can continue for many years after groundwater level decline slows or stops (Lees *et al*., 2022). Subsidence impacts may also occur due to continued pumping in neighboring subbasins, outside the jurisdiction of the GKGSA. The GKGSA intends to pursue a regional subsidence coordination effort as described in Management Action 8: Collaboration with Other Agencies and Interbasin Coordination (Section 6.7.8).

5.6.2.4 Effects on Beneficial Users and Land Uses

Subsidence undesirable results may impact water conveyance, flood control, domestic wells, municipal wells, or potentially other infrastructure. The GSAs have established a Mitigation Program to alleviate subsidence impacts to domestic and small community water system wells as well as critical infrastructure. The GKGSA Well Mitigation Plan Version 1.0, included in Appendix 6B, provides well mitigation for qualifying applicants. In 2025, the plan will be updated and expanded as version 2.0 to include mitigation in the form of technical assistance for non-drinking water wells and land subsidence impacts to critical infrastructure claims. The GSAs will perform outreach with local utility and infrastructure agencies to raise awareness of the Mitigation Plan and to explain its benefits and how to apply. During GSP implementation, the GSAs will also set up channels to routinely inquire about any infrastructure damage that may occur from land subsidence.

The Kaweah Subbasin GSAs understand the critical, regional importance of the operation of the FKC. No historical inelastic subsidence has been documented along the portion of the FKC that occurs in the Kaweah Subbasin and no inelastic subsidence or impacts to canal delivery capacity are anticipated in the future. However, recognizing the regional importance and value of the FKC, the GSAs have developed a Friant-Kern Canal Monitoring and Action Plan (FMAP). The goal of the FMAP is to detect inelastic land subsidence issues early, should they arise, and to have management actions established to prevent further inelastic subsidence.

The FMAP includes the following to avoid impacts:

1. Establishment of a focused monitoring zone located on either side of the FKC.
2. Identification of benchmarks within the monitoring zone for regular monitoring and analysis of InSAR data to monitor land elevation conditions and enable early detection of inelastic subsidence,
3. Establish conditions indicative of inelastic subsidence, and
4. Identify realistic management actions that will be evaluated and implemented to address negative trending conditions that threaten the FKC. Potential actions include:
    a. localized pumping restrictions,
    b. strategic, locational recharge efforts,
    c. importation of surface water to adjacent farm ground, and
    d. strategic, locational land fallowing, to name a few.

5.6.3 Subsidence Minimum Thresholds

The MT for land subsidence is both a rate and extent of total subsidence, which is defined as the sum of active subsidence caused by future lowering of groundwater levels and any residual subsidence from previous years. The horizontal extent of MT coverage is the entire GKGSA GSP area. The vertical extent of total subsidence is discussed below.

MTs are set at the 28 RMS shown on Figure 5-14. Cumulative MT subsidence values for each of the 44 GKGSA RMS are listed in Table 5-9. These MTs are a subset of the Subbasin-wide MTs developed in Appendix 5B. The MT subsidence rate is 1.25-times the annual average rate that would achieve the cumulative subsidence MT for all RMS.

The GSAs have elected to establish subsidence action levels that will trigger projects and management actions to address subsidence before a MT exceedance. The action levels are 75% of the MTs shown in Table 5-9. Action levels will give the GSAs the warning and opportunity to implement changes in the Subbasin before subsidence undesirable results occur.

Table 5-9. GKGSA Subsidence Minimum Thresholds

Representative Monitoring Site	Subsidence Minimum Threshold		
	Total (feet)	Action Level (feet)	Rate (feet/year)
36.0878_-119.5028	-6.64	-4.98	-0.42
36.1033_-119.4150	-7.00	-5.25	-0.44
36.1056_-119.4518	-7.00	-5.25	-0.44
36.1303_-119.4196	-7.00	-5.25	-0.44
36.1354_-119.4589	-7.00	-5.25	-0.44
36.1519_-119.2592	-5.72	-4.29	-0.36
36.1537_-119.3043	-6.03	-4.52	-0.38
36.1920_-119.2811	-5.89	-4.42	-0.37
36.2272_-119.5781	-7.00	-5.25	-0.44
36.2611_-119.6612	-7.00	-5.25	-0.44
36.2950_-119.4810	-6.80	-5.10	-0.43
36.3047_-119.5360	-5.27	-3.95	-0.33
36.3224_-119.4399	-4.91	-3.68	-0.31
36.3499_-119.4450	-3.88	-2.91	-0.24
36.3570_-119.4864	-4.45	-3.34	-0.28
36.3940_-119.4880	-2.92	-2.19	-0.18
36.4143_-119.4149	-2.08	-1.56	-0.13
DH6686	-1.26	-0.95	-0.13
DH6739	-5.09	-3.82	-0.32
GKGSA-1 (GK-1)	-7.00	-5.25	-0.44

Representative Monitoring Site	Subsidence Minimum Threshold		
	Total (feet)	Action Level (feet)	Rate (feet/year)
GKGSA-2 (GK-2)	-3.40	-2.55	-0.21
K001	-0.10	-0.08	-0.13
K003	-0.66	-0.50	-0.13
K012	-7.00	-5.25	-0.44
K015	-1.89	-1.42	-0.13
K015X	-2.91	-2.18	-0.18
K016	-3.13	-2.35	-0.20
K1081	-0.10	-0.08	-0.13
Kaweah River Check	-0.10	-0.08	-0.13
KSB-0531	-7.00	-5.25	-0.44
KSB-0550	-7.00	-5.25	-0.44
KSB-0856	-6.81	-5.11	-0.43
KSB-0905	-3.68	-2.76	-0.23
KSB-1259	-5.97	-4.48	-0.37
KSB-1535	-6.47	-4.85	-0.40
KSB-1580	-2.03	-1.52	-0.13
KSB-2017	-2.00	-1.50	-0.13
KSB-2058	-0.56	-0.42	-0.13
KSB-2095	-5.13	-3.85	-0.32
KSB-2114	-6.14	-4.61	-0.38
KSB-2203	-4.64	-3.48	-0.29

Representative Monitoring Site	Subsidence Minimum Threshold		
	Total (feet)	Action Level (feet)	Rate (feet/year)
P566	-0.50	-0.38	-0.13
S228	-7.00	-5.25	-0.44

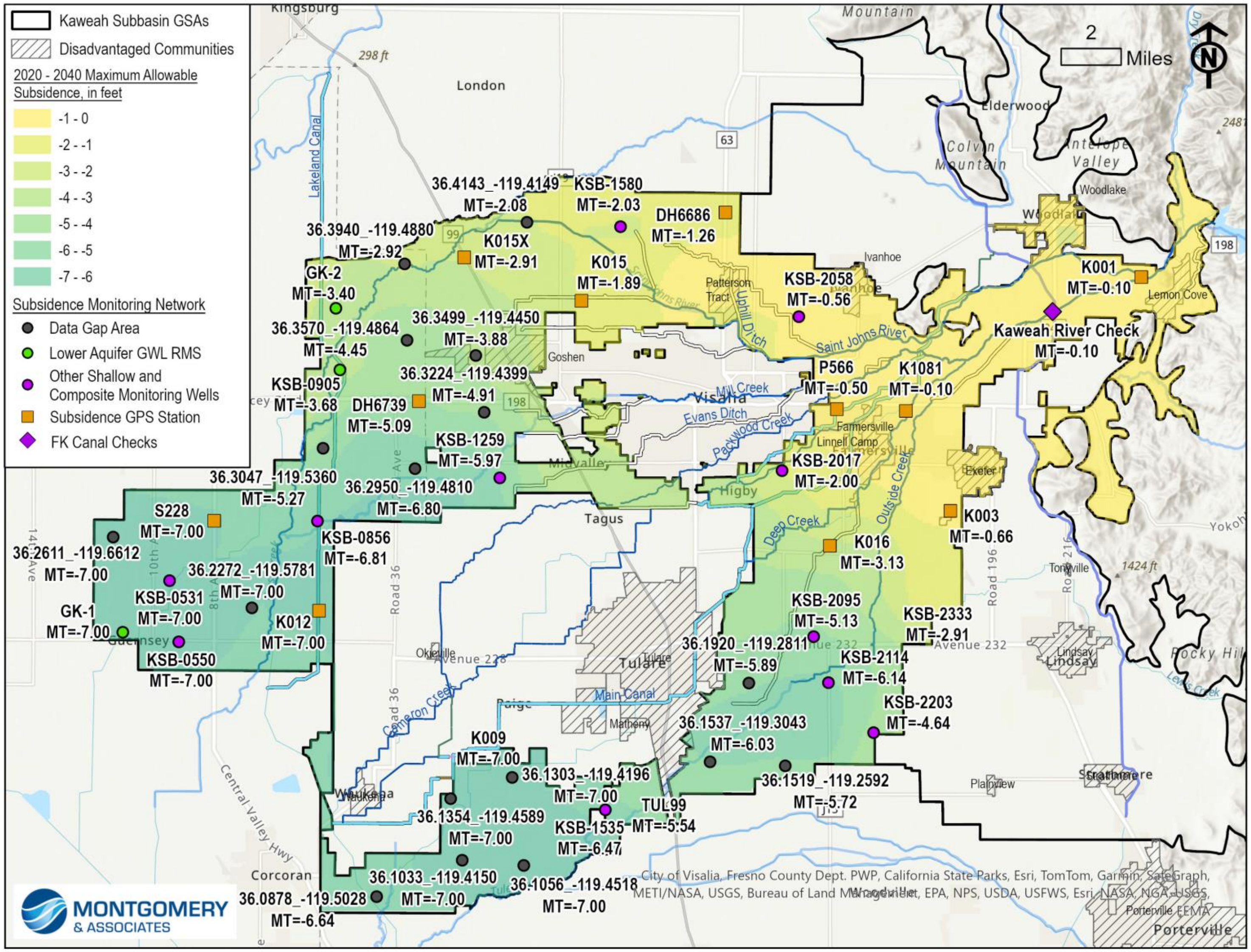


Figure 5-14. GKGSA Subsidence Minimum Thresholds

5.6.3.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

The general process to develop the subsidence SMC is shown in Figure 5-15. The various steps on Figure 5-15 are described in more detail in Appendix 5B.

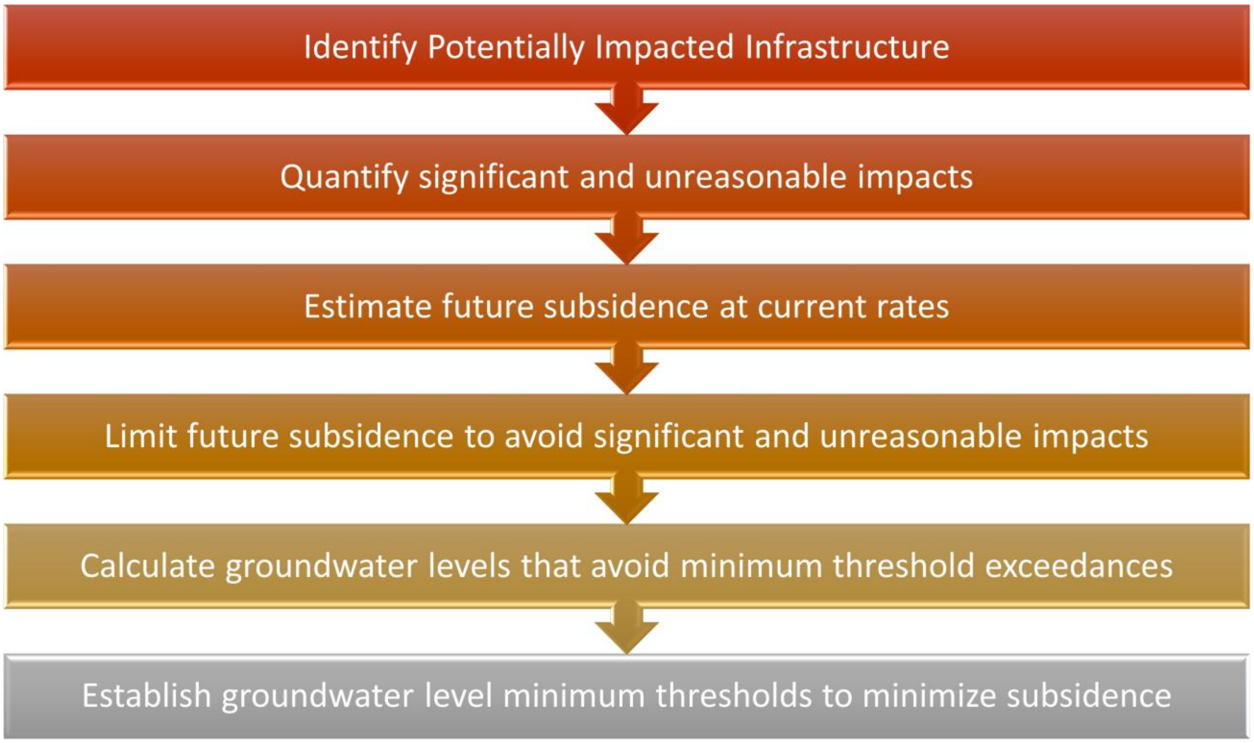


Figure 5-15. Process for Developing Land Subsidence SMC

5.6.3.2 Subsidence Minimum Threshold Extent

The spatial extent of MTs covers the entire GSP area. Subsidence MTs must address potential impacts to critical infrastructure from both total subsidence and differential subsidence. The process detailed in steps 3 and 4 in Appendix 5B shows how both total and differential subsidence are accounted for in the MTs.

Figure 5-16 shows the maximum allowable land subsidence in the GKGSA area on which the subsidence MTs area based and includes a histogram showing MT distribution across the GSP area. Subsidence MTs are different at every point in the GSP area and never exceed the significant and unreasonable levels for infrastructure discussed in Section 5.6.2.2

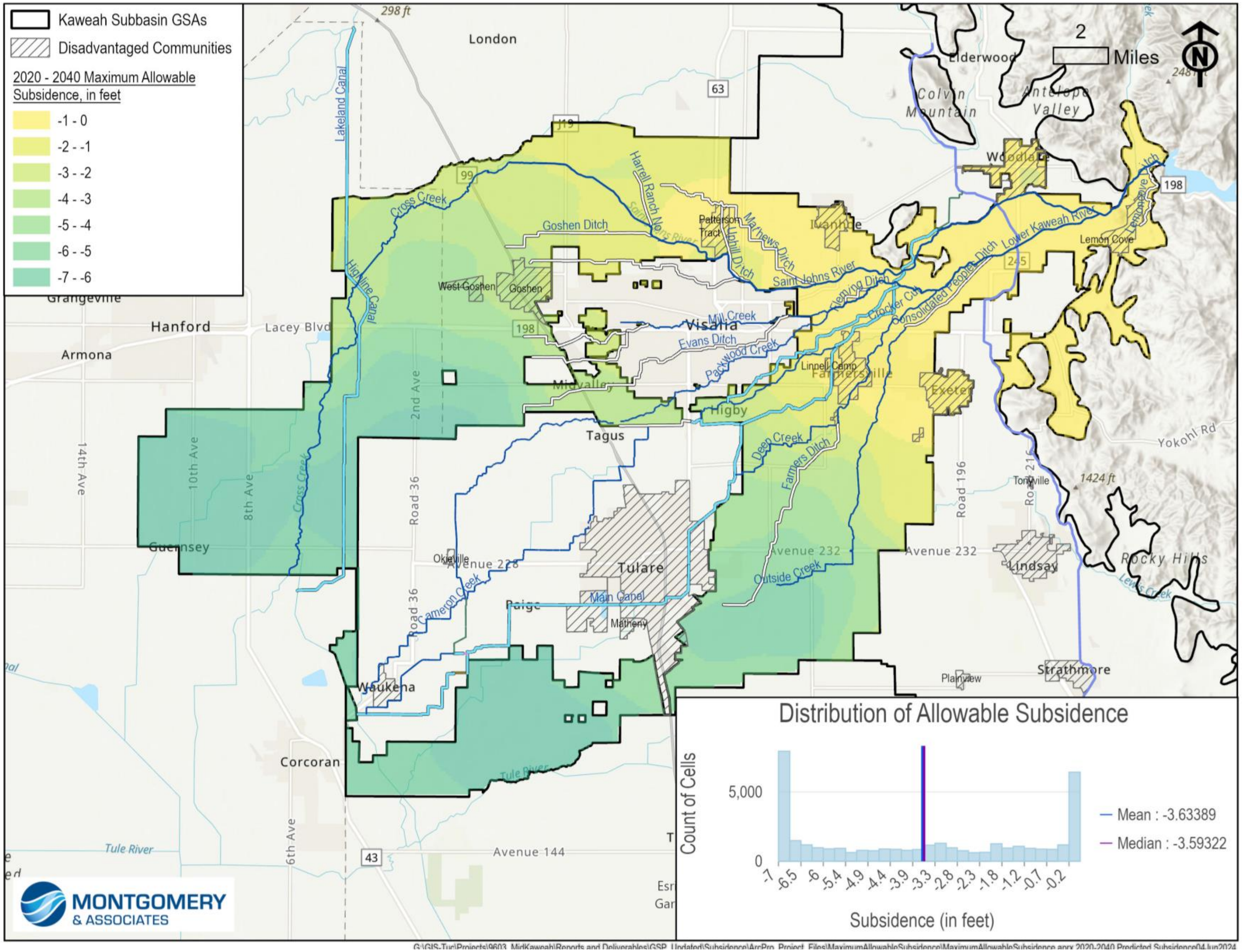


Figure 5-16. GKGSA Subsidence Minimum Threshold (Maximum Allowable Subsidence) and Histogram

5.6.3.3 Subsidence Minimum Threshold Rate

An annual subsidence MT rate is established at each monitoring site to complement the cumulative subsidence MT and help the GKGSA review annual subsidence measurements relative to long-term goals. First, the annual average subsidence rate to achieve the cumulative MT is calculated by dividing the cumulative value by the total number of years during the GSP implementation period (20). The subsidence MT rates range between 0.13 and 0.44 feet/year, which because of the downscaling steps performed to establish the cumulative MT, are less than average subsidence rates observed between 2015 and 2022. To account for downscaling effects, the subsidence MT rate is the downscaled annual average rate at each monitoring location multiplied by 1.25.

Both the rate and the extent criteria of MTs must be satisfied to avoid undesirable results. Therefore, subsidence will not continue unabated. If subsidence continues at the MT rate, it will eventually exceed the MT extent, producing an undesirable result.

5.6.3.4 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

The Kaweah Subbasin GSAs developed land subsidence MTs using smooth and continuous estimates of subsidence across the Subbasin, as discussed in Appendix 5B, based on best available data and tools. Therefore, there are no discontinuities in subsidence MTs and no conflict between MTs at individual RMS across the Kaweah Subbasin or within the jurisdictional boundaries of the GKGSA.

The subsidence minimum threshold has little or no impact on other MTs.

- **Chronic lowering of groundwater levels.** The lower aquifer groundwater level MTs are based on avoiding significant and unreasonable subsidence, as discussed in Appendix 5B. Therefore, the subsidence MTs and lower aquifer groundwater level MTs are aligned, and there is no negative impact of one on the other.

  Further geologic investigation may demonstrate that there is gradually increasing aquifer confinement with depth in parts of the single-aquifer system. In this case, the lower portion of the single aquifer may display a different groundwater level than the upper portion. A recent nested monitoring well installation in the Tule Subbasin suggests this might be the case in the southern portion of the Kaweah Subbasin (northern portion of the Tule Subbasin). If future investigations suggest a multi-zone system in the single-aquifer system, limits on lower zone groundwater levels in the single aquifer may be necessary to avoid undesirable subsidence.

- **Reduction in groundwater storage.** The groundwater storage MTs are based on the chronic lowering of groundwater level MTs. Because the subsidence MTs do not impact the chronic lowering of groundwater level MTs, they will similarly not impact the allowable reduction in groundwater storage MT.
- **Degraded water quality.** A relationship between the land subsidence MT and water quality MTs has not been established. It is not anticipated that land subsidence will result in significant and unreasonable degradation of water quality. However, the Kaweah Subbasin GSAs are coordinating with other local agencies, non-profit organizations, and landowners to monitor for any potential degradation of water quality due to subsidence.
- **Depletion of interconnected surface water.** Subsidence may change the slope of interconnected streams, but this likely has a marginal impact on depletion of interconnected surface water.

5.6.3.5 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

The following 3 subbasins of the San Joaquin Valley Basin adjoin the Kaweah Subbasin:

- Kings Subbasin to the north
- Tule Subbasin to the south
- Tulare Lake Subbasin to the west

Land subsidence throughout the San Joaquin Valley is driven by lowered groundwater levels, particularly in the deeper aquifers. Neighboring subbasins are facing similar challenges with subsidence, and the neighboring subbasin GSPs include the subsidence MTs in Table 5-10.

Table 5-10. Neighboring Subbasin Subsidence Minimum Thresholds

Groundwater Sustainability Agency	Subbasin	Maximum Subsidence Rate	Maximum Cumulative Subsidence
Kings River East	Kings	8 inches/year over 36 square miles	4 feet from 2020 elevations
East Tule	Tule	N/A	4 feet (E0048_B_RMS)
Lower Tule River ID	Tule	N/A	7 feet from 2020 elevations
Mid-Kings River El Rico	Tulare Lake	N/A	6 feet from 2023 elevations (approximately 8 feet from 2020 elevations)

The Kaweah Subbasin GSAs have intentionally set subsidence MTs to be less than or equal to neighboring subbasin MTs. Figure 5-17 compares the Kaweah Subbasin MTs with those of surrounding subbasins and GSAs. On this figure, darker green colors indicate more allowable subsidence. Figure 5- shows that the allowable subsidence in surrounding subbasins is greater than or equal to the subsidence in the Kaweah Subbasin, and there are no anticipated impacts on neighboring subbasins. The Kaweah Subbasin GSAs will continue to meet with neighboring subbasins during GSP implementation to coordinate strategies for minimizing subsidence and associated impacts.

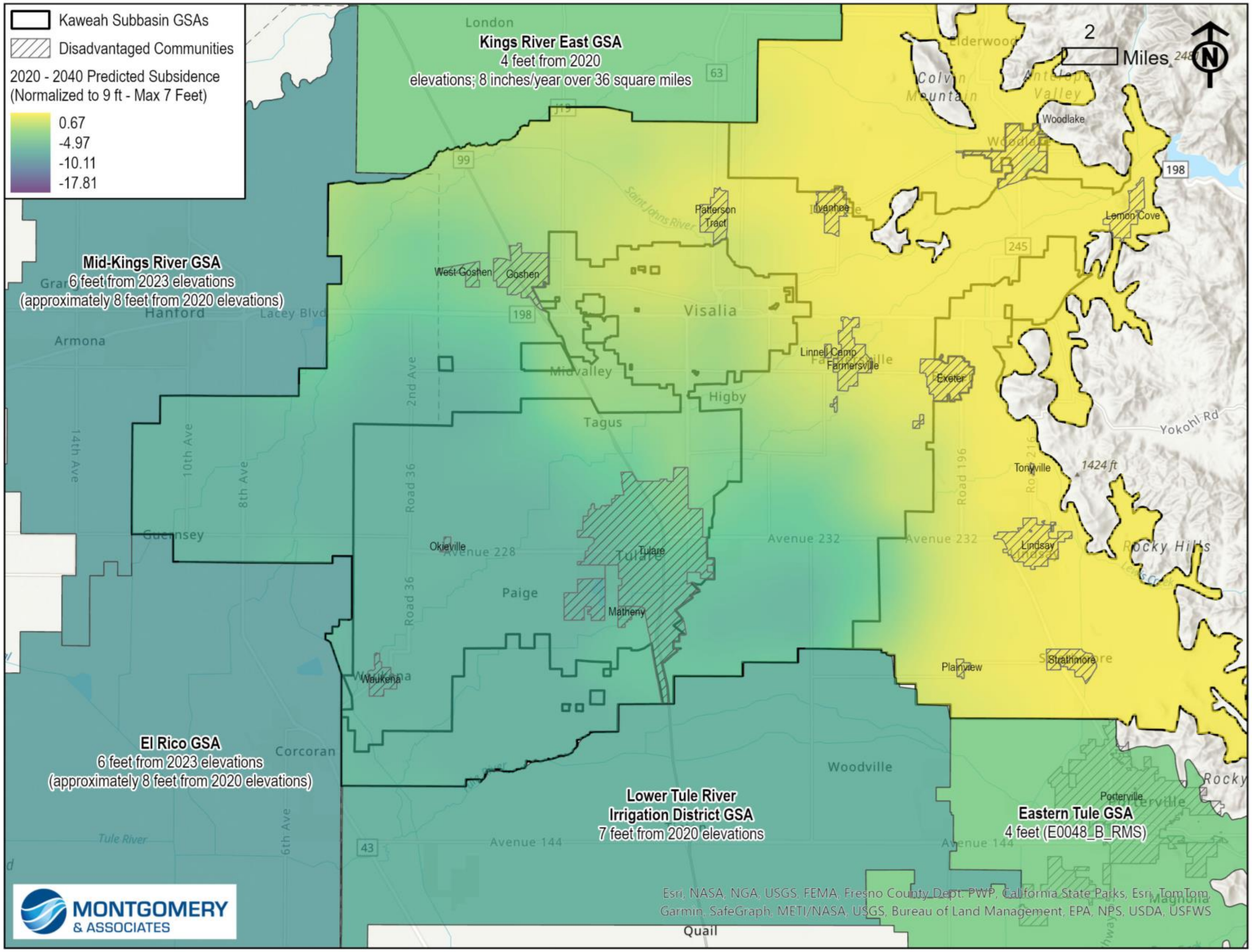


Figure 5-17. Kaweah Subbasin Subsidence Minimum Thresholds Compared to Surrounding Subbasins and GSAs

5.6.3.6 Effects on Beneficial Users and Land Uses

The subsidence MTs were explicitly set to have less than significant impacts on critical infrastructure. The GSAs will monitor land uses and users for which there is no existing quantitative data on subsidence impacts to ensure that any future subsidence does not result in an undesirable result. The GSAs have a unified Mitigation Program, and each GSA has its individual Mitigation Plan to lessen subsidence impacts to domestic and small community water system wells should subsidence impacts occur. The Mitigation Program is included as Appendix 6A.

5.6.3.7 Relevant Federal, State, or Local Standards

There are no federal, state, or local regulations related to subsidence.

5.6.3.8 Method for Quantitative Measurement of Minimum Thresholds

The GKGSA will assess subsidence annually using the subsidence monitoring network shown on Figure 5-4 and listed in Table 5-9.

5.6.4 Subsidence Measurable Objectives and Interim Milestones

The MO for land subsidence represents a target annual subsidence rate in the Subbasin. In accordance with GSA’s commitment to avoid or minimize subsidence, the MO is set to a rate of zero inelastic subsidence.

The GSA understands that this goal may not be achievable and has discussed this with DWR representatives. A recent study by Stanford University researchers found that even if groundwater levels stabilize immediately, ongoing subsidence could continue for decades, and result in as much as 10 feet of additional subsidence in some areas of the Subbasin (Lees *et al*., 2022). The same study showed that in the 1960s to 1980s when groundwater levels rose basin-wide because of increased use of surface water, subsidence continued at rates between 0.03 and 0.3 foot per year. Recent studies and historical observations suggest that some subsidence may occur after 2040 regardless of the projects and management actions implemented by the GSAs, making it difficult to achieve the objective of zero subsidence.

By setting the MO to a rate of zero subsidence, GSAs are committing to minimizing subsidence and limiting impacts on land surface uses and users. The GKGSA is implementing projects and management actions on an accelerated basis to reduce the subsidence and achieve the MOs (see Chapter 6).

5.6.4.1 Methodology for Setting Measurable Objectives and Interim Milestones

The MO was set to the best possible outcome: a rate of zero inelastic subsidence. This MO was chosen to minimize impacts on land surface uses and users.

A subsidence rate IM is established at 5-year intervals from 2025 through 2040. The IM rate is reduced over time to help the Subbasin achieve the MO of zero subsidence after 2040. The rates are calculated at each monitoring location using the following approach:

- **2025 IM** is equal to the MT rate.
- **2030 IM** is the average annual subsidence rate that achieves the subsidence MT.
- **2040 IM** is 1/2 the average annual subsidence rate that achieves the subsidence MT.

5.6.4.2 Measurable Objectives

Measurable objectives for each of the 44 subsidence RMS are set to zero**.**

5.6.4.3 Interim Milestones

IMs for all 44 subsidence RMS are listed in Table 5-18.

Table 5-18 GKGSA Subsidence Interim Milestones

Representative Monitoring Site	Interim Milestone Subsidence Rate (feet/year)		
	IM 2025	IM 2030	IM 2035
36.0878_-119.5028	-0.42	-0.33	-0.17
36.1033_-119.4150	-0.44	-0.35	-0.18
36.1056_-119.4518	-0.44	-0.35	-0.18
36.1303_-119.4196	-0.44	-0.35	-0.18
36.1354_-119.4589	-0.44	-0.35	-0.18
36.1519_-119.2592	-0.36	-0.29	-0.14
36.1537_-119.3043	-0.38	-0.30	-0.15
36.1920_-119.2811	-0.37	-0.29	-0.15
36.2272_-119.5781	-0.44	-0.35	-0.18
36.2611_-119.6612	-0.44	-0.35	-0.18
36.2950_-119.4810	-0.43	-0.34	-0.17
36.3047_-119.5360	-0.33	-0.26	-0.13
36.3224_-119.4399	-0.31	-0.25	-0.12
36.3499_-119.4450	-0.24	-0.19	-0.10
36.3570_-119.4864	-0.28	-0.22	-0.11

Representative Monitoring Site	Interim Milestone Subsidence Rate (feet/year)		
	IM 2025	IM 2030	IM 2035
36.3940_-119.4880	-0.18	-0.15	-0.10
36.4143_-119.4149	-0.13	-0.10	-0.10
DH6686	-0.13	-0.10	-0.10
DH6739	-0.32	-0.25	-0.13
GKGSA-1 (GK-1)	-0.44	-0.35	-0.18
GKGSA-2 (GK-2)	-0.21	-0.17	-0.10
K001	-0.13	-0.10	-0.10
K003	-0.13	-0.10	-0.10
K012	-0.44	-0.35	-0.18
K015	-0.13	-0.10	-0.10
K015X	-0.18	-0.15	-0.10
K016	-0.20	-0.16	-0.10
K1081	-0.13	-0.10	-0.10
Kaweah River Check	-0.13	-0.10	-0.10
KSB-0531	-0.44	-0.35	-0.18
KSB-0550	-0.44	-0.35	-0.18
KSB-0856	-0.43	-0.34	-0.17
KSB-0905	-0.23	-0.18	-0.10
KSB-1259	-0.37	-0.30	-0.15
KSB-1535	-0.40	-0.32	-0.16
KSB-1580	-0.13	-0.10	-0.10
KSB-2017	-0.13	-0.10	-0.10
KSB-2058	-0.13	-0.10	-0.10
KSB-2095	-0.32	-0.26	-0.13
KSB-2114	-0.38	-0.31	-0.15
KSB-2203	-0.29	-0.23	-0.12
P566	-0.13	-0.10	-0.10
S228	-0.44	-0.35	-0.18

5.7 Reduction of Groundwater Storage

5.7.1 Reduction of Groundwater Storage Undesirable Results [§354.26(a),(b)(1),(b)(2),(b)(3)]

§ 354.26. Undesirable Results.

(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.

(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 signed 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.

The overall process relied upon to define undesirable results for the reduction of groundwater storage sustainability indicator is the same as the chronic lowering of groundwater level sustainability indicator and is described in **Sections 5.3, 5.4, and 5.5**.

The evaluation of potential effects on beneficial uses and users, land uses, and property interests for the reduction of groundwater storage sustainability indicator is the same as for chronic lowering of groundwater levels. The effects of decreasing groundwater storage manifest as effects for other sustainability indicators (i.e., reduction of groundwater storage is associated with chronic lowering of groundwater levels). The qualitative description of undesirable results is reduction of groundwater storage that will likely cause other sustainability indicators to have undesirable results.

The criteria used to define undesirable results for the reduction of groundwater storage sustainability indicator are based on the qualitative description of undesirable results, which is causing other sustainability indicators to have undesirable results. As explained in **Section 5.7.2**, groundwater levels will be used as a proxy for the reduction of groundwater storage sustainability indicator minimum thresholds. Based on the foregoing, the combination of minimum threshold exceedances that is deemed to cause significant and unreasonable effects leading to undesirable results in the Basin for the reduction of groundwater storage sustainability indicator is the same as the combination deemed to cause undesirable results for the chronic lowering of groundwater levels sustainability indicator (**Table 5.4**).

5.7.2 Reduction of Groundwater Storage Minimum Thresholds [§354.28(d)]

§ 354.28. Minimum Thresholds.

(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.

Pursuant to GSP Emergency Regulations §354.28(d), groundwater levels may be used as a proxy for other sustainability indicators if a significant correlation between groundwater levels and the other sustainability indicators can be demonstrated. Groundwater levels are correlated to groundwater storage (i.e, rising groundwater levels indicate an increase in groundwater storage and vice versa), as described in **Appendix 5G**. Groundwater storage cannot be directly measured and can only be estimated using measured or modeled groundwater levels and knowledge of the basin geometry and subsurface hydraulic properties; therefore, the calibrated numerical model is used to estimate groundwater in storage for the Basin (**Appendix 5G**). Furthermore, groundwater levels are a more direct and reliable measure of sustainability as compared to estimated storage changes. For these reasons, the SMC for the chronic lowering of groundwater levels (**Table 5.4**) will be used as a proxy for the reduction of groundwater storage sustainability indicator.

Henceforth, the GSP Emergency Regulations under §354.28 for the reduction of groundwater storage sustainability indicator are described in the chronic lowering of groundwater levels section above (**Section 5.5.3**).

5.8 Degraded Groundwater Quality SMC [§354.28(c)(4)]

§354.28 Minimum Thresholds.

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:

(4) Degraded Water Quality. The minimum threshold for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.

Important Note:

SMCs for groundwater quality expressed below are the same as the 2022 GSP. The Kaweah Subbasin GSAs and Technical Team are in the process of considering revisions to groundwater quality SMCs in response to the SWRCB Draft Staff Report's new deficiencies received during the publishing process of this Public Draft GSP.

Preparation of this 2nd Amended GSP and its supporting analyses and documentation was conducted in 2023 and early 2024, before the draft Staff Report released in May 2024. Even though the draft Staff Report was released before publication of this document, given the completion rate of the GSP and the lack of a final Staff Report, publication of the GSPs continued without incorporating the comments from the draft Staff. Therefore, the only deficiencies and recommendations that the Kaweah Subbasins have available and are directed to address are DWR's deficiencies. The Kaweah Subbasin GSAs will collaborate with the SWRCB to address any additional supplemental recommendations from the SWRCB staff in accordance with the stakeholder feedback process outlined described in **SECTION 5.3.2**.

Per SGMA Regulations, significant and unreasonable degraded water quality is the migration of contaminant plumes that impair water supplies. With respect to SGMA, degradation of groundwater quality only applies to groundwater quality changes due to actions implemented as part of this GSP, such as changes in regional pumping patterns or implementation of projects or management actions.

5.8.1 Locally Defined Significant and Unreasonable Conditions

Per SGMA Regulations, significant and unreasonable degraded water quality is the migration of contaminant plumes that impair water supplies. With respect to SGMA, degradation of groundwater quality only applies to groundwater quality changes due to actions implemented as part of this GSP, such as changes in regional pumping patterns or implementation of projects or management actions.

5.8.2 Minimum Thresholds [§354.28(b)(1),(2),(3)]

The minimum thresholds are the MCLs or the Agricultural WQOs, whichever is applicable at the representative monitoring site. A summary of constituents to be monitored and tracked by the GKGSA is provided as Table 5-11.

The methodology used to distinguish between the applicability of either MCLs or agricultural constituents of concern is as follows:

- At each representative monitoring well, determine the dominant beneficial use for that monitoring well. If the majority of the beneficial use (greater than 50% of the pumping within a determined area) was agriculture and there were no public water systems (including schools) the minimum threshold would be a host of agricultural water quality constituents.

- The water will be monitored for drinking water standards; however if there is an exceedance of a MCL, the GSA shall inform any users in the area of the exceedance and provide technical assistance such as water quality testing and information on potential alternative water supply options (bottled water, reverse osmosis (RO) systems, connecting to a public water system, etc.).
- As a part of the technical assistance, water quality testing of residential systems could be offered, which would increase the water quality data temporally and spatially over the GKGSA.
- The GSA will also notify other responsible agencies and organizations of the MCL exceedance and coordinate activities such that the actions of the GSA do not contribute to the further exceedance of any MCL.
- If a monitoring well is located within an urban area, or near a public water system (e.g., within a mile), which includes schools, then the minimum threshold would be set at the MCL for drinking water. If an MCL is exceeded, then the public water agency responsible for the water quality in those wells shall be contacted and the GSA shall coordinate their activities such that they do not result in an exceedance of any MCL.

Minimum thresholds for water quality are summarized in Table 5-11. The groundwater quality monitoring network is provided in Section 4.6 of this Plan.

Table 5-11: Water Quality Monitoring Network

Well ID	System Name	Well Name	Latitude	Longitude	Top of Screen (feet bgs)	Bottom of Screen (feet bgs)	Aquifer System
5403144-002	ALI MUTUAL WATER CO	WELL 02 (DOC'S CORNER)	36.21141	-119.25936			Single
5400710-001	BADGER HILL ESTATES	WELL 01 - NORTH	36.30742	-119.07207	69	184	Single
5400710-002	BADGER HILL ESTATES	WELL 02 - SOUTH	36.30615	-119.07061	69	121	Single
5401044-001	CAL TRANS-VISALIA MAINTENANCE STATION	WELL 01	36.32536	-119.22948	255	295	Single
5403076-002	CENTRAL CAL TRISTEZA ERAD	WELL 02	36.20511	-119.26166			Single
1610004-001	CORCORAN, CITY OF	WELL 01A	36.12122	-119.53431	194	465	Both
1610004-002	CORCORAN, CITY OF	WELL 02A	36.12286	-119.53180	217	467	Both
5403148-001	COURAGE TO CHANGE	WELL 01	36.30593	-119.17090			Single
5400583-003	CUTLER PARK	WELL 03	36.35067	-119.22829			Single
5410041-004	CWS - TULCO WATER COMPANY	WELL 201-02	36.19995	-119.28180	450	510	Lower
5410016-178	CWS - VISALIA	WELL 33-02 (OAKRCH)	36.35638	-119.24062			Single
5410016-179	CWS - VISALIA	WELL 42-01 (OAKRCH)	36.35531	-119.23432			Single
5410016-182	CWS - VISALIA	WELL 95-01	36.35589	-119.40841	300	320	Lower
1600249-001	DEL MONTE FOODS, INC. PLANT #24	WELL 01 - WEST WELL	36.25513	-119.65086			Unknown
1600249-003	DEL MONTE FOODS, INC. PLANT #24	WELL 03 - SOUTH	36.25593	-119.64644			Unknown
1600249-004	DEL MONTE FOODS, INC. PLANT #24	WELL 04 - NORTHEAST	36.25674	-119.64646			Unknown
1600249-005	DEL MONTE FOODS, INC. PLANT #24	WELL 05 - STBY2017	36.25690	-119.65094			Unknown
5400844-002	ELBOW CREEK SCHOOL	WELL 02	36.38397	-119.26555			Single
5400846-002	ELBOW SCHOOL	WELL 02	36.35983	-119.21668			Single
5403130-001	ELEANOR ROOSEVELT COMM LEARNING CTR	WELL 01	36.35450	-119.17182			Single
5403147-001	EXETER KINGDOM HALL	WELL 01	36.29661	-119.16776			Single
5410003-002	EXETER, CITY OF	WELL E06W	36.29675	-119.14465	181	400	Single
5410003-004	EXETER, CITY OF	WELL E09W	36.29827	-119.15143	164	243	Single
5410003-007	EXETER, CITY OF	WELL E11W	36.29871	-119.15415	150	405	Single
5410003-012	EXETER, CITY OF	WELL E12W	36.30606	-119.13576	320	600	Single
5410003-014	EXETER, CITY OF	WELL E13W	36.28330	-119.15387	230	480	Single
5410004-001	FARMERSVILLE, CITY OF	WELL 01A	36.30496	-119.20462			Single
5410004-003	FARMERSVILLE, CITY OF	WELL 03A	36.29064	-119.20757	230	318	Single
5410004-004	FARMERSVILLE, CITY OF	WELL 04A	36.30920	-119.20671	150	235	Single
5410004-005	FARMERSVILLE, CITY OF	WELL 05A	36.30192	-119.20069	156	300	Single
5410004-006	FARMERSVILLE, CITY OF	WELL 06A	36.30198	-119.21294	150	300	Single
5410004-007	FARMERSVILLE, CITY OF	WELL 07A	36.32322	-119.20716	150	390	Single
5410004-014	FARMERSVILLE, CITY OF	WELL 08A	36.31254	-119.21250	310	670	Single
5403141-001	HELLWIG PRODUCTS CO INC	WELL 01	36.32743	-119.20931			Single
5403090-001	IN & OUT FOODMART	WELL 01	36.29645	-119.38316	175	275	Upper
5403121-001	INTERNATIONAL PAPER - EXETER BULK	WELL 01	36.30620	-119.17174			Single
5410019-004	IVANHOE PUBLIC UTILITY DIST	WELL 04	36.37737	-119.22054	174	234	Single
5410019-006	IVANHOE PUBLIC UTILITY DIST	WELL 06	36.38928	-119.22462	230	410	Single
5410019-007	IVANHOE PUBLIC UTILITY DIST	WELL 07	36.38725	-119.21531	250	460	Single
5410019-008	IVANHOE PUBLIC UTILITY DIST	WELL 08	36.38311	-119.22233			Single
5403030-001	JACK GRIGGS INC.	WELL 01	36.39505	-119.02122			Single
1600013-001	LAKESIDE ELEMENTARY SCHOOL	WELL #1	36.24160	-119.61998			Unknown
5400616-001	LEMON COVE WATER CO	WELL 01 - MC KAY'S POINT	36.38738	-119.04461			Single
5410006-015	LINDSAY, CITY OF	WELL 15 (CITY WELL)	36.22540	-119.15448	210	420	Single
5400631-001	LINNELL FARM LABOR CENTER	WELL 01 - SOUTH	36.30997	-119.22309			Single
5400631-002	LINNELL FARM LABOR CENTER	WELL 02 - NORTH	36.31090	-119.22225	152	302	Single
5403032-001	MONROVIA NURSERY - NURSERY	WELL 8	36.37351	-119.15681	140	320	Single
5403055-001	MONROVIA NURSERY - OFFICE	WELL 01	36.38143	-119.13602			Single
5400819-002	MOUNTAIN VIEW MHP	WELL 01 (DRILLED 93/94)	36.32775	-119.22620			Single
1600602-001	NICHOLS FARMS	WELL #1	36.27165	-119.47541			Unknown
1600602-002	NICHOLS FARMS	WELL #2	36.27181	-119.47632			Unknown
5400972-001	OUTSIDE CREEK SCHOOL	WELL 01	36.26887	-119.20662	254	350	Single
5400850-002	PACKWOOD SCHOOL	WELL 02	36.29862	-119.41925	270	421	Both
5400519-001	PALO VERDE SCHOOL	WELL 01	36.14546	-119.35621	150	300	Both
5402038-001	PATTERSON TRACT CSD	WELL 01 WEST	36.37850	-119.29194			Single
5402038-002	PATTERSON TRACT CSD	WELL 02 EAST	36.37850	-119.29159			Single

Well ID	System Name	Well Name	Latitude	Longitude	Top of Screen (feet bgs)	Bottom of Screen (feet bgs)	Aquifer System
5403122-001	PC'S FOOD MART	WELL 01	36.38424	-119.29807	130	134	Single
5400969-002	PENINSULA PACKAGING CO	WELL 02	36.30333	-119.17084			Single
5400709-001	SEQUOIA UNION ELEMENTARY SCHOOL	WELL 01	36.37711	-119.03888			Single
5400709-002	SEQUOIA UNION ELEMENTARY SCHOOL	WELL 02	36.37711	-119.03694			Single
5403031-001	SUN PACIFIC - TULARE	WELL 01	36.23996	-119.28219	210	460	Both
5403031-002	SUN PACIFIC - TULARE	WELL 02 - STANDBY	36.23831	-119.28198			Unknown
5400714-001	SUNDALE UNION SCHOOL	WELL 01	36.22596	-119.26184	320	400	Single
5400881-001	SUNRISE MUTUAL WATER CO.	WELL 01	36.37266	-119.30142			Single
5400881-002	SUNRISE MUTUAL WATER CO.	WELL 02	36.37457	-119.29733			Single
5400903-001	TRACT 92 CSD	WELL 01 - EAST	36.28915	-119.24204	196	223	Single
5400903-002	TRACT 92 CSD	WELL 02 - WEST	36.28915	-119.24214			Single
5403050-002	TULARE COUNTY HAULING	WELL 02	36.28069	-119.26128			Single
5402027-001	TULARE COUNTY ROAD YARD 2/3	WELL 01	36.25517	-119.25852			Single
5410015-069	TULARE, CITY OF	WELL 44	36.19611	-119.28921	400	540	Lower
5400873-001	UNION SCHOOL	WELL 01	36.29943	-119.24203			Single
5400928-003	VISALIA SALES YARD	WELL 02	36.32863	-119.23162			Single
5403154-002	WILLITTS EQUIPMENT CO., INC.	WELL 02	36.34398	-119.13355			Single
5410020-004	WOODLAKE, CITY OF	WELL 08	36.40320	-119.09778	100	175	Single
5410020-005	WOODLAKE, CITY OF	WELL 09	36.40380	-119.09832	75	130	Single
5410020-006	WOODLAKE, CITY OF	WELL 10	36.39982	-119.09799	106	199	Single
5410020-007	WOODLAKE, CITY OF	WELL 11	36.40022	-119.09626	80	200	Single
5410020-008	WOODLAKE, CITY OF	WELL 12	36.39760	-119.10152	100	195	Single
5410020-009	WOODLAKE, CITY OF	WELL 13	36.39631	-119.10903			Single
5410020-010	WOODLAKE, CITY OF	WELL 14	36.39577	-119.11168			Single

The minimum thresholds shall be set at the MCLs or the Ag WQOs, whichever is applicable at the monitoring site. MCLs have been established for numerous constituents in water and these constituents will be tracked as the responsible agencies develop their data. However, the Basin Setting Report identified six constituents of primary concern and **Table 5-12** lists the MCLs for this list.

5.8.2.1 Information and Methodology Used to Establish Minimum Thresholds

The minimum thresholds and measurable objectives are based on MCLs or Agricultural WQOs, whichever is applicable at the representative monitoring site.

5.8.2.2 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Preventing degradation of groundwater quality has little or no impact on minimum thresholds for other sustainability indicators, as described below:

- **Chronic lowering of groundwater levels**. The degradation of groundwater quality minimum thresholds could influence groundwater level minimum thresholds by limiting the types of water that can be used for recharge to maintain or raise groundwater elevations. Water used for recharge cannot exceed any groundwater quality standards.

- **Reduction in groundwater storage**. The degradation of groundwater quality minimum thresholds do not promote lower groundwater elevations. Therefore, the groundwater quality minimum thresholds will not result in an exceedance of the groundwater storage minimum threshold.
- **Land subsidence**. The degradation of groundwater quality minimum thresholds do not promote additional pumping that could cause subsidence. Therefore, the groundwater quality minimum thresholds will not result in an exceedance of the subsidence minimum threshold.

Table 5-12. GKGSA Groundwater Quality Constituent of Concern, Minimum Thresholds and Measurable Objectives.

Type	Constituent	Minimum Threshold		Measurable Objective	
Public Drinking Water	Arsenic	10	µg/L	7.5	µg/L
	Nitrate (as N)	10	mg/L	7.5	mg/L
	Chromium-VI	10	µg/L	7.5	µg/L
	DBCP	0.2	µg/L	0.15	µg/L
	1,2,3 TCP	0.005	µg/L	0.0038	µg/L
	PCE	5	µg/L	3.8	µg/L
	Perchlorate	6	µg/L	4.5	µg/L
	Uranium	20	pCi/L	15	pCi/L
	Sodium	no drinking water MCL		no drinking water MCL	
	Chloride	500 [1]	mg/L	375	mg/L
	TDS	1000 [1]	mg/L	750	mg/L
Agricultural [3]	pH (upper)	8.4	pH units	7.9 [2]	pH units
	pH (lower)	6.5	pH units	7.0 [2]	pH units
	Conductivity	700	uS/cm	525	uS/cm
	TDS	450	mg/L	338	mg/L
	Boron	700	µg/L	525	µg/L
	Calcium	No established Ag Water Quality Goal[3]		No established Ag Water Quality Goal	
	Magnesium	No established Ag Water Quality Goal		No established Ag Water Quality Goal	
	Sodium	69	mg/L	52	mg/L
	Potassium	No established Ag Water Quality Goal		No established Ag Water Quality Goal	
	HCO_3	No established Ag Water Quality Goal		No established Ag Water Quality Goal	
	Chloride	106	mg/L	80	mg/L
	Nitrate (as N)	No established Ag Water Quality Goal		No established Ag Water Quality Goal	
	Sulphate (as SO_4)	No established Ag Water Quality Goal		No established Ag Water Quality Goal	

[1] Chloride and TDS are regulated under secondary MCLs in California due to aesthetics. These constituents have three ranges for the MCL: recommended, upper, and short term. The MT use the upper limit of consumer acceptance MCL.

[2] Measurable Objective for pH calculated as 75% of the difference between the upper and lower Ag Water Quality goals.

[3] Agricultural thresholds are based on the State Water Resources Control Board's Compilation of Water Quality Goals available at: https://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/.

5.8.2.3 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

Coordination between all GSAs responsible for establishing minimum thresholds in the Kaweah Subbasin and neighboring subbasins occurred throughout the development of this GSP. All three GSAs in the Kaweah Subbasin used identical approaches to establish degradation of groundwater quality minimum thresholds. Because the same approach is used, GKGSA minimum thresholds will have no negative effects on neighboring GSAs within the Subbasin. In general, the neighboring subbasins used similar approaches to establish their minimum thresholds; therefore, maintaining groundwater quality above minimum thresholds or pre-SGMA baseline conditions, should not prevent the neighboring subbasins from achieving sustainability and vice versa. The GKGSA will continue to coordinate closely with other GSAs in the region during GSP implementation to ensure that minimum thresholds have no significant effects on neighboring GSAs ability to achieve sustainability.

5.8.2.4 Effects on Beneficial Users and Land Uses

Coordination between all GSAs responsible for establishing minimum thresholds in the Kaweah Subbasin and neighboring subbasins occurred throughout the development of this GSP. All three GSAs in the Kaweah Subbasin used identical approaches to establish degradation of groundwater quality minimum thresholds. Because the same approach is used, GKGSA minimum thresholds will have no negative effects on neighboring GSAs within the Subbasin. In general, the neighboring subbasins used similar approaches to establish their minimum thresholds; therefore, maintaining groundwater quality above minimum thresholds or pre-SGMA baseline conditions, should not prevent the neighboring subbasins from achieving sustainability and vice versa. The GKGSA will continue to coordinate closely with other GSAs in the region during GSP implementation to ensure that minimum thresholds have no significant effects on neighboring GSAs ability to achieve sustainability.

5.8.2.5 Relevant Federal, State, or Local Standards

The groundwater quality minimum thresholds specifically incorporate state and federal standards for drinking water and basin plan objectives.

5.8.2.6 Method for Quantitative Measurement of Minimum Thresholds

As described in Section 4.7, GKGSA will evaluate groundwater quality degradation by either directly performing groundwater sampling at representative monitoring sites and coordinating with other agencies responsible for the collection and reporting of groundwater quality through other regulatory programs. GKGSA will partner with these agencies to share data for inclusion in its GSP annual reports and five-year assessments. The relationship between groundwater levels and degradation trends, if any, is site-specific. Periodic sampling during the GSP implementation phase will assist in revealing any such relationship as water levels stay above water level minimum thresholds and within the confines of measurable objectives.

The 10-year average concentration of each constituent will be compared to the minimum threshold in GSP Annual Reports. Where MCLs are already exceeded prior to GSP implementation, this will be considered a baseline condition that GKGSA is not responsible for remediating.

5.8.3 Measurable Objectives and Interim Milestones [§354.30(a)(b)(c)(d)(e)(f)(g)]

§354.30 Measurable Objectives.

(a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 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.

(g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for a finding of inadequacy of the Plan.

5.8.3.1 Methodology for Setting Measurable Objectives

As explained in this Section, the GKGSA supports the protection of groundwater quality by coordinating with other regulatory agencies established to maintain and improve the groundwater quality in the Kaweah Subbasin. All future projects and management actions implemented by the GKGSA are designed to avoid causing further groundwater quality degradation.

To protect against further water quality degradation (exceedance of MCLs or Agricultural WQOs), the GKGSA will establish measurable objectives at 75% of the MCLs or WQOs. This objective will alert GKGSA to any constituent's concentration that is approaching the MCL or WQO. Using water quality data provided by other agencies, GKGSA will include time-series plots of water quality constituents to demonstrate projects and management actions are operating to avoid degradation. Should the concentration of constituents of concern raise to 75% of the MCL or WQO as the result of a GSA project, GKGSA will implement corrective measures (i.e., halting recharge operations, reducing pumping, etc.) to avoid an exceedance in the event that such concentrations result from GSA actions.

As progress towards improving water quality rests largely with other regulatory agencies, interim milestones for water quality will not be explicitly applied.

GKGSA will also coordinate with the entities responsible for complying with existing groundwater quality regulatory programs. Many of these programs (i.e., ILRP, Dairy Program, CV-SALTS) are still in the early stages of implementation and groundwater quality objectives are still under consideration. Once established, GKGSA will include these levels in the GSP periodic assessments outlined in Section 7 of this Plan.

Measurable objectives for water quality are provided in Table 5-12.

5.8.3.2 Interim Milestones

As progress towards improving water quality rests largely with other regulatory agencies, interim milestones for water quality will not be explicitly applied.

5.8.4 Undesirable Results

5.8.4.1 Criteria for Defining Groundwater Quality Undesirable Results

SGMA defines undesirable results for groundwater quality as the:

> *"Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies."*

The key SGMA directive is a degradation of existing water quality. GKGSA recognizes MCLs are relevant to public drinking water as a beneficial use. Since a large portion of this Plan area is in agriculture, with agricultural irrigation as the beneficial use, the GKGSA will also avoid degradation above the Agricultural Water Quality Objectives (Ag WQO) presented and described in the Basin Setting report (Appendix 3A).

An exceedance of any of the MCL or agricultural metrics as defined herein at any representative monitoring sites will trigger a management action within the applicable management area or GSA, subject to determination that the exceedance was caused by actions of the GSA. Should one-third of all Subbasin monitoring sites exhibit an exceedance, an undesirable result will be deemed to occur. Where MCLs are already exceeded prior to GSP implementation, this will be considered a baseline condition that GKGSA is not responsible for remediating. However, GKGSA will work cooperatively with water quality agencies charged with addressing these conditions.

Groundwater quality degradation will be evaluated relative to established MCLs or other agricultural constituents of concern by applicable regulatory agencies. The metrics for degraded water quality shall be measured by MCL compliance or by other constituent concentration measurements where appropriate. These metrics will include measurements for the following constituents where applicable:

- Arsenic
- Nitrate
- Chromium-6
- DBCP
- TCP
- PCE
- Sodium
- Chloride
- Perchlorate
- TDS

In regions where agriculture represents the dominant use of groundwater, Agricultural Water Quality Objectives will serve as the metric as opposed to MCLs within public water supply jurisdictions. An exceedance of any of the MCL or agricultural metrics as defined herein at any representative monitoring sites will trigger a management action within the applicable management area or GSA, subject to determination that the exceedance was caused by actions of the GSA. MCLs and water quality objectives are subject to changes as new water quality objectives are promulgated by the State of California and the Federal EPA. GKGSA will provide updates in our annual reports and GSP Updates throughout the implementation periods of 2020 to 2040.

5.8.4.2 Potential Causes of Undesirable Results

Undesirable results associated with water quality degradation can result from pumping localities and rates, as well as other induced effects by implementation of a GSP, such that known migration plumes and contaminant concentrations are threatening production well viability are causes of Undesirable results. Well production depths too may draw out contaminated groundwater, both from naturally occurring and man-made constituents which, if MCLs are exceeded, may engender Undesirable results. Declining water levels may or may not be a cause, depending on location. In areas where shallow groundwater can threaten the health of certain agricultural crops, rising water levels may be of concern as well.

5.8.4.3 Effects on Beneficial Users and Land Uses

The beneficial uses of groundwater in the Kaweah Subbasin are described in the Water Quality Control Plan for the Tulare Lake Basin Second Edition – 1995 (State Board Water Quality Control Plan). This document also includes a description of the Water Quality Objectives for Groundwater, an Implementation Plan, Relevant Plans and Policies, and Surveillance and

Monitoring. GKGSA's sustainability goal is in alignment with the State Board's Water Quality Control Plan.

The beneficial uses of groundwater in the Kaweah Subbasin include:

- Municipal, Small Community, Disadvantaged Community and Domestic Drinking Water Supply (MUN)
- Agricultural Supply (AGR)
- Industrial Service Supply (IND)
- Industrial Process Supply (PRO)
- Water Contact Recreation (REC-1)
- Non-Contact Water Recreation (REC-2)

The water quality objectives for each of these beneficial uses, including MCLs and their associated metrics for each constituent are based on SWRCB's *Compilation of Water Quality Goals*. MCLs change as new rules are promulgated by the Federal EPA and SWRCB. GKGSA will provide updates including the addition of any new constituents in its 5-year GSP assessments.

The potential effects of degraded water quality from migrating plumes or other induced effects of GSA actions include those upon municipal, small community, disadvantaged community and domestic well sites rendered unfit for potable supplies and associated uses, and/or the costs to treat groundwater supplies at the well head or point of use so that they are compliant with state and federal regulations. Potential effects also include those upon irrigated agricultural industries, as certain mineral constituents and salt build-up can impact field productivity and crop yields.

5.9 Depletion of Interconnected Surface Water SMC [§354.28(C)(6)(A), (6)(B)]

§354.28 Minimum Thresholds.

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:

(6)Depletions of Interconnected Surface Water. The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results. The minimum threshold established for depletions of interconnected surface water shall be supported by the following:

(A) The location, quantity, and timing of depletions of interconnected surface water.

(B) A description of the groundwater and surface water model used to quantify surface water depletion. If a numerical groundwater and surface water model is not used to quantify surface water depletion, the Plan shall identify and describe an equally effective method, tool, or analytical model to accomplish the requirements of this Paragraph.

Important Note:

SMCs for groundwater quality expressed below are the same as the 2022 GSP. SMCs for depletions of interconnected surface are in process of being revised in response to the SWRCB Draft Staff Report's new deficiencies received during the publishing process of this Public Draft GSP.

Preparation of this 2nd Amended GSP and its supporting analyses and documentation was conducted in 2023 and early 2024, before the draft Staff Report released in May 2024. Even though the draft Staff Report was released before publication of this document, given the completion rate of the GSP and the lack of a final Staff Report, publication of the GSPs continued without incorporating the comments from the draft Staff. Therefore, the only deficiencies and recommendations that the Kaweah Subbasins have available and are directed to address are DWR's deficiencies. The Kaweah Subbasin GSAs will collaborate with the SWRCB to address any additional supplemental recommendations from the SWRCB staff in accordance with the stakeholder feedback process outlined described in **SECTION 5.3.2**.

GKGSA has identified interconnected surface water as a data gap and has begun implementation of the Interconnected Surface Water Data Gap Workplan (Section 6.8.7) to address this data gap. As a result of this management action, the Kaweah Subbasin now has three new shallow RMS wells dedicated to evaluating the groundwater level conditions near Lewis Creek, in the perched aquifer, northwest of Strathmore and north of Woodlake and south of Elderwood, near Cottonwood Creek.

In addition to the three new RMS wells, GKGSA is evaluating inclusion of six additional monitoring wells along the Kaweah River in the monitoring plan.

It is important to clarify that groundwater levels are not a substitute for depletions of interconnected surface water; however, establishing protective groundwater level SMC adjacent to these potentially interconnected waterbodies are intended to avoid significant and unreasonable impacts by keeping potential interconnection present.

SGMA requires GSAs to develop and enforce groundwater management policies that avoid significant and undesirable results. This is especially challenging for the interconnected surface water sustainability indicator. The ability to assess relationships between groundwater pumping and depletions of interconnected surface water can be hindered by many other variables that influence groundwater levels and flow stage, such as snowpack declines, snowmelt variability, upstream vegetative type, density, and extent, landscape changes (such as indirect influenced from seasonal fires, such as landslides), and many other variables that are unrelated the anthropogenic groundwater management.

The DWR BMP on interconnected surface water was not available when this 2nd Amended GSP was published. Once it is available, the Kaweah Subbasin will evaluate it and revisit interconnected surface water identification, monitoring, and SMC.

The inclusion of interconnected surface water RMS and SMC does not suggest that these waterways are indeed interconnected; however, in the absence of sufficient data and information, the Kaweah Subbasin has established protective criteria based on GDE health (the most vulnerable beneficial user) under recent historic conditions. Through the monitoring of these new RMS and continued implementation of the Interconnected Surface Water Data Gap Workplan, the understanding of the potential for interconnection to be present in the Kaweah Subbasin is expected to be improved and expected to be established in future iterations of the GSP. Not only do more monitoring sites need to be installed, but sufficient time to evaluate the data is necessary to make meaningful determinations regarding the potential for interconnections.

SGMA requires sustainable management criteria considerate of surface water flow; however, this remains a data gap for the ephemeral streams within GKGSA and the Kaweah Subbasin that may be potentially interconnected. These new RMS wells and the volumetric SMC communicated below are intended as an interim measure and will be useful in supplementing the understanding of ISWs once stream flow data is made available through the Interconnected Surface Water Data Gap Workplan (**Section 6.7.12**).

5.9.1 Undesirable Results

Section 6.8 of Appendix 6 of the Kaweah Subbasin Coordination Agreement (**Appendix 1B**) discusses the undesirable result for interconnected surface waters in the Kaweah Subbasin. The Kaweah Subbasin (East Kaweah and Greater Kaweah GSAs specifically) are implementing the Interconnected Surface Water Data Gap Workplan (**Section 6.7.12**) which is intended to provide a clearer definition of where potentially interconnected surface waters are located and to what extent adverse impacts related to groundwater pumping are present and can be defined and quantified. Absent sufficient data and information, and the DWR BMP on interconnected surface water, EKGSA has established interim SMC, including undesirable results, based on groundwater levels nearest these potentially interconnected waterways.

5.9.1.1 Subbasin Defined Significant and Unreasonable Conditions

Interconnected surface waters remain a data gap; however, in the interim, a significant and unreasonable impact pertaining to depletions of interconnected surface waters in the Kaweah Subbasin include:

- GDE health has declined such that the ecosystem's recovery is non-recoverable. GDEs in the San Joaquin Valley and throughout California undergo seasonal changes and water year-type changes in health expression via an NDVI metric like what the Nature Conservancy uses to assess GDE health in the GDE Pulse 2.2 tool. These fluctuations in

GDE health are deemed significantly and unreasonably impacted when a GDE has surpassed the ability to recover in seasonal high, wet year conditions.

- Surface water access for surface water rights holders or riparian rights holders of adjacent or downstream users has been reduced due to groundwater pumping extracting underflows.

5.9.1.2 Criteria for Defining Chronic Lowering of Groundwater Levels Undesirable Results

Consistent with the Coordination Agreement (**Appendix 1B**), the current primary criteria and metrics for defining and quantifying adverse impacts and URs will be the estimated percentage of losses within potentially interconnected channels, measured as a rate or volume of depletion of surface water. 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.
However, sufficient streamflow and shallow groundwater monitoring is not available to establish such SMCs. To address this data gap, the Interconnected Surface Water Data Gap Workplan is being implemented.

The Kaweah Subbasin GSAs will continue prioritizing implementation and evolving the Interconnected Surface Water Data Gap Workplan (**Section 6.7.12**). Since the management action's initiation in 2022, multiple new RMS wells have been installed, and additional progress has been made in assessing ideal locations for flow monitoring.

5.9.1.3 Potential Causes of Undesirable Results

Section 6.8.1 of Appendix 6 of the Kaweah Subbasin Coordination Agreement (**Appendix 1B**) discusses the causes of groundwater conditions that could lead to significant and unreasonable depletions of interconnected surface waters in the Kaweah Subbasin. URs associated with interconnected surface waters are understood to be caused by several factors. Some of these factors may include groundwater pumping, drier hydrology, and changes within the upper watershed, or some combination of those factors. Within the Kaweah Subbasin, there are currently significant data gaps related to understanding the potential locations of interconnected surface waters and their nexus to depletions caused by groundwater pumping. More information is intended to be developed and shared through the Interconnected Surface Water Data Gap Workplan, being coordinated and implemented by the East and Greater Kaweah GSAs. More information on this management action is included in **Section 6.7.12**. Data gathered and/or timing of such data, there may be shifts or re-ordering of phases/tasks to better adapt and facilitate completion. Since this management action's development in 2022, progress has been made, such as the installation of multiple shallow monitoring sites adjacent to potentially interconnected streams and identifying ideal locations for stream flow monitoring.

5.9.1.4 Effects on Beneficial users and Land Uses

Currently identified potential beneficial uses/users related to interconnected surface water within the GKGSA are surface water users, riparian and/or groundwater dependent ecosystems, and water rights holders. As more data becomes available, the Interconnected Surface Water Data Gap Workplan (**Section 6.7.12)** may add or subtract to these uses/users in whole or part of the reaches of the selected waterways. The potential effects of depletions to interconnected surface water when approaching or exceeding minimum thresholds and thus becoming an undesirable result include:

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

SMC and impacts to beneficial users, uses, and property interests for each sustainability indicator must consider the relationship to other sustainability indicators SMC and beneficial users, uses, and property interests. Therefore, the effects of historic surface water flow and groundwater conditions in relation to GDE health, as presented on the Nature Conservancy's GDE Pulse 2.2 tool, were considered when evaluating the upper aquifer groundwater level sustainable management criteria. As described in **Section 5.9.2.1** and **Section 5.9.3.1,** the SMC for interconnected surface water is informed by upper aquifer groundwater level SMC because the establishment of those SMCs is considered the beneficial users, uses, and interests of interconnected surface water.

5.9.2 Minimum Thresholds [§354.28(b)(1)]

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

The potential, if any, groundwater-dependent ecosystems and waterways to be evaluated for interconnectivity in the Work Plan are shown in **Section 3.3.4**. The reaches selected are based on evaluating the spatial extents of the 30 ft depth to water contour for Spring 2015 and Spring 2017 or where there is no groundwater level data. These two Spring seasons represent the driest and wettest water years since SGMA has been enacted and are used for understanding the potential extents and fluctuations along reaches to be studied through the Work Plan. These 30ft DTW contours were not intended to imply conclusive locations of interconnected surface water at this time. Additionally, within the study area of Lewis Creek, there are portions that will need to be evaluated related to a perched water surface area that, at this time, appears to be independent of groundwater pumping and more linked to subsurface flow from the Sierra Nevada range to the east.

For the preliminary SMC for the interconnected surface water sustainability indicator, the GKGSA 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 to other indicators such as groundwater-level declines. As with all sustainability indicators, continued observations of conditions in the future and not less frequently than at each five-year GSP assessment, the GKGSA, in conjunction with the other Kaweah GSAs, will evaluate whether criteria should be changed.

Table 5-13 Preliminary Minimum Thresholds for Interconnected Surface Waters

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

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

5.9.2.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

The potential effects of depletions to interconnected surface water, when approaching or exceeding MTs and thus becoming a UR, are increased losses experienced by surface water users and rights holders and loss of potential riparian or groundwater-dependent ecosystems. The GKGSA is initially setting MTs for interconnected surface waters based on the limited local experience of surface water purveyors in the area who have operated these waterways for decades; however, to the extent channel losses have been caused by groundwater pumping is not understood. Based on this experience, typical losses in these channels have varied annually and seasonally but have been on the order of 30% of the flows in the channels. In dry periods these losses have increased. Losing half of the surface water supply may be considered significant and unreasonable given the importance of surface water supplies in the Kaweah Subbasin**. Thus, the GKGSA has set starting MT for interconnected surface waters based on 50% loss of the respective waterway's flow, data permitting (Table 5-13).**

In instances with little or no data, the 25-Year Storm capacity for the respective waterways is based on the 1970 Tulare County Flood Master Plan. Many of the waterways with little or no data are ephemeral in nature and take significant storms and/or wetter periods to generate surface water flow. Historic local hydrology suggests that approximately one out of four years are wetter hydrology, which guided the selection of the use of 25-year Storm data. **Table 5-10** 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).

5.9.2.2 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

The GKGSA has identified interconnected surface water as a data gap and, therefore, does not have enough data to meaningfully establish relationships between other sustainability indicators. In the interim, groundwater level data is being gathered at new monitoring sites to determine the relationship between chronic lowering of groundwater levels and depletions of interconnected surface water.

5.9.2.3 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

The SMC for interconnected surface water remains unapproved by DWR or SWRCB for any Subbasin within the San Joaquin Valley, as all Subbasin are awaiting the DWR Guidance Document on the topic to best determine the relationship. More information on this will be available in future years as the Kaweah Subbasin and neighboring Subbasins perform interconnected surface water studies, monitoring, and analyses.

5.9.2.4 Effects on Beneficial Users and Land Uses

The potential effects of depletions to interconnected surface water when approaching or exceeding minimum thresholds and thus becoming an undesirable result include:

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

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 by 50% channel loss.

5.9.2.5 Relevant Federal, State, or Local Standards

The Kaweah Subbasin GSAs will comply with existing federal, state, or local regulations pertaining to the implementation of the GSPs. In the context of interconnected surface water in the Kaweah Subbasin, riparian water rights and downstream surface water rights, enforced on the state level, will continue to be recognized in analyses, policies, and management actions. The MT and MO are expected to be protective and consistent with recent historic conditions; however, more importantly, the Kaweah Subbasin’s demand management strategies by GKGSA, are expected to be protective of the potential to interfere with riparian and other surface water rights for downstream users.

Once the BMP from DWR is released, the Kaweah Subbasin will evaluate recommendations on how to best evaluate the relationship between groundwater management and reductions in surface water supplies of interconnected systems. In addition, through implementation of the Interconnected Surface Water Data Gap Workplan (**Section 6.7.12**), the ability to identify interconnected surface waterbodies with greater certainty is expected.

5.9.2.6 Method for Quantitative Measurement of Minimum Thresholds

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

Additionally, groundwater levels at the three new interconnected monitoring sites will be evaluated. The reporting for these sites will start in the 2024 Water Year annual report.

5.9.3 Measurable Objectives and Interim Milestones

Similar to the approach used in setting MTs for interconnected surface waters, the GKGSA is leaning on limited local experience in the setting of MOs for interconnected surface waters.

From experience, the understanding of the typical losses in these waterways is on the order of 30% of the flows in the channels. The GKGSA is unaware of significant impacts and/or URs at this loss rate or whether groundwater pumping is impacting this rate. Thus, the GKGSA has set preliminary MO for interconnected surface waters based on estimated 30% loss of the respective waterway's flow, data permitting. In instances with little or no data, the 25-Year Storm capacity for respective waterways based on the 1970 Tulare County Flood Master Plan is used. **Table 5-13** summarizes the estimated MO rates for the potentially interconnected portions of the surface water ways in the GKGSA. The rates are in cubic feet per second per linear foot of channel (CFS/LF).

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.

5.9.3.1 Interim Milestones

IMs 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 IMs 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. IMs, 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.

6 PROJECTS & MANAGEMENT ACTIONS

6.1 Introduction

This Section discusses water supply availability for projects (Section 7.2), describes each project (Section 7.3), describes management actions (Section 7.4), discusses an implementation plan (Section 7.5), and summarizes the analyses of water supply benefits afforded by each applicable project (Section 7.6). These Subsections collectively comply with the requirements of Section §354.44 of DWR's Regulations.

6.2 Water Supply Accounting

A Water Accounting Framework (WAF) was developed by the 3 Kaweah Subbasin GSAs to direct development of projects and management actions and to track benefits accrued by each project and management action. The following subsections describe the WAF and how it informs the Subbasin allocation strategy.

It should be noted that the WAF has not been updated since 2020 because the GSAs' focus has been on addressing DWR deficiencies, including an intensive update of the numerical groundwater model in the Kaweah Subbasin that is used to establish an updated water budget (Section 3.4**Error! Reference source not found.**). Once groundwater quality and interconnected surface water deficiencies are also addressed, the WAF will be updated to reflect projected native, foreign, and salvaged water for each GSA and the Subbasin. Updating the WAF is a high priority for the GSAs to assist with 2025 allocations set in July 2024. The updated WAF will be included in the final version of this Amended GSP to inform the ongoing benefits and accounting of groundwater flows in the Kaweah Subbasin.

6.2.1 Application of Basin Setting Water Budget

Table 32 of the Kaweah Basin Setting (Appendix 3A) contains the Subbasin hydrogeologic water budget for the current period 1997-2017, showing all components of inflow and outflow. The water budget, however, does not account for who contributed to the GSA-managed inflows to the groundwater system within the Kaweah Subbasin or the GKGSA. The updated groundwater water budgets are derived from the Subbasin groundwater flow model, which was also used to develop both Subbasin-wide and GSA-specific projected water budgets incorporating groundwater pumping projections/cutbacks and planned projects and management actions of each GSA. Updated water budgets will be used to update the WAF in the final version of this GSP.

6.2.2 Water Accounting Framework Allocation

The Subbasin GSAs have discussed water budgets in the context of groundwater law and case law and have developed a means to account for various components of the water budget and ownership of said water, consistent with commonly accepted rules regarding surface and groundwater rights. These discussions also included recognition of water storage and conveyance infrastructure within the Subbasin as owned/operated by various water management entities within each GSA.

These discussions and common understanding are reflected in the Subbasin Coordination Agreement, and culminated in an agreed-to methodology to assign groundwater inflow components to each GSA consistent with categories that recognize a native, foreign, and salvaged portion of all such components. In general, this methodology defines the native portion of groundwater inflows to consist of those inflows which all well owners have access to on a pro-rata basis; the 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 the 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).

The methodology and apportionment of groundwater inflow components is shown in **Table 6-1**.

Table 6-1: Components of Groundwater Inflow

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

(*) Except for mountain-front recharge, sub-surface inflows in and out of the Subbasin are excluded from this apportionment and no ownership claims are asserted nor disavowed per this apportionment.

Applying the categorical apportionment in **Table 6-1** to each GSA and their member entities that hold appropriative and contract water rights and/or salvaged water infrastructure systems results in the following apportionment to each GSA, shown in **Table 6-2** below. Note that Table 6-2 has not been updated since 2020 but will be updated for the final version of this GSP.

Table 6-2: GSA Apportionment for Kaweah Subbasin (based on 2020 GSP Water Budget)

(values in acre-feet)

	Native Water			
	East	Greater	Mid	Total
Percolation of Precipitation (Ag and 'Native' non-Ag land	23,666	44,213	20,974	**88,854**
Streambed Percolation from Kaweah River Sources	16,767	31,324	14,860	**62,952**
Irrigation Return from Pumped Groundwater	41,484	77,501	36,766	**155,752**
Mountain Front Recharge	14,976	27,978	13,273	**56,227**
Total Native	**96,894**	**181,017**	**85,874**	**363,784**
GSA% of Total Native	**27%**	**50%**	**24%**	**100%**

	Foreign Water			
	East	Greater	Mid	Total
Streambed Percolation from Imported Sources	0	11,730	2,523	**14,253**
Ditch Percolation from Imported Sources	0	1,204	21,745	**22,949**
Basin Percolation from Imported Sources	0[1]	1,050	14,305	**15,355**
Irrigation Return from Imported Sources	12,073	1,241	7,140	**20,453**
Total Foreign	**12,073**	**15,225**	**45,713**	**73,010**
GSA% of Total Foreign	**17%**	**21%**	**63%**	**100%**

	Salvaged Water			
	East	Greater	Mid	Total
Ditch Percolation from Kaweah River Sources	8,835	49,771	34,880	**93,486**
Additional Storage	226	6,892	5,697	**12,815**
Stormwater Return Flows	508	2,370	8,491	**11,368**
Wastewater Treatment Plant Return Flows	1,470	3,129	13,878	**18,477**
Basin Percolation from Kaweah River Sources	0	16,005	23,479	**39,484**
Irrigation Returns from Kaweah River Sources	4,555	31,039	11,981	**47,574**
Total Salvaged	**15,593**	**109,205**	**98,406**	**223,205**
GSA% of Total	**7%**	**49%**	**44%**	**100%**

	East	Greater	Mid	Total *
Grand Total	**124,560**	**305,447**	**229,992**	**659,999 ****
GSA% of Total	**19%**	**46%**	**35%**	**100%**

(*) Excludes net sub-surface inflow of 60 TAF/yr
(**) Sustainable yield for the Kaweah Subbasin
Note: Data is based on water budget for the period Water Year 1997 to 2017 for the Kaweah Subbasin
This table is exported from the Water Accounting Framework, which was produced before many of the recharge basins, on-farm recharge and other activities were being implemented (therefore, this field is set to 0 when in reality, there is a sizeable volume of water that is not being recharged in basins across the Kaweah Subbasin.

In the 2020 GSP, the WAF included a comparison of groundwater inflow assignments into KGSA to annual groundwater pumping for the same period (1997-2017). The difference between the numbers results in an imputed water balance surplus for GKGSA. The imputed water balance will be updated with the updated water budget in the final version of the GSP.

As stipulated in the Coordination Agreement, Subbasin GSAs will continue discussions on water budgets and groundwater conditions during GSP implementation and, in so doing, manage the location, extent, and financial contributions to projects and management actions of each. The groundwater net inflow balances and hydrogeologic water budgets of each GSA region will be given due consideration in these future discussions. The Subbasin GSA groundwater inflow water balances are preliminary and a 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 components are refined, the Subbasin water budget will be periodically reevaluated, no less frequent than the 5-year Periodic Evaluations. Likewise, the individual GSA water balances will also be reviewed as this re-evaluation occurs at the Subbasin level.

6.2.3 Water Budget Reconciliation (based on 2020 GSP Water Budget)

The shared/owner water budget may be reconciled against the hydrogeologic water budget set forth in Section 3.4, as both methods of quantifying the groundwater inflow components necessarily arrive at the same volume in acre-feet. The reconciliation for the Kaweah Subbasin (based on the 2020 GSP water budget) is shown as follows:

Groundwater inflow budget (avg. of 1997-2017):

- Total inflow = 814 taf
- Mountain front recharge = 56 taf
- Sub-surface inflow = 209 taf

The shared/owner balance excludes the subsurface inflow from other adjacent subbasins, as this estimated quantity and accounting therefore awaits further discussions with the relevant GSAs within these adjacent subbasins. With this assumption, the reconciliation of the Subbasin groundwater budget to the GSAs' shared/owner water balance is:

814 taf – (209 taf+56 taf) ≈ 660 taf

Adding back in the mountain front recharge results in:

660 taf + 56 taf ≈ 720 taf, i.e., the safe yield of the Subbasin as discussed in Appendix 3A.

6.2.4 GSA Member Allocation Strategy

GKGSA Members recognize that the GSA water apportionments, as discussed in Section 6.2, may be further apportioned to different areas of the GKGSA area. This effort will take into consideration the existing water management and associated facility ownership agreements among the GKGSA Members as they relate to groundwater recharge activities. This apportionment will aid in determining Member participation in the various projects as well as shaping the extent of management actions (pumping restrictions), as outlined in Chapter 6. Any allocation strategy will give due consideration to the Sustainability Plan Cooperative Statement adopted by the GKGSA Board as stated in Section 6.7.11.

6.3 General Process for Developing Projects and Management Actions

Projects and management actions described in this Plan include groundwater recharge projects and programs, surface reservoir projects, leveraged surface water exchange programs, a groundwater extraction measurement implementation program, a conceptual groundwater marketing program, future urban and agricultural conservation, a groundwater allocation mechanism among well owners and operators, land fallowing program, and other projects and management actions. Following are each project and management action, along with the measurable objective and associated sustainability indicator that will benefit therefrom. The GKGSA will work to improve these projects and programs by evaluating opportunities to also create and enhance ecosystem benefits through the development and implementation of the projects and programs described in this chapter.

6.4 Overview of Projects and Management Actions

The Projects proposed in this Plan by the GKGSA consist of a combination of completed and ongoing projects, developed by the JPA Members of the GSA, and projects proposed by the GSA in partnership with either a JPA Member or another GSA in the Kaweah Subbasin. The following list includes a summary of the Project types developed by the GSA Board and its committees, and the Sustainability Indicator(s) primarily impacted by the implementation of each Project.

Further planning is necessary to address the partnerships, funding, and benefactors for each project.

Table 6-3: Summary of Projects and Management Action Benefits and Status

Project	**Agency**	**GW Levels**	**Reduction in Storage**	**Water Quality**	**Land Subsidence**	**Status**
Cross Creek Layoff Basin	KCWD LIWD	♦	♦		♦	Summer 2029
Recharge Basin Improvement	LIWD KCWD KDWCD	♦	♦	♦	♦	Summer 2025
New Recharge Basins	LIWD	♦	♦	♦	♦	Summer 2032
Delta View Canal	KCWD	♦	♦	♦	♦	7/1/2031
Lakeland Canal Deliveries	KCWD CID	♦	♦		♦	Ongoing or yearly
Kings River Floodwater Arrangement	KCWD LIWD	♦	♦		♦	Ongoing or yearly
Kings River Surplus Water	KCWD LIWD	♦	♦	♦	♦	Ongoing or yearly
Fallowing Program	KCWD LIWD	♦	♦		♦	Summer 2029
On-Farm Recharge & Storage	KCWD LIWD	♦	♦	♦	♦	Ongoing or yearly
Hannah Ranch Flood Control Project	KDWCD	♦	♦	♦	♦	Summer 2026
Paregien Flood Control & Recharge Project	KDWCD	♦	♦	♦	♦	Complete
Ketchum Flood Control & Recharge Project	KDWCD	♦	♦	♦	♦	Summer 2030
St. Johns River Water Conservation Project	KDWCD	♦	♦	♦	♦	Summer 2031
Basin No. 4 Improvement Project	KDWCD	♦	♦	♦	♦	Complete
Peoples Recharge Expansion Project	KDWCD	♦	♦	♦	♦	Summer 2027
Greater Fallowing Auction Program	**GKGSA**	♦	♦		♦	**Ongoing or yearly**
Management Action	**Agency**	**GW Levels**	**Reduction in Storage**	**Water Quality**	**Land Subsidence**	**Status**
Communication and Engagement	GKGSA	Not applicable				Ongoing or yearly
Terminus Reservoir Reoperation Program	KDWCD	Not applicable				7/1/2032
Groundwater Extraction Measurement Program	GKGSA	♦			♦	Ongoing or yearly
Well Characterization Program	GKGSA	Not applicable				7/1/2027
Geophysical Data Survey – Phase I	GKGSA	Not applicable				Complete

	MKGSA EKGSA					Complete
Kaweah Subbasin Mitigation Program & GKGSA Mitigation Plan (*new)	GKGSA	♦	♦		♦	Ongoing or yearly
Water Importation/Recharge Program (*new)	KDWCD	♦	♦		♦	Ongoing or yearly
Agricultural Water Conservation & Management	GKGSA	Not applicable				Ongoing or yearly
Fee & Incentive Program	GKGSA	Not applicable				Ongoing or yearly
Groundwater Market	GKGSA	Not applicable				Ongoing or yearly
Groundwater Allocation Program	GKGSA	Not applicable				Ongoing or yearly
Interconnected Surface Water Data Gap Work Plan	GKGSA	Interconnected surface water				7/1/2026
Well Registration Program (*new)	GKGSA	Not applicable				Begin Summer 2024
Small Community Well Proactive and Protection Action Plan (PPAP) (*new)	GKGSA	Not applicable				Program Development starts June 2024 Implement in June 2025
Well Permit Application Review and Technical Support (*new)	GKGSA	Not applicable				Beginning Implementation

Figure 6-1 shows the locations of the projects.

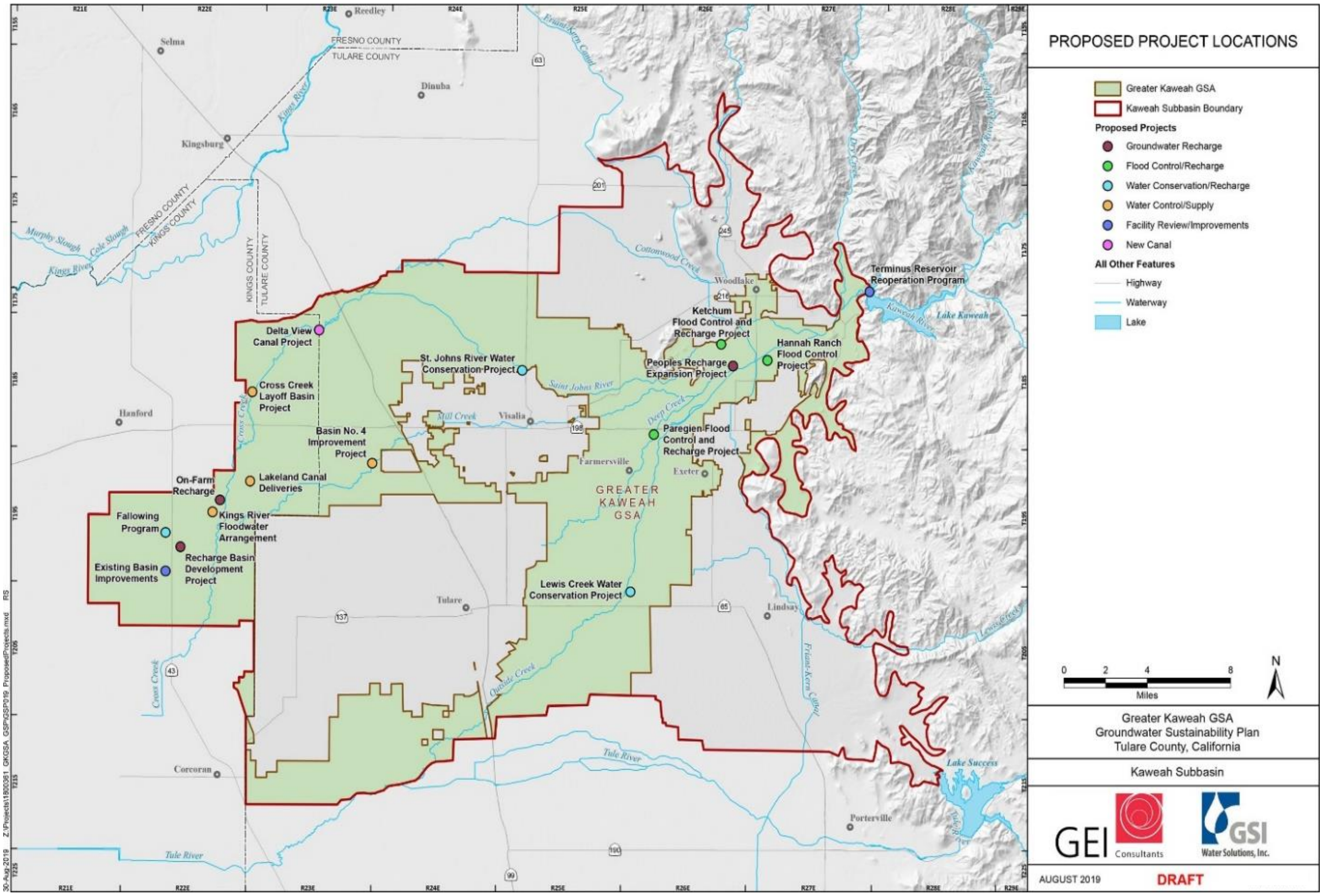


Figure 6-1: Proposed Project Locations

6.5 Water Supply Considerations

Most of the projects and management actions listed in Sections 6.6 and 6.7 will provide added water supply benefits, either in the form of groundwater storage or regulation of surface flows that would otherwise leave the Kaweah Subbasin. An assessment of the water supply availability is required to appropriately analyze the projects and management actions and their respective capabilities, particularly in a region subject to critical overdraft and considered as having limited surface water supplies exhibiting a high degree of variability from year to year.

6.6 Projects

6.6.1 P1: Cross Creek Layoff Basin

Project Type: Local Surface Storage

Project Location: The preliminary site for this project has been identified, but it is believed that if it is disclosed acquisition will become more costly. For this reason, the area is described as north of Grangeville Avenue, near where the Lakeland Canal, the Lakeside Ditch and Cross Creek cross.

Implementing Agency: Kings County Water District, in partnership with Lakeside Irrigation Water District

6.6.1.1 Project Description

The Cross Creek Layoff Basin will utilize roughly 115 acres to store floodwater for later use within a 125-acre site which will be located in the vicinity of the intersections of Lakeland Canal, the Lakeside Ditch and Cross Creek with Grangeville Avenue. The storable depth of the basin is anticipated to be 10 feet, which translates to a storable volume of roughly 1,100 acre-feet (AF). The basin might be utilized every fourth or fifth year during a wet winter season. Diversion and conveyance facilities will need to be developed for management of flows.

This project is located on agricultural acreage that relies on groundwater for irrigation and the elimination of this acreage will provide roughly 350 AF of in-lieu groundwater recharge per year (125 acres at 95% agriculture using 3 AF per year). Additional recharge may be realized through leakage from the basin during storage as well as deep percolation of the irrigated water.

6.6.1.2 Measurable Objective Addressed

The project will assist in achieving the measurable objectives for chronic lowering of groundwater levels, reduction in storage, subsidence, and possibly degradation of water quality.

6.6.1.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the KCWD is implementing this project to increase recharge to the subbasin.

6.6.1.4 Public Notice and Outreach Process

Environmental review for this project has not yet begun. Appropriate notice and outreach will be provided by the implementing agency (Kings County Water District [KCWD]) to various public agencies and other stakeholders, including Lakeside Irrigation Water District (LIWD), Kaweah Delta Water Conservation District (KDWCD), and GKGSA. In addition, a formal Public Notice is required by the California Environmental Quality Act (CEQA).

6.6.1.5 Estimated Annual Project Benefits

The project is estimated to provide an average annual benefit of 640 AF per year.

6.6.1.6 Permitting and Regulatory Process

The project will be subject to the Kings County Land Use Authority. Other regulatory process for large earth-moving projects include CEQA and the County ordinance (#558) for the Surface Mining and Reclamation Act (SMARA), as well as local permits.

6.6.1.7 Status and Schedule

The project is anticipated to be completed during 2026 and ready to receive floodwater by 2027.

6.6.1.8 Expected Benefits and Targeted Sustainability Indicators

The expected benefits are estimated at 29,300 AF of in-lieu recharge during the 50-year planning and implementation horizon with an average annual benefit of 640 AF per year. This estimate includes a total of 16,100 AF of direct in-lieu recharge each year due to the non-agriculture presence of the basin and 13,200 AF for periodic in-lieu recharge during above-normal water years when the basin contains diverted floodwater. The targeted sustainability indicators include stabilization of groundwater levels and, by proxy, groundwater storage, and land subsidence. Deep percolation of the stored floodwater could improve groundwater quality since the floodwaters would be high-quality with a relatively low concentrations of total dissolved solids (TDS) and other constituents.

6.6.1.9 Source and Reliability of Water

Current water rights will be utilized for the diversion of the floodwaters that prior to exceeded system capacity, according to past hydrology documented in watermaster reports, are anticipated to occur on a 4-year reoccurrence period.

6.6.1.10 Legal Authority Required

KCWD has the statutory authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its service area. *See, e.g.*, *Cal. Water Code* §§ 31020 et seq.

6.6.1.11 Costs and Funding

The estimated cost of the project is $6.6 million, including property acquisition, design, construction, and financing. The funding mechanism has not been selected but will likely be a land-based assessment and/or a groundwater pumping charge.

6.6.1.12 Management of Groundwater Extractions

The project will provide additional recharge to the subbasin during wetter years to increase groundwater levels and replenish storage as an offset to decreasing levels and storage during drought conditions.

6.6.1.13 Level of Uncertainty

Wet conditions occur infrequently, perhaps every four or five years, so the project will be available during the wet years to capture additional floodwaters for recharge.

6.6.2 P2: Recharge Basin Improvements for Lakeside Irrigation Water District

Project Type: Recharge Basin

Project Location: All existing basin locations within the jurisdictional boundary of Lakeside Irrigation Water District

Implementing Agency: Lakeside Irrigation Water District, in partnership with Kings County Water District and Kaweah Delta Water Conservation District

6.6.2.1 Project Description

The Lakeside Irrigation Water District (LIWD) operates numerous recharge basins and, during maintenance work on several basins, identified methods to improve recharge rates. This project will evaluate and rehabilitate other existing facilities to address sediment buildup, diversion capacities, and other issues.

6.6.2.2 Measurable Objective Addressed

The project will assist in achieving the measurable objectives for chronic lowering of groundwater levels, reduction in storage, subsidence, and possibly degradation of water quality.

6.6.2.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the LIWD is implementing this project to increase recharge to the subbasin.

6.6.2.4 Public Notice and Outreach Process

Appropriate notice and outreach will be provided to various public agencies and other stakeholders by Lakeside Irrigation Water District (LIWD). In addition, a formal Public Notice is required by the California Environmental Quality Act (CEQA).

6.6.2.5 Estimated Annual Project Benefits

The project is estimated to provide an average annual benefit of 1,600 AF per year.

6.6.2.6 Permitting and Regulatory Process

The project will be subject to the Kings County Land Use Authority.

6.6.2.7 Status and Schedule

The evaluation phase of the project is complete and the basin rehabilitation phase will be complete by 2025/2026.

6.6.2.8 Expected Benefits and Targeted Sustainability Indicators

The expected benefits are estimated at 78,000 AF of recharge during the 50-year planning and implementation horizon with an average annual benefit of 1,600 AF per year, based on a 4-year reoccurrence period.

The targeted sustainability indicators include stabilization of groundwater levels and, by proxy, groundwater storage, and land subsidence. Deep percolation of the recharge could improve groundwater quality since the surface waters would have relatively low TDS concentrations.

6.6.2.9 Source and Reliability of Water

Based on annual operational reports prepared by Friant Water Authority, the diversion of the CVP Section 215 flood water is anticipated to occur on a 4-year reoccurrence period.

6.6.2.10 Legal Authority Required

LIWD has the statutory authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its service area. See, e.g., Cal. Water Code §§ 31020 et seq.

6.6.2.11 Costs and Funding

The estimated cost of the project is $0.8 million for 250 acres of recharge basin, including geotechnical borings, design, and sediment removal. The cost would be borne by LIWD as a normal maintenance cost for operating a recharge basin.

6.6.2.12 Management of Groundwater Extractions

The project will provide additional recharge to the subbasin during wetter years to increase groundwater levels and replenish storage as an offset to decreasing levels and storage during drought conditions.

6.6.2.13 Level of Uncertainty

Wet conditions occur infrequently, perhaps every four or five years, so the project will be available during the wet years to capture additional recharge.

6.6.3 P3: New Recharge Basins for Lakeside Irrigation District

Project Type: Recharge Basin

Project Location: The preliminary sites for this project have been identified, but it is believed that if they are disclosed, acquisition will become more costly. For this reason, the areas are described as sandy parcels within Lakeside Irrigation Water District's (LIWD) boundary.

Implementing Agency: Lakeside Irrigation Water District

6.6.3.1 Project Description

LIWD currently utilizes recharge basins to store surplus CVP water This project would establish new recharge basins – 275 acres total during the first 20-year of the planning and implementation period. These 10-foot deep basins would have a total storage capacity of 13,600 AF.

6.6.3.2 Measurable Objective Addressed

The project will assist in achieving the measurable objectives for chronic lowering of groundwater levels, reduction in storage, subsidence, and possibly degradation of water quality.

6.6.3.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the LIWD is implementing this project to increase recharge to the subbasin.

6.6.3.4 Public Notice and Outreach Process

Appropriate notice and outreach will be provided to various public agencies and other stakeholders by LIWD, and as necessary it partners KCWD and GKGSA. In addition, the CEQA review process would include a formal Public Notice.

6.6.3.5 Estimated Annual Project Benefits

The project is estimated to provide an average annual benefit of 3,600 AF per year.

6.6.3.6 Permitting and Regulatory Process

The project will be subject to the Kings County Land Use Authority. Other regulatory processes will likely include CEQA and the County ordinance (#558) for SMARA, as well as local permits.

6.6.3.7 Status and Schedule

This project is in the early planning phase with an initial acquisition of land during 2025, followed by phased completions of approximately 25 percent of the project during subsequent 5-year intervals.

6.6.3.8 Expected Benefits and Targeted Sustainability Indicators

The expected benefits are estimated at 166,000 AF of recharge during the 50-year planning and implementation horizon with an average annual benefit of 3,600 AF per year. This estimate includes a total of 23,00 AF of in-lieu recharge each year due to the non-agriculture presence of the basin and 143,000 AF from periodic above-normal water years when excess CVP water is available.

The targeted sustainability indicators include stabilization of groundwater levels and, by proxy, groundwater storage, and land subsidence. Deep percolation of the surface could improve groundwater quality since the surface water would likely have a relatively low TDS concentration.

6.6.3.9 Source and Reliability of Water

Current water rights will be utilized for the diversion of the excess CVP Section 215 flood water that, according to reports prepared by Friant Water Authority, are anticipated to occur on a 4-year reoccurrence period.

6.6.3.10 Legal Authority Required

KCWD (*Cal. Water Code* §§ 31020 et seq.) and LIWD (Cal. Water Code §§ 22075 et seq.) have the statutory authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its service area.

6.6.3.11 Costs and Funding

The estimated cost of the project is $21.3 million, including property acquisition, geotechnical and biological surveys, design, permits, construction, and financing. The funding mechanism has not been selected but will likely be a land-based assessment and/or a groundwater pumping charge.

6.6.3.12 Management of Groundwater Extractions

The project will provide additional recharge to the subbasin during wetter years to increase groundwater levels and replenish storage as an offset to decreasing levels and storage during drought conditions.

6.6.3.13 Level of Uncertainty

Wet conditions occur infrequently, perhaps every four or five years, so the project will be available during the wet years to capture additional recharge.

6.6.4 P4: Delta View Canal in Kings County Water District

Project Type: Local Conveyance Improvements/Recharge Basin

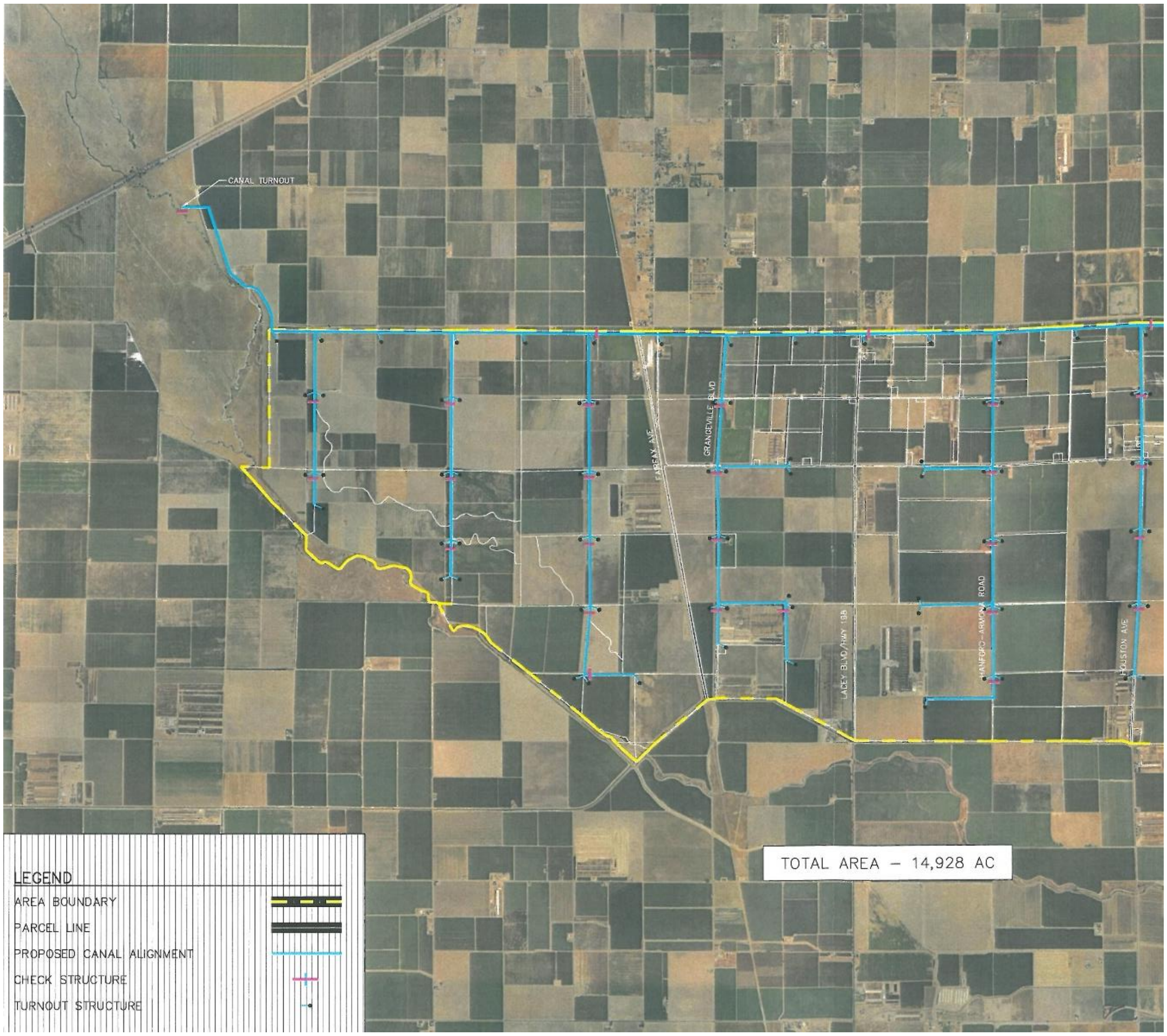
Project Location: The envisioned Project is located in the Kings County portion of the Kaweah Subbasin, outside of LIWD. The preliminary alignment for this project is along the western side of 1st Avenue in Kings County, from Cross Creek to Houston Avenue (Caldwell Ave in Tulare County).

Implementing Agency: Kings County Water District, in partnership with Kaweah Delta Water Conservation District

6.6.4.1 Project Description

The Delta View Canal will create a new 200-foot wide surface water conveyance alignment for roughly 6.5 miles (160 acres) and will terminate at either an existing 160-acre wastewater retention basin owned by the City of Visalia or a property of similar size nearby. The proposed canal alignment is located along 1st Avenue between Cross Creek and Houston Avenue. The canal would have a capacity of 100 cubic feet per second (cfs). The existing basin, if available, is not fully utilized by the City so about 120 acres may be improved to become a recharge basin. The project might be utilized every fourth or fifth year during a wet winter season with flows lasting up to 100 days. The total volume per use would be 20,000 AF, including 12,400 AF diverted to the groundwater recharge basin and 7,600 AF diverted for irrigation.

This canal will be located on agricultural acreage that relies on groundwater for irrigation and the elimination of this acreage will provide roughly 480 AF of in-lieu groundwater recharge per year (160 acres using 3 AF per year). Additional recharge may be realized through deep percolation of the irrigated water.



6.6.4.2 Measurable Objective Addressed

The project will assist in achieving the measurable objectives for chronic lowering of groundwater levels, reduction in storage, subsidence, and possibly degradation of water quality.

6.6.4.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the KCWD is implementing this project to increase recharge to the subbasin.

6.6.4.4 Public Notice and Outreach Process

Environmental review of the proposed project has not yet begun. Appropriate notice and outreach will be provided to various public agencies and other stakeholders by KCWD and as necessary its partners KDWCD and/or GKGSA.

6.6.4.5 Estimated Annual Project Benefits

The project is estimated to provide an average annual benefit of 3,900 AF per year.

6.6.4.6 Permitting and Regulatory Process

Environmental review of the proposed project has not yet begun. The project will be subject to the typical regulatory process for large earth-moving projects, including CEQA as well as local permits.

6.6.4.7 Status and Schedule

The canal is anticipated to be non-agriculture during 2023 and ready to receive floodwater by 2025.

6.6.4.8 Expected Benefits and Targeted Sustainability Indicators

The expected benefits are estimated at 180,000 AF during the 50-year planning and implementation horizon, including 22,100 AF of in-lieu recharge and 158,000 AF of recharge via the basin. The average annual benefit would be 3,900 AF per year.

The targeted sustainability indicators include stabilization of groundwater levels and, by proxy, groundwater storage, and land subsidence. The recharge basin would likely improve groundwater quality since the floodwaters would be high-quality with a relatively low TDS.

6.6.4.9 Source and Reliability of Water

According to past hydrology documented in watermaster reports, floodwaters from the Kings River and/or Kaweah River systems are anticipated to occur on a 4-year reoccurrence period.

6.6.4.10 Legal Authority Required

KCWD has the statutory authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its service area. *See, e.g., Cal Water Code* §§ 31020 et seq.

6.6.4.11 Costs and Funding

The estimated cost of the project is $2.5 million, including property acquisition, design, construction, and financing. The funding mechanism has not been selected but will likely be a land-based assessment and/or a groundwater pumping charge.

6.6.4.12 Management of Groundwater Extractions

The project will provide additional recharge to the subbasin during wetter years to increase groundwater levels and replenish storage as an offset to decreasing levels and storage during drought conditions.

6.6.4.13 Level of Uncertainty

Wet conditions occur infrequently, perhaps every four or five years, so the project will be available during the wet years to capture additional recharge.

6.6.5 P5: Lakeland Canal Deliveries

Project Type: Local Surface Storage

Project Location: The area of this effort would be the Kaweah Subbasin area within Kings County. Generally, this efforts area would be a one to two-mile buffer around the Lakeland Canal within the Kaweah Subbasin.

Implementing Agency: Kings County Water District, in partnership with Corcoran Irrigation District

6.6.5.1 Project Description

The Lakeland Canal deliveries water from the Kings River and Cross Creek to parties in the Tulare Lake area. The capacity of the upper canal, north of Idaho Avenue, is greater than the lower canal and, during the 2017 flood release flows, Corcoran Irrigation District (CID) allowed growers to use temporary floating pumps to divert water from the upper canal. The cost of these temporary diversions was the same as the cost for CID growers. The use of these floodwater for irrigation will reduce a comparable amount of groundwater pumping and provide in-lieu groundwater recharge. This project will formalize this type of diversion and define the condition under which diversions may occur.

6.6.5.2 Measurable Objective Addressed

The project will assist in achieving the measurable objectives for chronic lowering of groundwater levels, reduction in storage, and subsidence.

6.6.5.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the KCWD is implementing this project to increase recharge to the subbasin.

6.6.5.4 Public Notice and Outreach Process

The proposed project has not yet gone through environmental review. Appropriate notice and outreach will be provided to various public agencies and other stakeholders by KCWD, and as necessary by its partner GKGSA.

6.6.5.5 Estimated Annual Project Benefits

The project is estimated to provide an average annual benefit of 2,900 AF per year.

6.6.5.6 Permitting and Regulatory Process

The project would not be subject to any permitting or regulatory process.

6.6.5.7 Status and Schedule

The project is anticipated to begin in 2025.

6.6.5.8 Expected Benefits and Targeted Sustainability Indicators

The expected benefits are estimated at nearly 140,400 AF of in-lieu groundwater recharge during the 50-year planning and implementation horizon with an average annual benefit of 2,900 AF per year.

The targeted sustainability indicators include stabilization of groundwater levels and, by proxy, groundwater storage, and land subsidence.

6.6.5.9 Source and Reliability of Water

According to past hydrology documented in watermaster reports, floodwaters from the Kings River and/or Kaweah River systems are anticipated to occur on a 4-year reoccurrence period.

6.6.5.10 Legal Authority Required

KCWD (*Cal. Water Code* §§ 31020 et seq.) and CID (*Cal. Water Code* §§ 22075 et seq.) have statutory authority to manage, regulate, and engage in groundwater recharge operations for the benefit of their respective service areas.

6.6.5.11 Costs and Funding

The cost of negotiating the project is estimated at $0.1 million and would be borne by the benefactors of the project.

6.6.5.12 Management of Groundwater Extractions

The project will provide additional recharge to the subbasin during wetter years to increase groundwater levels and replenish storage as an offset to decreasing levels and storage during drought conditions.

6.6.5.13 Level of Uncertainty

Wet conditions occur infrequently, perhaps every four or five years, so the project will be available during the wet years to capture additional recharge.

6.6.6 P7: Kings River Surplus Water

Project Type: Local Surface Storage

Project Location: To be determined

Implementing Agency: Kings County Water District, in partnership with Lakeside Irrigation Water District

6.6.6.1 Project Description

During wet years, surplus Kings River water is often available late in the season from water-right holders that are at risk of potential flood releases later in the fall. This surplus water could be purchased for recharge and delivered via existing canals to existing and future recharge basins.

6.6.6.2 Measurable Objective Addressed

The project will assist in achieving the measurable objectives for chronic lowering of groundwater levels, reduction in storage, subsidence, and possibly degradation of water quality.

6.6.6.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the KCWD is implementing this project to increase recharge to the subbasin.

6.6.6.4 Public Notice and Outreach Process

Appropriate notice and outreach will be provided to various public agencies and other stakeholders by KCWD, and as appropriate by its partners LIWD and/or GKGSA.

6.6.6.5 Estimated Annual Project Benefits

The project is estimated to provide an average annual benefit of 1,800 AF per year.

6.6.6.6 Permitting and Regulatory Process

The project would be subject to any the surface water permitting process and would have to be coordinated with the water master(s).

6.6.6.7 Status and Schedule

The project is anticipated to begin in 2025 and benefits of the project would be realized immediately following the first year of available surplus water.

6.6.6.8 Expected Benefits and Targeted Sustainability Indicators

The expected benefits are estimated at 88,400 AF of groundwater recharge during the 50-year planning and implementation horizon with an average annual benefit would be 1,800 AF per year.

The targeted sustainability indicators include stabilization of groundwater levels and, by proxy, groundwater storage, and land subsidence. The recharge would likely improve groundwater quality since the surplus surface water would be high-quality with a relatively low TDS.

6.6.6.9 Source and Reliability of Water

According to past hydrology documented in watermaster reports, surplus water off of the Kings River system is anticipated to be available on a 4-year reoccurrence period. A floodwater agreement with KRWA has not been obtained and would be necessary to the success of the project.

6.6.6.10 Legal Authority Required

KCWD (*Cal. Water Code* §§ 31020 et seq.) and LIWD (*Cal. Water Code* §§ 22075 et seq.) have statutory authority to manage, regulate, and engage in groundwater recharge operations for the benefit of their service areas.

6.6.6.11 Costs and Funding

The estimated cost of the project would be $85,000 per year for the purchase of surplus water. The funding mechanism has not been selected but will likely be a land-based assessment and/or a groundwater pumping charge.

6.6.6.12 Management of Groundwater Extractions

The project will provide additional recharge to the subbasin during wetter years to increase groundwater levels and replenish storage as an offset to decreasing levels and storage during drought conditions.

6.6.6.13 Level of Uncertainty

Wet conditions occur infrequently, perhaps every four or five years, so the project will be available during the wet years to capture additional recharge.

6.6.7 P6: Kings River Floodwater Arrangement

Project Type: Local Surface Storage

Project Location: To be determined

Implementing Agency: Kings County Water District, in partnership with Lakeside Irrigation Water District

6.6.7.1 Project Description

The Kings River Service Areas excludes most of the Kings County portion of the Kaweah Subbasin. During significant flood releases, historically the Kings River Water Authority (KRWA) has allowed temporary use of the surplus supply under various flood water agreements.

As the lead agency, KCWD, as well as its partner, LIWD, are stockholders in the Peoples Ditch Company, which has a pre-1914 water right to the Kings River. This project will establish flood water agreements for KCWD and LIWD and reduce the demand for groundwater, which will provide in-lieu groundwater recharge. As new basins are developed in the area, the floodwaters could be used for groundwater recharge.

6.6.7.2 Measurable Objective Addressed

The project will assist in achieving the measurable objectives for chronic lowering of groundwater levels, reduction in storage, and subsidence.

6.6.7.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the KCWD is implementing this project to increase recharge to the subbasin.

6.6.7.4 Public Notice and Outreach Process

The proposed project has not yet gone through environmental review. Appropriate notice and outreach will be provided to various public agencies and other stakeholders by KCWD and as necessary by its partners LIWD and/or GKGSA.

6.6.7.5 Estimated Annual Project Benefits

The project is estimated to provide an average annual benefit of 4,700 AF per year.

6.6.7.6 Permitting and Regulatory Process

The project would not be subject to any permitting or regulatory process.

6.6.7.7 Status and Schedule

The project is anticipated to begin during 2026 and benefits of the project would be realized immediately following the first year of available flood water.

6.6.7.8 Expected Benefits and Targeted Sustainability Indicators

The expected benefits are estimated at nearly 228,800 AF of in-lieu groundwater recharge during the 50-year planning and implementation horizon with an average annual benefit of 4,700 AF per year.

The targeted sustainability indicators include stabilization of groundwater levels and, by proxy, groundwater storage, and land subsidence.

6.6.7.9 Source and Reliability of Water

According to past hydrology documented in watermaster reports, floodwaters off of the Kings River system are anticipated to occur on a 4-year reoccurrence period. A floodwater agreement with KRWA has not been obtained and would be necessary to the success of the project.

6.6.7.10 Legal Authority Required

KCWD (*Cal. Water Code* §§ 31020 et seq.) and LIWD (*Cal. Water Code* §§ 22075 et seq.) have statutory authority to manage, regulate, and engage in groundwater recharge operations for the benefit of their service areas.

6.6.7.11 Costs and Funding

The cost of negotiating a flood water agreement with KRWA is estimated at $0.1 million and would be borne by the benefactors of the project.

6.6.7.12 Management of Groundwater Extractions

The project will provide additional recharge to the subbasin during wetter years to increase groundwater levels and replenish storage as an offset to decreasing levels and storage during drought conditions.

6.6.7.13 Level of Uncertainty

Wet conditions occur infrequently, perhaps every four or five years, so the project will be available during the wet years to capture additional recharge.

6.6.8 P8: Fallowing Program by KCWD and LIWD

Project Type: Groundwater Conservation

Project Location: The project area for this program would be fields planted to annual crops where the owner is willing to accept the terms of the arrangement and compensation from the Districts.

Implementing Agency: Kings County Water District, in partnership with Lakeside Irrigation Water District

6.6.8.1 Project Description

KCWD and LIWD will develop a fallowing program in their combined areas to lease 1,500 acres of agricultural land from willing growers who are willing to accept compensation instead of irrigating a crop. This voluntary program would be similar to the former cotton fallowing program that sought to take cotton acreage out of production to synthetically limit the supply. For this program, the goal is to reduce cropped acreage and synthetically limit the amount of groundwater pumped each year while not permanently changing the agricultural land use status at the County Assessor's office.

Conceptually, KCWD and LIWD would determine an acreage target for the year in October, after the previous season was generally over. A sign-up period would be opened during January and February, prior to the next growing season. The lease would provide a payment to the growers for the fallowing of their agricultural land. If the acreage target is not roughly achieved, KCWD and LIWD would consider increasing the lease payment in the following year(s) to improve grower participation. The lease period would be for only one growing season, as defined by each district.

6.6.8.2 Measurable Objective Addressed

The project will assist in achieving the measurable objectives for chronic lowering of groundwater levels, reduction in storage, and subsidence.

6.6.8.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the KCWD and LIWD are implementing this project to reduce demand on the groundwater resources within the subbasin.

6.6.8.4 Public Notice and Outreach Process

The proposed project has not yet gone through environmental review. Appropriate notice and outreach will be provided to various public agencies and other stakeholders by KCWD, and as appropriate by its partners LIWD and/or GKGSA.

6.6.8.5 Estimated Annual Project Benefits

The project is estimated to provide an average annual benefit of 3,750 AF per year.

6.6.8.6 Permitting and Regulatory Process

The project would not be subject to any permitting or regulatory process.

6.6.8.7 Status and Schedule

The fallowing program began in 2023 and is anticipated to be offered as an annual option for landowners..

6.6.8.8 Expected Benefits and Targeted Sustainability Indicators

The expected benefits are estimated at 183,800 AF of in-lieu groundwater recharge during the 50-year planning and implementation horizon with an average annual benefit would be 3,750 AF per year.

The targeted sustainability indicators include stabilization of groundwater levels and, by proxy, groundwater storage, and land subsidence.

6.6.8.9 Source and Reliability of Water

An alternate source of water is not required for a fallowing program.

6.6.8.10 Legal Authority Required

KCWD (*Cal. Water Code* §§ 31020 et seq.) and LIWD (*Cal. Water Code* §§ 22075 et seq.) have statutory authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its service area.

6.6.8.11 Costs and Funding

The initial cost of the program is estimated at $500 per acre or $0.75 million per year for the lease plus annual administration and legal costs $65,000 per year. The funding mechanism has not been selected but will likely be a land-based assessment and/or a groundwater pumping charge

6.6.8.12 Management of Groundwater Extractions

The project will reduce groundwater extraction which will allow groundwater levels to recovery and replenish storage.

6.6.8.13 Level of Uncertainty

The level of participation in the fallowing program is the primary source of uncertainty. Fallowing can occur during the various types of hydrology (wet, normal, dry) within the subbasin.

6.6.9 P9: On-Farm Recharge and Storage in KCWD and LIWD

Project Type: Recharge Basins

Project Location: The area of this effort would be the Kaweah Subbasin area within Kings County.

Implementing Agency: Lakeside Irrigation Water District, in partnership with Kings County Water District

6.6.9.1 Project Description

The On-Farm Recharge in KCWD and LIWD intends to expand an on-going trend during the last ten years for growers to develop small, often temporary basin facilities that centralizes pumped groundwater for improved distribution within the irrigation system. The existing private facilities have taken small areas of acreage out of production and this project will take out an additional 500 acres (total) for use during periods of high surface water flows (every four to five years). Operating assumptions include nearly 60 days of operation and 0.25 AF per day per acre of recharge. The existing basins could also be used to store excess surface water during flood flows.

Conceptually, KCWD and LIWD would determine an acreage target for the year in October, after the previous season was generally over. A sign-up period would be opened during January and February, prior to the next growing season. The lease would provide a payment to the growers for the fallowing of their agricultural land. If the acreage target is not roughly achieved, KCWD and LIWD would consider increasing the lease payment in the following year(s) to improve grower participation. The lease period would be for only one growing season, as defined by each district.

6.6.9.2 Measurable Objective Addressed

The project will assist in achieving the measurable objectives for chronic lowering of groundwater levels, reduction in storage, subsidence, and possibly degradation of water quality.

6.6.9.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the LIWD and KCWD are implementing this project to increase recharge to the subbasin.

6.6.9.4 Public Notice and Outreach Process

The project has not yet begun the environmental review. Appropriate notice and outreach will be provided to various public agencies and other stakeholders by KCWD, and as necessary by its partners LIWD and/or GKGSA.

6.6.9.5 Estimated Annual Project Benefits

The project is estimated to provide an average annual benefit of 1,900 AF per year.

6.6.9.6 Permitting and Regulatory Process

Consultation and coordination will be required with the Kings and Kaweah & St. Johns River Watermasters.

6.6.9.7 Status and Schedule

New facilities are expected to be built during the first 5-year period of implementation.

6.6.9.8 Expected Benefits and Targeted Sustainability Indicators

The expected benefits are estimated at 93,600 AF of recharge during the 50-year planning and implementation horizon with an average annual benefit of 1,900 AF per year.

The targeted sustainability indicators include stabilization of groundwater levels and, by proxy, groundwater storage, land subsidence, and water quality since the low TDS surface water will decrease the TDS of the groundwater.

6.6.9.9 Source and Reliability of Water

Pumped groundwater will be available as a property right where production wells exist and will be limited to groundwater availability and any restrictions administered by GKGSA. According to past hydrology documented in watermasters reports, floodwaters off of the Kings River and Kaweah River systems are anticipated to occur on a 4-year reoccurrence period.

6.6.9.10 Legal Authority Required

KCWD (*Cal. Water Code* §§ 31020 et seq.) and LIWD (*Cal. Water Code* §§ 22075 et seq.) have statutory authority to manage, regulate, and engage in groundwater recharge operations for the benefit of their service areas.

6.6.9.11 Costs and Funding

The cost of the basin development would be borne by the land owner and the cost of the surface water would be an extension of the typical process to receive a normal allotment of surface water.

6.6.9.12 Management of Groundwater Extractions

The project will provide additional recharge to the subbasin during wetter years to increase groundwater levels and replenish storage as an offset to decreasing levels and storage during drought conditions.

6.6.9.13 Level of Uncertainty

Wet conditions occur infrequently, perhaps every four or five years, so the project will be available during the wet years to capture additional recharge.

6.6.10 P10: Hannah Ranch Flood Control Project

Project Type: Local Conveyance Improvements

Project Location: The proposed project is located adjacent and south of the Lower Kaweah River, northeast of the City of Visalia, in Tulare County.

Implementing Agency: Kaweah Delta Water Conservation District

6.6.10.1 Project Description

The Hannah Ranch Flood Control Project is located adjacent and south of the Lower Kaweah River, northeast of the City of Visalia. The Project would develop a 1,500 acre-foot reservoir with diversions occurring from the Lower Kaweah River and the Friant-Kern Canal onto a 380-acre parcel owned by KDWCD. The project will include the construction of five earthen basins built below grade, new diversion structures from the Lower Kaweah River and the Friant-Kern Canal, and a curtain wall with an interceptor/drain system around three sides of the property to protect adjacent landowners from potential impacts related to elevated groundwater levels. An existing rubble dam on the Lower Kaweah River will be replaced with a concrete structure equipped with overshot gates for both backwater head control and flow passage. A regulated discharge facility will be constructed to return water to the Lower Kaweah River.

6.6.10.2 Measurable Objective Addressed

The project will assist in achieving the measurable objectives for chronic lowering of groundwater levels, reduction in storage, subsidence, and possibly degradation of water quality.

6.6.10.3 Circumstances and Criteria for Implementation

KDWCD has developed a Long-Term Master Plan for Water Management/Groundwater Recharge Projects for the purposes of study, design, funding and implementation. The project was able to obtain a matching State grant and it was determined to be a viable improvement for capturing and regulating available native and imported water supplies by the Board of Directors.

6.6.10.4 Public Notice and Outreach Process

Appropriate notice and outreach will be provided to various public agencies and other stakeholders by KDWCD. The district holds monthly Board of Director's meetings and the project will be an agenda item for Board discussion regarding the project status, schedule, budget, necessary approvals and/or required action by the Board. KDWCD also maintains and regularly updates a website with project descriptions, current activities, and progress.

6.6.10.5 Estimated Annual Project Benefits

The primary purpose is the capture, regulation, and management of available native and imported surface water supplies to be distributed throughout multiple facilities within the subbasin for direct and/or in-lieu groundwater recharge. The project is estimated to generate a 2,250 AF annual average increase of water supply to mitigate overdraft within the subbasin.

6.6.10.6 Permitting and Regulatory Process

Numerous permits were retained for the project, including:

- Section 404 permit from the US Army Corps of Engineers (USACE) for in-stream alternations,
- 401 Water Quality Certification from the California Regional Water Quality Control Board (RWQCB) for potential degradation to water quality,
- Lake and Streambed Alteration Agreement from the California Department of Fish and Wildlife (CDFW) to address existing natural resources,
- Caltrans encroachment permit for work within a highway right-of-way,
- Grading permit from Tulare County,
- Dust control plan from the San Joaquin Valley Air Quality Control District (SJVAQCD),
- Storm Water Pollution Prevention Plan from the RWQCB,
- The CEQA process was completed early in the planning phase and resulted in a Mitigated Negative Declaration.

6.6.10.7 Status and Schedule

Design work is completed and permits obtained. Levees have been constructed forming the five basin, and approximately two-thirds of the basins have been excavated to final depth. The Friant Kern Canal turnout into the basin is complete and functional, and the Kaweah River check structure is undergoing construction (this was delayed by the 2023 flood operations). The Kaweah River inlet and outlet into the basin is designed and going out for bid late Summer of

2024 (this was delayed by the 2023 flood operations). The project has received state and federal grant funding and could be operational by as early as 2025.

6.6.10.8 Expected Benefits and Targeted Sustainability Indicators

The expected benefits are estimated at 112,500 AF of in-lieu groundwater recharge during the 50-year planning and implementation horizon with an average annual benefit of 2,250 AF per year. Other benefits would include storm and flood water capture, potential power generation enhancement, and improved local water management and water reliability.

The targeted sustainability indicators include stabilization of groundwater levels and, by proxy, groundwater storage, land subsidence, and improved water quality since the low TDS surface water will decrease the TDS of the native groundwater.

6.6.10.9 Source and Reliability of Water

According to past hydrology documented in watermaster reports, surplus surface water is expected to be available approximately every four to five years, from the Kaweah River as well as from the Friant-Kern Canal via an existing contract with Central Valley Project (CVP).

6.6.10.10 Legal Authority Required

KDWCD has statutory authority to manage, regulate, and engage in water management activities, including groundwater recharge operations, for the benefit of its service area. *See, e.g., Cal. Water Code* §§ 31020 et seq.

6.6.10.11 Costs and Funding

The estimated cost of the project is $6.3 million, including property acquisition, design, and construction. Grant funding that has been awarded will support the majority of the project, including a federal WaterSMART grant of $1.0 million from the US Bureau of Reclamation (USBR) and a state grant of $3.1 million for Storm Water Management. The remainder of funds ($2.2 million) will be provided from local sources.

6.6.10.12 Management of Groundwater Extractions

The project will provide additional recharge to the subbasin during wetter years to increase groundwater levels and replenish storage as an offset to decreasing levels and storage during drought conditions.

6.6.10.13 Level of Uncertainty

The project is currently under construction and in a location to optimize opportunities for maximizing its operational goals. Potential future circumstances that could reduce the effectiveness of the project include changes in climatic conditions, shifts in management schemes of regional native water rights users and imported supply contractors. Overall, the project should exhibit a relativity low level of uncertainty, primarily due to its favorable location near major sources of surface water supply.

6.6.11 P11: Paregien Flood Control Project

Project Type: Recharge Basin

Project Location: The Project is located along Deep Creek, northeast of the City of Farmersville, in Tulare County.

Implementing Agency: Kaweah Delta Water Conservation District

6.6.11.1 Project Description

The Paregien Flood Control and Recharge Project is located along Deep Creek, northeast of the City of Farmersville. The project is a storm and flood water control and groundwater recharge facility. The facility consists of a 60-AF groundwater recharge basin within an earthen levee that is perpendicular to the direction of flow in Deep Creek across a local depression (~20 acres, ~3 feet deep) and includes concrete water management structures and monitor wells. The project was completed in 2018.

6.6.11.2 Measurable Objective Addressed

The project will assist in achieving the measurable objectives for chronic lowering of groundwater levels, reduction in storage, subsidence, and possibly degradation of water quality.

6.6.11.3 Circumstances and Criteria for Implementation

KDWCD has developed a Long-Term Master Plan for Water Management/Groundwater Recharge Projects for the purposes of study, design, funding and implementation. The project was able to obtain a matching State grant and it was determined to be a viable improvement for capturing and regulating available native and imported water supplies by the Board of Directors.

6.6.11.4 Public Notice and Outreach Process

Appropriate notice and outreach were provided to various public agencies and other stakeholders by KDWCD. The district holds monthly Board of Director's meetings and the project will continue to be an agenda item for Board consideration regarding the project status, schedule, budget, necessary approvals and/or required action by the Board. KDWCD also maintains and regularly updates a website with project descriptions, current activities, and progress.

6.6.11.5 Estimated Annual Project Benefits

The primary purpose is the capture, regulation, and management of available native and imported surface water supplies for direct groundwater recharge in the natural channels and developed basins associated with the project. The project is estimated to provide an annual average of 2,370 AF for groundwater recharge to mitigate for overdraft within the subbasin.

6.6.11.6 Permitting and Regulatory Process

Numerous permits were acquired for the project, including

- USACE Section 404 permit for in-stream alternations,
- RWQCB 401 Water Quality Certification for potential degradation to water quality,
- CDFW Lake and Streambed Alteration Agreement to address existing natural resources,
- SJVAPCD Dust Control Plan,
- RWQCB Storm Water Pollution Prevention Plan,

The CEQA process resulted in a "Negative Declaration" and the NEPA determination by the USBR resulting in a "Finding of No Significance."

6.6.11.7 Status and Schedule

The project was completed and started operations in 2018.

6.6.11.8 Expected Benefits and Targeted Sustainability Indicators

The expected benefits are estimated at 118,500 AF of groundwater recharge during the 50-year planning and implementation horizon with an average annual benefit of 2,370 AF per year. Other benefits would include storm and flood water capture, potential power generation enhancement, and improved local water management and water reliability.

The targeted sustainability indicators include stabilization of groundwater levels and, by proxy, groundwater storage, land subsidence, and improved water quality since the low TDS surface water will decrease the TDS of the native groundwater.

6.6.11.9 Source and Reliability of Water

Surface water is expected to be available from the Kaweah River as well as from the Friant-Kern Canal via an existing CVP contract. According to past hydrology documented in watermasters reports, this water and floodwaters are expected to be available approximately every four to five years.

6.6.11.10 Legal Authority Required

KDWCD has statutory authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its service area. *See, e.g., Cal. Water Code* §§ 74520 et seq.

6.6.11.11 Costs and Funding

The estimated cost of the project was $1.85 million, including $0.92 million from a USBR WaterSMART grant and $0.93 million from KDWCD.

6.6.11.12 Management of Groundwater Extractions

The project will provide additional recharge to the subbasin during wetter years to increase groundwater levels and replenish storage as an offset to decreasing levels and storage during drought conditions.

6.6.11.13 Level of Uncertainty

The project has been completed recently and is operating in a location to optimize opportunities for maximizing its goals. Potential future circumstances that could reduce the effectiveness of the project include changes in climatic conditions, shifts in management schemes of regional native water rights users and imported supply contractors. Overall, the project should exhibit a relativity low level of uncertainty, primarily due to its favorable location near a significant source of surface water supply.

6.6.12 P12: Ketchum Flood Control & Recharge Project

Project Type: Recharge Basin

Project Location: The Project is proposed to be located along the St. Johns River, adjacent to Ketchum Ditch, southwest of the City of Woodlake, in Tulare County.

Implementing Agency: Kaweah Delta Water Conservation District

6.6.12.1 Project Description

The Ketchum Flood Control and Recharge Project is proposed to be located along the St. Johns River, adjacent to Ketchum Ditch, southwest of the City of Woodlake. The project will consist of a 75-AF groundwater recharge basin built below grade, a new diversion structure from Ketchum Ditch, and a release outlet structure to the St. Johns River. The nominal 20-acre basin will hold nearly four feet of water and is envisioned to be filled and emptied three times during a nominal 2-month period of flood flow. The percolation rate is estimated at 0.3 feet per day. Water should be available during alternating years and would be derived from floodwater, stormwater, and unused entitlement waters (water rights).

6.6.12.2 Measurable Objective Addressed

The project will assist in achieving the measurable objectives for chronic lowering of groundwater levels, reduction in storage, subsidence, and possibly degradation of water quality.

6.6.12.3 Circumstances and Criteria for Implementation

KDWCD has developed a Long-Term Master Plan for Water Management/Groundwater Recharge Projects for the purposes of study, design, funding, and implementation. The project was determined to be a viable improvement for capturing available native and imported water supplies by the Board of Directors. Study and design are currently on-going and additional partnerships are being pursued. A CEQA determination will have to be completed prior to the final dedication of funds for the implementation of construction.

6.6.12.4 Public Notice and Outreach Process

Appropriate notice and outreach will be provided to various public agencies and other stakeholders by KDWCD. The district holds monthly Board of Director’s meetings and the project will be an agenda item for Board consideration regarding the project status, schedule, budget, necessary approvals and/or required action by the Board. KDWCD also maintains and regularly updates a website with project descriptions, current activities, and progress.

6.6.12.5 Estimated Annual Project Benefits

The primary purpose is the capture, regulation, and management of available native and imported surface water supplies to be distributed throughout multiple downstream facilities within the sub-basin for direct and/or in-lieu groundwater recharge. The project is estimated to generate a 300 AF annual average increase of water supply to the benefit of the subbasin to mitigate overdraft in the subbasin.

6.6.12.6 Permitting and Regulatory Process

Numerous permits were acquired for the project, including

- USACE Section 404 permit for in-stream alternations,
- RWQCB 401 Water Quality Certification for potential degradation to water quality,
- CDFW Lake and Streambed Alteration Agreement to address existing natural resources,
- Grading permit from Tulare County,
- SJVAPCD Dust Control Plan,
- RWQCB Storm Water Pollution Prevention Plan,

The project will require a full CEQA evaluation and action by KDWCD to address impacts to natural resources.

Water rights and transfer agreements will need to be addressed prior to any operations because the project will receive, utilize, and regulate water from several different local and imported sources.

6.6.12.7 Status and Schedule

The project is in the initial conceptual development phase for evaluation of benefits by KDWCD in coordination with Tulare Irrigation Company (property owner).

6.6.12.8 Expected Benefits and Targeted Sustainability Indicators

The expected benefits are estimated at 18,400 AF of recharge during the implementation period if the project is in operation by 2025. The average annual benefit is estimated to be 300 AF per year, including an average of 200 AF per year from direct groundwater recharge during a nominal 2-month period of flow and an average of 100 AF per year from in-lieu groundwater recharge due to conveyance of the stored water. The project would also improve operational management of water in the area.

The targeted sustainability indicators include stabilization of groundwater levels and, by proxy, groundwater storage, land subsidence, and improved water quality since the low TDS surface water will decrease the TDS of the native groundwater.

6.6.12.9 Source and Reliability of Water

Surplus surface water is expected to be available from the Kaweah River and from the CVP contract. According to past hydrology documented in watermasters reports, this water Kaweah system and floodwaters are expected approximately every four to five years.

6.6.12.10 Legal Authority Required

KDWCD has statutory authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its service area. *See, e.g., Cal. Water Code* §§ 74520 et seq.

6.6.12.11 Costs and Funding

The preliminary estimated cost of the project is $0.53 million, including property acquisition, administration, design, permits, and construction. The funds will be provided by KDWCD and possibly from other partners.

6.6.12.12 Management of Groundwater Extractions

The project will provide additional recharge to the subbasin during wetter years to increase groundwater levels and replenish storage as an offset to decreasing levels and storage during drought conditions.

6.6.12.13 Level of Uncertainty

The project is in the initial planning and design phase with a proposed location to optimize opportunities for maximizing its goals. Potential future circumstances that could reduce the effectiveness of the project include changes in climatic conditions, shifts in management schemes of regional native water rights users and imported supply contractors. Overall, the project should exhibit a relativity low level of uncertainty, primarily due to its favorable location near a significant source of surface water supply.

6.6.13 P13: St. Johns River Water Conservation Project

Project Type: Regional Conveyance Improvements

Project Location: The proposed Project would be located along the St. Johns River, north of the City of Visalia, in Tulare County.

Implementing Agency: Kaweah Delta Water Conservation District

6.6.13.1 Project Description

The St. Johns River Water Conservation Project is located north of the City of Visalia and would make improvement to six existing in-stream check structures to better regulate and retain flows within the channel of the St. Johns River. This project would increase the average depth of the water by 1.5 feet (to 3 feet) and double the capacity of the existing structures to nearly 1,000 AF which can be used for irrigation instead of pumping groundwater. The existing structures are 300 feet wide by eight miles long total and will allow groundwater recharge at an estimated percolation rate of 0.3 feet per day during the nominal 3-week period of surplus water during alternating years.

6.6.13.2 Measurable Objective Addressed

The project will assist in achieving the measurable objectives for chronic lowering of groundwater levels, reduction in storage, subsidence, and possibly degradation of water quality.

6.6.13.3 Circumstances and Criteria for Implementation

KDWCD has developed a Long-Term Master Plan for Water Management/Groundwater Recharge Projects for the purposes of study, design, funding, and implementation. The project was determined to be a viable improvement for capturing available native and imported water supplies by the Board of Directors. Study and design are currently on-going and additional partnerships are being pursued along with potential grant funding opportunities. A CEQA determination will have to be completed prior to the final dedication of funds for the implementation of construction.

6.6.13.4 Public Notice and Outreach Process

Appropriate notice and outreach will be provided to various public agencies and other stakeholders by KDWCD. The district holds monthly Board of Director’s meetings and the project will be an agenda item for Board consideration regarding the project status, schedule, budget, necessary approvals and/or required action by the Board. KDWCD also maintains and regularly updates a website with project descriptions, current activities, and progress.

6.6.13.5 Estimated Annual Project Benefits

The primary purpose is the capture and management of available native and imported surface water supplies for direct groundwater recharge in the natural channel of the St. Johns River. The project is estimated to provide an annual average of 1,400 AF recharge to mitigate for overdraft within the subbasin.

6.6.13.6 Permitting and Regulatory Process

Numerous permits will be required for the project, including

- USACE Section 404 permit for in-stream alternations,
- RWQCB 401 Water Quality Certification for potential degradation to water quality,
- CDFW Lake and Streambed Alteration Agreement to address existing natural resources,
- SJVAPCD Dust Control Plan,
- RWQCB Storm Water Pollution Prevention Plan,

The project will require a full CEQA evaluation and action by KDWCD to address impacts to natural resources.

Water rights and transfer agreements will need to be addressed prior to any operations because the project will receive, utilize, and regulate water from several different local and imported sources.

6.6.13.7 Status and Schedule

The project is in the initial conceptual development phase for evaluation of benefits by KCWCD in coordination with the City of Visalia and various other water agencies to address stakeholder interests.

6.6.13.8 Expected Benefits and Targeted Sustainability Indicators

The expected benefits are estimated at 64,400 AF of recharge during the implementation period if the project is in operation by 2025. The average annual benefit is estimated to be 1,400 AF per year, including an average of 900 AF per year from direct groundwater recharge during the 3-week period of flow and an average of 500 AF per year from in-lieu groundwater recharge due to conveyance of the stored water. The project would also improve operational management of water in the area.

The targeted sustainability indicators include stabilization of groundwater levels and, by proxy, groundwater storage, land subsidence, and improved water quality since the low TDS surface water will decrease the TDS of the native groundwater.

6.6.13.9 Source and Reliability of Water

Surplus surface water is expected to be available from the Kaweah River and from existing CVP contracts. This water and floodwaters are expected approximately half the time – five out of every ten years.

6.6.13.10 Legal Authority Required

KDWCD has statutory authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its service area. *See, e.g., Cal. Water Code* §§ 74520 et seq.

6.6.13.11 Costs and Funding

The preliminary estimated cost of the project is $2.0 million, including property acquisition, administration, design, permits, and construction. The funds will be provided by KDWCD and possibly from other partners.

6.6.13.12 Management of Groundwater Extractions

The project will provide additional recharge to the subbasin during wetter years to increase groundwater levels and replenish storage as an offset to decreasing levels and storage during drought conditions.

6.6.13.13 Level of Uncertainty

The project is in the initial planning and design phase with a proposed location to optimize opportunities for maximizing its goals. Potential future circumstances that could reduce the effectiveness of the project include changes in climatic conditions, shifts in management schemes of regional native water rights users and imported supply contractors. Overall, the project should exhibit a relativity low level of uncertainty, primarily due to its favorable location near a significant source of surface water supply.

6.6.14 P14: Basin No. 4 Improvement Project

Project Type: Recharge Basin

Project Location: The proposed Project would be located on South Mill Creek, southwest of the City of Visalia.

Implementing Agency: Kaweah Delta Water Conservation District

6.6.14.1 Project Description

The Basin No. 4 Improvement Project is located on South Mill Creek, southwest of the City of Visalia on the Tulare County and Kings County line. Subject to agreement being reached with the City of Visalia, it would upgrade water control operations within the creek and to the nominal 120-acre City of Visalia-owned basin. The improvements would include the existing in-stream check structure that regulates water into the basin and downstream and would provide the ability to increase flow rates into the basin. The basin would have a capacity to store 500 AF of surplus water which can be used for irrigation instead of pumping groundwater, and recharge would occur during the nominal 3-week period of surplus water during alternating years at an estimated percolation rate of 0.3 feet per day.

6.6.14.2 Measurable Objective Addressed

The project will assist in achieving the measurable objectives for chronic lowering of groundwater levels, reduction in storage, subsidence, and possibly degradation of water quality.

6.6.14.3 Circumstances and Criteria for Implementation

KDWCD has developed a Long-Term Master Plan for Water Management/Groundwater Recharge Projects for the purposes of study, design, funding, and implementation. The project was determined to be a viable improvement for capturing available native and imported water supplies by the Board of Directors. Study and design are currently on-going and additional partnerships are being pursued along with potential grant funding opportunities. Agreement to proceed by City of Visalia and CEQA determination will have to be completed prior to the final dedication of funds for the implementation of construction.

6.6.14.4 Public Notice and Outreach Process

Appropriate notice and outreach will be provided to various public agencies and other stakeholders by KDWCD. The district holds monthly Board of Director's meetings and the project will be an agenda item for Board consideration regarding the project status, schedule, budget, necessary approvals and/or required action by the Board. KDWCD also maintains and regularly updates a website with project descriptions, current activities, and progress.

6.6.14.5 Estimated Annual Project Benefits

The primary purpose is the capture and management of available native and imported surface water supplies for direct groundwater recharge within the existing 160 acres of basins at the facility. The project is estimated to recharge a 500 AF annual average increase of water supply to mitigate for overdraft within the subbasin.

6.6.14.6 Permitting and Regulatory Process

Numerous permits were acquired for the project, including

- USACE Section 404 permit for in-stream alternations,
- RWQCB 401 Water Quality Certification for potential degradation to water quality,
- CDFW Lake and Streambed Alteration Agreement to address existing natural resources,
- SJVAPCD Dust Control Plan,
- RWQCB Storm Water Pollution Prevention Plan,

The project will require a full CEQA evaluation and action by KDWCD to address impacts to natural resources.

6.6.14.7 Status and Schedule

The project is in the initial conceptual development phase for evaluation of benefits by KCWCD in coordination with the City of Visalia to address the needs of both agencies.

6.6.14.8 Expected Benefits and Targeted Sustainability Indicators

The expected benefits are estimated at 9,000 AF of recharge during the implementation period if the project is in operation by 2025. The average annual benefit is estimated to be 500 AF per year from direct groundwater recharge during the 3-week period of increased flows into the facility of 12 cfs per day. The project would also improve local water management.

The targeted sustainability indicators include stabilization of groundwater levels and, by proxy, groundwater storage, land subsidence, and improved water quality since the low TDS surface water will decrease the TDS of the native groundwater.

6.6.14.9 Source and Reliability of Water

Surplus surface water is expected to be available from the Kaweah River and from the CVP contract. This water and floodwaters are expected approximately half the time – five out of every ten years.

6.6.14.10 Legal Authority Required

KCWD has statutory authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its service area. *See, e.g., Cal. Water Code* §§ 74520 et seq.

6.6.14.11 Costs and Funding

The preliminary estimated cost of the project is $0.4 million, including property acquisition, administration, design, permits, and construction. The funds will be provided by KDWCD and the City of Visalia.

6.6.14.12 Management of Groundwater Extractions

The project will provide additional recharge to the subbasin during wetter years to increase groundwater levels and replenish storage as an offset to decreasing levels and storage during drought conditions.

6.6.14.13 Level of Uncertainty

The project is in the initial planning and design phase with a proposed location to optimize opportunities for maximizing its goals. Potential future circumstances that could reduce the effectiveness of the project include changes in climatic conditions, shifts in management schemes of regional native water rights users and imported supply contractors. Overall, the project should exhibit a relativity low level of uncertainty, primarily due to its location.

6.6.15 P15: Peoples Recharge Expansion Project

Project Type: Recharge Basin

Project Location: The proposed Project is proposed to be located along the Lower Kaweah River, adjacent to Peoples Basin, southwest of the City of Woodlake, in Tulare County.

Implementing Agency: Kaweah Delta Water Conservation District

6.6.15.1 Project Description

The Peoples Recharge Expansion Project is being developed as a groundwater recharge facility on about 25 acres and will consist of a 100-AF basin built below grade with a new diversion structure from Peoples Basin. The project would allow recharge to occur using surplus during a nominal 2-month period during alternating years at an estimated percolation rate of 0.3 feet per day.

6.6.15.2 Measurable Objective Addressed

The project will assist in achieving the measurable objectives for chronic lowering of groundwater levels, reduction in storage, subsidence, and possibly degradation of water quality.

6.6.15.3 Circumstances and Criteria for Implementation

KDWCD has developed a Long-Term Master Plan for Water Management/Groundwater Recharge Projects for the purposes of study, design, funding, and implementation. The project was determined to be a viable improvement for capturing available native and imported water supplies by the Board of Directors. Study and design are currently on-going and additional partnerships are being pursued along with future grant funding opportunities. A CEQA determination will have to be completed prior to the final dedication of funds for the implementation of construction.

6.6.15.4 Public Notice and Outreach Process

Appropriate notice and outreach will be provided to various public agencies and other stakeholders by KDWCD. The district holds monthly Board of Director's meetings and the project will be an agenda item for Board consideration regarding the project status, schedule, budget, necessary approvals and/or required action by the Board. KDWCD also maintains and regularly updates a website with project descriptions, current activities, and progress.

6.6.15.5 Estimated Annual Project Benefits

The primary purpose is the capture and management of available native and imported surface water supplies for direct groundwater recharge within a proposed 40-acre basin at the facility. The project is estimated to provide an annual average of 300 AF of recharge to mitigate overdraft in the subbasin.

6.6.15.6 Permitting and Regulatory Process

Numerous permits will be required for the project, including

- Grading permit from Tulare County,
- SJVAPCD Dust Control Plan,
- RWQCB Storm Water Pollution Prevention Plan,

The project will require a full CEQA evaluation and action by KDWCD.

6.6.15.7 Status and Schedule

The project is in the initial conceptual development phase for evaluation of benefits by KDWCD, which has rights to develop the property under a long-term lease with Lindsay-Strathmore Irrigation District.

6.6.15.8 Expected Benefits and Targeted Sustainability Indicators

The expected benefits are estimated at 13,600 AF of recharge during the implementation period if the project is in operation by 2025. The average annual benefit will be about 300 AF per year, including an average of 200 AF per year from direct groundwater recharge during the 2-month period of flow and an average of nearly 100 AF per year from in-lieu groundwater recharge.

The targeted sustainability indicators include stabilization of groundwater levels and, by proxy, groundwater storage, land subsidence, and improved water quality since the low TDS surface water will decrease the TDS of the native groundwater.

6.6.15.9 Source and Reliability of Water

Surface water is expected to be available from the Kaweah River and from the CVP contract.

6.6.15.10 Legal Authority Required

KDWCD has statutory authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its service area. *See, e.g., Cal. Water Code* §§ 74520 et seq. According to past hydrology documented in watermasters reports, this water and floodwaters are expected to occur approximately every four to five years.

6.6.15.11 Costs and Funding

The preliminary estimated cost of the project is $0.53 million, including property acquisition, administration, design, permits, and construction. The funds will be provided by KDWCD and possibly from other partners.

6.6.15.12 Management of Groundwater Extractions

The project will provide additional recharge to the subbasin during wetter years to increase groundwater levels and replenish storage as an offset to decreasing levels and storage during drought conditions.

6.6.15.13 Level of Uncertainty

The project is in the initial planning and design phase with a proposed location to optimize opportunities for maximizing its goals. Potential future circumstances that could reduce the effectiveness of the project include changes in climatic conditions, shifts in management schemes of regional native water rights users and imported supply contractors. Overall, the project should exhibit a relativity low level of uncertainty, primarily due to its location.

6.6.16 P16: Greater Fallowing Auction Program

Project Type: Groundwater Conservation

Project Location: The project area for this program would be fields where the owner is willing to accept the terms of the arrangement and compensation from the GSA for one year of fallowing.

Implementing Agency: Greater Kaweah GSA

6.6.16.1 Project Description

An annual fallowing program will be made available to growers to submit an application/bid to participate in the Program. In the application growers will submit the lowest price they are willing to be compensated by the GSA for fallowing a certain amount of acreage for a year. Growers with the lowest bids will be accepted into the program.

6.6.16.2 Measurable Objective Addressed

The project will assist in achieving the measurable objectives for chronic lowering of groundwater levels, reduction in storage, and subsidence.

6.6.16.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the GSA is implementing this project to reduce demand on the groundwater resources within the subbasin.

6.6.16.4 Public Notice and Outreach Process

The project was first implemented for the Water Year 2023 – 2024 and was noticed through mailers, the GKGSA website, and email blasts. It will be implemented again in Water Year 2024 – 2025 through the same means.

6.6.16.5 Estimated Annual Project Benefits

The project is estimated to provide an average annual benefit of 3,000 AF per year. The first year saved 1,100 acre feet.

6.6.16.6 Permitting and Regulatory Process

The project would not be subject to any permitting or regulatory process.

6.6.16.7 Status and Schedule

The fallowing program is began in 2023 and is expected to be an annual program offered by the GSA.

6.6.16.8 Expected Benefits and Targeted Sustainability Indicators

The expected benefits are estimated at 150,000 AF of in-lieu groundwater recharge during the 50-year planning and implementation horizon with an average annual benefit would be 3,000 AF per year.

The targeted sustainability indicators include stabilization of groundwater levels and, by proxy, groundwater storage, and land subsidence.

6.6.16.9 Source and Reliability of Water

An alternate source of water is not required for a fallowing program.

6.6.16.10 Legal Authority Required

No specific authority is needed for this program.

6.6.16.11 Costs and Funding

The initial cost of the for the Water Year 2023 – 2024 program was approximately $370,000 amounting to an estimated $560 per acre. The funding mechanism is the pumping penalty charges for growers that pump in excess of sustainable yield. Each year the GSA Board of Directors will review the Fallowing Reserve Fund balance and set the total fallowing dollars.

6.6.16.12 Management of Groundwater Extractions

The project will reduce groundwater extraction which will allow groundwater levels to recovery and replenish storage.

6.6.16.13 Level of Uncertainty

The level of participation in the fallowing program is the primary source of uncertainty. Fallowing can occur during the various types of hydrology (wet, normal, dry) within the subbasin.

6.6.17 Conceptual Projects

The following conceptual projects are being explored by GKGSA but have not yet been evaluated for their impact on reaching the Sustainability Goal. When the concepts are adequately developed and determined to be reasonably feasible to move forward, they will be included in future updates to the Greater Kaweah GSP.

6.6.17.1 Lewis Creek Conservation Project

The Lewis Creek Water Conservation Project will be located along Lewis Creek immediately upstream of its confluence with Outside Creek, between the cities of Tulare and Porterville. As envisioned currently, the Project would consist of five in-stream check structures that would regulate and retain flows within the channel (water conservation) and enhance groundwater recharge. The overall dimensions are envisioned to be four miles long, 20 feet wide, and four feet deep, which would provide 40 AF of in-stream storage. The project would provide in-lieu groundwater recharge during a 3-week period of surplus in-stream storage and direct recharge during a nominal 2-month period of stream flow. The expected recharge benefits are estimated at an average annual benefit of 400 AF per year, including 200 AF per year from direct groundwater recharge during a 2-month stream flow period and an average of 200 AF per year from in-lieu groundwater recharge during the temporary storage of surplus water. The project would also improve operational management of water in the area. The source of water would be surplus supply from the Kaweah River and from existing CVP contracts. The preliminary estimated cost of the project is $1.0 million, including property acquisition, administration, design, and construction. Funding has not yet been identified but would likely be provided by KDWCD and Consolidated Peoples Ditch Company (CPDC), and possibly from other partners.

6.6.17.2 Kasbergen Basin Project

The proposed Kasbergen Basin is an example of a project that involves the construction of an on-farm retention and recharge basin. It is one of many projects being negotiated between Consolidated Peoples Ditch Company (CPDC) and its shareholders to construct cost effective, small on-farm basins for the purposes of capturing surface waters when available from the Kaweah River and from existing CVP contracts. Accounting of water conveyed to the project would be the responsibility of CPDC and would be reported to GKGSA in conformance with the Water Accounting Framework and water budgeting informational needs. The Kasbergen Basin could be built within the first year of GSP implementation, has an estimated cost of $5,000 and would be entirely funded by the land owner.

6.7 Management Actions

The Management Actions proposed in this Plan by the GKGSA are generally considered in two phases where the first phase includes pilot programs for the first five years and successful programs are implemented for a second phase during the remainder of SGMA implementation. This pilot phase would allow the GKGSA to monitor and evaluate the efficacy of each action prior to full implementation throughout the GSA.

6.7.1 MA1: Communication & Engagement

6.7.1.1 Management Action Description

The GKGSA will pursue in communication and engagement to all beneficial uses and users of groundwater within its jurisdiction in a manner consistent with the adopted GKGSA Communication and Engagement Plan. The goal is to provide ongoing correspondence to groundwater users and promote awareness of the aquifer condition and efforts and progress towards avoidance of Undesirable Results.

6.7.1.2 Measurable Objectives Addressed

The management action will not directly affect measurable objectives but, hopefully, will raise the awareness of groundwater users of the limited nature of this renewable resource and promote conservation, which will reduce demand and allow the recovery of groundwater levels and storage.

6.7.1.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the GKGSA is implementing this project to increase recharge to the subbasin.

6.7.1.4 Public Notice and Outreach Process

Appropriate notification and outreach will be conducted consistent with GSA authorities and requirements and with the adopted GKGSA Communication and Engagement Plan.

6.7.1.5 Estimated Annual Project Benefits

This management action will provide information to stakeholders and encourage them to conserve water, thus reducing demand on the groundwater resource. Quantification of this demand reduction is not practical and may not be possible given the other tangible efforts to manage the groundwater resource.

6.7.1.6 Permitting and Regulatory Process

Permitting and regulatory processes are not applicable to this management action.

6.7.1.7 Status of Management Action

The Management Action requires an update to the GKGSA Communication and Engagement Plan which will occur beginning in 2020. Updating the plan and initial implementation activities are expected to occur within six to nine months.

6.7.1.8 Expected Benefits and Targeted Sustainability Indicators

The GKGSA expects to benefit from this management action by encouraging involvement, open lines of communication and communicating future opportunities for input. Another expected benefit may include avoidance of Undesirable Results by educating the public on the use and condition of the groundwater resource.

6.7.1.9 Source and Reliability of Water

A source of reliable water is not needed for this Management Action.

6.7.1.10 Legal Authority Required

SGMA (*Cal Water Code* §§ 10725 et seq.) and related provisions and Article II of the agencies' Joint Powers Agreement provide GKGSA with the authority required to carry out activities related to this Management Action.

6.7.1.11 Costs and Funding

The ongoing cost to perform communication and outreach to beneficial users of groundwater in the GKGSA is $10,000 per year. Funding for related activities will be provide for by the GKGSA through either Member assessment, or land-based Proposition 218 assessment.

6.7.1.12 Management of Groundwater Extractions

This management action will promote the wise utilization of the groundwater resource and encourage conservation during wet periods to allow for the recovery of groundwater levels and storage after drought periods.

6.7.1.13 Level of Uncertainty\

The success of this communication program and the potential reduction in demand cannot be predicted at this time but will likely produce positive results during the course of the implementation period.

6.7.2 MA2: Terminus Reservoir Reoperation Program

6.7.2.1 Management Action Description

Flow in the Kaweah River is regulated by the United States Army Corps of Engineers (USACE) for flood control purposes via Lake Kaweah and the control works. KDWCD has a contract with USACE for water storage rights at Lake Kaweah, which provides operational management of entitled irrigation supplies for the region.

The proposed program will be a review of the USACE Terminus (Lake Kaweah) Water Control Diagram with the intent to revise the Diagram to improve operational management. The Water Control Diagram provides the basis for determining allowable storage at Lake Kaweah while providing sufficient vacant space to receive inflows that could be a flood risk below the lake. The advent of the Airborne Snow Observatory program offers a new tool for evaluating water stored in the snow pack and predicting watershed run-off under various conditions. This tool could potentially be utilized to refine the USACE approach to regulating the balance between allowable storage for flood control and maximizing the storage for the benefit of irrigation demands.

6.7.2.2 Measurable Objectives Addressed

This management action will maximize the available storage of surface water at Lake Kaweah, retain more of the native surface water within the subbasin, and reduce the overdraft of the groundwater resource. The action will allow the recovery of groundwater levels and an increase in groundwater storage.

6.7.2.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the GKGSA is implementing this project to increase recharge to the subbasin.

6.7.2.4 Public Notice and Outreach Process

Revision to the Water Control Diagram would be completed by the USACE in accordance with federal regulations. Public notices and outreach would occur in compliance with those federal regulations.

KDWCD holds monthly Board of Director's meetings and this management action will be an agenda item for Board consideration regarding the project status, schedule, budget, necessary approvals and/or required action by the Board. KDWCD also maintains and regularly updates a website with project descriptions, current activities, and progress.

6.7.2.5 Estimated Annual Project Benefits

This management action does not address demand reduction so quantification cannot be done, but rather seeks to change the operation of a reservoir to optimize and modernize the distribution of water.

6.7.2.6 Permitting and Regulatory Process

Revision to the Water Control Diagram would be under USACE jurisdiction in accordance with their prescribed procedures. Other permitting or regulatory processes are not expected outside of the USACE actions.

6.7.2.7 Status of Management Action

The proposed action is currently in the preliminary phase of planning. Consultants will be retained to perform an analysis of alternatives prior to seeking the USACE consideration of the revision.

6.7.2.8 Expected Benefits and Targeted Sustainability Indicators

An updated Water Control Diagram will maximize the available storage of surface water at Lake Kaweah, retain more of the native surface water within the subbasin, and reduce the overdraft of the groundwater resource. Increased knowledge of the watershed hydrologic conditions will promote the most efficient use of available storage at Lake Kaweah. In addition, this approach could improve the utilization of imported water to the subbasin via opportunities to capture available CVP water during timespans when there were previous operational conflicts.

6.7.2.9 Source and Reliability of Water

This management action is targeting excess water in the Kaweah River that cannot be stored in Lake Kaweah due to the existing and dated operational procedures. All such excess surface water is covered under the KDWCD entitlement. Any improvement in imported supply would be the result of KDWCD optimizing its CVP contract to gain access to available supplies from other CVP contractors.

6.7.2.10 Legal Authority Required

KDWCD has statutory authority to manage, regulate, and engage in water management activities, including groundwater recharge operations, for the benefit of its service area. *See, e.g., Cal. Water Code* §§ 31020 et seq. USACE has the authority to revise the Water Control Diagram for Lake Kaweah.

6.7.2.11 Costs and Funding

The preliminary estimated cost of the project is $0.33 million, including administration, consultant services, and USACE expense. The funds will be provided by KDWCD and Kaweah & St. Johns Rivers Association.

6.7.2.12 Management of Groundwater Extractions

The management action, if acceptable to the USACE, will optimize the flow of surface water and could provide additional recharge to the subbasin during wetter years to increase groundwater levels and replenish storage as an offset to decreasing levels and storage during drought conditions.

6.7.2.13 Level of Uncertainty

The USACE is responsible for the operation of the facility and has well-established rules for this effort. Revisions to these rules could require a considerable amount of deliberation before revisions are made.

6.7.3 MA3: Groundwater Extraction Measurement Program

6.7.3.1 Management Action Description

Within the GKGSA, all extractions by municipal systems are fully metered and such groundwater extractions and associated constituent levels are reported at least annually to the SWRCB. These municipal systems include the City of Farmersville, the City of Exeter, the City of Woodlake, Ivanhoe PUD, Tract 92 CSD, and Patterson Tract CSD. However, extraction measurements have not been required for private well owners within the irrigation districts and ditch company service areas, or in the undistricted lands within GKGA. Extractions from these wells, primarily for irrigation, must be reported in the aggregate annually to the state according to §10728 and measured according to §10725.8 of SGMA.

GKGSA plans to initiate a pilot program in conjunction with the other two GSAs of the Kaweah Subbasin to determine the most feasible means to comply with the SGMA measurement provision. The measurement alternatives and data processing methods to be evaluated are depicted by **Figure 6-2**:

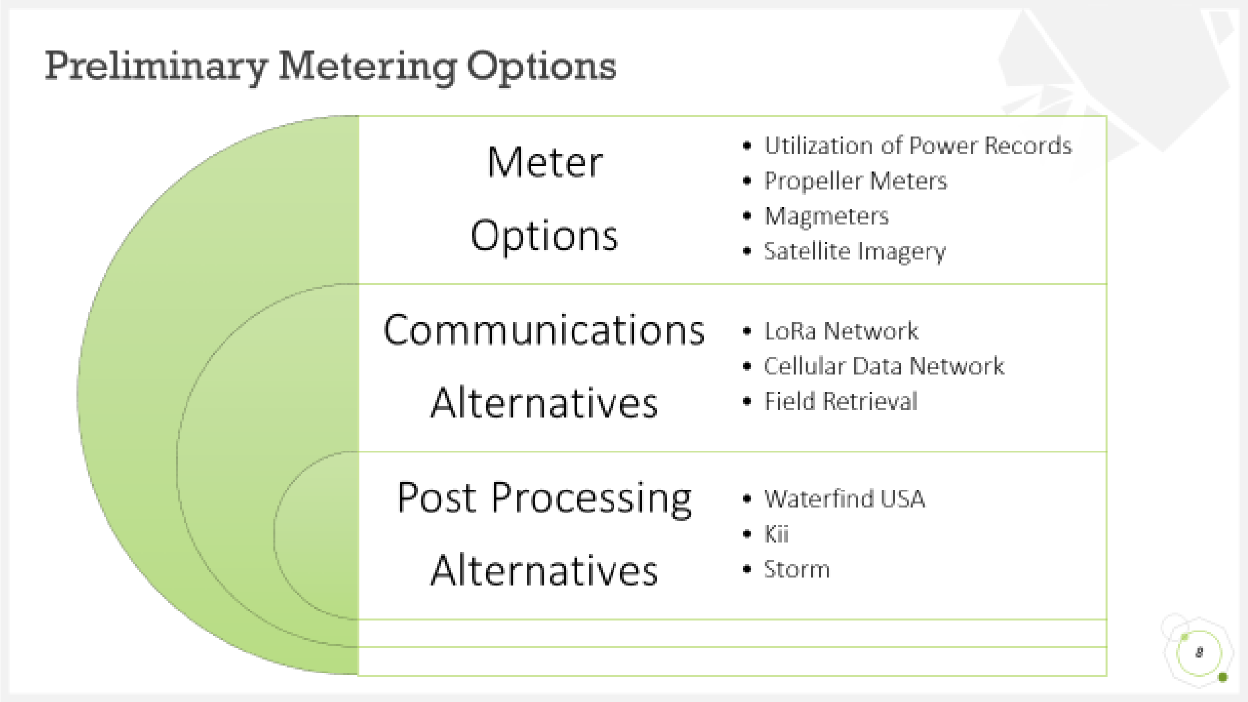


Figure 6-2: Data Measurement Alternatives

6.7.3.2 Measurable Objectives Addressed

This management action will initiate the quantification process for the volume of groundwater extracted by various users versus the assumed volume of extracted groundwater. Ideally, this validation process will lead to better estimates of use and perhaps a reduction in use, which would reduce demand and allow groundwater levels and storage to rise.

6.7.3.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the GKGSA is implementing this project to increase recharge to the subbasin.

6.7.3.4 Public Notice and Outreach Process

Appropriate notification and outreach will be conducted consistent with GSA authorities and requirements. The management action will begin as a voluntary pilot program with a notice sent to landowners and a general call for volunteers at the GKGSA public meetings and on the GKGSA website.

6.7.3.5 Estimated Annual Project Benefits

This management action will provide a better understanding of actual groundwater production versus assumed production and will enhance the management of the resource. An annual benefit cannot be defined at this time.

6.7.3.6 Permitting and Regulatory Process

Authority for groundwater measurement collection and processing resides within SGMA as previously cited. Additional permitting or regulatory compliance will not be necessary to implement a pilot program or to scale up to full coverage within the GSA.

6.7.3.7 Status of Management Action

This proposed action is in the preliminary phase of planning. A proposal to initiate an evaluation of options was submitted to DWR for consideration of Technical Services funding and is currently under review.

6.7.3.8 Expected Benefits and Targeted Sustainability Indicators

The management action will improve the knowledge on the timing and volume of groundwater extraction and, coupled with the aquifer response, should aid in the improvement of the Kaweah Subbasin predictive capability of the numerical model and in future groundwater management in general. Additionally, the development of a measurement standard for groundwater extraction will facilitate the development of a water market/allocation program, should the GKGSA decide to pursue such a program.

6.7.3.9 Source and Reliability of Water

An additional water source is not required for this Management Action.

6.7.3.10 Legal Authority Required

Extractions from these wells, primarily for irrigation, must be reported in the aggregate annually to the state according to §10728 and measured according to §10725.8 of SGMA.

6.7.3.11 Costs and Funding

A proposal to initiate an evaluation of options was submitted to DWR for consideration of Technical Services funding and is currently under review. Costs to measure groundwater extractions within GKGSA could vary widely, from $200,000 to upwards of $4 million for capital and installation, and from under $50,000 to as much as $250,000 annually for O&M. According to SGMA §10725.8(b), costs for the measurement devices will be borne by the well owner/operator, so the cost exposure to the GKGSA in implementing a measurement program is not presently known. Since the municipal GSA Members already fund and operate meters at their facilities, the costs associated with an extraction measurement program lie primarily with the irrigation districts, ditch companies, and private landowners in undistricted lands of the GKGSA and with the GKGSA for the compilation and evaluation of the data.

6.7.3.12 Management of Groundwater Extractions

The management action could lead to better quantification of groundwater production which could optimize the use of the groundwater resource. As such, groundwater levels and storage could improve during wet years and offset decreasing groundwater levels and storage during drought years.

6.7.3.13 Level of Uncertainty

The use of meters will reduce the level of uncertainty associated with the production of groundwater from the subbasin.

6.7.4 MA4: Well Characterization

6.7.4.1 Management Action Description

Many agricultural wells have limited or no information as to depth, casing characteristics or screen intervals. This project would entail video logging and spinner logging to ascertain well construction and delineate groundwater production zones, respectively. Water quality profiling and depth-specific sampling might further delineate differences in aquifer zones, based on the vertical distribution of select constituents.

6.7.4.2 Measurable Objectives Addressed

This management action will enhance the understanding of the wells that provide the characterization data of the aquifer system. The management of the groundwater resource will benefit from this improved understanding which could allow the recovery of groundwater levels and storage.

6.7.4.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the GKGSA is implementing this project to increase recharge to the subbasin.

6.7.4.4 Public Notice and Outreach Process

Appropriate notification and outreach will be conducted consistent with GSA authorities and requirements. The pilot phase of this program shall be voluntary, with noticing via mailers to landowners and a general call for volunteer participants at the GKGSA’s publicly held meetings and on the GKGSA’s website.

6.7.4.5 Estimated Annual Project Benefits

This management action provides assistance to well owners that are impacted by the management of the groundwater resources and does not provide an annual benefit to the aquifer system.

6.7.4.6 Permitting and Regulatory Process

Permitting and regulatory process are not applicable to this Management Action.

6.7.4.7 Status of Management Action

This Project will be defined and pursued during the first several years of GSP implementation and progress will be documented in the succeeding five-year assessment report to DWR.

6.7.4.8 Expected Benefits and Targeted Sustainability Indicators

Expected benefits from this program include improved understanding of groundwater production from wells within the GKGSA and associated aquifer responses to groundwater extraction operations. Overall improvements in characterization of principal aquifers and aquitards is expected once we are able tie specific wells and their water level and water quality information with specific aquifers. Sustainability indicators anticipated to benefit via this improved knowledge and incorporation into the Subbasin numerical model would include groundwater level stabilization and, by proxy, groundwater storage stabilization, as well as potentially reduced water quality degradation. In addition, well characterization could be integrated with the AEM data to better improve the understanding of the subsurface hydrogeology.

6.7.4.9 Source and Reliability of Water

An additional water source is not required for this Management Action.

6.7.4.10 Legal Authority Required

SGMA, at §10725.2, allows GSAs to pursue various means to improve its understanding of the subbasin and production wells therein.

6.7.4.11 Costs and Funding

Costs associated with this Management Action could be $15,000 per well, possibly more, for contractor costs and will be refined during the early stages of GSP implementation. A budget of $150,000 would allow ten wells to be characterized per year. An appropriate fee collection structure from GSA members will be determined during that time.

6.7.4.12 Management of Groundwater Extractions

This management action will not have a direct effect on groundwater extraction and recharge.

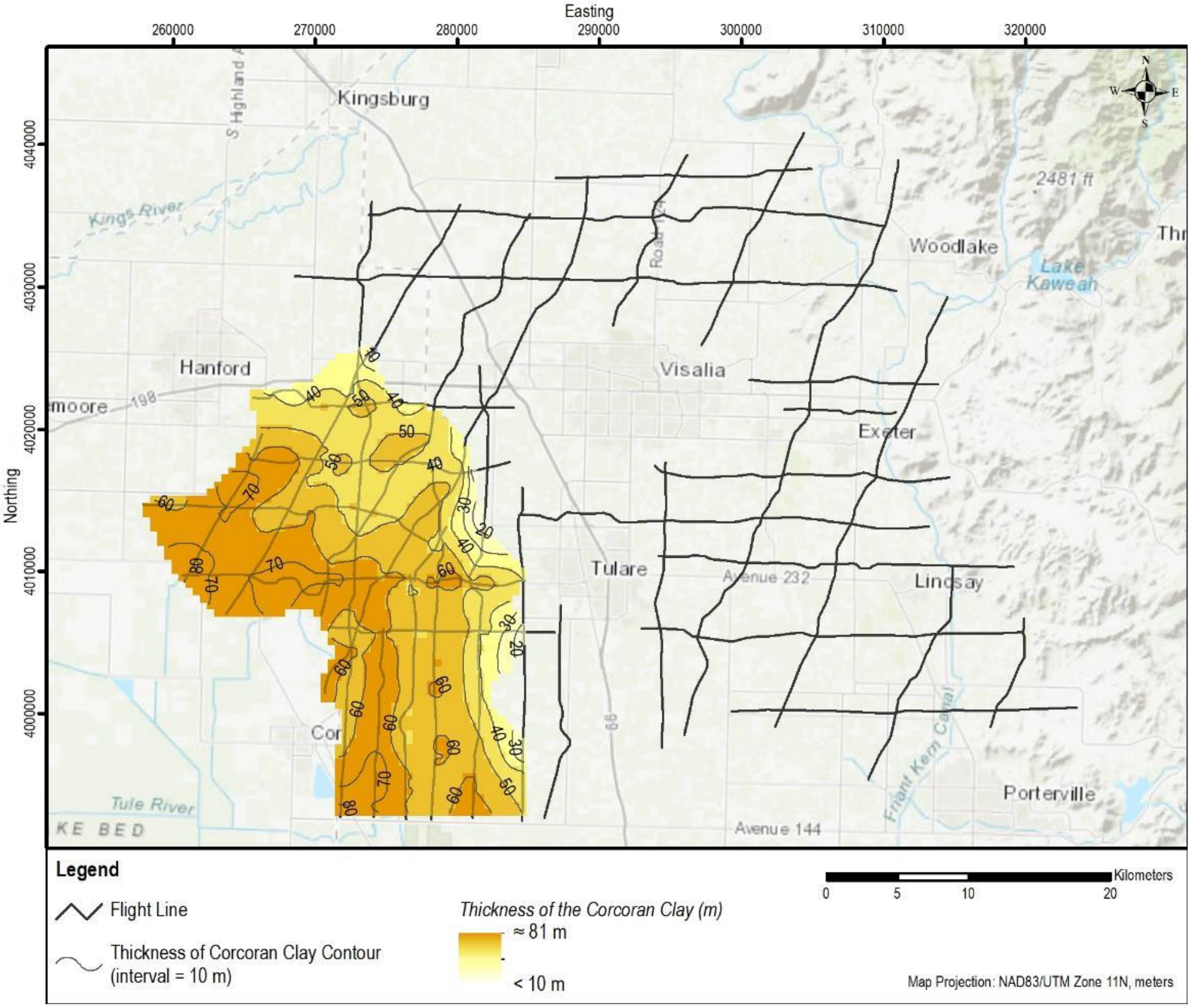
6.7.4.13 Level of Uncertainty

The characterization of wells will reduce the level of uncertainty associated with depths of groundwater production zones within the aquifer system and facilitate the refinement of various components of the basin setting.

6.7.5 MA5: Geophysical Data Survey

6.7.5.1 Management Action Description

GKGSA and the other two Kaweah GSAs in the Kaweah Subbasin served as a pilot geophysical program for hydrogeological subsurface data collection using an airborne electromagnetic method (AEM) via the company Aqua Geo Frameworks during the fall of 2018. This airborne survey method acquires deep aquifer resistivity data to better ascertain its characteristics and geology. The Phase I survey was jointly funded by Stanford University and the three Kaweah Subbasin GSAs, with data processing by Aqua Geo Frameworks using a SkyTEM system. The data was collected by way of helicopter fly-overs along pre-selected flight lines within the Kaweah Subbasin. Work products from this research and data analysis have been presented locally and statewide, and interest in furthering this means of sub-surface data collection are developing. The data were not available to the Kaweah GSAs in time for its inclusion in the Basin Setting Report (**Appendix 3A**); however, this information will be reviewed and incorporated into the 2025 Plan Update.



GKGSA may also utilize a towable electromagnetic imaging method that measures the resistivity of soils at depths of 100 ft or less. This resistivity information could be used to determine areas that are best suited (high infiltration rates) for groundwater recharge basins or for on-farm recharge programs. This ground-based technology is currently being evaluated and used within the Tulare Irrigation District areas of Mid-Kaweah GSA.

Stanford has also obtained a grant from National Academy of Sciences to integrate InSAR ground displacement data with AEM to improve groundwater modeling tools for the Kaweah Subbasin. These additional data will enhance the overall understanding of the Kaweah Subbasin and its underlying aquifer characteristics, assist with the Basin Setting and Hydrogeologic Conceptual Model, and provide new calibration parameters for the Subbasin numerical simulation model. The project will also provide direct benefits to the GSAs and landowners along the proposed new flight lines by providing detailed subsurface information not previously available.

6.7.5.2 Measurable Objectives Addressed

The study has improved the understanding of subsurface conditions and does not address measurable objectives and other management criteria.

6.7.5.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the GKGSA is implemented this study to further the understanding of subsurface conditions.

6.7.5.4 Public Notice and Outreach Process

The study was discussed in GKGSA public meetings. Future work, if any, will be appropriately noticed and outreach will be conducted consistent with GSA authorities and requirements.

6.7.5.5 Estimated Annual Project Benefits

The study has improved the understanding of subsurface conditions and will not produce an annual benefit to the groundwater resources.

6.7.5.6 Permitting and Regulatory Process

The regulatory process includes a FCC license due to electromagnetic wave signals and appropriate FAA plans due to the relatively low altitude flights.

6.7.5.7 Status of Management Action

Phase I of the fly-over data collection effort was completed during 2018 and a report was issued during late April 2019. Consideration of this information will be included in the 2025 GSP Update. The report includes several recommendations for a Phase II survey, including:

1. Additional AEM mapping with high density block flights would allow for improved hydrogeologic framework for identifying potential recharge areas and potential managed aquifer recharge sites and for estimating groundwater in storage and hydrogeologic boundary identification.
2. Siting new boreholes used for water quality and water quantity should use the results from this survey and future surveys to optimize locations.
3. Aquifer characteristic studies such as aquifer tests and other methods should be planned, based on the data from this study, to optimize location for studies and observation-production well installation.
4. Improved geophysical borehole logs will benefit current and future studies. This logging should use calibrated equipment for best results.

6.7.5.8 Expected Benefits and Targeted Sustainability Indicators

The anticipated benefits of this study include enhanced knowledge of the subsurface geology and a more robust HCM description as a result. Interpretation of the data resulted in three-dimensional mapping which could allow refinement of the structure of the Kaweah Subbasin numerical model and improved predictive accuracy. The mapping could benefit the siting of groundwater recharge projects and dedicated monitoring wells. These benefits are expected to be realized and documented in the first five-year GSP assessment to be conducted by each Subbasin GSA and submitted to DWR. Sustainability indicators anticipated to benefit via this improved knowledge would include groundwater level stabilization and, by proxy, groundwater storage stabilization, and possibly the identification of degraded water quality.

6.7.5.9 Source and Reliability of Water

An additional water source is not required for this Management Action.

6.7.5.10 Legal Authority Required

SGMA, at §10725.2, allows GSAs to pursue various means to improve its understanding of the subbasin.

6.7.5.11 Costs and Funding

The cost of the Phase I Survey was paid as follows:

- $300,000 from Stanford University for data collection costs
- $160,000 from Subbasin GSAs for data collection costs
- $25,000 from Subbasin GSAs for data management by GEI

A Phase II survey is estimated to cost $400,000. The funding mechanism has not yet been selected but will likely be a mix of grant funding (if available), land-based assessment, and/or a groundwater pumping charge.

6.7.5.12 Management of Groundwater Extractions

This management action will not have a direct effect on groundwater extraction and recharge.

6.7.5.13 Level of Uncertainty

Geophysical methods are an indirect measurement of subsurface conditions that must to correlated with actual data from the subsurface. The Phase 1 results appeared reasonably consistent with known subsurface conditions.

6.7.6 MA6: Kaweah Subbasin Mitigation Program & GKGSA Mitigation Plan (*New)

6.7.6.1 Management Action Description

The Mitigation Program establishes requirements for mitigation of wells and critical infrastructure demonstrated to have been adversely affected by declining groundwater levels, land subsidence, and groundwater quality degradation associated with groundwater overdraft. Each GSA has discretion to expand beyond the requirements detailed in the Mitigation Program in their own respective Mitigation Plans (**Figure 6-2**). **Figure 6-3** describes the Mitigation Program and GKGSA Plan (See Appendix 6A and 6B).

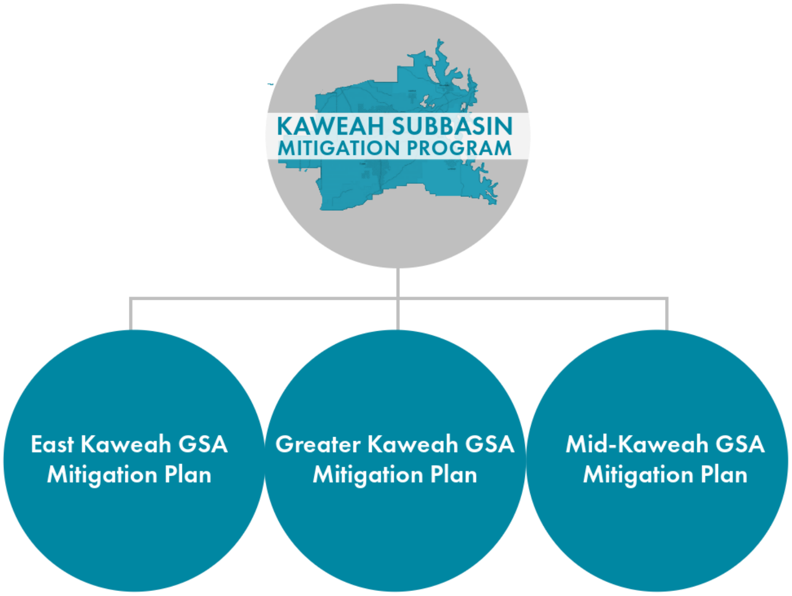


Figure 6-2 Relationship between Kaweah Subbasin Mitigation Program and GSA Mitigation Plans

The Kaweah Subbasin Mitigation Program and EKGSA Mitigation Plan offers two tracks for assistance, Drinking Water Well Mitigation and Technical Assistance for non-drinking water wells and critical infrastructure. Important distinctions between the two tracks are described in **Figure 7-10**:

The Mitigation Program will directly address the impacts of chronic lowering of groundwater levels, reduced groundwater in storage, groundwater quality, and land subsidence caused by lowered groundwater levels by providing funding for replacement wells, well modifications, alternative water supplies, or critical infrastructure (if applicable) improvements to eligible landowners. In addition, the Mitigation Program will directly support water system consolidation, well replacement or modifications, and/or well treatment for qualifying wells that experience groundwater quality due to groundwater conditions induced by the GSAs' allowable overdraft.

Figure 6-3 Kaweah Subbasin Mitigation Program Flyer (page 1 of 3)

KAWEAH SUBBASIN MITIGATION PROGRAM *VERSION 1.0*

Available June 2024

DRINKING WATER WELL MITIGATION TRACK

The Kaweah Subbasin Mitigation Program's Drinking Water Well Mitigation Track is intended to provide emergency and interim drinking water supplies and long-term mitigation for those experiencing a loss of access to drinking water due to groundwater overdraft conditions such as chronic lowering of groundwater levels, subsidence, and/or water quality induced by groundwater management in the Kaweah Subbasin. If translation services are needed, please contact Self-Help Enterprises to arrange.

If your household has lost access to drinking water, please call Self-Help Enterprises at your earliest convenience to arrange emergency bottled water supplies within 24-hours and an interim measure (such as a water tank) within 72-hours. Tenants or well owners may call to arrange access to emergency and interim supplies; however, well owners are required to submit claims to receive long-term solutions.

(559) 802-1685

www.selfhelpenterprises.org

8445 W Elowin Ct, Visalia CA

WHO CAN SUBMIT A CLAIM?

domestic (house) well owners

multi-use drinking water well owners

small community well owners

CRITERIA FOR A CLAIM TO QUALIFY

1. The well was impacted after January 1, 2015, and has undergone the on-site assessment via the Kaweah Subbasin Mitigation Program claims process.

2. The well or critical infrastructure impact was induced by overdraft conditions associated with the GSA's groundwater management.

3. The well or system of wells shall not have contributed to overdraft by pumping in excess of their individual prorata share of the sustainable yield for the GSA or contributed to other undesirable results. **This criterion does not apply to domestic (house) wells*

CLAIMS PROCESS

- Well user (owner or tenant) contacts Self-Help Enterprises (SHE) upon loss of drinking water supplies to receive emergency bottled water within 24 hours and interim supplies system within 72 hours.
- The well owner then fills out an online intake form or calls SHE for assistance https://www.selfhelpenterprises.org/programs/emergency-services/water-sustainability/
- SHE staff perform site assessment and gather information from well owner.
- SHE, GSA staff, and technical committee(s) evaluate the likely causation of well failure to determine if the claim qualifies for funding via the Mitigation Program or an alternative program.
- If the claim qualifies for any program that SHE administers, then SHE will arrange for long-term a solution and serve as the lender.
- If the claim qualifies for the Mitigation Program, then the GSA will reimburse SHE for all materials and administrative, technical, and mitigation services associated with the claim.

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Figure 6-3 Kaweah Subbasin Mitigation Program Flyer (page 2 of 3)

KAWEAH SUBBASIN MITIGATION PROGRAM VERSION 1.0

TECHNICAL ASSISTANCE TRACK

Available June 2024 for EKGSA

Available June 2025 for MKGSA & GKGSA
Contact MKGSA or GKGSA to arrange interim technical support before June 2025.

The Kaweah Subbasin Mitigation Program's Technical Assistance Track is intended to provide GSA funding and/or technical resources to identify meaningful solutions to non-drinking water well and/or critical infrastructure (pipelines, canals, etc) that are impacted by overdraft conditions within the Kaweah Subbasin.

EAST KAWEAH GSA
(559) 697-6095
www.ekgsa.org
315 E Lindmore Ave, Lindsay, CA

GREATER KAWEAH GSA
(559) 302-9987
www.greaterkaweahgsa.org
2975 Farmersville Rd, Farmersville, CA

MID-KAWEAH GSA
(559) 686-3425
www.midkaweah.org
6826 Ave 240, Tulare, CA

WHO CAN SUBMIT A CLAIM?

CRITERIA FOR A CLAIM TO QUALIFY

1. The well or critical infrastructure was impacted after January 1, 2015, and has undergone the on-site assessment via the Kaweah Subbasin Mitigation Program claims process.
2. The well or critical infrastructure impact was induced by overdraft conditions associated with the GSA's groundwater management.
3. The well or system of wells shall not have contributed to overdraft by pumping in excess of their individual prorata share of the sustainable yield for the GSA or contributed to other undesirable results. **This criterion does not apply to claims for critical infrastructure*

CLAIMS PROCESS

- Well or critical infrastructure owner contacts their respective GSA staff to set up a meeting to fill out the claim application together and disucss the program.
- Following the initial meeting, GSA staff and/or a technical contractor will perform a site assessment and analyses to determine the likely causation of well or infrastructure impacts.
- GSA staff and technical committee review findings of assessment and determine if the claim qualifies for technical assistance funding via the Mitigation Program.
- If the claim qualifies via the Mitigation Program, the GSA and Claimant (well/infrastructure owner) will enter an agreement and the GSA will fund technical assistance to support long-term solution(s) to the impacted well or critical infrastructure.

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Figure 6-3 Kaweah Subbasin Mitigation Program Flyer (page 3 of 3)

6.7.6.2 Circumstances Implementation

This is a high-priority Mitigation Program needed to maintain access to a water supply that meets basic health and safety needs by mitigating impacts of declining water levels, land subsidence, and groundwater quality induced by pumping-influenced water level changes. Declining groundwater levels created by allowable overdraft during the implementation phase of the GSPs may induce unintended groundwater quality impacts. Therefore, the Kaweah Subbasin GSAs are committed to mitigating such impacts by committing to implementing this Program. Funding is available for the Program through GSAs implementation of assessments, fees, charges, and penalties. In addition, the GSAs will explore other state, federal, and private funding opportunities including grant programs.

6.7.6.3 Process for Public Notification

The public and relevant entities must be given the opportunity and time to comment on the Program prior to adoption by the GSA. Each GSA must engage with its advisory committee(s) and stakeholders as detailed in the Stakeholder Outreach phase of the Mitigation Plan process. As outlined in the Outreach Section of the Mitigation Plan, each GSA and the Kaweah Subbasin have adopted an aggressive and broad outreach program to inform groundwater users of the Mitigation Program along with ensuring public input in the development of the Mitigation Program and Plans.

6.7.6.4 Permitting and Regulatory Process

The GSA will confirm with the Claimant that any mitigation efforts that are non-exempt from California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) requirements will comply with CEQA and NEPA prior to approval and issuance of mitigation assistance. Non-exempt critical infrastructure mitigation projects may have various permits in conjunction with the environmental planning process. New wells must comply with the Tulare County well permitting process.

6.7.6.5 Status and Schedule of Management Action

Figure 6-5 summarizes the schedule and status of the Mitigation Program and EKGSA Mitigation Plan.

Spring 2024
Upon adoption of Mitigation Program Version 1.0

- Drinking Water Well Mitigation Track initiated
  - Emergency drinking water supplies available (within 24-hours of request)
  - Interim drinking water supplies available (within 72-hours of request)
  - Long-term physical mitigation available for qualifying drinking water well claims
- Interim technical assistance available through GSAs for impacted non-drinking water wells and critical infrastructure
- Continued demand management and implementations of projects to reduce future mitigation circumstances

Spring 2025
Upon adoption of Mitigation Program Version 2.0

- Technical Assistance Track added to the Mitigation Program
  - Technical assistance funding available for qualifying non-drinking water wells claims
  - Technical assistance funding available for qualifying critical infrastructure claims
- Well Registration Program Phase 1 completed (data forms and initial outreach performed)
- Improved claims dispute process added to the Mitigation Program
- Phases 1-4 of the Small Community Well Proactive & Protective Action Program complete

Spring 2026

- Well Registration Program active and available for all well users within the Kaweah Subbasin to voluntarily participate in. Phase 2 and 3 completed (usable database and active notification protocol).
- Phase 5 of the Small Community Well Proactive & Protective Action Program completed/ongoing

Figure 6-4 Kaweah Subbasin Mitigation Program and GKGSA Mitigation Plan Schedule

6.7.6.6 Benefit Realization and Evaluation

The proposed Program will directly mitigate impacts due to the following:

- reduction in groundwater storage [1];
- chronic lowering of groundwater levels[1];
- land subsidence[1]; and
- degraded water quality[1]

[1]*induced by chronic lowering of groundwater levels (via overdraft during GSP implementation)*

The Mitigation Program will provide a direct benefit to beneficial users in the GSA who have had their well or infrastructure adversely impacted because of continued overdraft conditions while the GSA implements other projects and management actions to achieve sustainability. The metric for measuring Mitigation Program benefits will be the number of wells that are adversely impacted and mitigated and the Subbasin's ability to manage groundwater levels to the measurable objectives and avoid the need for mitigation. The Kaweah Subbasin GSAs will provide an annual accounting of the number of wells and other impacts that are identified and mitigated in the Kaweah Subbasin Annual Report, provided to the Department of Water Resources in April of each year.

6.7.6.7 How This Management Action Will Be Accomplished

The Mitigation Program is not reliant on securing new groundwater or surface water sources. The Mitigation Program claims process details how the Program will be accomplished.

6.7.6.8 Legal Authority

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 DWR is required to evaluate whether the GSP provides a reasonable means to mitigate continued overdraft, a mitigation program is an act necessary or proper to implement SGMA. (23 CCR §355.4(b)(6).)

6.7.6.9 Costs

GKGSA underwent significant financial analyses to estimate an annual and cumulative mitigation budget that is directly in alignment with sustainable management criteria in **Chapter 5**. Funding for the GKGSA Mitigation Plan is made available through fees established through policy changes in 2023 and 2024. A summary of the annual mitigation cost estimates that were used to develop the budgets is available in **Figure 6-6** below.

Current mitigation funding comes from penalties charged to growers who overdraft beyond sustainable yield. The GKGSA has established a Reserve Budget that sets aside the Mitigation Plan estimated annual costs (as described below in the Dry Well Susceptibility Analysis). As the GKGSA reaches sustainability, overdraft will diminish and the need to mitigate dry wells will diminish.

The Kaweah Subbasin Technical Team performed a Dry Well Susceptibility Analysis (described more **Chapter 5 – Sustainable Management Criteria**) which provided a cautious mitigation cost estimate under different drought scenarios with intentional protective funding buffers built-in to account for uncertainties. The mitigation cost estimates include costs to physically mitigate wells, emergency and interim supplies, SHE's administration of the program, GSAs' administration of the program, and contractor assistance during the assessment phase. The Kaweah Subbasin GSAs' mitigation budget estimates were designed to be sufficient to address mitigation needs, independent of the positive effects that projects and demand management changes that have taken place since the initial GSP was submitted in 2020.

In the event the costs to implement the Mitigation Program require revisions, the Kaweah Subbasin GSAs shall revisit their funding mechanisms and mitigation budgets to meet the mitigation commitments herein this Mitigation Program and respective Mitigation Plans. Alternatives may include raising groundwater extraction fees and/or a property-based tax.

The GSAs will explore grant funding at the state and federal levels. The state has many existing grant programs for community water systems and well construction funding. County, state, and federal assistance may be needed to best maximize the Mitigation Program in conjunction with similar programs that sprout up from similar regulatory requirements to SGMA, like CV-SALTS and ILRP. The GSAs will also work with local non-governmental organizations that may be able to aid or seek grant monies to assist Mitigation Program implementation.

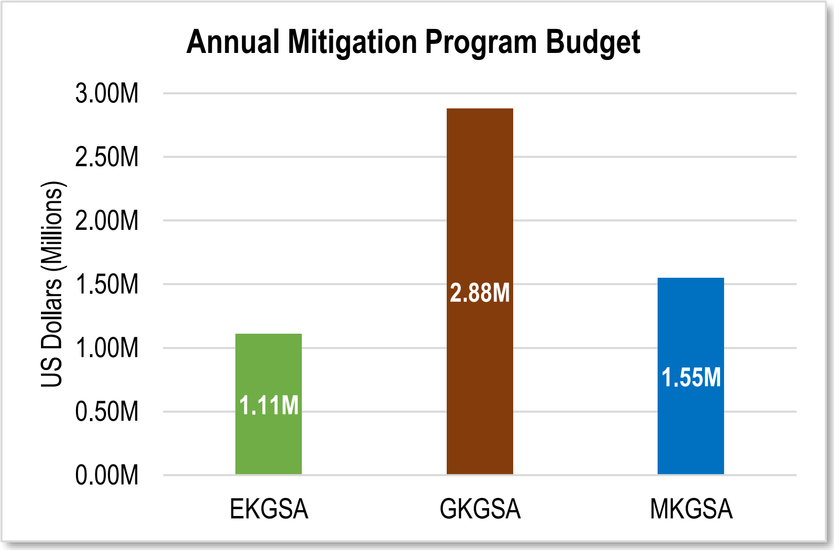

Figure 6-5 Annual Mitigation Cost Estimates and GSA Mitigation Budgets

6.7.7 MA7: Agricultural Water Conservation and Management

6.7.7.1 Management Action Description

The agricultural water service providers that are members of the GKGSA comply with all provisions of SB 7 (amending Division 6, Part 2.55 of the Water Code) passed into law in 2009 regarding agricultural water conservation and management. Efficient management practices in the law, related to SGMA objectives, include volumetric water pricing, incentives for conjunctive use and increased groundwater recharge, and development of an overall water budget. AB 1668 and SB 606 passed in 2018 did not materially add to these objectives, save for those districts serving between 10,000 and 25,000 acres who must now prepare water management plans under the newer laws.

While these new laws do not require water use objectives or savings thresholds, they do encourage more efficient use of water by the agricultural sector and its suppliers.

6.7.7.2 Measurable Objectives Addressed

The management action encourages the conservation of water and, if successful will reduce groundwater production which could allow the recovery of groundwater levels and increase groundwater storage.

6.7.7.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the GKGSA is implementing this project to reduce the demand on the groundwater resources of the subbasin.

6.7.7.4 Public Notice and Outreach Process

Noticing for this program would be conducted through the processes established by the GKGSA’s agricultural water service providers and their respective policies and requirements under law.

6.7.7.5 Estimated Annual Project Benefits

This management action encourages the conservation of water but does not require a specific benefit.

6.7.7.6 Permitting and Regulatory Process

Regulatory compliance resides with those provisions now codified into state law.

6.7.7.7 Status of Management Action

Most provisions of the conservation laws are being complied with by the agricultural water purveyors of the GKGSA. Water management plans, as originally required by USBR with the passage of the Central Valley Project Improvement Act (CVPIA) in 1992, are being regularly prepared by these districts for submittal to DWR.

6.7.7.8 Expected Benefits and Targeted Sustainability Indicators

Benefits cannot be quantified from compliance with the agricultural conservation laws at the present time. The JPA Members of GKGSA that provide agricultural water supply will continue to divert for beneficial use all local and imported water supplies to which they are entitled. Should agricultural demands for irrigation water diminish as a result of some of the conservation provisions, a larger portion of diverted supplies will be devoted to groundwater recharge in the future.

6.7.7.9 Source and Reliability of Water

Additional water source is not required for this Management Action.

6.7.7.10 Legal Authority Required

As irrigation districts per Division 11 of the California Water Code, the agricultural water suppliers within the GKGSA are empowered with ensuring the beneficial use of all water furnished thereby.

6.7.7.11 Costs and Funding

Costs for water management plan report preparation and submittals are ongoing for agricultural water suppliers in the GKGSA, and any future costs related to surface water measurement compliance and associated funding would be borne by each respective district.

6.7.7.12 Management of Groundwater Extractions

This management action encourages the conservation of water and this message will be just as applicable during wet conditions as during drought conditions.

6.7.7.13 Level of Uncertainty

This management action encourages the conservation of water and the success of this action is not certain at this time.

6.7.8 MA8: Urban Water Conservation Program

6.7.8.1 Management Action Description

As referenced in Section 2.5.1.4 of the Basin Setting Report (Appendix 3A), urban water usage in the future is expected to comply with the conservation mandates contained in SB 606 and AB 1668, both bills signed into law in May 2018. Based on that legislation, indoor residential use will be capped at 55 gallons per capita per day (gpcd) in 2019 and reduced to 50 gpcd by 2030. Outdoor residential use will be capped in the future based on local climate and size of landscaped areas. Standards for outdoor usage will be defined in a SWRCB rule-making process by June 2022.

6.7.8.2 Measurable Objectives Addressed

The management action encourages the conservation of water and, if successful will reduce groundwater production which could allow the recovery of groundwater levels and increase groundwater storage.

6.7.8.3 Circumstances and Criteria for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the GKGSA is implementing this project to reduce the demand on the groundwater resources of the subbasin.

6.7.8.4 Public Notice and Outreach Process

Noticing for this program would be conducted through the processes established by the GKGSA's municipal water service providers and their respective policies and requirements under law.

6.7.8.5 Estimated Annual Project Benefits

This management action encourages the conservation of water but does not require a specific benefit.

6.7.8.6 Permitting and Regulatory Process

The Water Conservation Act of 2009 mandated of a 20% reduction in urban per capita water usage by 2020 (SB7X7). Future achievements in urban conservation will be as derived from the passage of AB 1668 and SB 606 in 2018. Future amendments to UWMPs and modified city ordinances will eventually embody these recent laws.

6.7.8.7 Status of Management Action

The cities of Farmersville, Exeter, and Woodlake are currently evaluating their respective compliance measures for indoor use and are awaiting additional information and guidelines concerning regional outdoor and landscape compliance measures. The cities presently are complying with the 20X2020 mandates contained in SB7X7 and as embodied in their respective UWMPs. As the SWRCB establishes its compliance deadlines for both indoor and outdoor usage, anticipated to occur by 2025, the municipal JPA Members will have a clearer picture of an implementation schedule.

6.7.8.8 Expected Benefits and Targeted Sustainability Indicators

The Pacific Institute estimated in its 2014 report ("Urban Water Conservation and Efficiency Potential in California") that indoor usage could be reduced by 33 to 40 gpcd, and that outdoor/landscape usage could be reduced by 20 to 50 gpcd. These state-wide values are likely to be unrealistic in some regions; however, the report postulates that total urban water usage could be reduced by as much as 30 to 60%. Savings of this magnitude would represent a significant reduction in groundwater pumping. The Sustainability Indicators to benefit from additional urban conservation include stabilization of groundwater levels and, by proxy, groundwater storage stabilization as well as land subsidence.

6.7.8.9 Source and Reliability of Water

Additional water source is not required for this Management Action.

6.7.8.10 Legal Authority Required

Legal authorities for any additional urban water conservation will be as derived from the passage of AB 1668 and SB 606.

6.7.8.11 Costs and Funding

Costs to implement recent urban water conservation objectives are not known at this time. Funding would be as provided by each urban Member for their respective programs.

6.7.8.12 Management of Groundwater Extractions

This management action will lead to less demand on the groundwater resource and should allow groundwater levels and storage to recover further during wet years and offset decreasing groundwater levels and storage during drought years.

6.7.8.13 Level of Uncertainty

This management action encourages the conservation of water and the success of this action is not certain at this time.

6.7.9 MA9: Fee and Incentive Program

6.7.9.1 Management Action Description

The GKGSA has implemented a land-based assessment. In addition, the GKGSA anticipates both a groundwater extraction fee and penalties program to fund programs described herein and also discourage overdraft pumping. The Rules and Regulations were adopted in August 2022 and the GKGSA is currently implementing it's Third Amended version. The Rules and Regulations clarify the authority for the GKGSA and set forth the accounting and procedure for how such fees and penalties will be implemented. The board of directors plans to set the rate for each annually after legal compliance.

6.7.9.2 Measurable Objectives Addressed

This Action will benefit all of the following sustainability indicators: groundwater elevations, groundwater change in storage, land subsidence, and groundwater quality.

6.7.9.3 Circumstances and Criteria for Implementation

The GKGSA implement the fee and penalty structure after compliance with all procedural and substantive requirements of SGMA, and applicable Proposition 218 Constitutional requirements.

6.7.9.4 Public Notice and Outreach Process

The board will annually set groundwater extraction fees and penalty rates both held and noticed at public meetings in accordance with the Brown Act, SGMA, and in addition to any Proposition 218 requirements, if any.

6.7.9.5 Estimated Annual Project Benefits

The imposition of groundwater extraction fees and penalties is in part to disincentivize overdraft pumping and encourage sustainable levels of extraction.

6.7.9.6 Permitting and Regulatory Process

It is not anticipated any permits and other regulatory requirements are required for fees or penalty imposition. The GKGSA will comply with all procedural and substantive requirements of SGMA and any applicable Proposition 218 Constitutional requirements.

6.7.9.7 Status of Management Action

Penalties for all pumping beyond sustainably yield were first imposed during Water Year 2023 (October 1, 2022 – September 30, 2023).

6.7.9.8 Expected Benefits and Targeted Sustainability Indicators

The primary benefit resulting from fees and penalties is the reduction in groundwater overuse over time. The fee and penalty structure will help protect and enhance groundwater resources.

6.7.9.9 Source and Reliability of Water

The GKGSA complied with all procedural and substantive requirements of SGMA and any applicable Proposition 218 Constitutional requirements. Additional water source is not required for this Management Action.

6.7.9.10 Legal Authority Required

SGMA authorizes the imposition of fees and penalties pursuant to Water Code §10730, *et seq*. In addition, the GKGSA has authority to collect land-based assessment, other fees and penalties pursuant to the Joint Exercise of Powers Act and the common powers rule pursuant to Government Code §6500, *et seq*. In addition, a GSA is authorized to perform any act necessary or proper to carry out the purposes of this part (Water Code § 10725.2(a)) and adopt rules, regulations, ordinances and resolutions for the purposes of carrying out SGMA (Water Code §10725.2(b)).

6.7.9.11 Costs and Funding

Staff and consultant costs are necessary to impose the fees and penalties. The same will be required for collection and enforcement of the same.

6.7.9.12 Management of Groundwater Extractions

Imposition of fees and penalties will encourage use within sustainable limits and disincentivize overdraft pumping. The fees and penalties program will assist the GKGSA in reaching sustainability targets by enhancing groundwater resources and eliminating overdraft conditions.

6.7.9.13 Level of Uncertainty

This management action is active and running, and annually adjusted in the path to sustainability.

6.7.10 MA10: Groundwater Market

6.7.10.1 Management Action Description

The GKGSA will consider the feasibility and acceptance of a voluntary marketing program. With the existence of a groundwater allocation program and a suitable measurement program, the GKGSA will be in a position to administer a marketing program within the confines of the GKGSA and possibly with other GSAs in the Kaweah Subbasin. The program would consist of temporary or permanent transfers of groundwater extraction allotments for immediate use or for banking arrangements, as well as carry-over of unused allotments, all consistent with the provisions of SGMA §10726.4. A share-based methodology may be utilized, which would incorporate a fixed number of shares being issued to all groundwater rights holders, accompanied by an annual allotment dictating the volume of extractable water per share.

Stakeholder involvement will be important to this program, especially for agricultural pumpers, which will likely be the primary sellers/buyers, although the three cities within the GKGSA may be interested in participating in the program.

Prior to implementation, an accurate and reliable extraction measurement data collection protocol will be needed to support the accounting system and annual allotment per well owner. The GKGSA will seek guidance from agencies with experience in water markets to identify options for communications and outreach with stakeholders, program design, and mechanisms to ensure that non-participating stakeholders are not adversely impacted by the program.

6.7.10.2 Measurable Objectives Addressed

Measurable Objectives to be addressed by this action include chronic lowering of groundwater levels and reduction in storage (Section 5) and avoidance of associated Undesirable Results (Section 3).

6.7.10.3 Public Notice and Outreach Process

Noticing for this program would be conducted through the processes established by the MKGSA and the GKGSA, its adopted policies and requirements under law.

6.7.10.4 Estimated Annual Project Benefits

A market/transfer program will not provide any new source of groundwater to the GKGSA area but may improve the distribution and/or application of the available groundwater among stakeholders.

6.7.10.5 Permitting and Regulatory Process

Permitting and other regulatory compliance issues will be identified and addressed during the latter portion of the first 5-year period of the GSP implementation, consistent with city and county ordinances and SGMA §10726.4 (a) (3 & 4).

6.7.10.6 Status of Management Action

Both programs are under construction at this time and will likely be implemented at some scale by 2025.

6.7.10.7 Expected Benefits and Targeted Sustainability Indicators

A market/transfer program will not provide any new source of groundwater to the GKGSA area but could address the lowering of groundwater levels.

6.7.10.8 Source and Reliability of Water

The GKGSA area will be the source of the groundwater and will be limited by the hydrology of the region.

6.7.10.9 Legal Authority Required

SGMA §10726.4 (a) (3 & 4) provides legal authority for a groundwater transfer and accounting programs.

6.7.10.10 Costs and Funding

Costs to implement a marketing/transfer program are estimated to cost $10,000 for programing, but it is not known at this time the full cost for GSA staffing to administer such a program. A grant application was submitted by TID to the USBR and seeks funding for the entire subbasin to establish a pilot program, based on an outreach task, a scoping and planning task and a strategy task. Funding for the complete program will likely be included in the administrative process and will be borne by the participants.

6.7.10.11 Management of Groundwater Extractions

The implementation of a groundwater transfer program will include provisions for the recovery of groundwater levels and groundwater storage during non-drought periods.

6.7.10.12 Level of Uncertainty

The interactions with experienced agencies and the detailed evaluation of the components will reduce the level of uncertainty.

6.7.11 MA11: Groundwater Allocation and Accounting Program

6.7.11.1 Management Action Description

The GKGSA is in the process of developing a groundwater accounting system, referred to as the Water Dashboard, to track groundwater use and implement a groundwater allocation program as also described herein. The rules upon which the Water Dashboard operate based on the GKGSA's Third Amended Rules and Regulations dated February 12, 2024, . The Water Dashboard and the Rules and Regulations specifically restrict groundwater pumping within the GKGSA.

The Water Dashboard was designed to enable to the GKGSA to efficiently manage activity relevant to its SGMA compliance efforts. These activities include management of individual and/or entity groundwater accounts pursuant to various policies, and enable the GKGSA staff to undertake core administrative tasks such as member management, tracking, billing and reporting.

6.7.11.2 Measurable Objectives Addressed

The program directly benefit lowering groundwater levels, groundwater storage, land subsidence, and water quality. The purpose of the program is to reduce groundwater extractions and reach sustainability.

6.7.11.3 Circumstances and Criteria for Implementation

This is a high priority program that is necessary to limit groundwater extractions to ensure the avoidance of undesirable results. Use of groundwater is pursuant to the Rules and Regulations through either meters or Land IQ. GKGSA contracted with Land IQ in 2021 to monitor and measure total consumptive use. Through the Rules and Regulations, the GKGSA is using Land IQ to measure consumptive use for each individual parcel within the GKGSA. A landowner has the option to use Land IQ or a meter for his/her individual account within the Water Dashboard.

6.7.11.4 Public Notice and Outreach Process

An extensive public review process has been conducted for both the Rules and Regulations and the Water Dashboard. Numerous workshops have been conducted. The Stakeholder and Rural Communities Committee have also directly engaged in the drafting and development of the Rules and Regulations and the Water Dashboard.

6.7.11.5 Estimated Annual Project Benefits

The Rules and Regulations set forth an annual allocation of groundwater based on a ramp down schedule, which overtime reduces pumping to reach sustainability. This action identifies the need to maintain average annual groundwater use within a sustainable limit and proposes to reach this sustainable limit through the gradual reduction in allowable groundwater use over time.

6.7.11.6 Permitting and Regulatory Process

Pursuant to SGMA, groundwater management implemented by GKGSA is consistent with Section 2 of Article X of the California Constitution and does not determine or alter water rights (Water Code § 10720.5). 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.

6.7.11.7 Status of Management Action

Early access to the Water Dashboard began in June 2022. The Dashboard is running and populated with grower accounts. Having completed the first year of implementation, GKGSA is now processing invoices for the first year.

6.7.11.8 Expected Benefits and Targeted Sustainability Indicators

It is anticipated that overtime the Dashboard and the Rules and Regulations will protect and enhance groundwater resources by reducing groundwater overdraft gradually until groundwater use reaches sustainable limits. Other benefits include mitigating decline of groundwater levels, and limiting or eliminating land subsidence and/or the migration of contaminated plumes.

Benefits to relevant sustainability indicators and their associated measurable objectives will be evaluated pursuant to annual reports to DWR.

6.7.11.9 Source and Reliability of Water

The Rules and Regulations will be implemented through board action, which is anticipated to take place in August 2022. The water source is groundwater and the limitation of extractions from the same.

6.7.11.10 Legal Authority Required

A GSA is authorized to:

- Require the registration of groundwater extraction facilities (Water Code § 10725.6);
- Control groundwater extractions by regulating, limiting, or suspending groundwater extractions (Water Code § 10726.4(a)(2).);

- Authorize temporary and permanent transfers of groundwater extraction allocations within the agency (Water Code § 19726.4(a)(3));
- Establish accounting rules to allow unused groundwater allocations issued by the agency to be carried over from one year to another (Water Code § 10726.4(a)(4)).
- Perform any act necessary or proper to carry out the purposes of this part (Water Code § 10725.2(a)); and
- Adopt rules, regulations, ordinances and resolutions for the purposes of carrying out SGMA (Water Code §10725.2(b)).

6.7.11.11 Costs and Funding

The Program cost is staff, legal and consulting time to develop the documents and online program to implement the accounting. The GKGSA previously based a land-based assessment to cover staff, legal and consulting time for purposes such as this Program.

6.7.11.12 Management of Groundwater Extractions

The purpose of the Program is to limit groundwater extractions in order to reach sustainability. Various components of the Rules and Regulations, including allocations, carryover, recharge credits, and enforcement, will ensure that groundwater users are able to plan for and manage against periods of drought while operating within limits determined to be sustainable.

6.7.11.13 Level of Uncertainty

The process of public review has already been conducted and project implemented.

6.7.12 MA12: Interconnected Surface Water Data Gap Work Plan

Within the GKGSA, 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 interconnection surface water indicator in the Kaweah Subbasin, particularly in the GKGSA. 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.

6.7.12.1 Management Action Description

GKGSA began implementation of this Work Plan in 2022, which has included the installation of new monitoring wells and identification of optimal locations for future stream flow gauges. As a result of implementing this management action, the Kaweah Subbasin has made progress and three new monitoring well locations have been installed in the Subbasin. See **Section 4.7** in EKGSA GSP for more information on these new sites.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 to 2025 GSP Update

Phase 1: Filling Data Gaps and Further Research

With interconnected surface water being an identified data gap, the GKGSA 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 GKGSA'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 GKGSA 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 GKGSA 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 to determine whether it adversely impacts interconnected surface waterways.
- Stream flow and/or estimated hydrology—Some of the selected waterways cannot monitor surface water flows. Or, studies or analyses that may have been developed to estimate flows based on hydrological conditions are not well known. Pending further research, new or additional stream measurement sites may be installed in locations of the selected waterways.
- Presence of Riparian Habitat and/or GDE – Further investigations will be performed utilizing available data sets for the presence of riparian and/or GDEs along the selected waterways. Field investigations may be performed to confirm the physical presence and current status of these habitats. These efforts, combined with other monitoring efforts of groundwater levels and streamflow, will be used to better understand if adverse impacts are being potentially 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 the mechanics of water movement naturally as well as impacted through groundwater extraction.
- Influence of the mountainfront recharge—Additional research is needed to determine the volume coming off the mountainfront watersheds and how it impacts the upper reaches of the waterways. The Kaweah Subbasin has estimated mountainfront recharge in its Water Budgets; however, the location and magnitude of the recharge in different portions of the mountainfront are not well understood.

Phase 2: Analytical Tool Development

As the additional research and data gaps are being filled, the GKGSA will begin to evaluate an analytical tool that will be appropriate and practical to support decision-making and management. At this time, the type of tool that will be appropriate is unknown but may range from a model, series of equation calculations, or another 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 development of 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 for 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 is unknown at this time. However, the GKGSA understands that providing the results of the Work Plan and modifying SMC, where applicable, is targeted for the five year update following the submittal of this 2nd Amended GSP, should it be approved. An example of volumetric SMC is included in **Table 6-4** below. This example SMC metric is expected to be possible to adhere to following the completion of this management action is included below for context.

Table 6-4. Preliminary MT and MO for Interconnected Surface Waters

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

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

6.7.12.2 Measurable Objectives Addressed

This management action initiates a Work Plan aimed at understanding the presence of interconnected surface waters, if any, and the quantification of potential depletions caused by groundwater pumping. Ideally, this effort aims at supporting groundwater management that avoids adverse impacts to interconnected surface waters due to groundwater pumping.

6.7.12.3 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 GKGSA 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 pumping.

6.7.12.4 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 and GKGSA Board and committee meetings, which are open to the public. Management changes stemming from the results of the Work Plan will follow a review and public comment period.

6.7.12.5 Estimated Annual Project Benefits

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

6.7.12.6 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.

6.7.12.7 Status 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 6-5 Anticipated Work Plan Schedule

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

6.7.12.8 Expected Benefits and Targeted Sustainability Indicators

The management action will improve the knowledge on the timing and volume of depletion to interconnected surface water caused by groundwater pumping, if any. Pending the results of the Work Plan, the GKGSA 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.

6.7.12.9 Source and Reliability of Water

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

6.7.12.10 Legal Authority Required

The GKGSA 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 GKGSA 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.

6.7.12.11 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 GKGSA, 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 GKGSA in implementing will be whole or in part of this estimate. The GKGSA and EKGSA will be looking to find partnership on this effort as it most directly impacts their GSA boundaries. The GKGSA may also look to funding opportunities at State and/or Federal levels that support such efforts.

6.7.12.12 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 pumping in certain proximities of surface water channels could be reduced to minimize or eliminate depletions caused by groundwater pumping.

6.7.12.13 Level of Uncertainty

There is high certainty the Work Plan will be implemented, the GKGSA is committed to following the Work Plan as set forth. The level of uncertainty associated with the direction of the Work Plan and the corresponding results are high as, absent data, the certainty related to presence of interconnected surface waters and the nexus to groundwater pumping 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.

6.7.13 MA13: Well Registration Program (*New)

6.7.13.1 Management Action Description

The Kaweah Subbasin GSAs have committed to developing a Well Registration Program to be completed in phases and available for full implementation in Spring 2026. The purpose of voluntary registration of wells is to create a baseline record for each well in the event of a future claim and to have the necessary information on file to identify at-risk domestic wells for notification and advance mitigation purposes. The Well Registration Program is designed to gather as much data on well construction, location, ownership, use, groundwater levels, and groundwater quality.

This can be particularly beneficial for drinking water wells, as many of these wells’ construction, maintenance, exact location, site-specific groundwater levels and quality are considered a data gap. SGMA noted wells that extract less than 2 acre-ft per year were deemed De Minimis, and not required to participate in the GSP process. Existing domestic well records through the DWR include inactive and abandoned wells and documentation errors. The exact locations of most domestic wells are not well understood. The registration will require the well owner to provide information on well location, construction, water quality, and well maintenance history. Having a well registered will not be a prerequisite for Mitigation Plan qualification, but it should speed up the GSAs' assessment of claims, should it arise, because there is already background information on the well. Additionally, if a well is registered it may be possible to apply for mitigation before the well goes dry. Although there is an emphasis on domestic wells, all well types will be asked to voluntarily enroll in the program, as the more data and information available can improve water management, planning, and proactive efforts.

This management action requires considerable time and resource commitments to make usable. The upfront effort is for the GSAs to continue efforts to build trust in the local communities and communicate the benefits that well users will receive if enrolling (early notification and early processing). The GSAs are expecting there to be initial hesitation out of concern for the landowners' private data to become public and impact property values and future economic opportunities. That said, the Well Registration Program entails three primary phases listed below. Additional phases may be added as the program is being developed and implemented.

a. **Phase 1** (Summer 2024-Fall 2024): Initial outreach and development of data and information forms (consider online submittal options). The initial outreach phase will require several months to continue trust building as there is expected to be an initial hesitance with landowners sharing their private data and information with a public agency. The outreach campaign will highlight the benefits of voluntarily enrolling, such as early risk notifications, reduced risk as GSAs use this information to adapt management policies, and improvements in the GSAs' groundwater level and quality analyses which inform sustainability planning. Ongoing outreach is not clarified as a specific phase; however, it is a critical component of a successful Well Registration Program.
b. **Phase 2** (Fall 2024-Spring 2025): The well registration database is structured to receive registrants' data and information and beta tested. This may include incorporation of this database into the existing Data Management System.
c. **Phase 3** (Summer 2025): Voluntary well registration active and available for all well owners in the Kaweah Subbasin and risk notification and consideration of management changes proceeds for all at-risk wells.

An important element of the partnership between the Kaweah Subbasin GSAs and SHE for the Mitigation Program is the data, information, and resource sharing across the agencies. This includes the opportunity for existing and future participants of SHE's emergency services to be educated on the importance of SGMA, data sharing, and existing GSA programs.

This management action is still in the early phases and more information on the approach will be made available at GSA public meetings in early 2025.

6.7.13.2 Circumstances for Implementation

The Kaweah Subbasin has challenges with data gaps, particularly for domestic wells. This makes it especially difficult to evaluate which domestic wells may be at risk and have the ability to reach out to domestic well owners to notify if their well is at risk. It is important to the Kaweah Subbasin GSAs that sufficient data and information is gathered on all existing wells, with a particular focus on domestic wells, to best achieve sustainability and avoid undesirable results.

6.7.13.3 Process for Public Notification

The process for public notification is described in Phase 1 of the description and the GSA's current outreach and engagement opportunities and strategies are available in **Section 2.7**.

6.7.13.4 Permitting and Regulatory Process

No permitting or regulatory processes are expected to be needed to implement this management action.

6.7.13.5 Status and Schedule

The project is currently in the early stages of planning and development and is broken down into three phases.

- **Phase 1** (Summer 2024-Fall 2024): Initial outreach
- **Phase 2** (Fall 2024-Spring 2025): The well registration database is developed and beta tested
- **Phase 3** (Summer 2025): Voluntary well registration active and available for all well owners in the Kaweah Subbasin and risk notification and consideration of management changes proceeds for all at-risk wells.

6.7.13.6 Benefit Realization and Evaluation

Table 7-1 details the challenges addressed, benefiting parties, and explanation of benefits.

6.7.13.7 How this Management Action Will Be Accomplished

This management action will be accomplished through coordination across all stakeholder groups, GSA funding, exhaustive outreach efforts, and data management and notification system development. The GSAs recognize the need to invest in outreach specialists and technical support to develop databases and usable information forms. The GSAs have the capacity to complete this management action in-house; however, would prefer partnering with local community leaders and agencies to build trust, offer translation services, and reach the domestic well owners who may note be aware of GSA efforts. The strategy by the GSAs is to emphasize the benefits of enrolling, such as early notification of risks, the GSAs having the information necessary to avoid impacts to shallow wells, and expedited processing of mitigation claims. In addition, it is important that the GSAs remain transparent about the use of private information, the risks of sharing private data with public agencies, and what the GSA can do to protect private information. The success of this program is contingent on the trust the community has in the GSA – therefore, the initial phase (outreach and engagement) is the most critical and resource intensive.

6.7.13.8 Legal Authority

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. (23 CCR §355.4(b)(6).)

6.7.13.9 Costs

The capital and ongoing costs are unknown; however, it can be estimated that approximately $75,000 is needed for phases 1 and 2 and $10,000 per year to maintain phase 3 through the implementation period. There may be opportunities for cost-sharing between all three GSAs which would reduce the cost estimate.

6.7.14 MA14: Small Community Well Proactive & Protection Action Plan (PPAP) (*New)

6.7.14.1 Management Action Description

Small community wells/systems identified as being at-risk by the State Water Resources Control Board's metrics for small community wells will receive proactive mitigation via the Small Community Well Proactive & Protective Action Program (PPAP).

The GSAs have an ethical and financial interest in avoiding impacts to these small community wells and after consultations with local community well mitigation providers, it was determined the most effective and helpful mitigation for small community wells is to avoid the need for mitigation altogether. That said, the GSAs intend to avoid impacts to these community wells through a series of site-specific proactive measures, which may include but are not limited to the options listed below. The proactive measure(s) implemented will vary on a case-by-case basis.

1) Assess what next steps are needed to avoid or mitigate impacts to support Contingency Plan development and/or improvement
2) Develop or support development of Preliminary Engineer Reports for small community wells that have been stuck with lack of funding or resources to take the next steps in their own contingency plans
3) Implement groundwater pumping restriction policies near at-risk community wells

4) Host Financial Empowerment Workshops to map out long-term planning for resiliency and maintenance, with a focus on prioritizing future access to affordable drinking water
5) Support grant writing and cost-share, when funding and opportunities allow
6) Consider additional technical assistance that meets the unique needs of the at-risk small community well.

Although the claims process is designed more for private domestic and multi-use drinking water well owners, community well owners may still notify Self-Help Enterprises in the event of potential impacts to their well.
This process will establish continued trust-building with the leaders within these at-risk communities. Before proactive technical assistance/mitigation is underway, the GSAs are committed to meeting with community leaders to understand their unique challenges to map out the best strategy for contingency plans and supplemental assistance.

The GSAs are committed to this management action component of the Kaweah Subbasin Mitigation Program. As this management action will be the first of its kind in the region, there is considerable uncertainty associated with budget, schedule, and available data and information. The GSAs have experience developing methods of navigating uncertainty, such as sensitivity analyses and adapting schedules and budget priorities to achieve sustainability initiatives. The schedule and budget are subject to change as additional information and experience are gained through development and implementation.

More information on the current schedule and approach of the PPAP is available in **Figure 6-6**.

Figure 6-6. Small Community Well Proactive & Protective Action Program (PPAP) Approach and Schedule

6.7.14.2 Circumstances for Implementation

This is a high-priority management action needed to maintain access to a water supply that meets basic health and safety needs by mitigating impacts of declining water levels, land subsidence, and groundwater quality induced by pumping-influenced water level changes. Declining groundwater levels created by allowable overdraft during the implementation phase of the GSPs may induce unintended groundwater quality impacts. Therefore, the Kaweah Subbasin GSAs are committed to taking protective, proactive measures to avoid the need for mitigation of the small community water systems.

6.7.14.3 Process for Public Notification

The public and relevant entities must be given the opportunity and time to comment on the Program prior to adoption by the GSA. Opportunities to comment will be made available at stakeholder advisory committee meetings, Amended GSP public comment period, and at GSA Board Meetings. More information on the public process is available in **Section** 2.7.

6.7.14.4 Permitting and Regulatory Process

The GSA will confirm with the Claimant that any mitigation efforts that are non-exempt from California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) requirements will comply with CEQA and NEPA prior to approval and issuance of mitigation assistance. New wells must comply with the Tulare County well permitting process.

6.7.14.5 Status and Schedule

The schedule for the PPAP is available in **Figure 6-6**.

6.7.14.6 Benefit Realization and Evaluation

This management action will directly address the impacts of chronic lowering of groundwater levels, reduced groundwater in storage, groundwater quality, and land subsidence caused by lowered groundwater levels by providing strategies to avoid impacts to small community wells and identify next steps to confirm their sustainability and resiliency.

This management action is designed to provide the following benefits for small community water systems:

1. Improved risk management and planning
2. Reduced risk of experience impacts related to:
    a. reduction in groundwater storage [1];
    b. chronic lowering of groundwater levels[1];
    c. land subsidence[1]; and
    d. degraded water quality[1]

[1]*induced by groundwater management activities.*

SGMA required annual reporting provides the GSAs the opportunity to review progress on this management action and regularly assess if the risk status of the Subbasin's small community wells' changes.

6.7.14.7 How this Management Action Will Be Accomplished

The Mitigation Program is not reliant on securing new groundwater or surface water sources. **Figure 7-13** details the phases to accomplish this management action. This management action will require both technical and outreach expertise and resource prioritization, both of which the GSAs have in-house and on their technical teams.

6.7.14.8 Legal Authority

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. (23 CCR §355.4(b)(6).)

6.7.14.9 Costs

The costs to develop and implement the PPAP are unknown at this time as the PPAP is undergoing initial planning and development. It may cost approximately $100,000 per year; however, opportunities to cost-share with other Kaweah Subbasin GSAs may reduce that estimate.

The primary source of funding for the Mitigation Program is through GSA fees. The same funding source is used to fund outreach and technical consultant costs associated with GSA administration and GSP implementation.

6.7.15 MA15: Well Permit Application Review and Technical Support (*New)

6.7.15.1 Management Action Description

The Kaweah Subbasin GSAs have coordinated with Tulare County to receive all domestic and agricultural well permit applications, which provides the GSAs the information necessary to reach out to the landowner if the proposed well appears to be at-risk of experiencing impacts or if the well may induce impacts. In either case, the GSA will also provide recommendations on well depth, location, opportunities to connect to a municipal or small community well/system, etc. to support the applicant's groundwater access while avoiding unintended impacts as a result of new wells drilled without GSA consultation.

Well permit application review by the GSAs will use both the permit application and available data and resources to review the consider the following:

- The proposed location of the new well.
- The planned depth and perforated interval of the new well; GSA will determine from which aquifer (Upper, Lower, or Single) the well is planned to extract.
- The planned use of the water from the well (domestic supply, agricultural irrigation, etc.).
- Identifying the closest Representative Monitoring Sites to the proposed well to determine minimum thresholds for groundwater levels, water quality and subsidence.
- Identifying existing domestic wells and critical infrastructure in the area.
- Estimating current groundwater levels around the proposed well.

6.7.15.2 Circumstances for Implementation

As new wells are being installed, the GSA is concerned that new wells may be installed at locations and depths that may not be in alignment with the sustainability mission. Additionally, new wells can also be drilled in locations and depths that elevate the risk of impacts. The GSAs are in a unique position to support landowners who are installing new wells with data and information to inform their decision to minimize impacts and maximize sustainability for the landowner and the surrounding beneficial uses, users, and property interests.

6.7.15.3 Process for Public Notification

The GSAs will include information on this management action through protocols identified in **Section 2.7**. In addition, the GSAs will contact local drillers and water haulers and build the relationship in which the driller or hauler is encouraged to share information about this management action and information on the Kaweah Subbasin Mitigation Program and GSA Mitigation Plans (MA9) with the landowner.

6.7.15.4 Permitting and Regulatory Process

The Kaweah Subbasin GSAs will abide by existing Tulare County permitting code and requirements. The GSAs do not have the authority to authorize or reject well permit applications. The role of the GSA is to provide information which may encourage long-term sustainability for the applicant.

6.7.15.5 Status and Schedule

This management action is currently active. GSAs receive well permit applications for all domestic and agricultural wells within their respective jurisdiction.

6.7.15.6 Benefit Realization and Evaluation

It is challenging to quantify the benefit of this measure as there are many variables and the activities are proactive, in an effort to avoid future unknowable impacts. More information on the benefits is found in **Table 7-1**.

6.7.15.7 How this Management Action Will Be Accomplished

This management action is accomplished by GSA staff and/or their technical team reviewing the considerations listed in the description to evaluate risks. After this assessment, if a risk is identified, the GSAs contact the landowner and share recommendations on changed location, depth, and other construction or connection options.

6.7.15.8 Legal Authority

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. (23 CCR §355.4(b)(6).)

6.7.15.9 Costs

The cost to implement this management action is minimal. This proactive measure is more affordable than costs to mitigate or initiate new projects and management actions that may arise as a result of not engaging in Well Permit Review and Technical Support. Because GSA staff and/or their technical teams have data and information readily available on current and future groundwater conditions, locations of nearby critical infrastructure and wells as a result of SGMA implementation and aerial photography, this management action is expected to cost the GSA an estimated $5,000 per year. This cost is expected to fluctuate over time.

6.7.16 MA16: Water Importation/Recharge Program (*New)

6.7.16.1 Management Action Description

The GKGSA will form an agreement with the Kaweah Delta Water Conservation District (KDWCD) to actively source CVP water through the District's long-Term Contact with the U.S. Bureau of Reclamation and import and recharge water whenever market conditions are favorable for water purchase.

6.7.16.2 Circumstances for Implementation

The Kaweah Subbasin has been designated as critically overdrafted and the GKGSA is implementing this project to reduce the demand on the groundwater resources of the subbasin.

6.7.16.3 Process for Public Notification

Appropriate notice and outreach will be provided to various public agencies and other stakeholders by KDWCD. The district holds monthly Board of Director's meetings and the project will be an agenda item for Board discussion regarding the project status, schedule, budget, necessary approvals and/or required action by the Board. KDWCD also maintains and regularly updates a website with project descriptions, current activities, and progress.

6.7.16.4 Permitting and Regulatory Process

No permitting or regulatory processes are expected to be needed to implement this management action.

6.7.16.5 Status and Schedule

This management action is currently active. The GKGSA intends to formalize the importation process by the drafting of a formal agreement with KDWCD to actively fund and support regular CVP water importation activities.

6.7.16.6 Benefit Realization and Evaluation

It is challenging to quantify the benefit of this measure as there are many variables as water year type, price, and KDWCD system capacity issues impact available water.

6.7.16.7 How this Management Action Will Be Accomplished

This management action is accomplished by annual collaboration between GSA staff and KDWCD staff to monitor CVP Water supply status through the United States Bureau of Reclamation management of releases from Friant Dam to manage San Joaquin River resources for flood control and water supply. This will be managed though the administration of transfers from other Long-Term Contractors to KDWCD. KDWCD will then wheel the water to designated recharge channels and basins for percolation.

6.7.16.8 Legal Authority

KDWCD has statutory authority to manage, regulate, and engage in water management activities, including groundwater recharge operations, for the benefit of its service area. *See, e.g., Cal. Water Code* §§ 31020 et seq.

6.7.16.9 Costs

The cost to implement this management action is not known and annual importation water cost will vary significantly from year to year mostly due to the Water Year type (supply and demand pricing). Dry years will result in low supply and high cost per acre foot, whereas wetter years will provide more water, more transfer opportunities, and lower costs per acre foot.

6.8 Benefits Analyses

As described in **Section 2** of this Plan, the GKGSA region, primarily via the conjunctive-use operations of Kaweah Delta Water Conservation District (KDWCD) as a CVP Contractor, has benefited from historical practices of groundwater recharge. There are, however, wet seasons and years during which local stream flows and surplus entitlements from KDWCD's Long-Term Contract for CVP Water are not imported into the area because all such facilities are at capacity from the local Kaweah River system. The Friant CVP Contractor allotments ramp up significantly in wet seasons and, as such, are ideally suited for groundwater recharge projects and programs. Through historical operations, records, and communications with water facility managers, GKGSA and KDWCD assessed the future availability of CVP/Friant and Kaweah River surplus sources.

Between the two sources there exist about 30 - 45 days on average during which surplus flows are available for diversion and recharge. The number of days from each source individually are not additive, as there occur overlapping days within certain months, particularly in the wetter year types. These surplus flows can be troublesome as flood flows can cause damage, so GKGSA diversion and recharge abilities provide a dual role of flood control and groundwater management.

7 GROUNDWATER SUSTAINABILITY PLAN IMPLEMENTATION

The adoption of the GSP will be the official start of the Plan Implementation. The GKGSA 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 GKGSA will coordinate with various stakeholders and beneficial users to improve the monitoring networks and begin the implementation process for projects and management actions.

7.1 Schedule and Estimated Cost [§354.6 (e)]

§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 GKGSA 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 GKGSA 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 GKGSA follows in the years ahead. The GKGSA 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 GKGSA 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.

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 GKGSA staffing and/or policy decisions in the future.

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.

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 GKGSA Board should it be deemed necessary. The funding for projects and management actions will likely come from specific project proponents and/or beneficiaries.

The schedule and costs associated with GSP implementation activities are detailed in **Table 7-1**.

Table 7-1 Schedule and Cost of Implementation

GKGSA GSP Implementation Cost Estimate & Schedule	2020-2025		2025-2030		2030-2035		2035-2040	
	Capital Cost	Annual O&M Cost	Capital Cost	Annual O&M Cost	Capital Cost	Annual O&M Cost	Capital Cost	Annual O&M Cost
1. Regular/Ongoing SGMA Compliance Activities								
GSA Administration	$ -	$ 816,000.00	$ -	$ 1,000,000.00	$ -	$ 1,100,000.00	$ -	$ 1,250,000.00
Outreach and Engagement	$ -	$ 40,000.00	$ -	$ 20,000.00	$ -	$ 22,000.00	$ -	$ 24,000.00
Database Management System	$ -	$ 20,000.00	$ -	$ 5,000.00	$ -	$ 5,000.00	$ -	$ 5,000.00
Annual Reporting	$ -	$ 30,000.00	$ -	$ 33,000.00	$ -	$ 36,000.00	$ -	$ 40,000.00
GSP & Allocation Enforcement	$ -	$ 750,000.00	$ -	$ 500,000.00	$ -	$ 300,000.00	$ -	$ 330,000.00
2. GSP Amendments (Deficiency Updates and 5-Year Updates)								
Technical Consultant(s)	$ -	$ 300,000.00	$ -	$ 500,000.00	$ -	$ 400,000.00	$ -	$ 440,000.00
3. Plans to Fill Data Gaps								
Coordination and Implementation	$ -	$ 100,000.00	$ -	$ 50,000.00	$ -	$ 55,000.00	$ -	$ 60,000.00
4. Priority Projects (projects completed or in-process)								
P1 - Cross Creek Layoff Basin	$ 1,500,000.00	$ -	$ 5,000,000.00	$ 4,000.00	$ -	$ 4,400.00	$ -	$ 4,800.00
P2 - Recharge Basin Improvements for Lakeside Irrigation Water District	$ 200,000.00	$ -	$ 200,000.00	$ -	$ 200,000.00	$ -	$ -	$ -
P3 - New Recharge Basins	$ -	$ -	$ 6,000,000.00	$ -	$ 15,000,000.00	$ -	$ -	$ 4,000.00
P4 - Delta View Canal	$ -	$ -	$ 2,000,000.00	$ -	$ 500,000.00	$ -	$ -	$ 6,000.00
P5 - Lakeland Canal Deliveries	$ 50,000.00	$ 37,000.00	$ -	$ 40,000.00	$ -	$ 45,000.00	$ -	$ 50,000.00
P6 - Kings River Floodwater Arrangement	$ 50,000.00	$ 37,000.00	$ -	$ 40,000.00	$ -	$ 45,000.00	$ -	$ 50,000.00

P7 - Kings River Surplus Water	$ -	$ 21,000.00	$ -	$ 23,000.00	$ -	$ 25,000.00	$ -	$ 27,000.00
P8 - Fallowing Program	$ -	$ -	$ -	$ 255,000.00	$ -	$ 255,000.00	$ -	$ 250,000.00
P9 - On-Farm Recharge & Storage	$ -	$ 2,000.00	$ -	$ 2,000.00	$ -	$ 2,200.00	$ -	$ 2,400.00
P10 - Hannah Ranch Flood Control Project	$ 1,600,000.00	$ -	$ -	$ -	$ -	$ 8,000.00	$ -	$ 8,800.00
P11 - Paregien Flood Control & Recharge Project	$ 1,800,000.00	$ -	$ -	$ 4,000.00	$ -	$ 4,400.00	$ -	$ 4,800.00
P12 - Ketchum Flood Control & Recharge Project	$ -	$ -	$ -	$ 4,000.00	$ -	$ 4,400.00	$ -	$ 4,800.00
P13 - St. Johns River Water Conservation Project	$ 500,000.00	$ -	$ 1,500,000.00	$ -	$ -	$ 1,000.00	$ -	$ 1,100.00
P14 - Basin No. 4 Improvement Project	$ 400,000.00	$ -	$ -	$ 4,000.00	$ -	$ 4,400.00	$ -	$ 4,800.00
P15 - Peoples Recharge and Exansion Project	$ 425,000.00	$ -	$ -	$ 2,000.00	$ -	$ 2,200.00	$ -	$ 2,400.00
P16 – Greater Fallowing Auction Program	$ 1,000.00	$ 300,000.00	$ 5,000.00	$ 500,000.00	$ 2,000.00	$ 50,000.00	$ 2,000.00 -	$ 500,000.00
5. Priority Management Actions (management actions completed or in-process)								
MA1 - Communication and Engagement	$ 10,000.00	$ -	$ -	$ -	$ 10,000.00	$ -	$ 10,000.00	$ -
MA2 - Terminus Reservoir Reoperation Program	$ -	$ -	$ -	$ -	$ 45,000.00	$ -	$ -	$ -
MA3 - Groundwater Extraction Measurement Program	$ 10,000.00	$ -	$ -	$ -	$ 30,000.00	$ -	$ 40,000.00	$ -
MA4 - Well Characterization Program	$ 5,000.00	$ -	$ -	$ -	$ 11,000.00	$ -	$ 15,000.00	$ -
MA5 - Geophysical Data Survey - Phase I	$ 200,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -
MA5 - Geophysical Data Survey - Phase II	$ -	$ -	$ 200,000.00	$ -	$ -	$ -	$ -	$ -
MA6 – Kaweah Subbasin Mitigation Program & GKGSA Mitigation Plan *new	$ 1,000,000.00	$ -	$ 4,000,000.00	$ -	$ 3,000,000.00	$ -	$ 1,000,000.00	$ -

MA7 - Agricultural Water Conservation & Management	$ 10,000.00	$ -	$ 20,000.00	$ -	$ 22,000.00	$ -	$ 30,000.00	$ -
MA8 - Urban Water Conservation Program	$ -	$ -	$ 40,000.00	$ -	$ -	$ -	$ -	$ -
MA9 - Fee & Incentive Program	$ 20,000.00	$ -	$ 15,000.00	$ -	$ 17,000.00	$ -	$ 20,000.00	$ -
MA10 - Groundwater Market	$ 25,000.00	$ -	$ 10,000.00	$ -	$ 5,000.00	$ -	$ 5,000.00	$ -
MA11 - Groundwater Allocation and Accounting Program	$ 40,000.00	$ -	$ 20,000.00	$ -	$ 10,000.00	$ -	$ 10,000.00	$ -
MA12 - Interconnected Surface Water Data Gap Work Plan	$ 10,000.00	$ -	$ 20,000.00	$ -	$ -	$ -	$ -	$ -
MA13 - Well Registration Program *new	$ 5,000.00	$ -	$ 30,000.00	$ -	$ -	$ -	$ -	$ -
MA14 - Small Community Well Proactive & Protection Action Plan (PPAP) *new	$ 5,000.00	$ -	$ 20,000.00	$ 2,000.00	$ 20,000.00	$ 2,200.00	$ -	$ 2,500.00
MA15 - Well Permit Application Review and Technical Support *new	$ 1,000.00	$ 5,000.00	$ 75,000.00	$ 1,000.00	$ 50,000.00	$ 1,200.00	$ -	$ 15,000.00
MA16 – Water Importation/Recharge Program *new	$ 1,000.00	$ 200,000.00	$ 1,000.00	$ 400,000.00	$ 1,000.00	$ 600,000.00	$ 1,000.00	$ 2,500.00

7.2 Cumulative Accomplishments

The Subbasin's sustainability path has evolved since the inception of SGMA. During the development of the 2020 GSPs, the GSAs pursued water supply projects that could increase groundwater recharge activities to recover groundwater levels and avoid undesirable results. Historically, this was the approach to solve groundwater problems. During the 2020-2022 drought period, however, it became apparent that relying on groundwater recharge projects would only be successful if there was a guarantee of enough wet years with excess water to recharge in developed recharge projects. Amid a drought and declining groundwater levels, the GSAs understood that demand management implemented through an allocation system was a priority to halt declining groundwater levels and continued overdraft. Achieving the Subbasin's sustainability goal relies on the GSAs' allocation systems to reduce groundwater extractions to within the sustainable yield.

Groundwater benefits from projects and management actions are a reduction of groundwater overdraft to stop the chronic lowering of groundwater levels and land subsidence. With increasing groundwater levels, benefits will also be realized for groundwater quality. The Kaweah Subbasin groundwater model provides a tool by which these benefits can be quantified. The model allows for the evaluation of individual project and management action benefits and cumulative benefits for individual GSAs and the Subbasin. As part of developing this amended GSP, a GSP Implementation scenario was used to determine the management actions and projects needed to avoid MTs and achieve MOs. Sections 6.6 and 6.7 describe the projects and management actions in the GKGSA area, respectively. Appendix 5E includes projected hydrographs for RMS to demonstrate avoidance of undesirable results.

A difference between model-simulated annual groundwater extractions and the sustainable yield (Section 3.4.6) approximates annual overdraft. Based on an implementation schedule of each GSA's projects and management actions, a 33% increase in managed aquifer recharge, and projected groundwater extractions that include a 34% reduction in irrigated agriculture pumping over current extractions, the graph on Figure 7-1 demonstrates the elimination of annual overdraft by 2040, which is sustained through the remainder of the planning horizon.

There is no one project or management action that can achieve sustainability in the Kaweah Subbasin. It will take coordinated effort by the 3 GSAs to reduce groundwater extractions and to maximize groundwater recharge.

7.3 Data Management System

The Kaweah GSAs have developed a DMS in adherence to GSP Regulations § 352.6 and § 354.40 that is used to store, review, and upload data collected as part of GSP development and implementation.

The Kaweah Subbasin DMS consists of 2 custom SQL databases. The HydroSQL database stores information about each monitoring site (well or surveying/benchmark site) in a stations table, and includes the following:

- Site Name (Local Site Name, State Well Number, Site Code)
- Site Location (X and Y Coordinates, Ground Surface Elevation and Reference Point Elevation, and Location and Elevation Accuracy and Source)
- Site Status
- Well Depth and Perforation Intervals
- Well Type and Use
- SMC (Suitability Indicators, MT/MO, and Interim Milestones) for RMS

The HydroSQL database also stores related groundwater level and subsidence time-series data. The time-series data for groundwater levels include the following fields:

- Site Name
- Measure Date/Time
- Water Level Elevation (ft. NAVD88)
- Depth to Water (ft. bls)
- Measurement Method and Accuracy
- Collecting Agency

The time-series data for subsidence include the following fields:

- Site Name
- Sample Date/Time
- Cumulative Vertical Displacement (ft.) from a specified start date
- Land Surface Elevation (ft. NAVD88)

Water quality data are stored in the EnviroSQL database, which utilizes Enviro Data and is linked to HydroSQL for data management purposes. EnviroSQL contains water quality time-series data, including the following fields:

- Site Name
- Parameter
- Sample Date
- Detection (detect or non-detect)
- Value
- Unit

Data used to populate the Kaweah Subbasin DMS are listed in **Table 7-2**. Categories marked with an X indicate datasets that were used in populating the DMS, including data that are publicly accessible. Additional datasets will be added in the future as appropriate, such as recharge or diversion data.

Table 7-2. Datasets Available for Use in Populating the DMS

Data Sets	Well and Site Information	Groundwater Level	Subsidence	Groundwater Quality
DWR (SGMA Data Viewer)	X	X	X	
CA Water Boards (GAMA Groundwater Information System)	X			X
DMS Provided by GEI			X	

Data stored in the DMS are compiled and reviewed to comply with quality objectives. The review included the following checks:

- Removing or flagging questionable data being uploaded to the DMS. This includes identifying outliers that may have been introduced during the original data entry process and plotting each well hydrograph to identify and remove anomalous data points.
- Loading into the database and checking for errors and missing data.

The DMS also includes a publicly accessible web portal linked to on each GSA's website. The link via the GKGSA's website is greaterkaweahgsa.org. The web portal provides stakeholders and the general public access to a web map that includes non-confidential hydrogeologic information used in the development of the GSP and annual reports. In the web map, users can view monitoring sites and attributes and create time-series charts of groundwater level, groundwater quality, and subsidence time-series data. Users can customize these time-series charts, e.g., plot data for multiple sites, plot multiple time-series, and display MT/MO threshold lines. In the web map, users can also turn on and off various geospatial layers compiled from public data sources, including the following:

- Land Use/Crops
- Streams and Canals/Ditches
- Recharge Basins
- Water Surface Elevation Contours
- Well Completion Reports and Household Water Supply Shortage Reports
- Parcels
- GSA Boundaries
- Groundwater Subbasin Boundaries
- Water District Boundaries
- Municipal Boundaries
- AEM Survey Lines
- Corcoran Clay Extent
- TRE ALTAMIRA InSAR Subsidence Data (Annual Vertical Displacement and Total Vertical Displacement rasters)

In addition, the web map provides functionalities for users to search for specific monitoring sites in the database, label and mark sites, change base maps, draw and measure, and locate themselves on the map. The DMS and web map will be regularly updated as new information is made available to the Subbasin GSAs.

7.4 Reporting [§ 354.4]

The GKGSA together with the other two GSAs will continue to develop and submit a Subbasin annual report by April 1 of each year. 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

Additionally, GKGSA will re-evaluate and, if needed, amend its 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. When a Periodic Evaluation is required, it will contain the information contained in DWR's *A Guide to Annual Reports, Periodic Evaluations, & Plan Amendments*[9]. Periodic evaluations track progress 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 are acquired that change understanding of the Subbasin or operations, or priorities change. While the GKGSA is evaluating key components of the GSP, such as sustainable management criteria, it will seek 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. Results from these processes and any changes will be incorporated into the GSP when it is resubmitted to DWR at least every five years.

[9] https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/GSP-Implementation-Guidance-Report.pdf

8 REFERENCES

Ayers, R.S., and Westcot, D.W. 1985. Water Quality for Agriculture – FAO Irrigation and Drainage Paper 29 rev. 1. Food and Agriculture Organization of The United Nations (FAO). http://www.fao.org/docrep/003/t0234e/t0234e00.htm

Bertoldi, Gilbert L., Johnston, Richard H., and Evenson, K.D. 1991. *Ground Water in the Central Valley, California - A Summary Report*, USGS Professional Paper 1401-A.

Bookman-Edmonston Engineering (B-E). 1972. *Report on Investigation of the Water Resources of Kaweah Delta Water Conservation District*, consultant's unpublished report prepared for the Kaweah Delta Water Conservation District, February.

Belitz, K. and Burton, C, 2012, *Groundwater quality in the Southeast San Joaquin Valley, California*: U.S. Geological Survey Fact Sheet 2011-3151, 4 p. https://pubs.usgs.gov/fs/2011/3151/pdf/fs20113151.pdf

Braatne, Jeffrey H.; Rood, Stewart B.; Heilman, Paul E. 1996. *Life history, ecology, and conservation of riparian cottonwoods in North America. In: Steller, R. F., ed. Biology of Populus and its implications for management and conservation.* Ottawa, ON: National Research Council of Canada, NRC Research Press: 57-85.

Bureau of Reclamation (USBR). Technical Studies in Support of Factual Report, Ivanhoe Irrigation District. Fresno; Apr 1949. 199 p.

Bureau of Reclamation (USBR). Exeter Irrigation District and Stone Corral Irrigation District Irrigation Suitability Land Classification Report, Volume 2 of 2, Technical Studies in Support of Factual Report, Exeter Irrigation District. Fresno; Nov 1949. 174 p.

____, 1948. Geologic Study of the Lindmore Irrigation District. Fresno; 29 p, June.

___, 1949. Exeter Irrigation District and Stone Corral Irrigation District Irrigation Suitability Land Classification Report, Volume 2 of 2, Technical Studies in Support of Factual Report, Exeter Irrigation District. Fresno, 174 p, November.

___, 1949. *Factual Report Ivanhoe Irrigation District, Central Valley Project, California*. U.S. Bureau of Reclamation, Region II, Tulare Basin District, 80 pages.

Burton, C.A., Shelton, J.L., and Belitz, Kenneth, 2012, Status and understanding of groundwater quality in the two southern San Joaquin Valley study units, 2005–2006—California GAMA Priority Basin Project: U.S. Geological Survey Scientific Investigations Report 2011–5218, 150 p. https://pubs.usgs.gov/sir/2011/5218/

Burton, C.A., and Belitz, Kenneth, 2008, *Ground-water quality data in the Southeast San Joaquin Valley, 2005-2006 – Results from the California GAMA Program*: U.S. Geological Survey Data Series Report 351, 103 p. https://pubs.usgs.gov/ds/351/

California Department of Finance. 2017. *County Population and Housing Estimates, 2010-2017 with 2010 Benchmarks.*

California Department of Water Resources (CDWR), 2003. *California's Groundwater Bulletin 118, Update 2003.*

___, 2014. Historical, and Estimated Potential for Future Land Subsidence in California.

___, 2016. *California's Groundwater Bulletin 118, Update* 2016.

___, 2018. Guidance Document for the Sustainable Management of Groundwater, Guidance for Climate Change Data Use During Groundwater Sustainability Plan Development.

California Regional Water Quality Control Board. 2003. *Initial Site Investigation Report, Country Club Cleaners, 2000 West Whitendale Avenue, Visalia, Tulare County*, July http://geotracker.waterboards.ca.gov/regulators/deliverable_documents/8753980338/July%2016%202003%20Country%20Club.pdf

California State Water Resources Control Board. 2016. Groundwater Ambient Monitoring and Assessment (GAMA) Domestic Well Project Groundwater Quality Data Report – Tulare County Focus Area, July 2016. https://www.waterboards.ca.gov/water_issues/programs/gama/docs/tularesummaryreport.pdf

California Water Service (Cal Water). 2016. *2015 Urban Water Management Plan, Visalia District.* June 2016

Croft, M.G. 1968. Geology and Radiocarbon Ages of Late Pleistocene Lacustrine Clay Deposits, Southern Part of San Joaquin Valley, California, USGS Professional Paper 600-B, p. B151-B156.

Croft, M.G. and Gordon, G.V., 1968. Geology, hydrology, and quality of water in the Hanford-Visalia area, San Joaquin Valley, California (No. 68-67).

Davids Engineering. 2013. *Time Series Evapotranspiration and Applied Water Estimates from Remote Sensing*, consultant's unpublished report prepared for the Kaweah Delta Water Conservation District, March.

Davids Engineering, 2018. *Kaweah Subbasin Development of Evapotranspiration and Applied Water Estimates Using Remote Sensing*, consultant's unpublished report prepared for the Kaweah Delta Water Conservation District, November.

Davis G.H., Green, J.H., Olmsted, F.H., and Brown, D.W. 1959. *Ground-Water Conditions and Storage Capacity in the San Joaquin Valley, California*, USGS Open-file Report 1469.

Duffield, Glenn M., 2016. *Representative Values of Hydraulic Properties.* AQTESOLV. http://www.aqtesolv.com/aquifer-tests/aquifer_properties.htm

Dziegielewski, B. and Kiefer, J.C. 2010. *Water Conservation Measurement Metrics Guidance Report*. The American Water Works Association Water Conservation Division Subcommittee Report. January 22, 2010.

Farr, T.G., C. Jones, Z. Liu, 2015, Progress report: Subsidence in the Central Valley, California. Submitted to California Department of Water Resources. Available at: http://www.nasa.gov/jpl/nasa californiadrought-causing-valley-land-to-sink

___, 2016, Progress report: Subsidence in the Central Valley, California. Submitted to California Department of Water Resources

Faunt, C., R.T. Hanson, K. Belitz, W. Schmid, S. Predmore, D. L. Rewis, and K. McPherson, 2009, Groundwater availability of the Central Valley Aquifer, California. USGS Professional Paper 1766. Reston, Va.: United States Department of the Interior, Geological Survey. http://pubs.usgs.gov/pp/1766, 225.

Faunt, C.C., R.T. Hanson, and K. Belitz, 2009, Development of a three-dimensional model of sedimentary texture in valley-fill deposits of Central Valley, California, USA, Hydrogeology Journal (2010) 18: 625– 649.

Freeze, R.A., and Cherry, J.A., 1979. Groundwater. Prentice-Hall, Inc., Englewood Cliffs.

Frink, J.W. and Kues, H.A. 1954. *Corcoran Clay, a Pleistocene Lacustrine Deposit in San Joaquin Valley, California*, American Association of Petroleum Geologists Bulletin, v. 38, no. 11, p. 2357-2371.

Fugro West, Inc. 2003 (revised 2007). *Water Resources Investigation of the Kaweah Delta Water Conservation District*, consultant's unpublished revised report prepared for the Kaweah Delta Water Conservation District, July.

Fugro Consultants, Inc. 2016. *Water Resources Investigation Update, Kaweah Delta Water Conservation District*, consultant's unpublished report prepared for the Kaweah Delta Water Conservation District, January.

[FWA] Friant Water Authority. 2018. Technical Memorandum: Estimate of Future Friant Division Supplies for use in Groundwater Sustainability Plans, California. December 2018, 23 p.

[FWA] Friant Water Authority. 2023. Friant-Kern Canal System-Wide Capacity Correction: Reconnaissance Study. January 2023, 488 p

GEI Consultants, Inc. 2016. *Review of Kaweah Delta Water Resources Investigation Reports*, consultant's unpublished technical memorandum prepared for the Mid-Kaweah Groundwater Sustainability Agency Technical Advisory Committee, July 28.

Grismer, M.E. 1990. *Leaching Fraction, Soil Salinity, and Drainage Efficiency*. Journal of California Agriculture, Vol. 44, No. 6.

Hilton, G.S., McClelland, E.J., Klausing, R.L, and Kunkel, F. 1963. Geology, Hydrology, and Quality of Water in the Terra Bella-Lost Hills Area, San Joaquin Valley, California, USGS Open-file Report, 158 p.

Jennings, C.W., 2010. Geologic Map of California, California Geological Survey.

KDWCD, 2012. *Groundwater Management Plan 2010 Annual Report,* consultant's unpublished report prepared for the Kaweah Delta Water Conservation District, August. http://www.tulare.ca.gov/home/showdocument?id=2301

Klausing, R.L. and Lohman, K.E. 1964. *Upper Pliocene Marine Strata on the East Side of the San Joaquin Valley, California, Art. 124* in Short papers in geology and hydrology, USGS Professional Paper 189-C, p. 81-102.

Land IQ. 2022. Field by field monthly evapotranspiration and precipitation for the Kaweah Subbasin. www.landiq.com/land-iq-et.

Lees, M. Knight, R., Smith, R. (2022). Development and Application of a 1D Compation Model to Understand 65 Years of Subsidence in the San Joaquin Valley. Water Resources Research. E2021WR031390. http://doi.org/10.1029/2021WR031390Lewis, D. C.; Burgy, R. H. 1964. *The relationship between oak tree roots and groundwater in fractured rock as determined by tritium tracing.* Journal of Geophysical Research. 69(12): 2579-2587.

Luhdorff & Scalmanini Consulting Engineers (LSCE), J.W. Borchers, M. Carpenter. 2014. *Land Subsidence from Groundwater Use in California. Full Report of Findings* prepared for California Water Foundation. April 2014. 151 p http://ca.water.usgs.gov/land_subsidence/california-subsidence-cause-effect.html.

Page, R.W. 1986. *Geology of the Tulare Formation and Other Continental Deposits, Kettlemen City Area, San Joaquin Valley, California*, with a Section on Ground-Water Management Considerations and Use of Texture Maps, USGS Water Resources Investigations Report 83-4000.

Park, W.H. and Weddle, J.R. 1959. Correlation Study of Southern San Joaquin Valley, Summary of Operations, in California Oil Fields, V. 45, No. 1, p. 33-34.

State Water Resources Control Board, 1995. *Water Quality Control Plan for the Tulare Lake Basin, Second Edition.* 1995.

Tulare County, 2012. *2030 Update Tulare County General Plan.* August 2012.

Tulare County Flood Control District, 1971. *Flood Control Master Plan for the County of Tulare California*. June 1971.

University of California at Berkeley, 2017. "*Trading Sustainably: Critical Considerations for Local Groundwater Markets Under the Sustainable Groundwater Management Act*". June 2017

USDA National Agricultural Statistics Service Cropland Data Layer. 2018. *Published crop-specific data layer [Online]. Available at https://nassgeodata.gmu.edu/CropScape/ (accessed 3/29/2019). USDA-NASS, Washington, DC.*

USGS, 2015. *California Water Service Well 32-01 Final Results*. USGS Report. November 15, 2015. https://www.envirostor.dtsc.ca.gov/public/deliverable_documents/6835767984/usgs%20well%2032-01%20%20%20%2011%2010%202015.pdf.

___, 2012. *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. *Streamflow Depletion by Wells – Understanding and Managing the Effects of Groundwater Pumping on Streamflow*. USGS Circular 1376, 2012.

___, 1998. *Environmental Setting of the San Joaquin-Tulare Basins, California*. Water Resources Investigations Report 97-4205.

USGS and State Water Resources Control Board (SWRCB) 2017. *Groundwater Quality in the Shallow Aquifers of the Tulare, Kaweah, and Tule Groundwater Basins and Adjacent Highlands areas, Southern San Joaquin Valley, California*, Fact Sheet, January.

___, 2008. *Groundwater Quality Data in the Southeast San Joaquin Valley, 2005-2006: Results from the California GAMA Program*, Data Series 351.

Williamson, A.K., Prudic, D. E., and Swain, L. A., 1989. *Ground-Water Flow in the Central Valley, California*. USGS Professional Paper 1401-D.

Woodring, W.P., Stewart, Ralph, and Richards, R.W. 1940. *Geology of the Kettleman Hills Oil Field, California*, USGS Professional paper 195, 170 p., 15 fig.