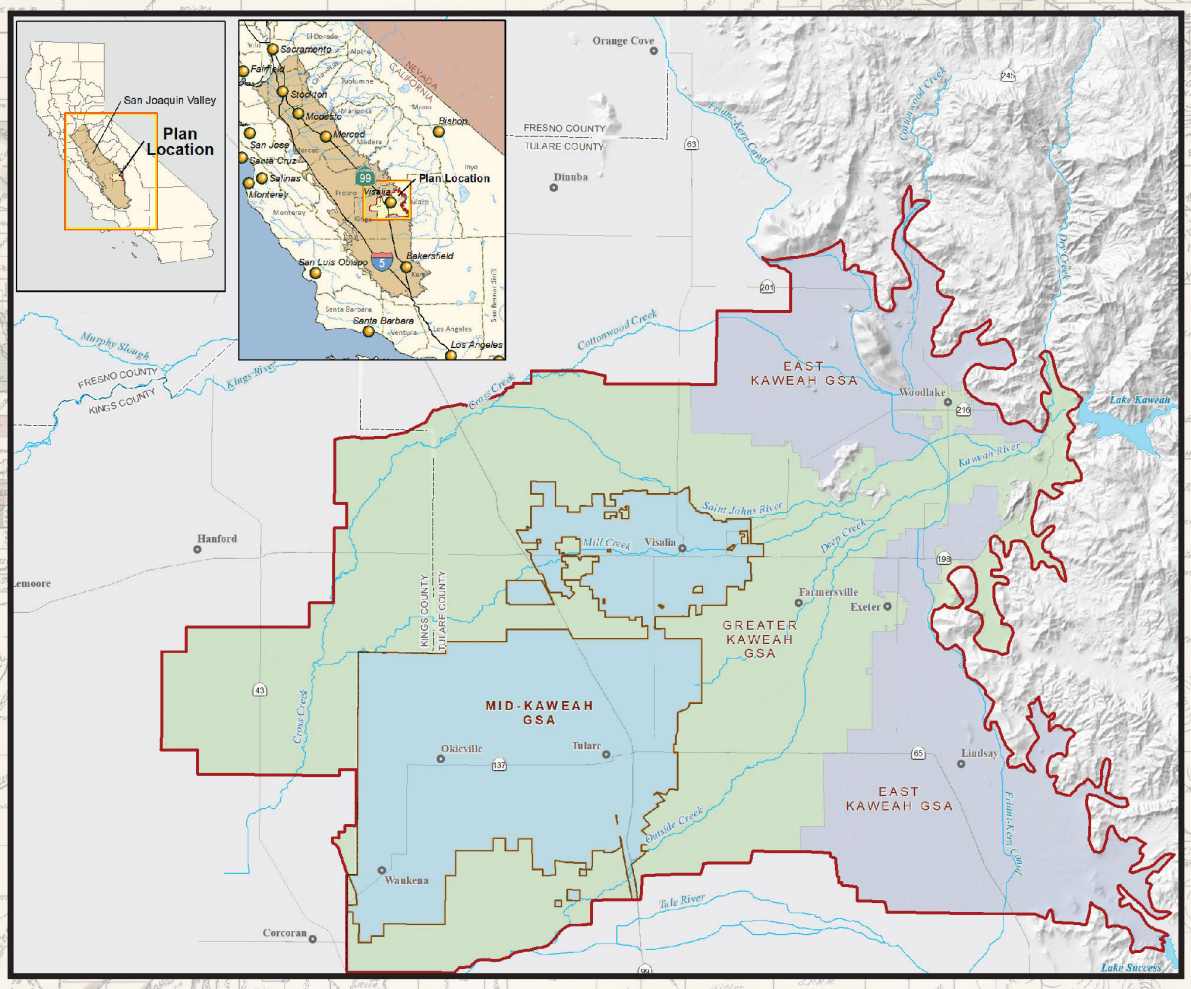
MID-KAWEAH GSA



Groundwater Sustainability Plan

Mid-Kaweah Groundwater Sustainability Agency

December 18, 2019

Prepared under the Kaweah Subbasin Coordination Agreement with Greater Kaweah GSA and East Kaweah GSA

Groundwater Sustainability Plan

Mid-Kaweah Groundwater Sustainability Agency

December 18, 2019

Submitted to:
J. Paul Hendrix
Mid-Kaweah Groundwater Sustainability Agency

Submitted by:

PROFESSIONAL GEOLOGIST
CHRISTIAN E. PETERSEN
No. 6189
CERTIFIED HYDROGEOLOGIST
No. 463
STATE OF CALIFORNIA

Christian E. Petersen, PG, CHg
GEI Consultants, Inc.
Professional Geologist License Number 6189
Professional Hydrogeologist License Number 463

PROFESSIONAL GEOLOGIST
TIMOTHY A. NICELY
NO. 8377
PROFESSIONAL GEOLOGIST
STATE OF CALIFORNIA

PROFESSIONAL GEOLOGIST
TIMOTHY A. NICELY
NO. 898
CERTIFIED HYDROGEOLOGIST
STATE OF CALIFORNIA

Timothy A. Nicely, PG, CHg
GSI Water Solutions, Inc.
Professional Geologist License Number 8377
Professional Hydrogeologist License Number 898

Table of Contents

Tables

Figures

Appendices

Appendices correspond with GSP Section. Note that there is no Appendix to Sections 6, 8, or 9.

Acronyms and 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
FEMA	Federal Emergency Management Agency
gpcd	gallons per capita per day
GEI	GEI Consultants, Inc.
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

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
MSL	Mean Sea Level
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
WWTP	wastewater treatment plant

Definitions

The following definitions are an assemblage of those provided in the SGMA legislation (CWC §10721), the GSP Regulations (23 CCR §351), and those provided by GSA management to clarify terms used in the Kaweah Subbasin GSPs. These definitions apply to this GSP document but may also be found in the Appendices or other attachments to the Mid Kaweah Groundwater Sustainability Agency's Groundwater Sustainability Plan.

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 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.
Alternative	An alternative to a Plan described in Water Code Section 10733.6.
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 MKGSA, "current water budget" refers to the period between water years 1997 and 2017. For the Kaweah basin the 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 (1981-2017) and the projected future water budget (2017-2070).

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, two acre- feet or less per year.
Governing body	The legislative body of a groundwater sustainability agency.
GPS Monitoring Station	For this purpose of the MKGSA 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.

Groundwater sustainability program	A coordinated and ongoing activity undertaken to benefit a basin, pursuant to a groundwater sustainability plan.
Historical Water Budget	Also known as a "base period," the MKGSA "historical water budget" was selected to be between the years of 1981 and 2017. Fulfills DWR's regulatory requirement that, "a quantitative assessment of the historical water budget (be prepared) starting with the most recently available information (2017 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."
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.
Key Well	Approximately 118 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.
Minimum threshold	A numeric value for each sustainability indicator used to define undesirable results.
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 2017 and 2070, fulfilling the DWR regulatory requirement that the GSP utilize 50 years of hydrology, and consider the impact of climate change on precipitation, evapotranspiration, streamflow.
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.
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).
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 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	One or more of the following effects caused by groundwater conditions occurring throughout the basin: • Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods. • Significant and unreasonable reduction of groundwater storage. • Significant and unreasonable seawater intrusion. • Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.

	• Significant and unreasonable land subsidence that substantially interferes with surface land uses. • Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.
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

23 Cal. Code Regs. § 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.

The purpose of this Executive Summary is to provide a concise but complete overview of the content and primary messages in the Mid-Kaweah Groundwater Sustainability Plan (GSP or Plan), making clear the pathway to sustainability in the Mid-Kaweah Groundwater Sustainability Agency (MKGSA). This summary also provides the basis, supporting rationale, and limitations associated with the plan for achieving sustainability. The Executive Summary is organized by GSP section.

The Mid-Kaweah Groundwater Sustainability Agency (MKGSA or Agency) has prepared this Groundwater Sustainability Plan (GSP) to comply with the Sustainable Groundwater Management Act of 2014 (SGMA) for a portion of the Kaweah Subbasin. The remainder of the subbasin will be addressed by GSPs for the East Kaweah GSA and the Greater Kaweah GSA. **Figure ES-1** shows the location of these GSAs in the Kaweah Subbasin and GSAs in the adjacent subbasins. One or more GSP is required by SGMA for medium- and high-priority subbasins, including management criteria, to achieve the sustainable use of the groundwater resource. The Kaweah Subbasin is classified as high-priority, according to California Water Code § 10933 (b), and has been designated in critical overdraft by the California Department of Water Resources (DWR). This latter designation requires the submittal of the GSP to DWR by January 31, 2020.

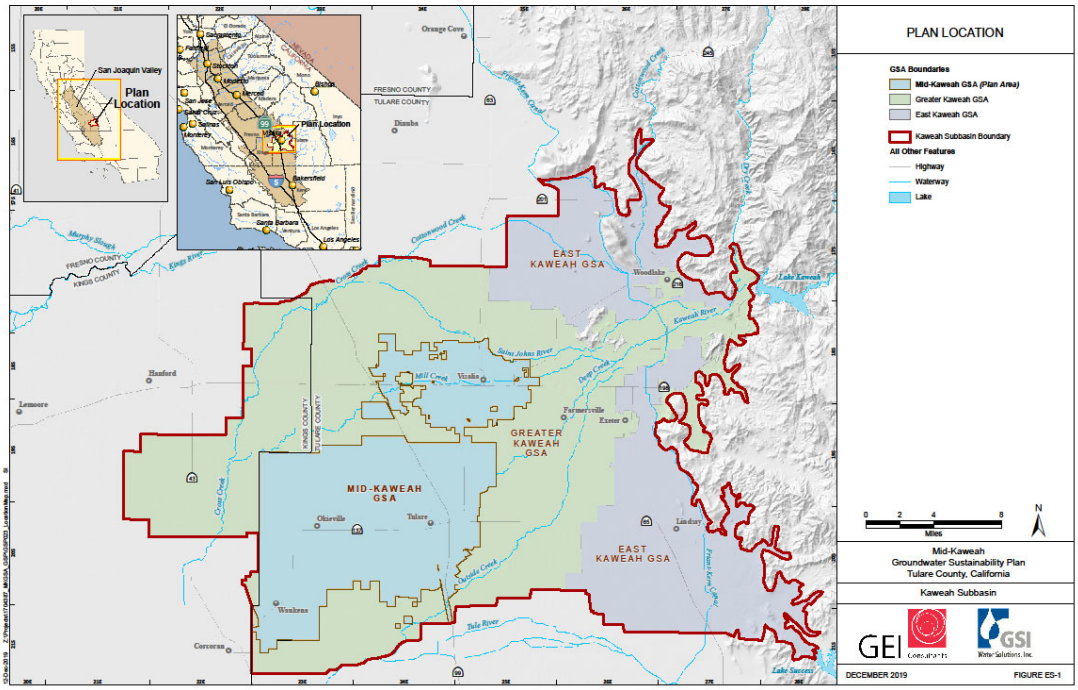


Figure ES-1: MKGSA Plan Location Map
Full-size figure provided at the end of this Section.

Section 1 Introduction

Section 1 provides introductory information about the MKGSA and its jurisdictional area, including land use, water use, wells, and other characteristics, outreach to stakeholders, and the organization of the GSP.

The Kaweah Subbasin (No. 5-22.11 per DWR Bulletin 118, 2003, 2016) covers 696 square miles within the larger San Joaquin Valley Basin and is situated primarily within Tulare County with a small portion in eastern Kings County. The region is a prime agricultural area in the Central Valley and home to numerous small towns and communities, as well as the larger cities of Tulare and Visalia. Surface water supplies consist of the local Kaweah River system, as well as the Friant Unit of the Central Valley Project (CVP). Most urban communities rely exclusively on groundwater, and agricultural lands possess a mix of surface supplies as well as groundwater depending on location. Conjunctive-use recharge operations have utilized these water supply sources for several decades.

The MKGSA was formed September 14, 2015, through execution of a joint powers agreement between the City of Tulare, City of Visalia, and Tulare Irrigation District to establish the Mid-Kaweah Groundwater Subbasin Joint Powers Authority. **Figure ES-2** shows the location of these agencies as well as other related agencies. Pursuant to Water Code §10723.8, these Members notified DWR on September 16, 2015, of the Agency's formation and its intent to develop a GSP. The decision-making structure of the MKGSA Board of Directors is supported through a hierarchical structure that includes the GSA's Manager, a Management Committee comprised of key staff from each member agency, and a Technical Advisory Sub-Committee. To provide for a venue for consultation with community members, the agency formed an 11-member Advisory Committee. Advisory Committee meetings are held monthly, or otherwise announced, and publicly noticed consistent with the Brown Act.

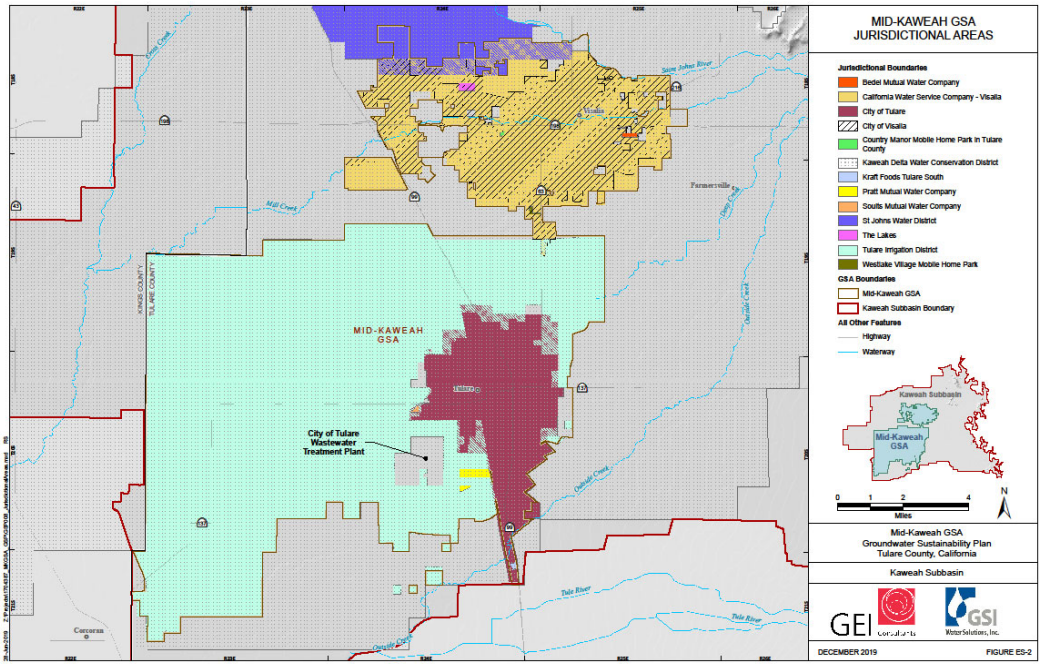


Figure ES-2: Jurisdictional Areas
Full-size figure provided at the end of this Section.

The MKGSA jurisdictional area is approximately 163 square miles (25% of the Subbasin). **Figure ES-1** shows 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.

Well density data available from DWR indicate that, within the MKGSA, there are a total of 2,147 wells of which 1,274 wells are clearly within the MKGSA boundary, but the other 873 are along the boundary with bordering GSAs and may not all lie with MKGSA. These wells are used to meet the water supply needs of agriculture, small and large public water systems, and rural dwellings (domestic use).

General plans have been prepared by Tulare County and by the cities of Tulare and Visalia. These plans promote the conservation of water and the protection of the quantity and quality of groundwater in their respective areas.

Beneficial users of groundwater were identified and engaged by MKGSA based on the place-based and interest-based categories described in SGMA and codified in Water Code §10723.2. Beneficial users of groundwater in MKGSA include agricultural users, domestic well owners, municipal well operators, public water systems, local land use planning agencies, California Native American Tribes, disadvantaged communities, and entities engaged in monitoring and reporting groundwater elevations.

Section 2 Basin Setting

The three GSAs in the Kaweah Subbasin have coordinated and jointly prepared a comprehensive Basin Setting which is included as **Appendix 2A** of this Plan. Much of the GSA is underlain by the Corcoran Clay, which creates an upper and lower aquifer system. A single aquifer system is present beneath the eastern half of Visalia in the northeastern GSA. The thickness of the fresh groundwater system varies from about 900 feet on the northeastern corner of MKGSA to about 1,600 feet near the southwestern corner. In general, groundwater flows across the MKGSA in a southwesterly direction and to local cones of depression during the irrigation season.

Groundwater quality is generally good, but available data are primarily located in the northern and eastern portions of the MKGSA. 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, and 1,2,3-trichloropropane.

Subsidence has occurred throughout the MKGSA area during the last 90 years. The largest amounts of subsidence occurred along the western and southern boundaries of the MKGSA area. According to DWR, subsidence between 1949 and 2005 has varied from as much as 5 feet in the Visalia area to as much as 10 feet in the Tulare area to as much as 15 feet along the southwestern corner of the MKGSA area based on land survey technology. As much as 20 feet of subsidence has occurred to the west of the MKGSA area and this area is tangential to the MKGSA area.

Key sustainability outcomes discussed in the Basin Setting document is an overall basin Safe Yield of 720 TAF. Using this information to facilitate numerous public and advisory committee meetings, the three GSAs in the basin have agreed to a sustainable yield of 660 TAF. This will be achieved in part by limiting pumping to the sustainable yield of the Kaweah Subbasin which has been determined to

be 660 TAF per year on average by 2040. The sustainable yield of the Subbasin is further discussed in Appendix 3 to the Subbasin Coordination Agreement.

Section 3 Sustainability Goal and Undesirable Results

Section 3 provides the Sustainability Goal and defines the undesirable results for the sustainability indicators (four of six) for the Kaweah Subbasin. The broadly stated sustainability goal for the Kaweah Subbasin as agreed to by the three GSAs therein is for each GSA to manage groundwater resources to preserve the quality of life through maintaining the viability of existing enterprises of the region, both agricultural and urban. The goal will also strive to fulfill the water needs of existing enterprises as well as existing and amended county and city general plans that commit to continued economic and population growth within Tulare County.

These overarching definitions were developed by the three GSAs and are fundamental to the Coordination Agreement between the GSAs in their sustainable management of their groundwater resources. Four sustainability indicators were clearly applicable to the Kaweah Subbasin, including chronic lowering of groundwater levels, reduction in groundwater storage, degraded water quality, and land subsidence. Seawater intrusion is clearly not applicable to the Kaweah Subbasin because the Pacific Ocean is located over 80 miles to the west on the opposite side of the coast range. Interconnected surface water was not considered to be a likely sustainability indicator due to groundwater depths exceeding 50 feet throughout most of the Subbasin but will be studied further during the initial portion of the implementation period.

Section 4 Monitoring Network

Section 4 provides information on the monitoring network for groundwater levels, groundwater quality, and land subsidence for the MKGSA area. The network includes 43 representative wells for groundwater levels, 117 public water supply wells for groundwater quality, and 11 land subsidence stations.

Section 5 Sustainable Management Criteria

Section 5 provides sustainable management criteria (SMC) for the MKGSA area, including numeric values for minimum thresholds (MTs) and measurable objectives (MOs) at the various monitoring locations of groundwater levels, storage, and quality and for subsidence plus interim milestones for groundwater levels and storage. As discussed above, SMCs were not developed for seawater intrusion due to the vast distance from the Pacific Ocean or for interconnected surface water.

For groundwater SMCs in the MKGSA, groundwater levels for 2006 to 2016 were fit with a straight-line projection into the future for each representative monitoring well and the respective 2030- and 2040-projected levels were the basis for picking MOs and MTs, respectively, for most of the representative wells. An optimal objective was also selected for each, which represents the groundwater levels that will be achieved if favorable hydrology is realized, and these levels were selected based on groundwater model forecasts considering the benefit of projects and management actions outlined in Section 7. An undesirable result will be recognized if 30% of groundwater levels across the Kaweah Subbasin exceed the MT.

SMCs for groundwater storage were set for the entire MKGSA based on calculated storage volumes above the minimum threshold groundwater levels for 2017 and 2030 (projected) and 2040 (projected). The volume difference between the average 2017 groundwater level in relation to MTs is 1.59 MAF, the volume in storage if the optimal objective is realized at 2040 is 1.34 MAF, and the volume in storage at the MO in 2040 is 0.64 MAF.

For groundwater quality SMCs, the MCL or the agricultural water quality objective (WQO) was the basis for the MTs for 10 primary constituents, including arsenic, chromium-VI, sodium, chloride, nitrate, perchlorate, total dissolved solids, tetrachloroethene, dibromochloropropane, and 1,2,3-TCP. The choice of the MCL or the WQO will be based on the primary use of the groundwater. The MOs were set at 75% of the MCL or WQO. MKGSA will track these constituents at the public supply wells and alert the well owners if a result exceeds the respective MO and will factor the circumstance into its periodic evaluation of overall groundwater conditions. However, MKGSA does not believe it is responsible to address such an exceedance given the pre-existing water quality issues within the Subbasin unless the exceedance can be shown to be related to SGMA implementation of projects or management actions.

For the subsidence SMC, two continuous global positioning satellite (CGPS) stations were used to estimate potential future subsidence, those being the stations near Corcoran and Farmersville. Subsidence at the Corcoran station has varied with changes in groundwater storage, whereas subsidence has been considerably less at the Farmerville station and relatively steady during its history. The relationship between recent changes (2011-2016) in groundwater storage and subsidence was coupled with the projected 2017-2040 reduction in groundwater storage to determine the maximum potential subsidence (87 inches) at the Corcoran station by 2040, and this value was selected at the maximum MO. For the Farmersville station, the MO is 12 inches. The MTs at these two "anchor" stations were double the MO, or 174 inches and 24 inches respectively. The annual rates of subsidence were determined by dividing the maximum values by 24 years. For the 11 other stations, the MOs and MTs were determined by interpolating between the Corcoran and Farmersville stations and then projecting values (rate and total) northwest or southeast to the station. For stations east of Farmerville, the MOs and MTs were uniformly based on 12 inches and 24 inches during the 24-year period.

Section 6 Water Supply Accounting

Section 6 provides an accounting of various types of groundwater budget components 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 MKGSA was apportioned 35% of the total volume, including 24% of the native water, 63% of the foreign water, and 44% of the salvaged water for a total of 230 TAF.

Section 7 Projects and Management Actions

Section 7 provides a description of 18 projects and 9 management actions to enable the MKGSA to succeed at the sustainable management of its groundwater resources. 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, and other projects and management actions. The estimated total capital cost is estimated at $50,000,000 for the projects described in Section 7. Annual O&M is estimated at $70,000. Annual GSA management, administration reporting is estimated at $565,000. The cost of the 5-year GSP Assessment and Update is estimated at $250,000.

Section 8 DWR Reporting

Section 8 describes the effort to produce an annual report for submittal to DWR and for the periodic 5-year assessment of the GSP. Each annual report is due on April 1st for the preceding water year, which starts on October 1st and ends the following September 30th. For example, the 2020 annual report will be submitted by April 1, 2010, for the period between October 1, 2019, to September 30, 2020.

Section 9 References

This section includes a detailed listing of all the reference information used in developing the GSP for MKGSA.

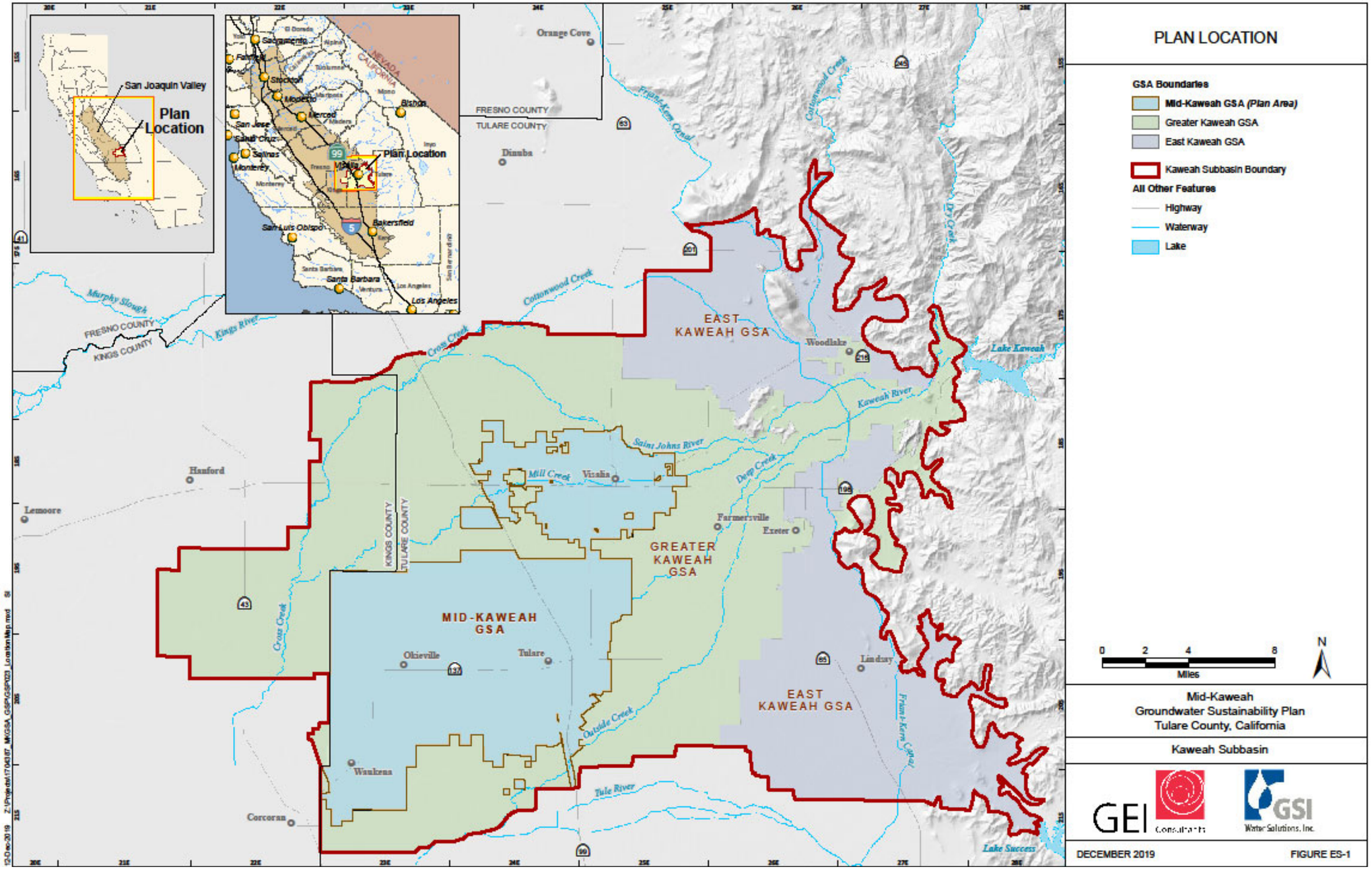


Figure ES-1: MKGSA Plan Location Map

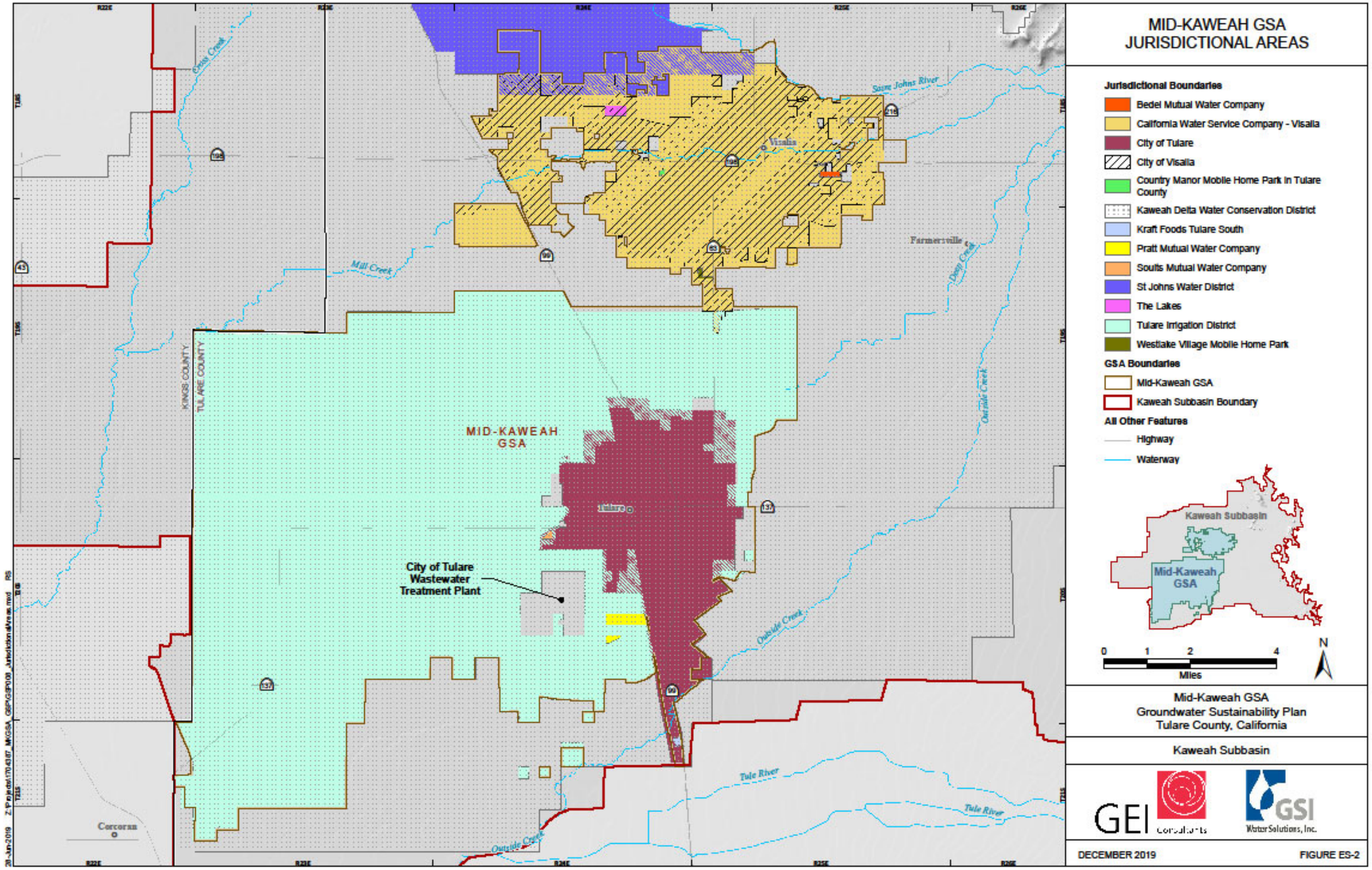


Figure ES-2: Jurisdictional Areas

1. Introduction

1.1 General Information

This section is comprised of a purpose statement, Mid-Kaweah Groundwater Sustainability Agency (MKGSA) information, information regarding the cost of implementing this Groundwater Sustainability Plan (GSP or Plan), and a general description of the plan area. Many of the figures in this GSP are 11x17 fold outs and are provided at the end of each section. Where possible we have included the locations of small disadvantaged community water systems on these figures. In some cases the density of subject information being presented precluded us from also showing these small community water systems.

1.1.1 *Purpose of GSP*

To comply with the requirements of the Sustainable Groundwater Management Act (SGMA), the MKGSA has contracted with GEI Consultants, Inc. (GEI) for the preparation of this GSP. The GSP serves to do the following:

Define and describe the geographic and geologic features of the MKGSA

Identify and describe the sustainability goal for the Kaweah Subbasin and the MKGSA jurisdictional area

Identify and describe the six undesirable results set forth in SGMA, as they pertain to the Kaweah Subbasin and the MKGSA jurisdictional area

Establish a monitoring network sufficient to collect data characterizing groundwater and related surface water conditions that occur during Plan implementation

Identify and describe the specific minimum thresholds and measurable objectives required for the MKGSA to achieve the sustainability goal

Define and identify projects and management actions proposed by MKGSA to achieve, in coordination with the other Subbasin Groundwater Sustainability Agencies (GSAs), the sustainability goal and ensure that the Subbasin is ultimately operated within the sustainable yield

This Section 1 addresses all aspects of DWR's GSP Emergency Regulations (Regulations) in §354.2 through §354.10 thereof.

1.1.2 *Overview*

The Kaweah Subbasin [#5-22.11 per 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. 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 utilizing these sources has long been practiced.

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 78,000 acre-feet (AF) per year. Water quality concerns, related primarily to small-system and domestic wells, are localized throughout the Subbasin and stem from legacy fertilizer applications in agricultural areas and contaminant plumes from other land uses and possible degraded individual septic systems as the result of age, poor maintenance, and/or lack of routine service.

This Plan addresses SGMA compliance aspects for the MKGSA in a coordinated fashion with the two other Subbasin GSAs (East Kaweah and Greater Kaweah). Section 1.6 delineates the eight sections of this Plan, which in general, are designed to describe the basin setting, Subbasin goals, future monitoring, thresholds and objectives leading to sustainability, and efforts to achieve those objectives.

An initial apportionment of the Subbasin water budget has been undertaken and is detailed in Sections 2 and 6 of this Plan. These sections identify both the hydrogeologic budget, denoting the area's water balance, as well as the legal/appropriator budget, denoting an initial segregation of native groundwater from other groundwater associated with water agencies and purveyors. The Plan lists and describes 18 projects and 9 management actions in Section 7 to address MKGSA's responsibilities to eliminate the Subbasin overdraft and occurrence of other undesirable results. Measurable objectives to be reached in 2040, as well as interim milestone targets over time are laid out in Section 5. Monitoring to gauge the effectiveness of projects and management actions and adherence to interim milestones are described in Section 4.

1.1.3 *References*

A list of references and technical studies relied upon by the Agency in developing the Plan is provided as Section 9.

1.2 Agency Information

Agency's Name:	Mid-Kaweah GSA (MKGSA)
Agency's Address:	144 L Street, Suite N Tulare, CA 93274
Agency's Phone Number:	(559) 686-2166
Agency's Website:	midkaweah.org
Contact Person:	J. Paul Hendrix
Contact Person's Title:	Manager

Notice of Formation Documentation: See **Appendix 1A**

The MKGSA, formed in September 2015, was one of the first GSAs in the state. Its Members consist of the City of Tulare, the City of Visalia, and the Tulare Irrigation District. These agencies desire to expand upon several water management agreements in a collective effort to comply with SGMA. These agreements are listed following:

Tulare-TID Assessment Agreement - circa 1954

Tulare-TID Recharge Agreement - circa 2008

Tulare-TID Joint Recharge Facilities Construction - circa 2007

Visalia-TID Channel Use Agreements - circa 2001

Visalia-TID Tertiary-Treated Water Exchange Agreement - circa 2013

Each of the above-listed agreements operates in furtherance of groundwater management and preservation within the region.

1.2.1 *Legal Authority of Agency*

On September 14, 2015, the City of Visalia, the City of Tulare, and the Tulare Irrigation District (TID) entered into a Joint Powers Authority (JPA) Agreement to form the MKGSA. Under this JPA Agreement, the MKGSA was granted the authority to do all acts necessary for the exercise of all the powers authorized under SGMA as necessary to satisfy the requirements of SGMA while allowing the Members of the GSA to maintain control and autonomy over the surface and groundwater assets to which they are currently legally entitled. This original JPA Agreement and Amendment 1 are included as **Appendix 1B**.

1.3 GSP Implementation Costs

The MKGSA, on behalf of its Members, will incur costs to implement its GSP and maintain the Plan via 5-year updates. These costs and sources of funding are described below.

1.3.1 *Costs Generated by GSP Implementation*

Table 1-1 presents a description and an estimate of the costs associated with the implementation of the MKGSA 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	$65,000
Capital Costs Projects	Includes Projects with estimated costs per Sec. 7	$50,000,000
Annual Operations & Maintenance (O&M)	Project Operations and Maintenance	$70,000
GSA Management	Enforcement, others TBD	$100,000
Administration of GSA	Administration, legal, data management, monitoring, measurement	$400,000
Annual Report	Compilation per DWR Regulations	$25,000
5-Year GSP Update and Report	Compilation per DWR Regulations, assessment report	$250,000

1.3.2 *GSP Implementation Funding*

A joint operating fund was established for the Members to contribute to the operation and administration of the MKGSA as detailed in the JPA Agreement (**Appendix 1B**). Member contributions to the fund may be in equal proportions or, in the case of planned projects and management actions, as a function of management area water budget deficits. The MKGSA is granted the authority to pursue alternative funding sources, such as state and federal grants or loans. Unless otherwise specified by the MKGSA Board, all funding contributions obtained from alternative sources shall be equally allocated to each Member.

If the MKGSA experiences an unanticipated need to pay for extraordinary costs, and to the extent that these costs cannot be funded through use of reserves on hand or through other revenue sources authorized by the JPA Agreement (e.g., fees), the MKGSA Board may allocate additional costs to the MKGSA Members.

1.4 Description of Plan Area

The MKGSA 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 River Subbasin to the south, and the Sierra Nevada Mountains to the east. The MKGSA is roughly bisected by California State Highway 99. The section below describes the area covered by the MKGSA's GSP.

1.4.1 *Geographic Areas Covered*

As shown in **Figure 1-1**, the MKGSA's jurisdictional area (163 square miles) represents approximately 23% of the area within the Kaweah Subbasin (696 square miles). Also depicted on that figure are the three management areas within the GSA as further described in Section 2.

The MKGSA is adjacent to the Tule River Subbasin to the south and the Greater Kaweah GSA and Tulare Lake Subbasin to the west, with the Greater Kaweah GSA to the north and east. Both Disadvantaged Communities (DAC) and Severely Disadvantaged Communities (SDAC) exist in the MKGSA and are shown on **Figure 1-2**. Adjudicated Areas have not been established within the MKGSA or the Kaweah Subbasin. If there were Adjudicated Areas, those areas would also be shown in **Figure 1-2**.

The St. Johns River runs along the northern boundary of MKGSA and the City of Visalia, while the Lower Kaweah River becomes Mill Creek east of the City of Visalia, before entering the MKGSA jurisdictional area. Mill Creek roughly bisects the City of Visalia as it drains to the southwest, toward Cross Creek and the Tulare Lake Subbasin. Several other creeks and seasonal streams reach their terminus within the boundaries of MKGSA, including Packwood Creek and Cameron Creek. Elk Bayou drains along the eastern boundary of MKGSA near the City of Tulare and through the southwestern portion of Greater Kaweah GSA, until it reaches the Tule River at the boundary of the Kaweah Subbasin.

Two incorporated cities are located completely within MKGSA's jurisdictional area, including the City of Tulare and the City of Visalia, as shown on **Figure 1-3**.

In addition to the cities, the Tulare Irrigation District (TID) also has jurisdiction within the MKGSA area. Numerous *de minimus* domestic water users and multi-parcel water systems are located within the MKGSA, which will be covered by this GSP.

1.4.2 *Plan Area Setting*

Land use within the MKGSA consists mainly of urban and agricultural, as shown in **Figure 1-4**, which also depicts land-use types within the entire Subbasin. Agricultural use in MKGSA can be described as mostly seasonal field crops and grain and hay crops, interspersed with deciduous fruits and nuts and pasture. Urban land use is located within the limits of the cities of Tulare and Visalia and the surrounding unincorporated areas within the sphere of influence for the cities. Land use maps included in the most recent General Plans for the City of Tulare (2014), City of Visalia (2014) and Tulare County (2012) are included as **Appendix 1C**

It is important to monitor water levels throughout the plan area. There are several water resource monitoring programs. One of these is the California Statewide Groundwater Elevation Monitoring (CASGEM)[1] program, which tracks groundwater elevation trends throughout numerous groundwater basins. This system is managed by DWR with local agencies, counties, and associations providing groundwater level data.

Within the Kaweah Subbasin, numerous programs exist for monitoring and management of groundwater. These programs are described in detail in Section 2.3 of the Kaweah Subbasin Basin Setting report included as **Appendix 2A** of this Plan. The monitoring and management programs within the MKGSA are presented and described in Chapter 4 of this GSP. Chapter 4 also details the

[1] https://www.casgem.water.ca.gov/OSS/(S(pjww1s3s4mocqq0rft2t2g1n))/GIS/PopViewMap.aspx?Public=Y

agencies and activities associated with monitoring and management of surface water inflow, weather and precipitation, and land surface subsidence.

Figure 1-5 provides information on water use sector and water source type within the MKGSA. This figure shows land use areas occupied by wetlands, recharge basins, commercial/industrial including confined animal facilities, urban areas, and agricultural areas. It also shows areas receiving a mix of groundwater and surface water, the approximate locations for municipal supply wells in the cities of Visalia and Tulare, which are both supplied by 100% groundwater, and the locations of water recycling facilities which treat wastewater for use in agricultural irrigation. A detailed water budget accounting for the entire Kaweah Subbasin is provided in the comprehensive Basin Setting (**Appendix 2A**). Chapter 2 of this GSP presents a water budget accounting for the MKGSA.

Figure 1-6, **Figure 1-7**, and **Figure 1-8** are well-density maps which show the general distribution of domestic, production, and public supply wells within the MKGSA and are based on information from the DWR's website for the Well Completion Report Map Application[2] 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 vast majority of production wells in the MKGSA are likely agricultural wells. The figures show 221 "square-mile" sections to address the MKGSA areas, including 131 sections wholly located within the MKGSA, 37 sections mostly located within the MKGSA, and 21 sections partially within in the MKGSA, plus 32 sections that are tangential to the MKGSA. This latter group was included because the shapefiles for the GSA boundaries and the sections overlap slightly and the application includes these sections. This GSP was not intended to produce any finer resolution than provided by the DWR map application.

Table 1-2 summarizes the well density information for domestic, production, and public wells and is subdivided into the three types of well locations: wholly within, mostly within, and partially within the MKGSA. Overall, a total of 2,147 wells were identified for the MKGSA areas, including 1,274 wells within the MKGSA area and 873 wells along the complex boundary of the MKGSA (581 wells for sections mostly in the area and 292 wells for sections with smaller portions). The total number of domestic wells is slightly higher (1,088) than production wells (937) and the number of public supply wells is relatively small (121). Note that these counts represent all wells on record within the DWR map application and do not necessarily represent current useable wells. Usability is a factor that is discussed in Chapter 4 regarding identification of well sites to include in the representative monitoring network.

The maximum total well density was nearly 40 wells per nominal square mile for the three location categories of area. The higher density sections are generally located in the northeastern portions of MKGSA, in the Visalia area or north of Tulare. Lesser well densities are generally found in the southwestern portion of MKGSA. Only one section (20S-24E-21) was devoid of any documented well and is located about 3 miles southwest of Tulare.

[2] https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37

Table 1-2: Summary of Well Information

	Location	Total	Domestic	Production	Public
Number of Wells	Within MKGSA	1,274	594	598	82
	Mostly in MKGSA	581	351	204	25
	Partially within MKGSA	292	143	135	14
	Total number of wells	**2,147**	**1088**	**937**	**121**
Maximum Well Density	Within MKGSA	39	30	19	6
	Mostly in MKGSA	38	32	12	4
	Partially within MKGSA	39	30	11	3
Median Well Density	Within MKGSA	8	3	4	1
	Mostly in MKGSA	17	9	5	1
	Partially within MKGSA	11	5	6	1
Sections without Wells	Within MKGSA	1	16	3	78
	Mostly in MKGSA	0	3	0	19
	Partially within MKGSA	0	1	0	12

Well density units: Wells per section or nominal square mile

All the communities in the MKGSA are groundwater dependent (**Figure 1-9**). These include the two incorporated cities and the state small systems owned and operated by California Water Services Company (Cal Water), and one private mutual water company (Okieville). Two other private mutual water companies have recently been connected to the City of Tulare's water supply system (Soults Tract and Matheny Tract). The *de minimis* domestic water users and multi-parcel water systems located within the MKGSA are also groundwater dependent. The locations of these water users can be approximated with the maps presented as **Figures 1-6 to 1-8**.

1.4.3 *General Plans in Plan Area*

The SGMA regulation [§ 10726.9] requires a GSP to consider the most recent planning assumptions stated in local general plans of jurisdictions overlying the basin. Each of the two incorporated cities in MKGSA'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 plans promote the conservation of water and the protection of the quantity and quality of groundwater in their respective areas and were considered in this GSP.

GEI reviewed the 2015 Urban Water Management Plans for the cities of Visalia (Cal Water, 2016) and the Tulare (City of Tulare, 2015) and California Department of Finance population projections (California Department of Finance, 2017). Information in these documents were useful in understanding both current and projected future water supplies and demands.

1.4.3.1 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 Tulare County 2012 General Plan has a Water Resources Element that requires the County to adopt ordinances and measures to:

- Regulate the permanent extraction and exportation of groundwater from the County
- 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
- Where feasible, the county shall participate in coordinated local, regional, and statewide groundwater monitoring and planning programs
- Encourage active participation by local stakeholders and develop groundwater monitoring partnerships with local groundwater users and developers
- Avoid the destruction of established recharge sites
- Work with federal, state, local, and regional agencies to improve local groundwater pollution detection and monitoring
- Encourage responsible agencies and organizations to install and monitor additional groundwater monitoring wells in areas where data gaps exist
- Research the development of an education program to inform homeowners in the valley and mountain areas regarding water quality concerns
- 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
- Identify and evaluate conditions within established watersheds which are causing deterioration of the water quality, water supply, or declining water yields
- Develop an education program to inform residents of water conservation techniques and the importance of water quality and adequate water supplies
- Protect groundwater recharge areas
- Amend county ordinances to include development standards which protect groundwater basins and surface water drainage areas and provide incentives for use of conservation techniques

Establish development or design standards for the protection of groundwater recharge areas

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

The Tulare County General Plan includes both policies and implementation measures that address water supply, wastewater treatment, adequate infrastructure, plans, programs, and funding in the following elements:

Planning Framework (Chapter 2),

Agriculture (Chapter 3),

Land Use (Chapter 4),

Economic Development (Chapter 5),

Housing (Chapter 6),

Environmental Resources Management (Chapter 8),

Health and Safety (Chapter 10),

Water Resources Chapter 11),

Public Facilities and Services Chapter 14),

Gen Plan Water Resources Element Policies Include:

Water Supply WR-1.1

Groundwater Withdrawal, WR-1.3

Water Export Outside County, WR-1.4

Conversion of Agricultural Water Resources, WR-1.5

Expand Use of Reclaimed Wastewater, WR-1.6

Expand Use of Reclaimed Water, WR 1.7

Collection of Additional Groundwater Information, WR-1.8

Groundwater Basin Management, WR-1.9

Collection of additional Surface Water Information, WR-1.10

Channel Modification, WR-3.1

Develop Additional Water Sources, WR-3.2

Develop an Integrated Regional Water Master Plan, WR-3.3

Adequate Water Availability, WR-3.4

Water Resource Planning, WR-3.5

Use of Native and Drought Tolerant Landscaping, WR-3.6

Agricultural Irrigation Efficiency, WR 3.7

Emergency Water Conservation Plan, WR-3.8

Educational Programs, WR-3.9

Establish Critical Water Supply Areas WR-3.10

Diversion of Surface Water, WR-3.11

Policy Impacts to Water Resources, WR-3.12

Joint Water Projects with Neighboring Counties, WR-3.13

Coordination of Watershed Management on Public Land PFS-2.1

Water Supply, PFS-2.2

Adequate Systems, PFS-2.3

Well Testing, PFS-2.5

New Systems or Individual Wells, Water Quality, WR-1.2

Groundwater Monitoring, WR 1.7

Collection of Additional Groundwater Information, WR-1.8

Groundwater Basin Management, WR-2.1

Protect Water Quality, WR-2.2

NPDES Enforcement, WR-2.3

Best Management Practices, WR-2.4

Construction site Sediment, WR-2.5

Major Drainage Management, WR-2.6

Degraded Water Resources, WR-2.7

Industrial and Agricultural Sources, WR-2.8

Point Source Control, WR-2.9

Private Wells, PFS-2.1

Water Supply, PFS-2.5

In addition to the county's ongoing efforts to address these objectives in the Water Resources Element of the General Plan, the MKGSA will address these issues with the adoption and implementation of its GSP, pursuant to California Water Code § 10726.9.This GSA, as well as others within Tulare County, meet on a monthly basis to coordinate relevant county data sets, ordinances, and related needs of the GSAs regarding new wells and enforcement measures.

1.4.3.2 City of Visalia General Plan

The 2030 General Plan Update for the City of Visalia, adopted on October 14, 2014, has several objectives related to water resources in general and groundwater, in particular. These objectives can be found in the Open Space and Conservation Element of the Plan in Chapter 6.

One of the objectives is to: "work with the county and other organizations to protect prime farmland and farmland of statewide importance outside the city's Urban Development Boundary for agricultural production, and to preserve areas for groundwater recharge."

Two policies are listed to further this objective:

1. Open Space Policy #1: "Conduct an annual review of cancelled Williamson Act contracts and development proposals on agricultural land within the Planning Area Boundary to foresee opportunities for acquisition, dedication, easements or other techniques to preserve agricultural open space or for groundwater recharge."
2. Open Space Policy #6: "Continue cooperative efforts with the Kaweah Delta Water Conservation District, Integrated Regional Water Management Planning group, and others to partner on pursuing grant funding and development of water resource, recharge, and conservation projects and programs."

The Water Resources section of the city's General Plan Open Space and Conservation Element includes a description of both surface water resources and groundwater resources. The objectives of the Water Resources section are:

1. Protect water resources vital to the health of the community's residents and important to the Planning Area's ecological and economic stability
2. Preserve and enhance Planning Area waterways and adjacent corridors as valuable community resources which serve as plant and wildlife habitats, as groundwater recharge facilities, as flood control and irrigation components, and as connections between open space areas
3. Continue to participate in a waterway program involving the Tulare Irrigation District, irrigation companies, private water companies, and state agencies

Among the policies listed in the General Plan to meet these objectives, the City of Visalia included:

1. Protect, restore and enhance a continuous corridor of native riparian vegetation along Planning Area waterways, including the St. Johns River; Mill, Packwood, and Cameron Creeks; and segments of other creeks and ditches where feasible, in conformance with the Parks and Open Space diagram of this General Plan
2. Establish design and development standards for new projects in waterway corridors to preserve and enhance irrigation capabilities, if provided, and the natural riparian environment along these corridors. In certain locations or where conditions require it, alternative designs may be appropriate (e.g., terraced seating or a planted wall system)

3. Place special emphasis on the protection and enhancement of the St. Johns River Corridor by establishing extensive open space land along both sides
4. Where no urban development exists, maintain a minimum riparian habitat development setback from the discernible top of the bank: 50 feet for both sides of the Mill, Packwood, and Cameron Creek corridors and 25 feet for both sides of Modoc, Persian, and Mill Creek ditches. Where riparian trees are located within 100 feet of the discernible top of the banks of the creek corridors and 50 feet from the banks for the ditches, the setback shall be wide enough to include five feet outside the drip line of such trees. Restore and enhance the area within the setback with native vegetation as follows:
    a. Where existing development or land committed to development prohibits the 50-foot setback on Mill, Packwood, and Cameron Creek corridors, provide the maximum amount of land available for a development setback
    b. Where existing development or land committed to development prohibits the 25-foot setback along Modoc, Persian, and Mill Creek ditches, provide the maximum amount of land available for a development setback

These objectives and policies are addressed in the projects and management actions portion of this GSP, particularly with respect to groundwater recharge facilities and use of riparian habitat corridors for groundwater recharge (City of Visalia, 2014).

1.4.3.3 City of Tulare General Plan

The 2035 General Plan Update for the City of Tulare, adopted on October 7, 2014, addresses water supply and usage in several of its elements (City of Tulare, 2014). Under its Land Use Element, the Tulare General Plan addresses existing water supply by requiring that, "water supply systems be adequate to serve the size and configuration of land developments. Standards as set forth in the subdivision ordinance shall be maintained and improved as necessary." To address future water supply, the General Plan calls for "all new development, prior to the approval of any subdivision applications, the developers shall assure that there is sufficient available water supply to meet projected buildout."

The Plan Implementation Measures adopted in the General Plan, with respect to water supply, include the following:

> *"The City shall update its water master plan to address future water supply treatment, and distribution system. The water master plan shall explore:*
>
> *a. Water supply alternatives*
>
> *b. Treatment alternatives, including wellhead and centralized treatment*
>
> *c. Alternatives for reuse of grey water*
>
> *d. Water conservation program"*

While the General Plan does not have specific actions to meet these objectives, it refers to maintaining and improving infrastructure to support these objectives. The adoption of the MKGSA GSP will address these measures, particularly with respect to promotion of water supply alternatives and water conservation.

The Conservation and Open Space Element of the Tulare General Plan also addresses the issue of water resources for the City. One of the element's objectives is to "ensure a reliable, adequate water supply to sustain a high quality of life, while protecting and enhancing the environment."

The Water Resources Section of the Conservation and Open Space Element states that the City's Goal is "to preserve and enhance surface waterways and aquifers." This section of the plan includes the following policies, pertaining to groundwater and water conservation:

> **Regional Groundwater Protection**. The City shall work with Tulare County and special districts to help protect groundwater resources from overdraft by promoting water conservation and groundwater recharge efforts.
>
> **Groundwater Recharge Area Protection**. When considering new development, the City shall protect existing open spaces, natural habitat, floodplains, and wetland areas that serve as groundwater recharge areas.
>
> **Continued Recharge of Groundwater Basin**. In known or identified groundwater recharge areas, the predominant land use and resource activities should be designed to promote recharge of the groundwater basin and protection of groundwater quality at a level superior to standard development practices. When appropriate to the land use designation, clustered development should be encouraged to promote open space and continue infiltration.
>
> **Groundwater Wells**. The City shall protect and monitor its groundwater wells to ensure a sufficient groundwater supply.
>
> **Water Source**. The city shall cooperate with other jurisdictions to jointly study the potential for using surface water sources to help protect the groundwater supply.
>
> **Water Conservation**. The City shall promote efficient water use and reduced water demand by:
>
> - Requiring water-conserving design and equipment in new construction
> - Encouraging water-conserving landscaping and other conservation measures
> - Encouraging retrofitting of existing development with water-conserving devices
> - Providing public education programs
> - Distributing outdoor lawn watering guidelines
> - Promoting water audit and leak detection programs
> - Enforcing water conservation programs

These City and County policies are complimentary to the MKGSA GSP or are addressed indirectly as a result of the GSP implementation. The outreach and education policies and actions are addressed in the Communication & Engagement (C&E) Plan, developed by Stantec for MKGSA and adopted on August 14, 2018 and included as **Appendix 1D**.

1.4.4 *Well Permitting Process*

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 City of Visalia has a well permit application for the construction or destruction of wells within its jurisdiction. The county is in the process of updating and revising 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. More information on Tulare County's well permitting process is available at:

https://tularecountyeh.org/eh/index.cfm/our-services/water-wells/

and include the following information as of December 2019:

Water Well Guidance

Water Well Forms

Water Well Contractors

Voluntary Water Well Testing Program

1.4.5 *Existing Monitoring and Management Programs*

Existing monitoring and measurement programs are presented and described in the Basin Setting Report (**Appendix 2A**) and Section 4 of this document.

1.5 Notice and Communication

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:

> *"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:

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

Pursuant to these requirements, MKGSA conducted several activities to engage beneficial users of groundwater, interested parties, and the general public in the development of the GSP. MKGSA was responsible for conducting outreach and engagement related to SGMA and conducted a series of coordinated activities aimed at engaging stakeholders within its service area. This section describes the coordinated tools, methods, and activities the MKGSA used to inform and engage stakeholders in development of the GSP.

1.5.1 *Participating Agencies*

§354.10 (d) A communication section of the Plan that includes the following:
(1) An explanation of the Agency's decision-making process.

The MKGSA was formed September 14, 2015, through execution of a joint powers agreement between the City of Tulare, City of Visalia, and Tulare Irrigation District to establish the Mid-Kaweah Groundwater Subbasin Joint Powers Authority. Pursuant to Water Code §10723.8, these members notified DWR on September 16, 2015, of the agency's formation and its intent to develop a GSP. The decision-making structure of the MKGSA Board of Directors (**Figure 1-10**) is supported through hierarchical structure that includes the GSA's Manager, a Management Committee comprised of key staff from each member agency, and a Technical Advisory Sub-Committee. To provide for a venue for consultation with community members, the agency formed an 11-member Advisory Committee. Committee meetings are held monthly, or otherwise announced, and publicly noticed consistent to the Brown Act.

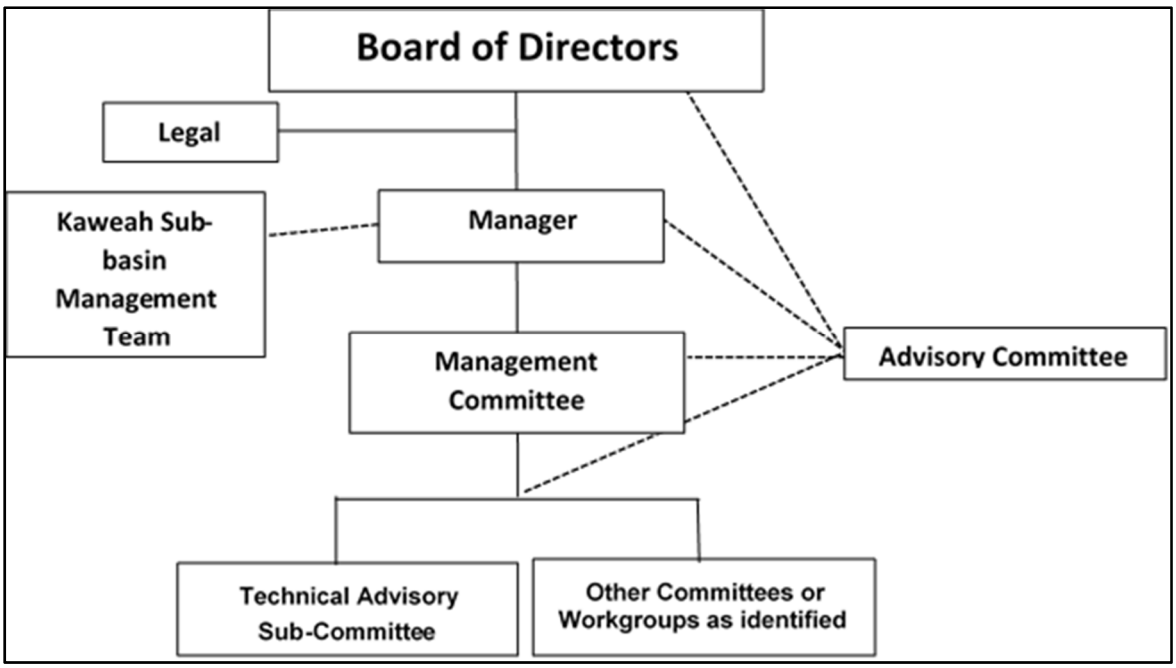


Figure 1-10: Mid-Kaweah Groundwater Sustainability Agency Decision-Making Structure

The governing body of the JPA consists of a six-member Board of Directors that includes two representatives from each of the founding JPA members. Members eligible to sit on the Board of Directors are the elected officials of each member agency, with the City of Tulare able to appoint a member of the Tulare Board of Public Utilities to serve on its behalf. Members may also appoint up to two members to serve as an alternate in the event of an absence. All decisions require a majority vote of the present and voting Board of Directors, except the following found in **Table 1-3**.

Table 1-3: MKGSA Voting Thresholds

Key Authority	Threshold
Adoption of initial budget	Unanimous vote by entire Board (which may include alternates)
Adoption or modification of the annual budget	Modified majority of the Board(*) (which may include alternates)
Contracts over $25,000 and for terms in excess of two (2) years	Modified majority of the Board(*) (which may include alternates)
Admissions of additional members	Modified majority of the Board(*) (which may include alternates)
Appointment, employment, or dismissal of an employee, including any independent contractor who functions as an employee	Modified majority of the Board(*) (which may include alternates)
Setting the amounts of any contributions or fees to be made or paid to the Authority from any Member	Modified majority of the Board(*) (which may include alternates)

Key Authority	Threshold
Compromise or payment of any claim against the Authority	Modified majority of the Board(*) (which may include alternates)
Acquisition by grant, purchase, lease, gift, devise, contact, construction, or otherwise, and hold, use, enjoy, sell, let, and dispose of, real and personal property of every kind, including lands, water rights, structures, buildings, rights-of-way, easements, and privileges, and construct, maintain, alter, and operate any and all works or improvements, within or outside the agency, necessary or proper to carry out any of the purposes of the Authority	Modified majority of the Board(*) (which may include alternates)
Adoption and imposition of any fees pursuant to Water Code §§ 10730-10731	Modified majority of the Board(*) (which may include alternates)
Replacement of the annual special audit required by Government Code § 6505 with an audit covering a two-year period	Unanimous vote by entire Board (which may include alternates); A Tulare County reqt.
Approval of a GSP for the portions of the Subbasin identified by the GSA boundaries.	Modified majority of the Board(*) (which may include alternates)
(*) Modified majority is defined in the amended JPA to mean four affirmative votes, with at least one from each Member.	

1.5.2 *Beneficial Uses and Users*

1.5.2.1 Legal Requirements

§354.10 Each plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:

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

Beneficial uses of groundwater within MKGSA primarily include agricultural water supply, industrial process supply, and municipal and domestic water supply. MKGSA serves as GSA for the area comprising the collective jurisdictional area of its members, which is approximately one-quarter of the Kaweah Subbasin, or about 170 square miles of the 700 square-mile Subbasin. Beneficial users of groundwater were identified and engaged by MKGSA based on the place-based and interest-based categories described in SGMA and codified in Water Code §10723.2:

Citizens Groups

General Public

Disadvantaged Communities[3]

[3] Includes those served by private domestic wells or small community water systems (Water Code §10723.2(i)

Agricultural Well Owners

Domestic Well Owners

Commercial and Industrial Self-Supplied

Private and Public Water Purveyors

Surface Water Users[4]

Governmental and Land Use Agencies

Tribal Governments and Communities

Environmental and Ecosystem Interests

Remediation and Groundwater Cleanup

Beneficial users of groundwater in MKGSA include agricultural users, domestic well owners, municipal well operators, public water systems, local land use planning agencies, California Native American Tribes, disadvantaged communities, and entities engaged in monitoring and reporting groundwater elevations. Beneficial users and types of parties representing these users are further described below.

1.5.2.2 Citizens Groups and General Public

Citizens groups and members of the general public were considered beneficial water users and were invited to engage in the Advisory Committee and participate in public meetings. Outreach was conducted to civic organizations of Visalia, City of Tulare and the Tulare Irrigation District by requesting to present at pre-existing organizational meetings or to disseminate SGMA and GSP development information to their members.

1.5.2.3 Disadvantaged Communities

The MKGSA region includes five areas identified as a Census Designated Place or Census Designated Tract by the 2016 U.S. Census Bureau as disadvantaged or severely disadvantaged communities. Census Designated Places within the GSA include the City of Tulare, and the unincorporated communities of Matheny Tract and Waukena. The City of Tulare has been identified as a Disadvantaged Community, while Matheny Tract and Waukena have been identified as Severely Disadvantaged Communities. The unincorporated communities of Okieville/Highland Acres, Lone Oak Tract, and Soults Tract have been identified as severely disadvantaged Census Designated Tracts. T Stakeholders in these communities have had the opportunity to consult on the plan during the agency's Board of Directors meetings, Advisory Committee meetings, and during review of this Plan.

[4] If there is a hydrologic connection between surface and groundwater bodies (Water Code §10723.2(g))

1.5.2.4 Agricultural Users

Agriculture and rangeland cover a broad area of the Kaweah Subbasin and accounts for about 50 percent of the land area within the MKGSA. Representatives from the agricultural community serve on MKGSA's Board of Directors and the Advisory Committee, and agricultural interests are represented in GSP development by landowners and water users within the Tulare Irrigation District service area. Other types of parties representing agricultural users include Tulare County Farm Bureau, agricultural-based interest organizations, farmworkers, individual growers, and ranchers. Consultation with these parties included periodic briefings led by Tulare Irrigation District, and through information discussed during meetings of the agency's Board of Directors and Advisory Committee and during development and review of this Plan.

1.5.2.5 Private Domestic Well Owners

Private domestic well operators within the MKGSA primarily include rural residents interspersed with active farmlands; the communities of Waukena and Oakieville/Highland acres; and rural schools including Waukena Joint Union Elementary, Buena Vista Elementary, Buena Vista School, Oak Valley Union School, Liberty School, and Packwood School. They are located in the unincorporated area of Tulare County and are represented on the MKGSA Board of Directors by Tulare Irrigation District. Stakeholders have the opportunity to consult on the Plan during the agency's Board of Directors and Advisory Committee meetings, and during review of this Plan.

1.5.2.6 Municipal and Industrial Well Operators

Municipal and industrial water supplies within the MKGSA are provided by the City of Tulare and California Water Service, a private water company regulated by the California Public Utilities Commission. Some food and industrial manufactures maintain deep wells as back-up supplies in the event of service interruption by municipal and industrial well operators. The City of Tulare and the City of Visalia account for 12.7 and 21.7 percent of the land area within the MKGSA, respectively. Consultation with the City of Tulare consists of information dissemination and coordination with the Tulare Board of Public Utilities and through the city's participation as MKGSA member agency. California Water Service consulted during development of this Plan as members to the agency's Advisory Committee and Technical Advisory Subcommittee.

1.5.2.7 Surface Water Users

Surface water users within the MKGSA include farm, ranch, and dairy operations that purchase runoff from the Kaweah River and San Joaquin River watersheds from Tulare Irrigation District. San Joaquin River supplies are delivered by Friant Water Authority, which provides operation and maintenance of the Friant Division of the Central Valley Project. Kaweah supplies are managed by Kaweah Delta Water Conservation District. Members of this agricultural community attend meetings and serve on the MKGSA Advisory Committee and Board of Directors.

1.5.2.8 Governmental and Land Use Planning Agencies

Governmental and land use planning agencies in the MKGSA include the planning commissions of the County of Tulare, City of Tulare, and City of Visalia, and the Tulare County Local Agency Formation Commission. Consultation with these planning commissions included briefings and requests to comment on the public draft GSP.

1.5.2.9 California Native American Tribes

As part of the MKGSA's 2015 formation notification to DWR, the agency preliminarily identified two California Native American Tribes for potential engagement in the planning process as beneficial water users: the Santa Rosa Rancheria Tachi-Yokut Tribe of Lemoore, California, and the Waksache Tribe. No details were available for the later tribe and the Santa Rosa Rancheria Tachi-Yokut Tribe's reservation is located in the Tulare Lake Subbasin.

1.5.2.10 Environmental and Ecosystem Interests

Environmental and ecosystem interests in MKGSA include representatives of the Tulare Basin Wildlife Partners, Sierra Club Mineral King Group, and Sequoia Riverlands Trust.

1.5.2.11 Groundwater Elevation Monitoring and Reporting Entities

Groundwater elevation monitoring and reporting in the MKGSA is primarily led by the Tulare Irrigation District and Kaweah Delta Water Conservation District. The Tulare Irrigation District updated its Groundwater Management Plan in 2012. The Kaweah Delta Water Conservation District leads development of an Integrated Regional Water Management Plan and manages a series of wells registered in the California Statewide Groundwater Elevation Monitoring (CASGEM) Program. Tulare Irrigation District is a member agency of MKGSA and representatives of Kaweah Delta Water Conservation District regularly attend meetings of the Board of Directors and Advisory Committee.

1.5.3 *Stakeholder Communications and Engagement Plan*

§354.10 (d): A communication section of the Plan that includes the following:
(3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of population within the basin.

Notification and communication activities for development of this Plan were guided by the MKGSA C&E Plan (August 2018). 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 MKGSA.

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 MKGSA implemented to engage interested parties and stakeholder groups to participate in development of the GSP. Individuals and organizations were initially assigned one of the three groups by the MKGSA's Advisory Committee, with the anticipation that each stakeholder's involvement would change based on consultation with stakeholder and GSP 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 agency in coordination with its Kaweah Subbasin sister agencies – East Kaweah GSA and Greater Kaweah GSA – established the Kaweah Groundwater Communication Portal (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 MKGSA website (www.midkaweah.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, MKGSA member agencies, Board of Directors, 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 MKGSA Board, the Advisory Committee, and the Kaweah Subbasin Management Team (See Section 1.5.5. Intra-Basin and Inter-Basin Coordination). The site is cross-linked to the Greater Kaweah GSA and the East Kaweah GSA websites, the DWR SGMA information portal, and other related sites.

1.5.4 *Public Meetings*

§354.10 (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.

To encourage active involvement in the diverse social, cultural, and economic communities in the development of this Plan, MKGSA staff and Advisory Committee members coordinated several types of targeted stakeholder outreach meetings and presentations. Initial outreach activities focused on raising awareness of SGMA and establishment of MKGSA as the local public agency responsible for complying with the new law. These later matured to technically-oriented presentations during regularly scheduled public meetings of the MKGSA Advisory Committee and other venues, as appropriate. These meetings are described as follows:

1.5.4.1 Kaweah Subbasin Presentations:

The MKGSA reached out to more than 40 community organizations, stakeholder groups and agencies as part of a Speaker's Bureau Program to raise awareness of the agency and encourage participation development of this Plan at Board and Advisory 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 15 presentations and the distribution of MKGSA information to an additional 27 organizations. **Table 1-4** includes the list of presentations provided during development of this Plan. **Table 1-5** provides the list of organizations that received information from MKGSA representatives through the Speaker's Bureau Program.

Table 1-4: Speaker's Bureau Program Presentations

Presentation	Organization Name	Organization Type	Point of Contact	Email
Jun. 14, 2019	Tulare Noon Rotary	Citizens Groups	Kathy Mederos	
May 16, 2019	Sycamore Valley Academy	Domestic Well Users, Rural School	Ruth Dutton	
May 14, 2019	Almond Board: "Navigating the Waters"	Agriculture	J.P. Cativiela	Jp.cativiela@padillaco.com
May 8, 2019	Buena Vista School	Domestic Well Users, Rural School	Carole Mederos	cmederos@buenavistaeagles.org
May 1, 2019	Tulare Sunrise Rotary	Citizens Groups	Brett Schroder	

Presentation	Organization Name	Organization Type	Point of Contact	Email
Apr. 21, 2019	Leadership Tulare – Tulare Chamber of Commerce	Citizens Groups	Darcy Phillips	
Apr. 16, 2019	Tulare County League of Women Voters	Citizens Groups	Maile Melkonian	maile@melkonian.org
Apr. 15, 2019	Leadership Visalia – Visalia Chamber of Commerce	Agriculture	Dante Rosh	
Apr. 8, 2019	210 Connect (Visalia Times-Delta & first Presbyterian Church)	Citizens Groups	Teresa Douglas	
Mar. 26, 2019	Visalia County Center Rotary Club	Citizens Groups	Sam Logan	sam-logan@ml.com
Mar. 25, 2019	Visalia Planning Commission, Parks and Recreation Department, Environmental Committee	Government and Land Use Planning Agency	Paul Bernal	paul.bernal@visalia.city
Mar. 19, 2019	Downtown Visalia Kiwanis Club	Citizens Groups	Olivia Velasquez	oliviaspost@yahoo.com, kiwanisvisalia@gmail.com
Mar. 6, 2019	Sequoia-Visalia Kiwanis Club	Citizens Groups	Jeff Sweeney	info@sequoia-visaliakiwanis.org
Mar. 3, 2019	Visalia Host Lions Club	Citizens Groups	Ruth McKee	rmckee.2@netzero.net
Feb. 20, 2019	Tulare International Kiwanis Club	Citizens Groups	Kenneth Hood,	kenneth.hood@usw.salvationarmy.org

Table 1-5: Speakers Bureau Program Information Dissemination

Organization Name	WC 10723.2	Point of Contact
Rotary Club of Visalia Breakfast	Citizens Group	Daniel Evans
Rotary Club of Visalia	Citizens Group	Paul Hurley
Tulare Host Lions Club	Citizens Group	Ruth McKee
Tulare Morning Kiwanis	Citizens Group	Kent Jensen, Neva Stevenson
Visalia Breakfast Lions Club	Citizens Group	Karen McVeigh
Visalia Economic Development Corporation	Citizens Group	Nancy Lockwood
Visalia Latino Rotary	Citizens Groups	Lina Contreras

Organization Name	WC 10723.2	Point of Contact
Visalia Masonic Lodge	Citizens Groups	Linda Godsave
Visalia Sequoia Lions Club	Citizens Groups	Steve Gerard
Visalia Sunset Rotary	Citizens Group	Barbara Hood
West Visalia Kiwanis Club	Citizens Group	Buz Southard
Building Industry Association	Commercial & Industrial Self-Supplied	Brian Todd
Kraft Foods	Commercial & Industrial Self-Supplied	Laura Burns Manager
Land O Lakes	Commercial & Industrial Self-Supplied	Pete Garboni
Saputo Dairy Foods USA	Commercial & Industrial Self-Supplied	Michael "Buck" Buchanan
County Manor Mobile Home Community	Disadvantaged Community	George or Carolyn
Mooney Grove Manor Mobile Home Park	Disadvantaged Community	Neil Pilegard
Mountain View Mobile Home Park	Disadvantaged Community	Lonny Fulton
Royal Oaks Mobile Home Park	Disadvantaged Community	Laura Fierro
Westlake Village Mobile Home Park	Disadvantaged Community	Richard Popkins
Willow Glen Mobile Estates	Disadvantaged Community	Linda McCuin
Liberty School	Domestic Well Owner, Rural School	Keri Montoya
Oak Valley School	Domestic Well Owner, Rural School	Fernie Marroquin
Palo Verde School	Domestic Well Owner, Rural School	Phil Anderson
Sundale School District	Domestic Well Owner, Rural School	Terri Rufert
Waukena Joint Union School District	Domestic Well Owner, Rural School	Superintendent Terri Lancaster
City of Tulare, Planning Department	Governmental and Land Use Agencies	Josh McDonnell

1.5.4.2 Board of Directors Meetings

Meetings of the Board of Directors 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, Advisory Committee members and other stakeholders 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 were 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 an interested party on the Kaweah GCP.

The MKGSA Board of Directors meet monthly, unless otherwise publicly noticed in accordance with the Brown Act. Since September 14, 2015, the Board has held 27 meetings, with one meeting held at the City of Visalia Administration Building, 220 N. Santa Fe St. Visalia, CA. The balance of the Board sessions were held at the Tulare Public Library and Council Chambers, 491 North M.

Street Tulare, CA. The list of meetings is available at 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 activities of the Advisory Committee and Technical Advisory Committee.

1.5.4.3 Advisory Committee Meetings

The publicly noticed Advisory Committee meetings are important venues for development of recommendations to the Board of Directors to key technical and policy issues. The public was encouraged to engage and consult in these discussions and assist Advisory Committee members in their consideration of a preferred approach. These recommendations were later provided to the Board of Directors for their consideration. Written notification of each meeting was posted on the MKGSA website and by email to all parties that subscribed to the Kaweah CCP. Notifications were additionally posted for public review at the meeting location, as required by the Brown Act.

The MKGSA Advisory Committee holds monthly meetings, unless otherwise publicly noticed. It has held 16 meetings since the committee's May 9, 2016 formation. The majority of the meetings were held at the City of Visalia Wastewater Treatment Plant, 7579 Ave. 288, Visalia, CA. Two meeting were held at the City of Visalia's City Clerk's office, 220 N. Santa Fe St. Visalia, CA, and one at the Tulare City Hall, 411 East Kern Ave. Tulare, CA. Common agenda topics include a public comment session, status and planning of outreach activities, committee reports and updates, and technical presentation. Another frequent agenda topic included brief presentations focused on water resource supplies and supply reliability applicable to the Mid-Kaweah region. These educational briefings were provided by staff of member agencies of the MKGSA and other parties. For a full schedule of the Advisory Committee meetings, meeting materials, agendas and meeting summaries, visit the MKGSA website.

1.5.5 *Comments Received*

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

The MKGSA held a public comment period on the Draft GSP from July 31 to September 16, 2019. The Draft GSP was posted on the MKGSA website, as well made available for review at multiple public locations. Written comments on the Draft GSP could be submitted electronically via email or hard copy via mail or hand delivery. The MKGSA received 13 comment letters on the Draft GSP during the public comment period. From the 13 letters, a total of 197 individual comments were identified. MKGSA staff and consultants reviewed and categorized each comment. Every comment was provided a response, which was recorded in a comment matrix tool. The GSP was revised to address any comments that raised credible technical or policy issues. **Appendix 1G** Public Comment Summary further describes the MKGSA's process to solicit, review, and address comments on the Draft GSP. This summary further describes external peer review processes that were led by Member agencies of the MKGSA Joint Powers Authority. Copies of comments received on the Draft GSP are provided as Attachment B to **Appendix 1G**.

Pursuant to California Water Code § 10728.4, the MKGSA also provided notice of the MKGSA's intent to adopt the GSP to cities and counties within the plan area. This notification included a letter sent to the cities of Tulare and Visalia and the county of Tulare on August 13, 2019, provided as Attachment A to **Appendix 1G** as a courtesy, the MKGSA also provided notice to California Water Service, which serves as the water purveyor for the City of Visalia. Cities and counties within the GSP area were provided 30 days from receipt of the notice to request consultation on the Draft GSP. The MKGSA did not receive any requests for consultation during this time. Cities and counties within the GSP area will be notified of any future amendments to the GSP and GSP implementation activities.

1.5.6 *Inter-Basin Coordination*

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 to these topics. The schedule of KSMT, and other intra-basin activities, is provided in **Table 1-6.**

Inter-basin coordination activities included participation in events scheduled by other organizations, or events led by Kaweah Subbasin GSAs. These inter-basin activities focused 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 1-6**.

Table 1-6: Inter-Basin, Intra-Basin Coordination Meetings

Date	Type	Event Name	Location	Participating GSAs or Subbasin	Key Agenda Topics
Jun. 19, 2019	Intra-basin	Management Team Committee Meeting	City of Visalia Wastewater Treatment Plan, Visalia, CA	East Kaweah GSA, Greater Kaweah GSA, Mid-Kaweah GSA	GSA updates and progress, coordination agreement, consultant presentation and recommendations
May. 15, 2019	Intra-basin	Management Team Committee Meeting	Tulare County Board of Supervisors Chambers, Visalia, CA	East Kaweah GSA, Greater Kaweah GSA, Mid-Kaweah GSA	Public comment, GSA updates and progress, coordination agreement status, consultant and SkyTem presentations
Apr. 23, 2019	Inter-basin	Farmer-Rancher Meeting	International Agri - Center, Tulare, CA	Tulare Lake Subbasin	SGMA and GSP development

Date	Type	Event Name	Location	Participating GSAs or Subbasin	Key Agenda Topics
Apr. 17, 2019	Intra-basin	Management Team Committee Meeting	Tulare County Board of Supervisors Chambers, Visalia, CA	East Kaweah GSA, Greater Kaweah GSA, Mid-Kaweah GSA	GSA updates and progress, coordination agreement status, consultant presentation
Mar. 20, 2019	Intra-basin	Management Team Committee Meeting	Exeter Museum, Exeter, CA	East Kaweah GSA, Greater Kaweah GSA, Mid-Kaweah GSA	GSA updates and progress, coordination agreement status, consultant presentation
Jan. 16, 2019	Intra-basin	Management Team Committee Meeting	Tulare County Board of Supervisors Chambers, Visalia, CA	East Kaweah GSA, Greater Kaweah GSA, Mid-Kaweah GSA	GSA updates and progress, coordination agreement elements, next steps and future activities
Dec. 18, 2018	Inter-basin	South Valley SGMA Practitioners Roundtable IV	Tulare County Agricultural Commissioner's Office, Tulare, CA	Tulare Lake Subbasin	SGMA updates, inter-basin coordination, basin boundary flows and minimum thresholds, mapping aquifers and hydrogeologic frameworks near Tulare, SkyTem, DACs and groundwater marketing
Dec. 14, 2018	Inter-basin	South Valley Technical Group Meeting	Greater Kaweah GSA, Farmersville, CA	Tulare Lake Subbasin	Technical GSP development and coordination
Sep. 19, 2018	Intra-basin	Management Team Committee Meeting	Kaweah Delta Water Conservation District, Farmersville, CA	East Kaweah GSA, Greater Kaweah GSA, Mid-Kaweah GSA	GSA updates and progress, coordination agreement elements, next steps and future activities
May 16, 2018	Intra-basin	Management Team Committee Meeting	Tulare County Board of Supervisors Chambers Visalia, CA	East Kaweah GSA, Greater Kaweah GSA, Mid-Kaweah GSA	GSA updates and progress, memorandum of understanding amendment, coordination agreement elements, next steps and future activities (**Appendix 1D**)
Apr. 18, 2018	Intra-basin	Management Team Committee Meeting	Tulare County Board of Supervisors Chambers Visalia, CA	East Kaweah GSA, Greater Kaweah GSA, Mid-Kaweah GSA	GSA updates and progress, coordination agreement elements, GSA coordination, management team work plan, next steps and future activities

Date	Type	Event Name	Location	Participating GSAs or Subbasin	Key Agenda Topics
Apr. 10, 2018	Inter-basin	The Community Water Center: Drinking Water Vulnerability Assessment Web Tool Kick-Off Meeting	Resources Legacy Fund Sacramento, CA	Tulare Lake Subbasin	Development of an accessible, interactive and publicly available drinking water vulnerability assessment web tool, groundwater management needs of SDACs for GSPs
Mar. 2, 2018	Inter-basin	Technical Group Meeting	Kaweah Delta WCD Office, Farmersville, CA	Tulare Lake Subbasin	SkyTEM proposal, technical memorandum discussing accounting framework, water budgets
Feb. 16, 2018	Inter-basin	South Valley Technical Group Meeting	Technical Three-hour Webinar	Tulare Lake Subbasin	SGMA overview, DWR inter-basin relationships regulations, subbasin perspectives, hydrogeologists/modelers subbasin concerns, hydrogeologic conceptual model development, subbasin numerical surface water and groundwater modeling efforts, adjacent subbasins, next steps
Jan. 30, 2018	Intra-basin	Management Team Committee Meeting	Kaweah Delta Water Conservation District, Farmersville, CA	East Kaweah GSA, Greater Kaweah GSA, Mid-Kaweah GSA	GSA updates and progress, subbasin Memorandum of Understanding, management team administration, consultant presentation, subbasin water budget apportionment, management team work outlook
Oct. 20, 2017	Inter-basin	South Valley SGMA Practitioners Roundtable III	International Agri-Center Heritage Complex, Tulare, CA	Tulare Lake Subbasin	Subbasin updates, DWRs SGMA technical assistance, SkyTem in the South Valley, headwaters coordination
Mar. 17, 2017	Inter-basin	South Valley SGMA Practitioners Roundtable II	International Agri-Center Heritage Complex, Tulare, CA	Tulare Lake Subbasin	Inter-basin coordination, objectives and best practices, groundwater flows between subbasins, next steps
Jul. 22, 2016	Inter-basin	South Valley SGMA Practitioners Roundtable I	Southern California Edison, Ag Technology Application Center, Tulare, CA	Tulare Lake Subbasin	Perspective from a functioning GSA, coordinating the uncoordinated, SGMA fees, and SGMA implementation in the South Valley updates.

1.5.7 *GSP Implementation*

> *§ 354.10(b)(4):* The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

Following GSP adoption, the MKGSA will continue to inform beneficial users and interested parties through continuation of activities implemented to develop this Plan. Key activities for the public to follow and engage in GSP implementation include attendance at regularly scheduled meetings of the MKGSA Board of Directors, the MKGSA Advisory Committee, and the Kaweah Subbasin Management Team. The agency intends to continue to notify the public of these meetings by email, public postings of agendas, and social media. The agency anticipates civic and non-profit organizations contacted during the planning phase may request follow-up presentations. The agency will support these requests as resources allow. The agency will continue to provide new and updated information on GSP implementation on its agency website, including the Kaweah Subbasin Annual Report (GSP Emergency Regulations §356.2). The website will also assist implementation of projects subject to the California Environmental Quality Act and Assembly Bill 52, as applicable.

1.6 GSP Organization

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

Section 1 – Introduction

Section 2 – Basin Setting

Section 3 – Sustainability Goal and Undesirable Results

Section 4 – Monitoring Networks

Section 5 – Minimum Thresholds, Measurable Objectives, and Interim Milestones

Section 6 – Water Supply Accounting

Section 7 – Projects and Management Actions

Section 8 – DWR Reporting

Section 9 – References

Section 1 – Introduction

The development of this MKGSA Introduction Section was informed by DWR's GSP Annotated Outline Guidance Document and Stakeholder Communication and Engagement Guidance Document. These documents are provided in **Appendix 1F**.

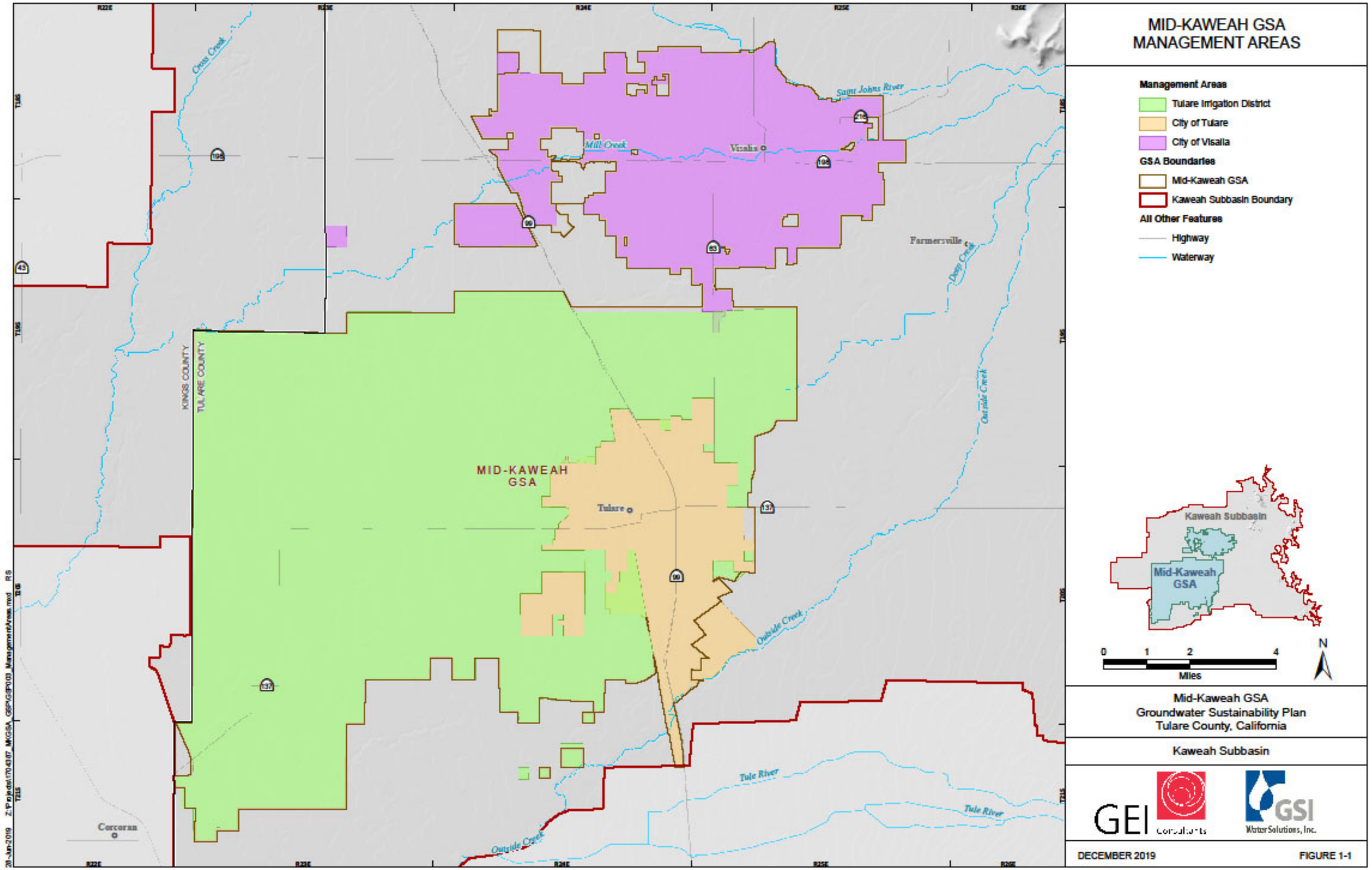


Figure 1-1: Management Areas

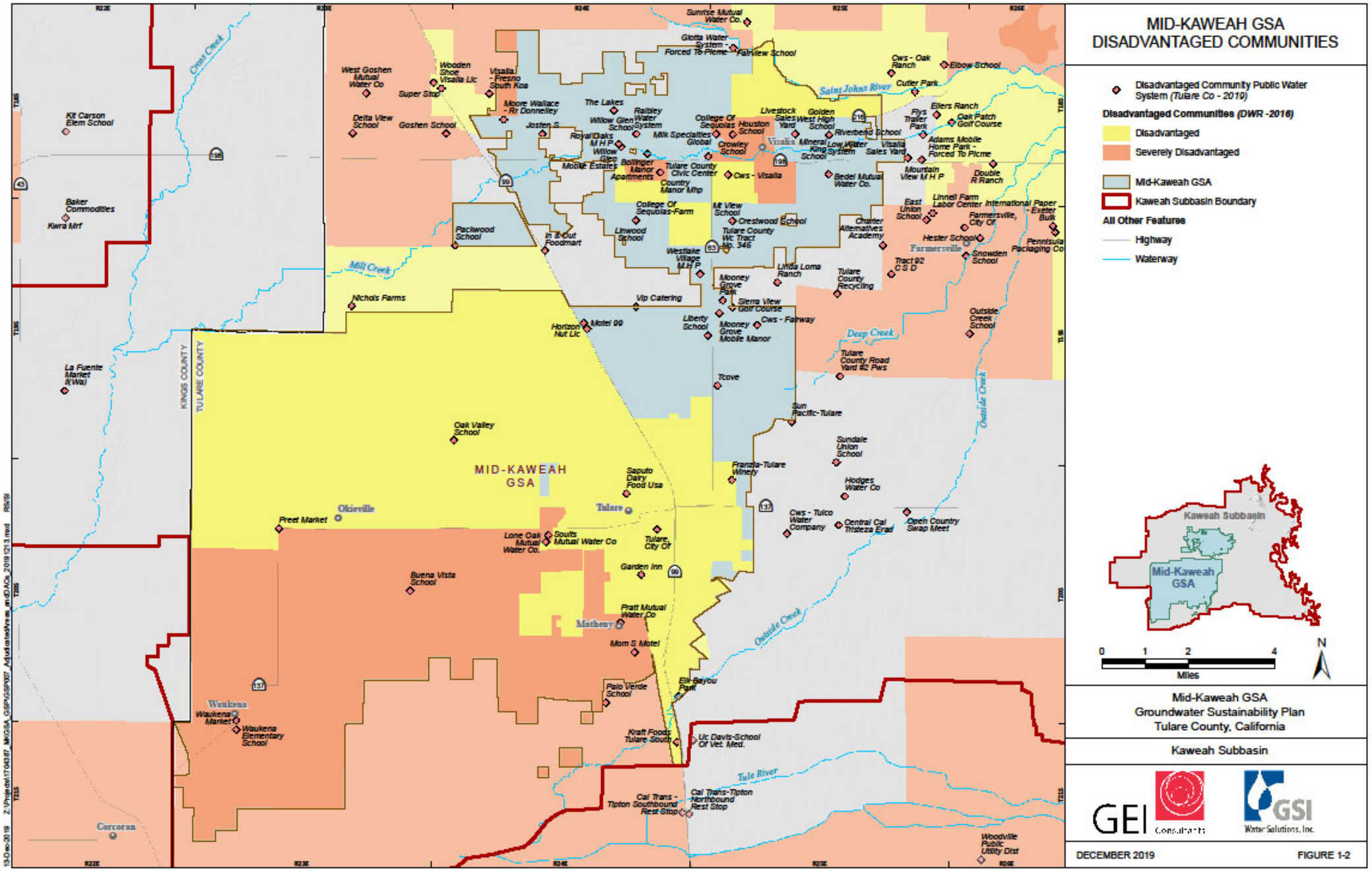


Figure 1-2: Adjudicated Areas and Disadvantaged Communities

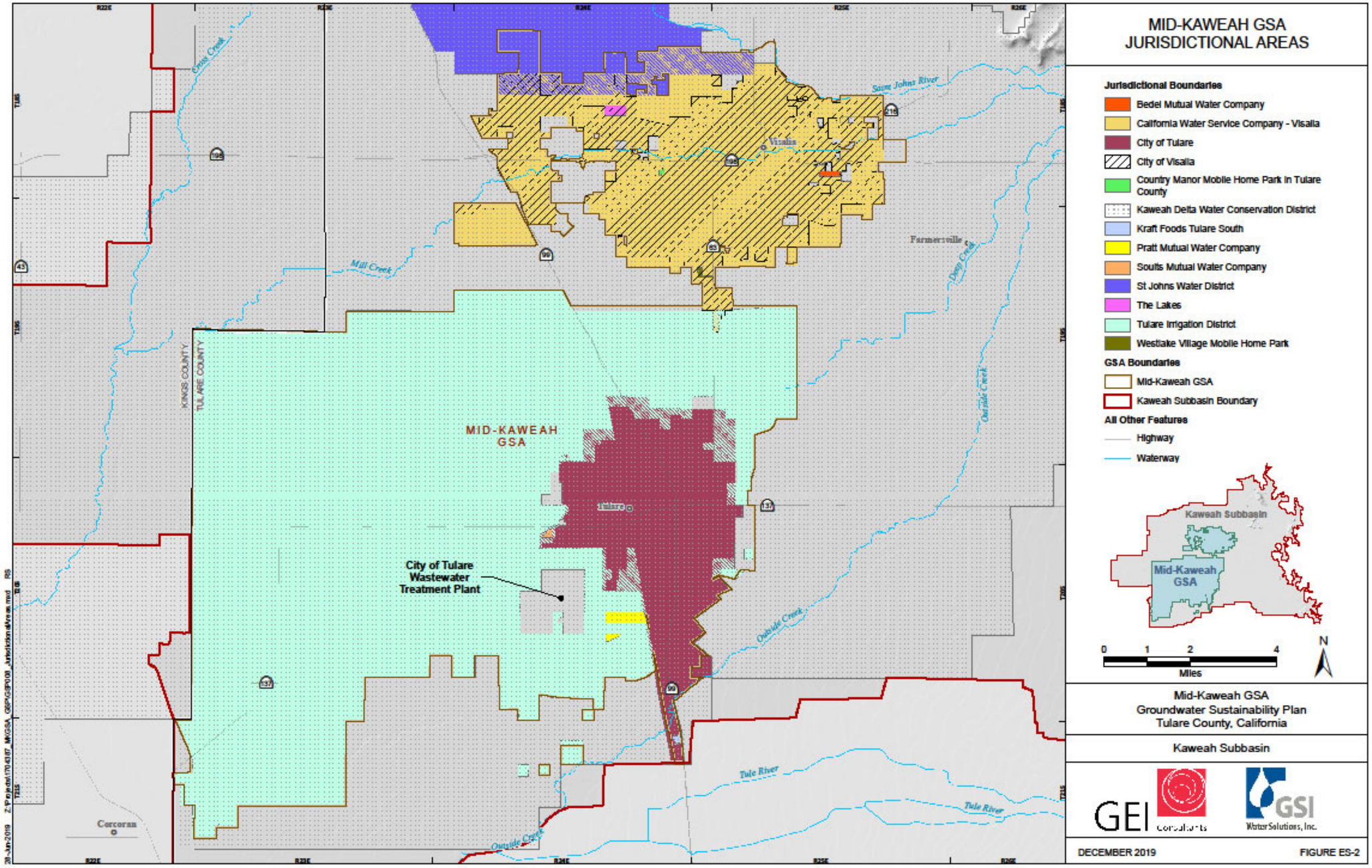


Figure 1-3: MKGSA Jurisdictional Boundaries

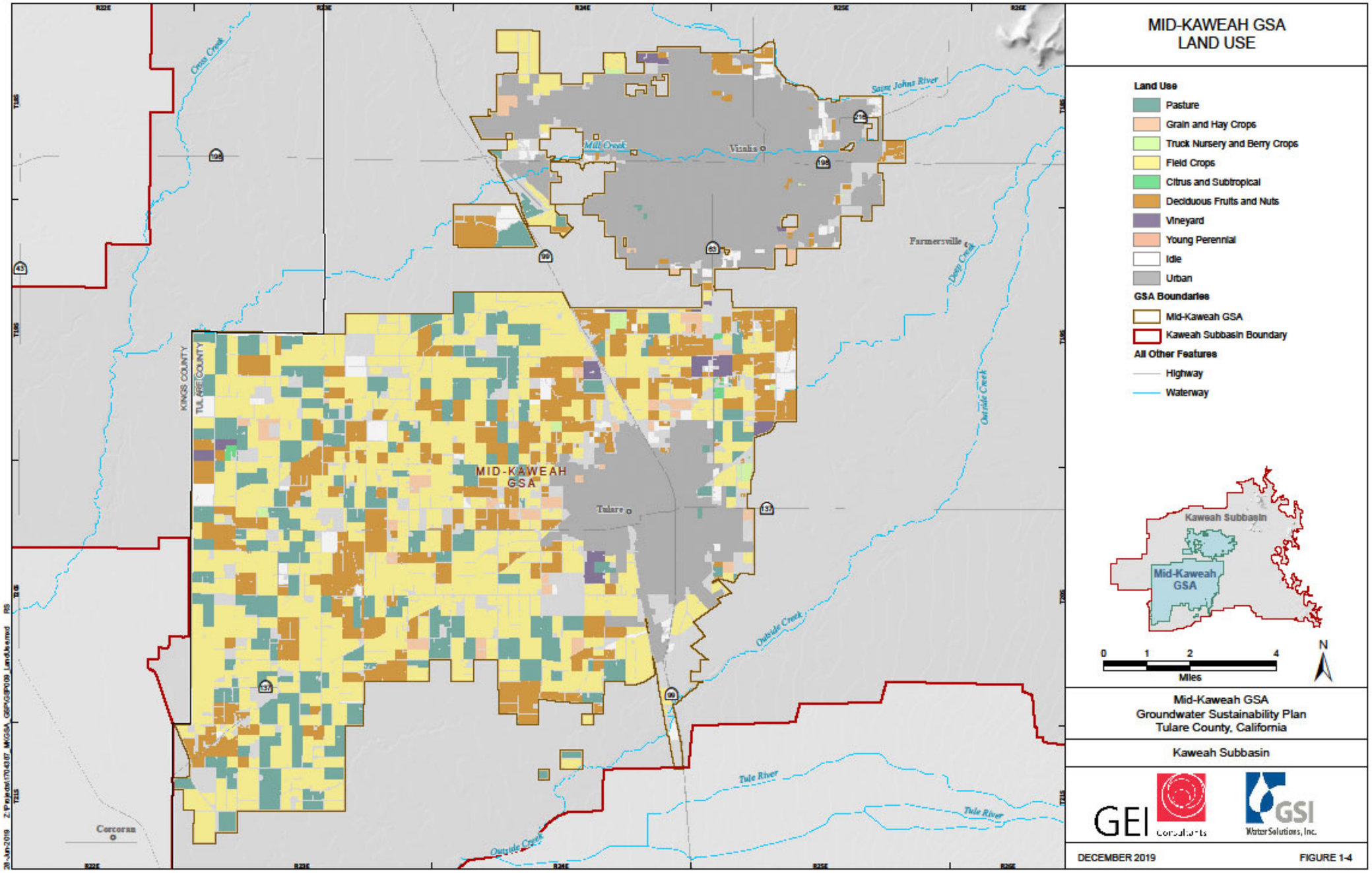


Figure 1-4: MKGSA Land Use

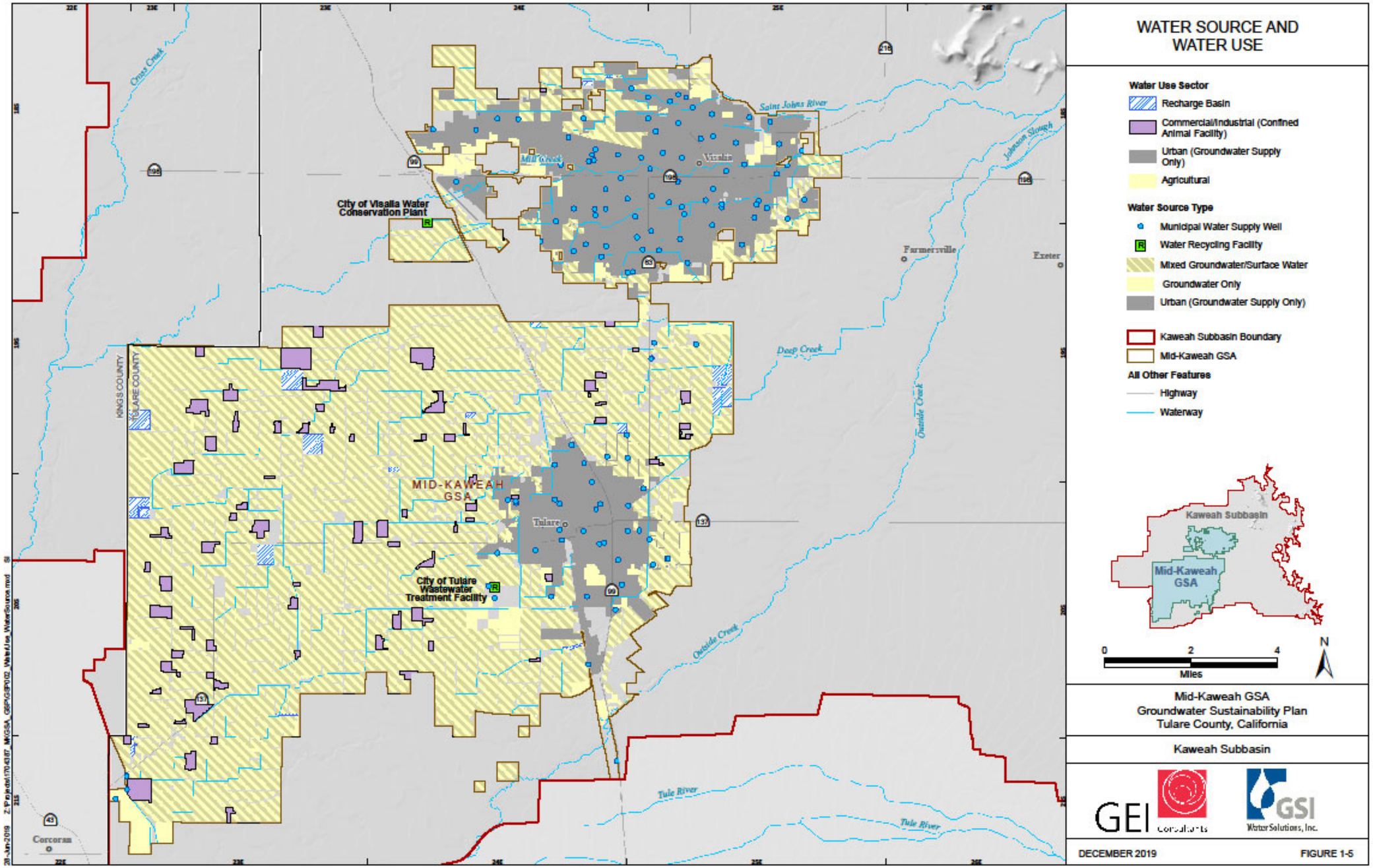


Figure 1-5: Water Source and Water Use

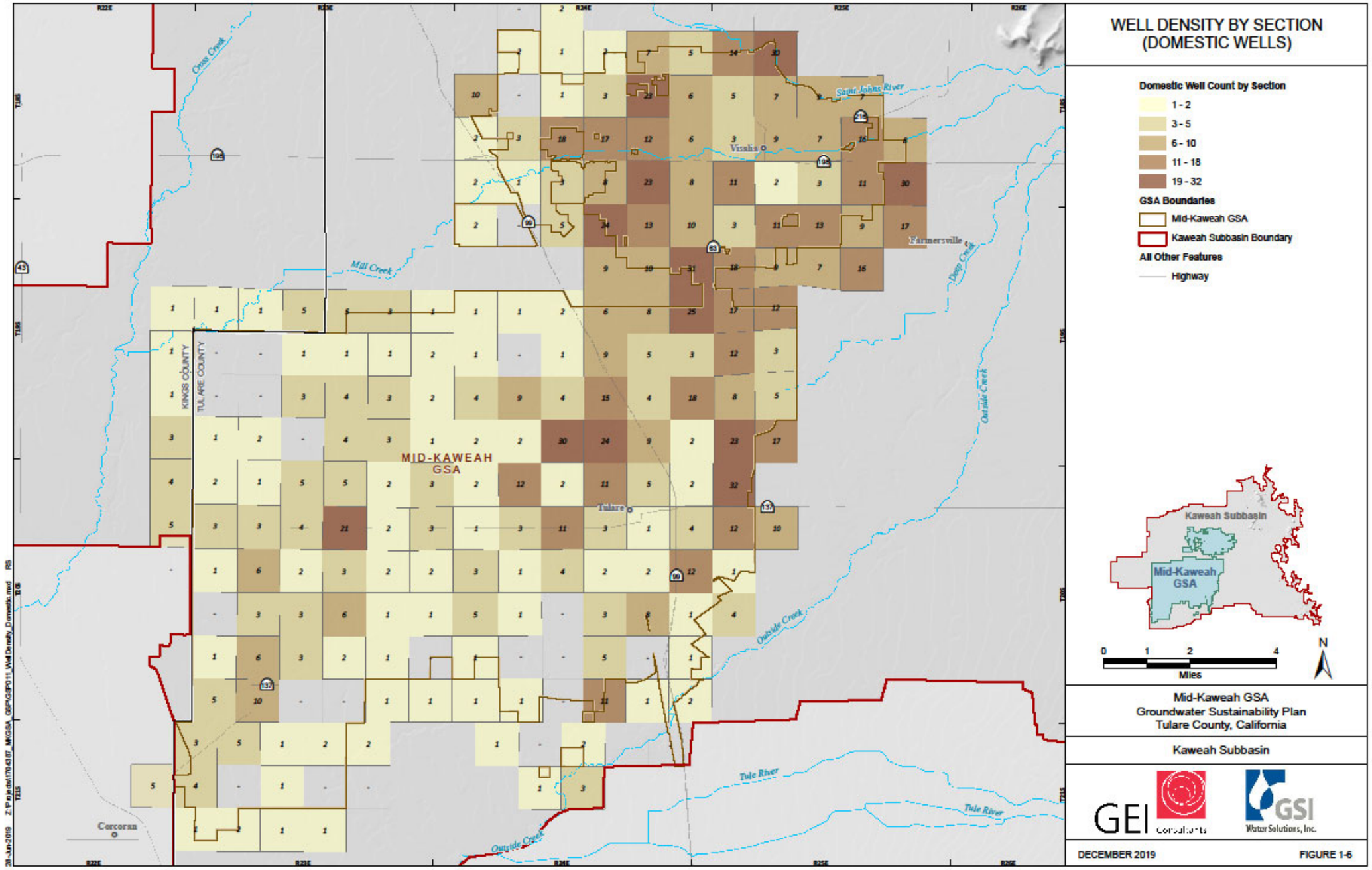


Figure 1-6: Density of Wells – Domestic

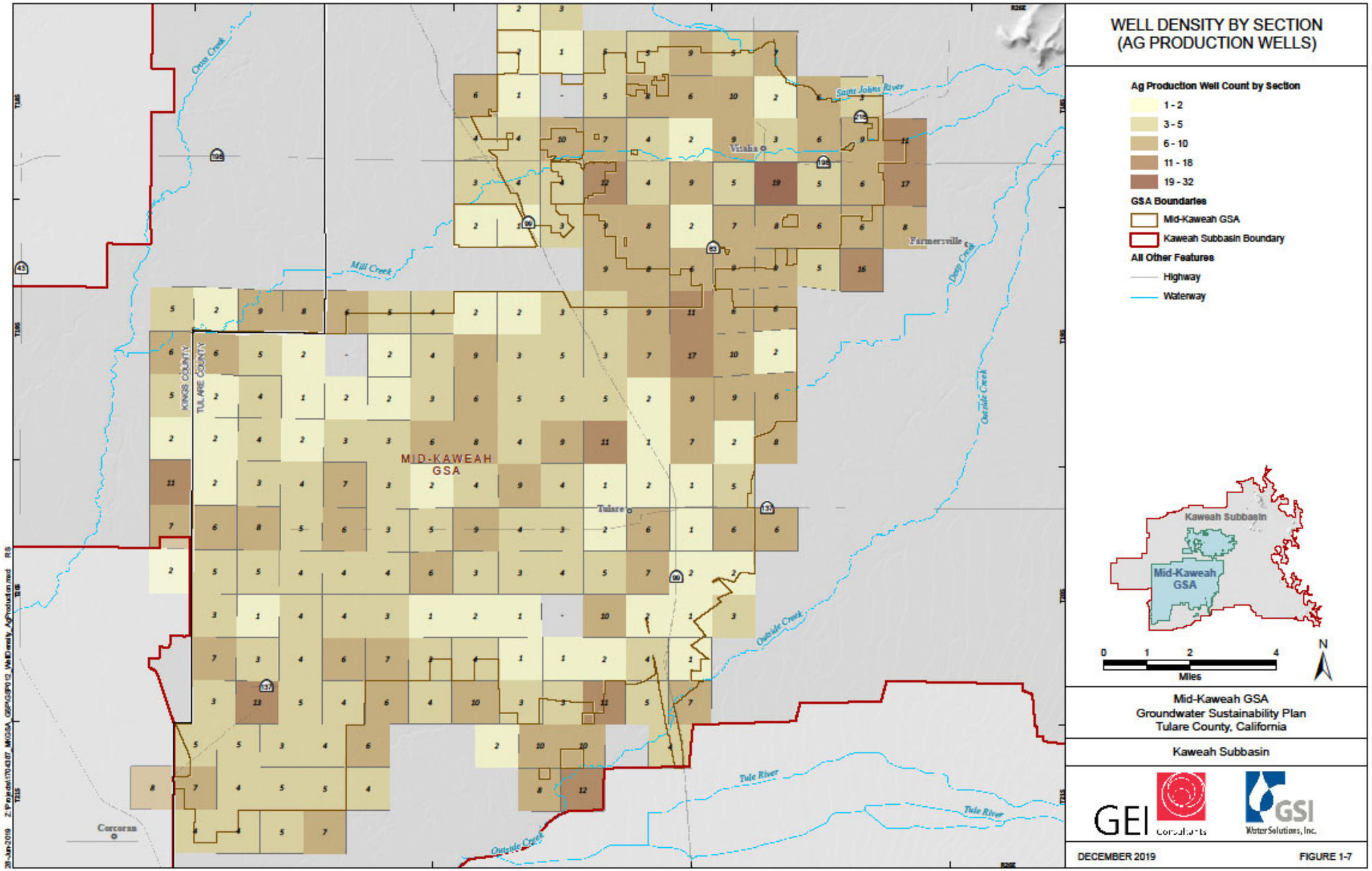


Figure 1-7: Density of Wells – Production

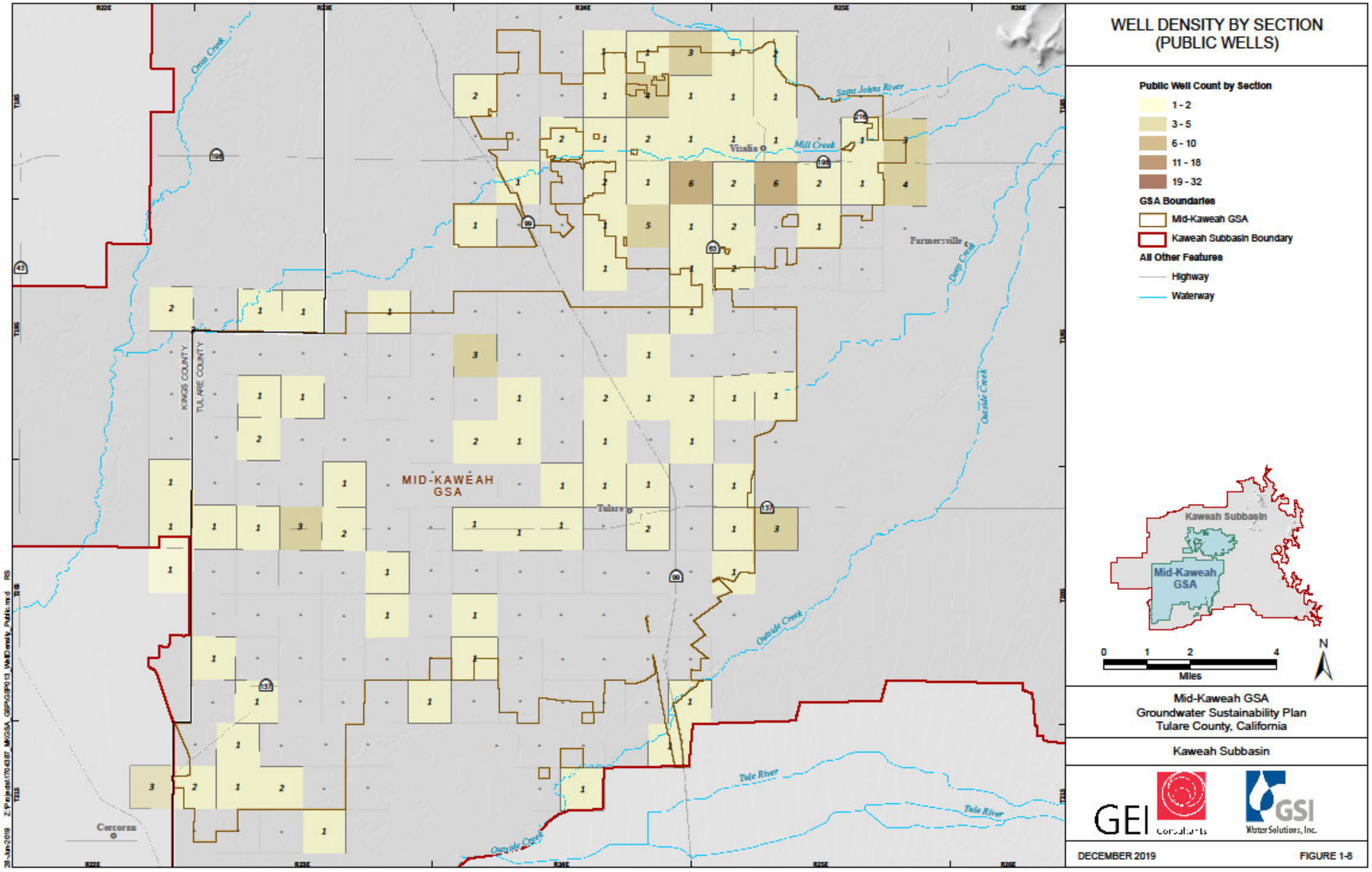


Figure 1-8: Density of Wells – Public

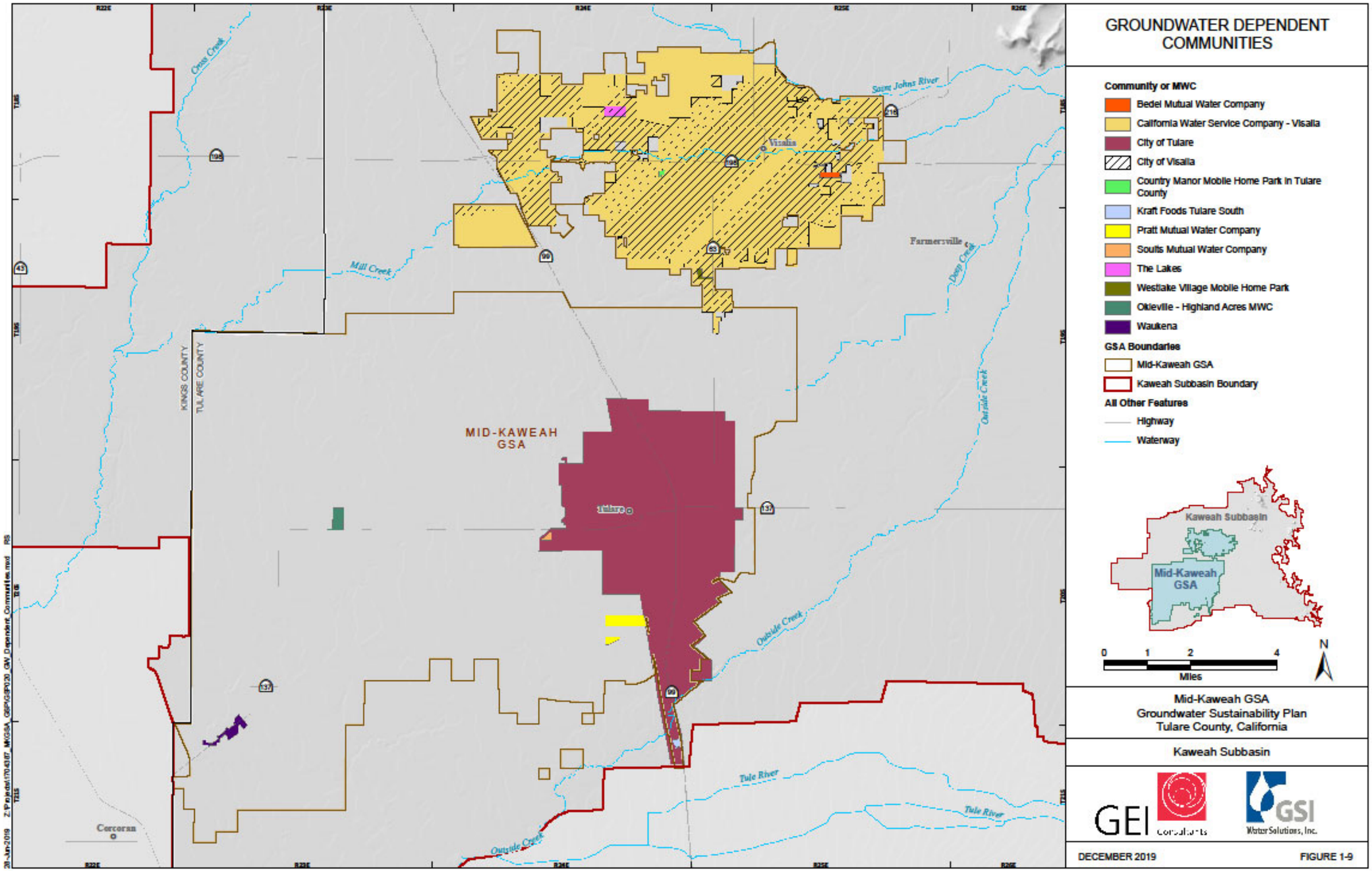


Figure 1-9: Groundwater Dependent Communities

This page intentionally left blank.

2. Basin Setting

2.1 Overview

The three GSAs in the Kaweah Subbasin have coordinated and jointly prepared a comprehensive Basin Setting which is included as **Appendix 2A** of this Plan. The process and work effort to prepare this document are 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. Key sustainability outcomes discussed in the Basin Setting document is an overall basin Safe Yield of 720 TAF. Using this information to facilitate numerous public and advisory committee meetings, the three GSAs in the basin have agreed to a sustainable yield of 660 TAF. **Appendix 2A** fully addresses §354.14, §354.16, and §354.18 of the GSP Regulations. The following sections highlight information for the MKGSA from **Appendix 2A**, but we strongly encourage the reader to review **Appendix 2A** to understand the hydrogeologic and groundwater conditions in the MKGSA within the context of the entire Subbasin.

The Kaweah Subbasin's safe yield is estimated to be about 720,000 AF, which includes net sub-surface inflow. As defined in SGMA, however, the Subbasin's sustainable yield may additionally be impacted when considering undesirable results other than reductions in groundwater storage. The Parties therefore have preliminarily determined that the sustainable yield may be something less and have agreed that the total groundwater inflow of 660,000 AF, which does not include net subsurface inflow (other than mountain front recharge) and was agreed to be most protective of both the Kaweah and adjacent subbasins. This estimated sustainable yield will continue to be revised pursuant to the monitoring of sustainability indicators and avoidance of undesirable results.

Building on the Kaweah Subbasin Basin Setting document provided in Appendix **2A,** this section provides an overview of the basin setting followed by more detail on elements unique to the MKGSA, including:

GSA Groundwater Level Trends

GSA Water Budget for Current Period

GSA Disconnection between Surface and Groundwater

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

2.2 GSA Basin Setting Features

The MKGSA is located within the central to southwestern side of the Kaweah Subbasin, midway between the mountain front and the center of the San Joaquin Valley. Much of the GSA is underlain by the Corcoran Clay, which creates an upper and lower aquifer system, as shown by

Sections B-B' and E-E' of **Appendix 2A**. A single aquifer system is present beneath the eastern half of Visalia in the northeastern GSA. The thickness of the fresh groundwater system varies from about 900 feet on the northeastern corner of MKGSA to about 1,600 feet near the southwestern corner. In general, groundwater flows across the MKGSA in a southwesterly direction and to local cones of depression during the irrigation season. The vertical flow gradient is from shallow to deep conditions. Groundwater quality is generally good, but available data are primarily located in the northern and eastern portions of the MKGSA. 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, and 1,2,3-trichloropropane. Subsidence has occurred throughout the MKGSA area during the last 90 years. The largest amounts of subsidence occurred 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. According to DWR, subsidence between 1949 and 2005 has varied from as much as 5 feet in the Visalia area to as much as 10 feet in the Tulare area to as much as 15 feet along the southwestern corner of the MKGSA area based on land survey technology. As much as 20 feet of subsidence has occurred to the west of the MKGSA area and this area is tangential to the MKGSA area. More recently, radar technology has been used to identify subsidence for various time periods (January 2007 to March 2011, May 2015 to April 2017). Up to 0.5 feet (total) of recent subsidence is documented for the northeastern corner of the MKGSA area (northeast of Visalia) while near the southwestern corner, recent subsidence totals nearly 4 feet, excluding any potential subsidence between the measurement periods.

The following data gaps were identified for the MKGSA:

Accurate count of wells in the MKGSA area, including well type (domestic, irrigation, etc.) and status (active, inactive, abandoned)

Construction details of wells, especially production/screen interval(s). This was a significant data gap that prevented a comprehensive understanding of groundwater level and groundwater quality conditions above and below the Corcoran Clay

Groundwater production records from direct measurement and locally generated estimates of groundwater use in rural areas of the MKGSA. This information will improve the water budget.

Lithologic composition of aquifer, including geophysical logs at strategic locations

Hydraulic parameters of principal aquifers such as transmissivity, storativity and porosity based on pumping tests preferably. This information could then help with the interpretation of Aerial Electro-Magnetic (AEM) data recently collected.

Water quality data for small rural community, domestic (rural residential home owners) and agricultural irrigation wells

Understanding of groundwater quality trends with depth (i.e. between upper and lower principal aquifers and vertical changes within each principal aquifer). With

this information, an improved understanding is possible regarding depth of base of freshwater throughout the MKGSA as well as the Kaweah subbasin as a whole.

Measurements of subsidence within the MKGSA. The historical record of measured subsidence is incomplete and provides no information to inform an understanding of subsidence with depth. 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.

Expanded monitoring of groundwater levels and groundwater quality in small rural communities and disadvantaged communities

The data gaps will be addressed as MKGSA implements the management actions designed to close such gaps, as described in Section 7.4.

2.3 GSA Groundwater Level Trends

Current and historic groundwater level trends for the entire basin are presented in Section 2.4.1 and Appendix B of the Basin Setting document included as **Appendix 2A** to this GSP. This section provides more detail on these trends throughout the MKGSA. These trends are observable on **Figure 2-1** which include 10 long-term hydrographs across the MKGSA with records beginning in the 1950s or 1960s and extending to the present. Groundwater levels are lowest in the southwest region of the GSA where groundwater levels in the range up to 300 feet or more below ground surface as shown on the hydrographs for KSB-889 and KSB-922 provided in Figure 2-1. The highest groundwater levels in the GSA are observed in the northeast region of the GSA near the St. Johns River where depth to groundwater is in the range of 100 to 150 below ground surface as shown on KSB-1977 and KSB-1696 on Figure 2-1.

2.4 GSA Water Budget

Water budget information was compiled for the three GSAs within the Subbasin to evaluate the historic availability and reliability of past surface water supply deliveries and the aquifer response to water supply and demand trends relative to water year type (or hydrologic condition). All readily available data were collected, and a water budget was compiled in accordance with a coordination agreement between the three GSAs "to ensure that the three plans are developed and implemented utilizing the same data and methodologies, and that the elements of the Plans necessary to achieve the sustainability goal for the basin are based upon consistent interpretations of the basin setting." (§354.4 (a))

Within the Kaweah Subbasin, the historical water budget period (base period) was selected to be between water years 1981 and 2017. The current water budget period was between water years 1997 and 2017. The projected of future water budget extends to 2070 accounting for climate change impacts on both supply and demand. Each of these are described in detail in the Kaweah Subbasin Basin Setting Document in **Appendix 2A**. Of these three water budgets, the current water budget is the most accurate because better data, records, and estimating methods were available. Table 32 of

Appendix 2A presents the annual tabulation of the current (1997-2017) water budget for the Subbasin. The basin current water budget was used in the numerical groundwater model and the future water budget was used to run model simulation to estimate future groundwater levels under a number of different scenarios. The model was a helpful tool in setting measurable objectives for this GSP. For more information on the details of groundwater modeling for use in the development of the GSP, please review the groundwater modeling report included as an appendix to the Coordination Agreement.

Based on the jurisdictional areas of each Subbasin GSA and the water budget components physically located within each area, a MKGSA water budget is presented in **Table 2-1**. This localized water budget represents the estimated physical movement of water in and out of the MKGSA area on an annual basis and provides an average for the 21-year period. A brief description of each of the inflow and outflow components is provided in this section, but more detailed descriptions of methods are provided in the Current Water Budget section of the **Appendix 2A**.

2.4.1 *Inflows to the MKGSA*

The inflow components to the MKGSA groundwater system include the following:

Subsurface inflow

Percolation of waste water

Streambed percolation in the natural and man-made channels

Artificial recharge

Percolation of irrigation water

Percolation of precipitation

Each of these components and the method used for each calculation is presented in this section.

Subsurface Inflow

Subsurface flow into the MKGSA was calculated using the Darcy equation Q = PiA, where 'P' is the coefficient of aquifer permeability (horizontal hydraulic conductivity), 'i' is the average hydraulic gradient, and 'A' is the cross-sectional area of the saturated aquifer. Permeability data for the aquifers in the Kaweah Subbasin, including the MKGSA, were discussed in Section 2.2.5.2 of **Appendix 2A**, which were used in the numerical groundwater model. Hydraulic gradient data, derived from annual water level contour maps developed for this Basin Setting were analyzed on an annual basis over the base period. The cross-sectional areas of the aquifer at each groundwater flux line representing the boundaries of the MKGSA were estimated using GIS analysis. From these, annual magnitudes of subsurface flow were tallied. These initial calculations were refined using the numerical groundwater model which was run to generate subsurface inflows and outflows over the current water budget period. The average annual subsurface inflow to MKGSA from 1997 to 2017 was 111.3 TAF.

Wastewater Inflow

Several municipal WWTPs are operated within the Kaweah Subbasin, the principal ones of which are the cities of Visalia and Tulare, located entirely within the MKGSA. Treated wastewater is discharged to holding ponds for percolation, evaporation, or agricultural reuse. Both WWTPs are regulated by Waste Discharge Requirements (WDRs) and Monitoring and Reporting Programs by the RWQCB (Fugro West, 2007). The managers of the two treatment plants were contacted by GSI, and Annual Use Monitoring Reports for the City of Tulare were consulted during this analysis. Based on this research, on average, approximately 80 percent of the Visalia WWTP effluent percolates to groundwater while the other 20 percent is applied to adjacent crops. At the city of Tulare's WWTP, on average, 30 percent of the WWTP effluent percolates to groundwater while the other 70 percent is applied to nearby crops. The annual sums of wastewater that percolate to groundwater within MKGSA are presented in ***Table 26*** of **Appendix 2A**. For the MKGSA, the average annual percolation of wastewater is 13.9 TAF from 1997 to 2017.

Streambed Percolation and Conveyance Losses

Streambed losses from natural streambed channels was estimated using available stream gauge data. Percolation in these natural channels was estimated based on the number of days that water flowed in each reach and the difference between an adjusted reach loss and any known riparian diversion within the reach (Fugro West, 2007; Fugro Consultants, 2016). Ditch losses were calculated by subtracting total water demand (estimated by Davids Engineering) from total surface water delivered and then correcting for area (total ditch area divided by total irrigable acreage). For the MKGSA, the average annual percolation from streambeds and conveyance ditches was 53 TAF from 1997 to 2017.

Percolation of Recharge Basins

Artificial recharge basins receive surface water, which percolates directly to groundwater, the volumes of which were estimated for the MKGSA. The method of estimating these volumes was developed as part of the WRIs for KDWCD, which involved multiplying the number of days each recharge basin received water by the basin's known percolation rate. The basin recharge factors were refined for the entire period of the WRI (Fugro Consultants, 2016) and were utilized for this analysis for the entire base period. For the MKGSA, the average annual percolation from artificial recharge basins was 32.1 TAF from 1997 to 2017.

Percolation of Irrigation Return Water

Similar to the method used to quantify conveyance losses, percolation of irrigation return water was calculated by subtracting total water demand (estimated by Davids Engineering) from total surface water delivered and then correcting for area (total crop area divided by total irrigable acreage). A detailed description of this methodology as applied to the entire subbasin is provided in **Appendix 2A**. For the MKGSA, the average annual percolation irrigation return water was 48.4 TAF from 1997 to 2017.

Percolation of Precipitation

The amount of rainfall that percolates deeply into the groundwater system depends on many factors including the type and structure of the soil, density of the vegetation, the quantity, intensity and duration of rainfall, the vertical permeability of the soil, the relative saturation of the soil during rainfall episodes, and local topography. Deep percolation of rainfall does not occur until the initial soil moisture deficiency is exceeded. In most years, rainfall events do not produce sufficient quantities and timing of rainfall to penetrate beyond the root zone of native vegetation. However, in irrigated soils, because of the artificial application of water, the initial fall and winter moisture content is greater, and less annual rainfall is required to meet and exceed the soil moisture deficiency. Once the soil moisture deficiency within the root zone has been satisfied, continued precipitation (occurring prior to evapotranspiration) will percolate downward and eventually reach the groundwater reservoir.

Estimation of the deep percolation of precipitation was performed for the earlier period (prior to 2000) using an established method that incorporates the distribution of known crop types, rainfall distribution, reference evapotransporation (ET) data from the CIMIS, and soil data. From these data, the percolation of precipitation was calculated with the development of a monthly moisture model spreadsheet that accounted for immediate evaporation, effective rainfall, percolation of infiltrated rainfall, and percolation of rainfall runoff (Fugro West, 2007).

Since 2000, estimates of the percolation of precipitation were made by a different method, based on a combination of remote sensing (satellite) images and computer simulations, which relied on a daily root zone water balance model and crop ET. The method utilizes Davids Engineering's "Normalized Difference Vegetation Index" (NDVI) analysis methods, which were applied to the area of the KDWCD (Davids Engineering, 2013) and the entire Subbasin (Davids Engineering, 2018[***Appendix C*** *of* ***Appendix 2A***]).

For the MKGSA, the average annual percolation of precipitation was 25.4 TAF from 1997 to 2017.

2.4.1 *Outflows from the MKGSA*

Outflow from the groundwater system occurs through the following components:

Municipal and industrial pumping

Agricultural pumping

Extraction by phreatophytes

Evaporative Losses

Subsurface outflow

Each of these components and the method used for each calculation is presented in this section

Municipal and industrial pumping

The categories of water users included in this component include:

Urban

Small public water system

Golf course

Dairy

Nursery

Rural domestic

The total M&I groundwater pumping estimate within the MKGSA is the sum of the individual groundwater pumping estimates each of these water uses. Data used in the M&I groundwater pumping estimate were collected from a variety of sources, including metered municipal groundwater pumping records, estimates based on service connections and categories of facilities, population and dwelling unit density estimates, interviews with various industrial facility managers (nursery, food processing, and packing plants, etc.), and information provided by the County Agricultural Commissioner's Office and the Dairy Advisor. **Appendix 2A** provides more detail on M&I pumping estimates. For the MKGSA, the average annual estimate of M&I pumping was 54.4 TAF from 1997 to 2017.

Agricultural Pumping

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

$$AP = CD - SWc$$

where: AP = Agricultural Pumping

CD = Agricultural Crop Demand

SWc = Surface Water Crop Delivery

Agricultural pumping is the largest groundwater outflow component in the MKGSA with an average annual estimate of 137.9 TAF from 1997 to 2017.

Evaporative Losses

Evaporation of surface water features (ditches, streams, groundwater recharge basins, etc.) represent a very small fraction of total water outflow from the basin at 0.17%.

Riparian Extractions

Riparian vegetation occurs in a few areas throughout the MKGSA adjacent to surface water features such as natural streams, ditches and irrigation channels. The abundance of surface water in these features occasionally supports natural vegetation due to the proximity of these plants to available surface water. **Table 2-1** shows that these loses are small at 0.02%.

Subsurface Outflow

Subsurface outflow of groundwater at depth is that fraction of groundwater passing beyond the downgradient boundary of the MKGSA. The same methodology described above to calculate subsurface inflow was used to calculate subsurface outflow. For the MKGSA, the average annual estimate of subsurface outflow was 103.8 TAF from 1997 to 2017.

MKGSA Water Budget Summary

During the current water budget period of 1997 to 2017, groundwater outflow exceeded groundwater inflow in 12 of the 21 years. During this period, the average groundwater storage depletions were 12.6 thousand acre-feet (TAF) per year due to a combination of water management activities within the GSA as well as influences from neighboring GSAs both in the Kaweah Subbasin and in neighboring subbasins.

To apportion responsibilities for the development of projects and management actions (extraction reductions), Section 6 of this GSP segregates groundwater inflows based on a legal construct of native, foreign, and salvaged components. These components are proportionately assigned to each of the three Subbasin GSAs. This construct and apportionment were designed so as not to impact surface water or groundwater rights, were considered and accepted by each GSA, and represent a preliminary water accounting framework to be further discussed and refined during the first five-year assessment of this GSP.

2.5 GSA Disconnection between Surface and Groundwater

The MKGSA jurisdictional area is located on the valley floor portion of the Subbasin, many miles west of the aquifer forebay area along the Sierra foothills. As such, all reaches of the Kaweah River, slough channels, and distributaries, both natural and man-made, have been disconnected from the underlying water table for many decades. **Figure 2-2** shows the depth to groundwater in the upper principal aquifer for the Spring of 2017 condition which is both a recent and very wet year. Depth to water in the upper principal aquifer is at least (60-80 feet) north and north east of the City of Visalia near the St. Johns river. Depth to groundwater is greatest in the southwest area of the GSA (200 ft). **Figure 2-2 (new figure)** appeared as Figure 2 in The Nature Conservancy's report entitled "Identifying GDEs (Groundwater Dependent Ecosystems) under SGMA**.**

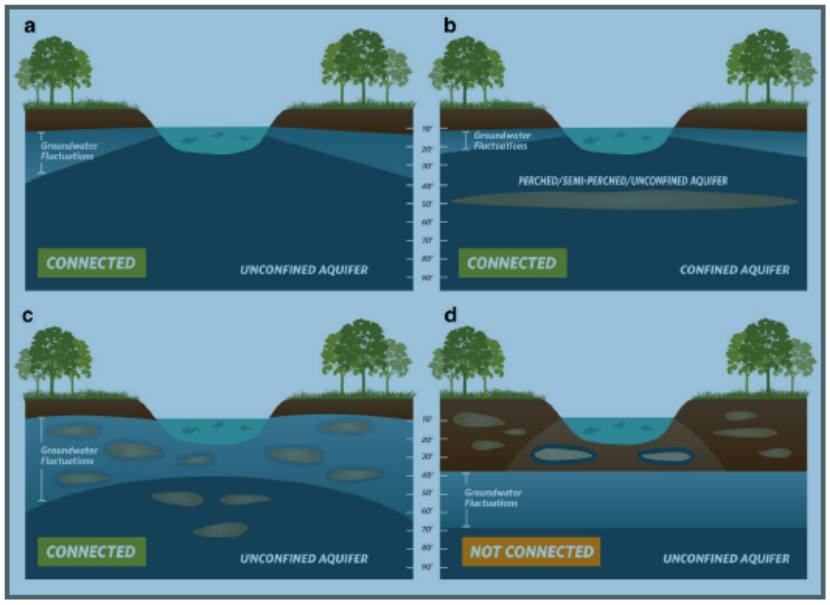


Figure 2. Confirming whether an ecosystem is connected to groundwater. Top: (a) Under the ecosystem is an unconfined aquifer with depth-to-groundwater fluctuating seasonally and interannually within 30 feet from land surface. **(b)** Depth-to-groundwater in the shallow aquifer is connected to overlying ecosystem. Pumping predominately occurs in the confined aquifer, but pumping is possible in the shallow aquifer. **Bottom: (c)** Depth-to-groundwater fluctuations are seasonally and interannually large, however, clay layers in the near surface prolong the ecosystem's connection to groundwater. **(d)** Groundwater is disconnected from surface water, and any water in the vadose (unsaturated) zone is due to direct recharge from precipitation and indirect recharge under the surface water feature. These areas are not connected to groundwater and typically support species that do not require access to groundwater to survive.

Figure 2-3 – Connected and Disconnected Surface and Groundwater Conditions
(Source: TNC, July 2019)

Based on the recent past (pre SGMA) and current depth-to-groundwater conditions in the MKGSA as shown on the groundwater level hydrographs provided in **Figure 2-1** and the depth to groundwater map **Figure 2-2** described above, groundwater is disconnected from surface water. **Figure 2-3** caption (d) best matches the conditions in the MKGSA and water in the unsaturated zone above the upper principal aquifer is due to recharge from precipitation and indirect recharge under streams and irrigation ditches in the MKGSA. Therefore, any species present along the surface water features in MKGSA do not require access to groundwater for survival, but instead are accessing surface water for their survival.

MKGSA reviewed the "Natural Community Dataset Viewer" maps for the Kaweah Subbasin to evaluate the possibility of whether groundwater-dependent ecosystems could exist in the MKGSA management area. The mapping system identifies stream reaches supporting habitat that *may* rely on groundwater. Collections of Valley Oak and Cottonwood populate some reaches of the St. Johns River, which traverse along the northern boundary of the City of Visalia. The same habitat species reside along reaches of Mill Creek and Packwood Creek, which traverse through Visalia and to the southwest into Tulare ID in the case of Packwood. Certain reaches of the St. Johns River are indicated to be wetlands of the type "Palustrine, Scrub-Shrub, Seasonally Flooded." However, this river (the northern fork of the Kaweah River) carries water primarily during releases from Terminus Dam at Lake Kaweah, and flows occur on an average of four to five months annually within this river channel as well as Mill and Packwood creeks fed by the same releases from the dam.

The water table lies some 60 to 150 feet below the invert of all three of these channels reaches, which is generally 40 to 130 feet below the root zone of the Valley Oak, which represent the deepest root zone of the native trees in the MKGSA, this being an alluvial environment. Valley Oaks have a rooting depth that has been measured to as much as 80 feet below ground surface in a fractured-rock environment. However, the MKGSA is underlain by alluvial deposits rather than fractured rock (Lewis and Burgy, 1964; Braatne, et.al., 1996). Because the water table is not connected to the systems and the root zones do not reach the groundwater elevations, the aforementioned habitat species depend on bank seepage and not groundwater.

Table 2-1: Mid-Kaweah Water Budget

Mid-Kaweah Estimated Deep Percolation, Extractions and Change in Storage - Current Period

Values in 1,000s af

Water Year	Rainfall		Components of Inflow						Components of Outflow								Total Inflow	Total Outflow	Change in Storage	Cumulative Change in Storage
									Groundwater Pumpage											
	Inches	% of Average	Subsurface Inflow	Wastewater Inflow	Steambed Percolation and Conveyance Losses	Percolation of Recharge Basins	Percolation of Irrigation Water	Percolation of Precipitation (Crop and Non-Ag Land)	M & I	Gross Applied Irrigation Water (Crop Water Demand)	Delivered Surface Water	*GW Pumping for Irrigated Agriculture*	*Total Net Extraction*	Extraction by Riparian Vegetation	Evaporative Losses	Subsurface Outflow	*Total Inflow*	*Total Outflow*	*Inventory Method*	*Inventory Method*
1997	12.5	128%	82.0	11.9	86.4	50.7	51.6	33.9	46.2	216.6	106.0	*110.6*	*156.8*	0.1	0.5	***-15.9***	*316.5*	*141.5*	*175.0*	*175.0*
1998	22.8	234%	87.6	12.2	103.7	67.9	39.2	73.9	40.1	164.9	147.5	*34.9*	*75.0*	0.1	0.5	***-26.3***	*384.6*	*49.3*	*335.2*	*510.2*
1999	9.6	99%	107.1	12.7	53.4	28.0	50.3	21.7	46.2	208.4	115.5	*104.4*	*150.5*	0.1	0.5	103.6	*273.2*	*254.7*	*18.5*	*528.7*
2000	11.4	117%	107.1	13.3	55.9	21.9	49.8	24.6	46.7	217.8	116.4	*106.9*	*153.6*	0.1	0.5	101.9	*272.5*	*256.1*	*16.4*	*545.1*
2001	10.1	103%	102.2	13.6	25.3	7.7	44.8	21.6	50.8	215.2	54.6	*160.7*	*211.5*	0.1	0.5	106.8	*215.2*	*318.9*	*-103.7*	*441.4*
2002	10.4	107%	101.0	13.3	32.9	8.2	48.3	22.0	53.5	230.8	65.8	*165.9*	*219.5*	0.1	0.5	108.5	*225.7*	*328.5*	*-102.9*	*338.6*
2003	8.7	90%	107.0	13.9	55.6	21.8	49.9	19.1	55.0	231.8	98.6	*133.1*	*188.2*	0.1	0.5	111.1	*267.3*	*299.8*	*-32.5*	*306.0*
2004	8.0	82%	102.6	14.3	26.0	11.2	47.3	16.1	58.7	235.3	48.2	*188.0*	*246.6*	0.1	0.5	109.6	*217.6*	*356.8*	*-139.2*	*166.8*
2005	12.2	125%	121.2	14.4	102.8	66.7	44.9	31.7	57.3	206.9	155.9	*68.0*	*125.3*	0.1	0.5	115.9	*381.8*	*241.8*	*140.0*	*306.8*
2006	15.4	159%	127.3	14.8	93.2	49.1	49.4	39.6	57.5	212.3	149.9	*70.4*	*127.9*	0.1	0.5	113.2	*373.4*	*241.7*	*131.7*	*438.5*
2007	3.8	39%	107.8	14.7	17.6	15.7	51.6	10.5	61.6	239.0	33.6	*211.5*	*273.1*	0.0	0.5	120.3	*218.0*	*393.9*	*-175.9*	*262.6*
2008	5.0	52%	104.1	14.8	32.9	10.6	48.6	16.7	62.4	237.2	60.5	*176.7*	*239.1*	0.0	0.5	138.9	*227.7*	*378.5*	*-150.8*	*111.8*
2009	6.4	66%	106.1	14.6	40.4	13.8	48.0	13.6	61.8	246.5	77.8	*168.8*	*230.5*	0.0	0.5	145.3	*236.5*	*376.4*	*-139.9*	*-28.1*
2010	11.1	114%	121.8	14.7	71.8	63.9	44.7	22.9	58.6	215.6	153.5	*73.6*	*132.2*	0.1	0.5	141.2	*339.8*	*274.0*	*65.8*	*37.6*
2011	13.7	140%	155.9	14.7	78.8	81.9	53.2	47.9	56.8	219.6	171.5	*58.0*	*114.9*	0.1	0.5	131.9	*432.3*	*247.4*	*185.0*	*222.6*
2012	4.4	45%	136.9	14.5	26.4	14.8	50.9	16.7	58.2	236.2	40.5	*195.8*	*253.9*	0.0	0.5	121.9	*260.2*	*376.4*	*-116.2*	*106.4*
2013	4.4	45%	116.6	14.3	15.9	5.4	51.1	11.8	60.5	235.1	6.9	*228.6*	*289.0*	0.0	0.5	122.0	*215.2*	*411.5*	*-196.4*	*-90.0*
2014	4.7	48%	108.1	14.2	3.8	0.0	52.2	9.5	56.1	241.3	4.6	*236.8*	*292.8*	0.0	0.5	109.6	*187.9*	*403.0*	*-215.1*	*-305.1*
2015	6.2	63%	99.6	13.4	1.2	0.0	48.1	16.9	49.9	217.1	3.3	*213.8*	*263.7*	0.0	0.5	97.2	*179.3*	*361.5*	*-182.2*	*-487.3*
2016	9.8	100%	99.7	13.2	35.0	14.7	44.2	25.4	51.0	202.8	54.5	*149.3*	*200.3*	0.1	0.5	100.6	*232.1*	*301.5*	*-69.4*	*-556.6*
2017	14.0	143%	136.1	13.7	154.5	119.6	48.2	37.5	52.8	200.6	190.2	*39.9*	*92.7*	0.1	0.5	123.4	*509.7*	*216.7*	*293.0*	*-263.7*
Maximum	22.8	234%	155.9	14.8	154.5	119.6	53.2	73.9	62.4	246.5	190.2	236.8	292.8	0.1	0.5	145.3	509.7	411.5	335.2	
Minimum	3.8	39%	82.0	11.9	1.2	0.0	39.2	9.5	40.1	164.9	3.3	34.9	75.0	0.0	0.5	-26.3	179.3	49.3	-215.1	
Average	**9.7**	**100%**	**111.3**	**13.9**	**53.0**	**32.1**	**48.4**	**25.4**	**54.4**	**220.5**	**88.3**	**137.9**	**192.2**	**0.1**	**0.5**	**103.8**	**284.1**	**296.7**	**-12.6**	
% of Total			39%	5%	19%	11%	17%	9%	18%			46%		0.02%	0.17%	35%				
			100%						100%											

Italic = Calculation
= Component of Inflow
= Component of Outflow

2.6 Management Areas

MKGSA has established three management areas (MAs) within the GSAs boundaries. The three MAs consist of the respective jurisdictional areas of MKGSA's three Members, i.e., the City of Visalia, City of Tulare, and the Tulare Irrigation District, and are depicted on **Figure 1-1**. Below addresses §354.20(b) and (c) of the GSP Regulations for MAs.

The reasons for the creation of the three aforementioned Management Areas are:

> Each Member of the MKGSA is a separate public agency. The two incorporated municipalities are charter cities with the ability to enact laws distinct from those adopted by the State. The agricultural area is administered by an independent special district.
>
> As distinct public agencies, the GSA Members have differing means of raising funds to comply with SGMA and abilities to implement the projects and management actions described in Section 7 of this GSP.
>
> Water sources vary among Members – Visalia and Tulare rely exclusively on groundwater, whereas TID has local and imported surface water to supplement groundwater uses of its landowners. TID also diverts its surface water supplies for groundwater recharge purposes, particularly in wet years. Furthermore, Visalia's water supply system is owned and operated by the California Water Service Company (CWSC), while Tulare's water supply system is under City ownership and operation.
>
> Financial contributions by each Member towards projects may depend on an evaluation of existing water management agreements among them and on the water accounting framework (Section 6) which will define the water budget components of each Member. These contributions may not be equal and would therefore vary depending on the management area.
>
> Management actions by each Member may differ due to varying water supply sources, participation in projects, and other available resources.
>
> Tulare and Visalia have exclusively urban demands including municipal, industrial, commercial, and residential uses, while TID serves exclusively irrigated agricultural demands and related uses. Small-system and domestic wells also exist within the TID service area, but these types of wells are not prevalent within the confines of the cities.
>
> Each Member has maintained an existing groundwater monitoring program for differing purposes and time periods. While these programs may be incorporated into a common platform for DWR annual reporting purposes, these programs will continue and will be somewhat distinct.
>
> The Corcoran Clay is present beneath both Tulare and TID, and unconfined groundwater is present above the clay while semiconfined/confined groundwater

is present beneath the clay. The Corcoran Clay is present beneath the western half of Visalia but not the eastern half, so groundwater occurs under unconfined/confined conditions as well as only unconfined conditions, respectively. In addition, Visalia benefits from percolation from the St. Johns River branch of the Kaweah River flanking its northerly boundary, whereas Tulare and TID do not receive direct percolation from the larger natural water courses in the Subbasin.

The minimum thresholds and measurable objectives for each management area are identified in Section 5 of this Plan and the monitoring and associated data evaluation are described in Section 4.

Each MA's minimum thresholds have been determined using hydrogeologic zone mapping as a starting point, as explained in Section 5 and detailed in **Appendix 5A**. This approach provides assurances that the minimum thresholds are compatible based on historical well hydrograph trends for selected well monitoring sites. Measurable objectives for groundwater storage have been chosen on a monolithic basis, embracing all three management areas, and by application of the Subbasin numerical model for water levels.

CWSC wells serving Visalia are generally tapping the unconfined aquifer system east of the Corcoran Clay whereas Tulare's well field overlies this clay layer and pumps from the confined aquifer. Newer wells serving recently annexed portions of Visalia along its westerly boundary do produce from semi-confined/confined zones. Both systems pump on a year-round basis and static water-level conditions are rarely if ever reached in these areas.

A historic cone of depression exists under Tulare due to steady-state pumping; however, this is not expected to create undesirable results in the future. The numerical model results under implementation of the chosen measurable objectives do not indicate any adverse impacts as among the management areas leading to undesirable results. Action triggers, as described in Section 5, will avoid any significant deviation from these measurable objectives in any one management area.

Lastly, the selected management areas in two instances contain DACs, the presence of which may dictate unique management actions to address localized undesirable results. These two management areas are the Tulare ID and the City of Tulare, which is itself considered by the state as a DAC. A description of DACs and SDACs within the GSA is provided in Section 1.5.2.3. Should DAC's sustainability needs within Tulare ID dictate a more focused management effort, consideration may be given to designating additional management areas therein if warranted.

Section 2 – Basin Setting

The development of this MKGSA Basin Setting Section was informed by DWR's Water Budget Best Management Practices (BMP), Hydrogeologic Conceptual Model BMP, and Guidance for Climate Change Data Use During Sustainability Plan Development. These documents are provided in **Appendix 2B**.

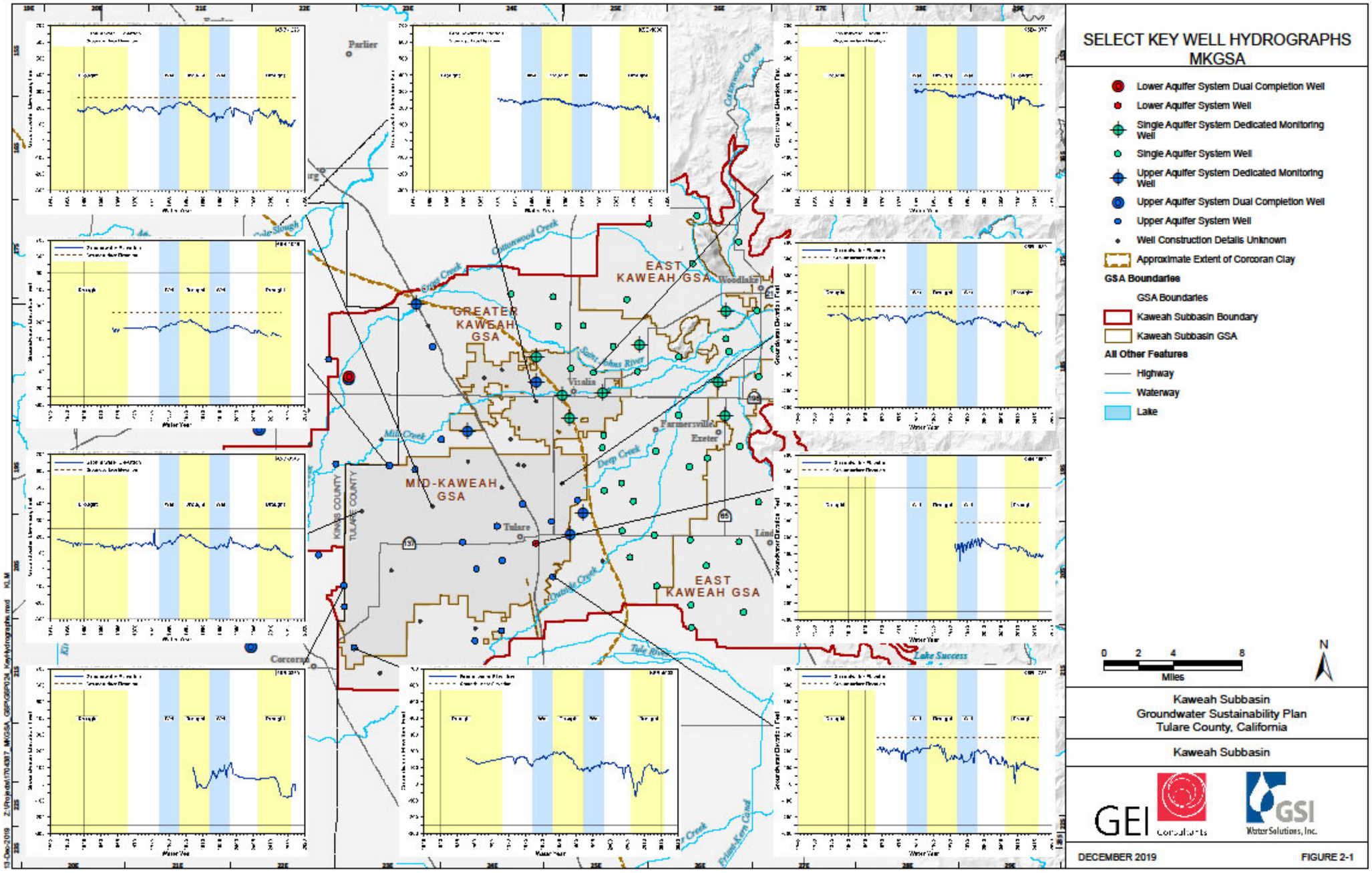


Figure 2-1: Long Term Groundwater Level Trends in the MKGSA Plan Area

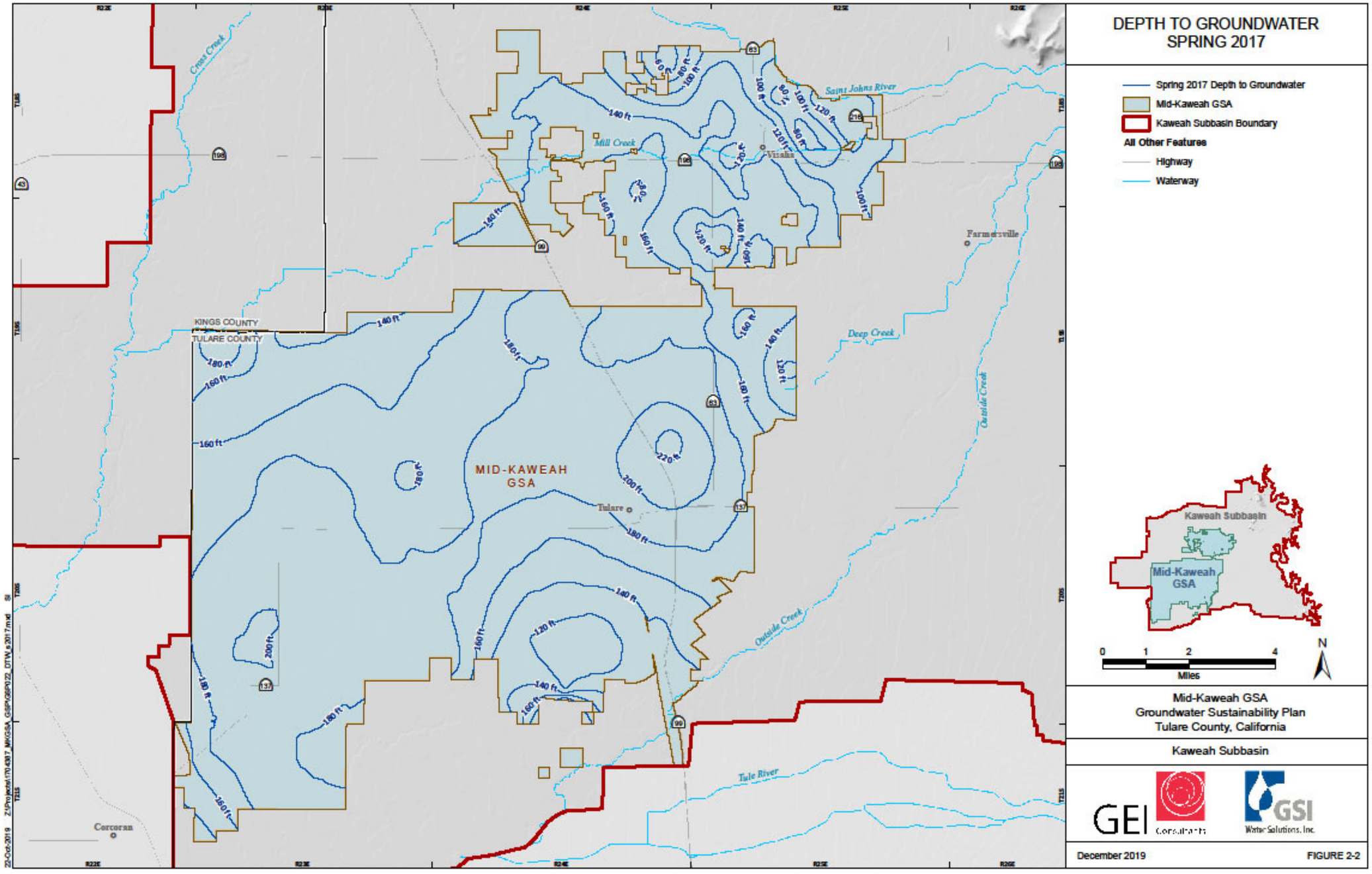


Figure 2-2: Depth to Groundwater in the MKGSA Area, Spring 2017

3. Sustainability Goal and Undesirable Results

The Sustainability Goal and Undesirable Results presented in this chapter reflect those agreed-upon by the three Kaweah Subbasin GSAs as documented in the Coordination Agreement and basinwide Kaweah Basin Setting Report. How the Undesirable Results apply specifically in the MKGSA is discussed in Chapter 5 alongside the discussion of Minimum Thresholds. Note that the Undesirable Results are viewed as a starting point which will be further refined as uncertainty is reduced and data gaps are filled throughout GSP implementation.

3.1 Sustainability Goal

The broadly stated Sustainability Goal for the Kaweah Subbasin is for each GSA to manage groundwater resources to preserve the viability of existing agricultural enterprises of the region and the smaller communities that provide much of their job base in the Sub-basin, including the school districts serving these communities. The Goal will also strive to fulfill the water needs of existing and amended county and city general plans that commit to continued economic and population growth within Tulare County. This goal statement complies with §354.24 of the Regulations.

These Goals will be achieved by:

> The implementation of the EKGSA, GKGSA and MKGSA GSPs, each designed to identify phased implementation of measures (projects and management actions) targeted to ensure that the Kaweah Subbasin is managed to avoid undesirable results by 2040 or as may be otherwise extended by DWR. This will be achieved in part by limiting pumping to the sustainable yield of the Kaweah Subbasin which has been determined to be 660 TAF per year on average by 2040.
>
> Collaboration with other agencies and entities to arrest chronic water-level and groundwater storage declines, reduce or minimize land subsidence where significant and unreasonable, decelerate ongoing water quality degradation where feasible, and protect beneficial uses.
>
> Application of the Kaweah Subbasin Hydrologic Model (KSHM) – incorporating the initial selection of projects and management actions by the Subbasin GSAs – and its simulation output is summarized in the Subbasin Coordination Agreement to help explain how the sustainability goal is to be achieved within 20 years of GSP implementation.
>
> Assessments at each interim milestone of implemented projects and management actions and their achievements towards avoiding undesirable results as defined herein.

Continuance of projects and management action implementation by the three GSAs as appropriate through the planning and implementation horizon to maintain this sustainability goal.

In furtherance of this Subbasin goal, MKGSA advances the following objectives:

Pursuit of projects to sustain and maximize the delivery of local and imported water supplies into the Subbasin for beneficial use, including groundwater recharge via sinking basins, incentivized on-farm programs, and natural and man-made water conveyance systems. MKGSA recognizes that maximizing deliveries of Sierra watershed surface supplies into the Subbasin will provide inherent water quality improvements for all beneficial uses including benefits to plant and animal communities. MKGSA further recognizes the importance of the Kaweah/St. Johns river system and its connected streams and creeks as a key source of groundwater recharge and role in achieving sustainability.

Where necessary, imposition of management actions to ensure that the rate of groundwater hydrostatic pressure/water-level decline in semiconfined zones and rate of groundwater-level decline in the unconfined zone reaches zero on a rolling 10-year average basis in GSAs and Management Areas as identified in Subbasin Plans by 2040 or as otherwise extended by DWR. Management actions may include land fallowing or other land-use conversion alternatives and will incorporate a demand reduction program.

Implementation of water conservation measures consistent with state mandates and as reflected in urban water management plans.

Where feasible, installations and modifications and upgrades of wastewater treatment facilities, both public and private, where effluent discharges reach the underlying aquifer, all as approved and authorized by the owner/operator of such facilities.

Placement of recharge projects and management of pumping regimes in each GSA/Management Area such that acceleration of contaminant plume migration that impairs domestic and municipal supply well production as induced by GSP projects and management actions is avoided. Where technologically and economically feasible as determined by the GSA, consideration will be given to those projects and management actions (e.g., pumping regimes) that could result in key water quality constituent improvements leading to a deceleration of ongoing water quality degradation for potable uses. Any improvements would be consistent with MCLs or other constituents of concern as established by applicable regulatory agencies. Projects and management actions affording such improvements would be undertaken in partnership with other agencies charged with enforcing MCLs or otherwise engaged in water quality regulation.

Placement of recharge projects and management of pumping regimes and adherence to minimum thresholds in each GSA/Management Area such that

newly induced subsidence is not causing significant and unreasonable harm to surface and sub-surface infrastructure, including water conveyance systems, or contributing to significant and unreasonable sub-surface water quality degradation.

Continued use of the Subbasin groundwater simulation model and monitoring network data to assist with projecting achievement of the sustainability goal.

3.2 Undesirable Results

The undesirable results were set at a basin-scale and are therefore derived for MKGSA from the basinwide Kaweah Basin Setting; its characterization as described in the Hydrogeologic Conceptual Model; the historical, current, and projected groundwater conditions and trends; and stakeholder input. The three Subbasin GSAs have concurred with the undesirable results, their causes, determination criteria and effects, all as defined in this section. The several sustainability indicators used to determine undesirable results are referenced herein. This section complies with §354.26 of the Regulations. How the undesirable results apply specifically in the MKGSA is discussed in Chapter 5 of this GSP alongside the discussion of minimum thresholds.

3.2.1 *Causes leading to Undesirable Results*

Causes of undesirable results are delineated herein for groundwater-level declines and likewise for reduction in storage, land subsidence, water quality degradation, interconnected surface waters, and seawater intrusion. The three Subbasin GSAs have concurred with these causes leading to undesirable results.

3.2.1.1 Groundwater Levels

Undesirable results associated with groundwater level declines are caused by over-pumping or nominal groundwater recharge operations -such that groundwater levels fall and remain below minimum thresholds. Over-pumping and lack of recharge is area specific, and some GSA Management Areas experience greater adverse impacts than others. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods. (Sustainable Management Criteria- BMP document, November 2017, page 4)

3.2.1.2 Groundwater Storage

Undesirable results associated with groundwater storage are caused by the same factors as those contributing to groundwater level declines. Given assumed hydrogeologic parameters of the Subbasin, direct correlations exist between changes in water levels and estimated changes in groundwater storage.

3.2.1.3 Land Subsidence

Undesirable results associated with subsidence are caused by over-pumping or nominal groundwater recharge operations during drought periods such that groundwater levels fall and remain below minimum thresholds. Over-pumping and lack of recharge is area specific, and some GSA Management Areas experience greater adverse impacts than others. Over-pumping during drought periods, which may result in new lows in terms of groundwater elevations, is of particular concern based on current scientific understanding of subsidence trends in this region. Local correlations of water levels v. subsidence trends remain difficult to quantify and pinpoint with existing data because of the lack of pumping depth and volume information at specific wells and well fields. While the basin setting and other reference information in the plan relates subsidence to water levels, in our basin it remains a data gap that will be filled over time through collection of data from our land surface subsidence monitoring network.

3.2.1.4 Degraded Water Quality

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.

3.2.1.5 Interconnected Surface Waters

Depletions of interconnected surface waters are minimal and, to the extent they occur, impact only vegetation along the banks of unlined channels within the forebay regions of the aquifer system where natural channels exhibit gaining reaches from time to time. Undesirable results may occur should any such groundwater-dependent vegetation disappear from locations of known historic existence or if depletions negatively impact deliveries of surface water to downstream rights holders

3.2.1.6 Seawater Intrusion

Causes leading to undesirable results from seawater intrusion do not exist within the Kaweah Subbasin due to its location and the physical lack of continuity with any seawater source now or in the future.

3.2.2 *Criteria to Define Undesirable Results*

Minimum thresholds which, when exceeded in sufficient number as to constitute an undesirable result, are fully described for MKGSA in Section 5 of this Plan and constitute the primary criteria to gauge the occurrence of undesirable results. Minimum threshold components, including supporting information, spatial relationships, adjacent basin mutual effects, impacts on beneficial users, other regulatory standards, and monitoring metrics are all addressed in that section. The application of

these criteria is specifically defined herein for water level declines, groundwater storage, land subsidence, and degraded water quality. For interconnected surface waters, a proxy relationship to water levels is discussed in general fashion. The three Subbasin GSAs have concurred with these criteria and MKGSA is basing minimum thresholds and measurable objectives based upon these agreed-upon criteria.

It is the preliminary determination

that the percentages identified in the sections below represent a sufficient number of monitoring sites in the Subbasin such that their exceedance would represent an undesirable result for water-level declines, reduction in groundwater storage, land subsidence, and interconnected surface waters where applicable. Screen interval data for agricultural, municipal and domestic wells identified in Section 5.3.2 has been scrutinized and a determination was made that the percentage of wells completely dewatered by 2040 (less than 15 %) should the minimum thresholds not be exceeded would not constitute an undesirable result. Based on observed groundwater conditions in the future, no less frequently than at each five-year assessment, the GSAs will evaluate whether these percentages need to be changed.

3.2.2.1 Groundwater Levels Undesirable Result

Groundwater elevations serve as the sustainability indicator and metric for chronic lowering of groundwater levels. With respect to water-level declines, undesirable results occur when one-third of the representative monitoring sites in all three GSA jurisdictions combined exceed their respective minimum threshold water level elevations. Should this occur, a determination shall be made of the then-current GSA water budgets and resulting indications of net reduction in storage. Similar determinations shall be made of adjacent GSA water budgets in neighboring subbasins to ascertain the causes for the occurrence of the undesirable result.

3.2.2.2 Groundwater Storage Undesirable Result

The water-level sustainability indicator is used as the driver for calculated changes in groundwater storage. As such, when one-third of the Subbasin representative monitoring sites for water levels exceed their respective minimum thresholds, an undesirable result for storage will be deemed to occur. Given assumed hydrogeologic parameters of the Subbasin, direct correlations exist between changes in water levels and estimated changes in groundwater storage, and water levels are to serve as a metric for groundwater storage reductions as well. As discussed in Section 5.3.1, the current estimated volume of groundwater in storage in the Subbasin of 15 to 30 MAF is sufficient such that further depletion over the implementation period is not of a level of concern such that an undesirable result would emerge during the GSP implementation period.

3.2.2.3 Land Subsidence Undesirable Result

The primary criteria and metric will be the annual rate of reduction in land surface elevation and areal extent of such elevation changes. An undesirable result will occur when one-third of the Subbasin's subsidence monitoring sites exceed their respective minimum thresholds. In addition, MKGSA will evaluate cumulative subsidence at each of the interim milestones as described in

Section 5. The water-level sustainability indicator will be considered for differential land subsidence, although the current body of knowledge relative to subsidence and local and regional declines in water levels is limited. As set forth in Section 5.3.6, subsidence rates that represent minimum thresholds have been identified that reflect recent historical rates in the MKGSA region. Within the eastern portions of the Subbasin, the East Kaweah GSA has established minimum thresholds using a metric tied to loss of conveyance capacity in the Friant-Kern Canal which traverses from north to south through that GSA.

Subsidence becomes a land-surface problem when it is differential in nature i.e., elevation shifts across the areal extent of infrastructure deemed of high importance. For example, subsidence linearly along a major highway is manageable if gradual in its occurrence. In contrast, localized subsidence traversing across a highway, if sizable, would cause major cracking of the pavement surface and become a significant hazard to travelers. The same comparisons may be made for other infrastructure as well. For this reason, should an exceedance of a minimum threshold at a monitoring site occur, the applicable GSA will reach out to the County, cities, water districts, and others, both public and private, and inquire as to any infrastructure damages which may be occurring determine a corrective course of action if deemed necessary.

A broad areal extent of land subsidence thus may not be of major concern, except for the associated loss of aquifer system water storage capacity. However, the large volume of dewatered space currently existing is deemed by the Subbasin GSAs as more than sufficient to accept additional recharge water as planned with new GSA projects during GSP implementation. The likely limiting factor by far will be the availability of local and imported surface water to supply these planned projects.

3.2.2.4 Degraded Water Quality Undesirable Result

Should one-third of all Subbasin designated water quality monitoring sites exhibit a minimum threshold exceedance, and those exceedances are all associated with GSA actions, an undesirable result will be deemed to occur. 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 content 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

As explained in Section 5.3.4, 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 listed in **Appendix 3A** and these are subject to changes as new water quality objectives are promulgated by the State of California and the Federal EPA. MKGSA will provide updates in our annual reports and GSP Updates throughout the implementation periods of 2020 to 2040.

3.2.2.5 Interconnected Surface Waters Undesirable Result

The water level sustainability indicator is to serve, by proxy, for establishing interconnected surface waters. Periodic comparisons of surface water elevations and flowrate depletions in applicable stream channels and adjacent groundwater will be pertinent to this establishment. As discussed in Section 3.2.3.5, minimum thresholds across the Subbasin have not been currently set for interconnected surface waters and undesirable results are not likely to occur.

3.2.2.6 Seawater Intrusion Undesirable Result

As stated in Section 3.2.1.6, causes leading to undesirable results from seawater intrusion do not exist within the Kaweah Subbasin due to its location and the physical lack of continuity with any seawater source now or in the future. The Kaweah Subbasin GSAs have therefore concluded that sustainability indicators for seawater intrusion are essentially non-existent and thus no criteria need be established.

3.2.2.7 Combined Criteria for Sustainability Indicators

The occurrence of minimum thresholds for any of the five applicable sustainability indicators defined in this section are not necessarily additive in terms of causing an undesirable result. As stated in Section 3.2.2.1, if one-third of the monitoring sites exhibit an exceedance of their respective water-level minimum thresholds, then a Subbasin undesirable result would occur. Groundwater storage reductions, in and of themselves, will not cause an undesirable result as stated in Section 3.2.2.2 but, rather, are directly related to water level declines. For subsidence, if one-third of all such monitoring stations exceed their respective minimum thresholds, an undesirable result is likewise employed. Water quality degradation is not considered to be tied in any consistent fashion to water levels, thus the occurrence of an undesirable result due to such degradation is determined independent of water level changes over time; however, a one-third criteria for exceedance across all water quality monitoring sites is to be applied as with water level declines. Any undesirable results caused by habitat loss within stream channels will be evaluated on a case-by case basis and independent of other undesirable results

3.2.3 *Potential Effects on Beneficial Uses and Users*

Potential effects are generally described for declines in water levels and similarly for reductions in groundwater storage, land subsidence, degraded water quality and for interconnected surface waters. The three Subbasin GSAs have concurred with these potential effects.

3.2.3.1 Groundwater Levels

The potential effects of lowered groundwater levels, when approaching or exceeding minimum thresholds and thus becoming an undesirable result, are reduced irrigation water supplies for agriculture and for municipal systems through loss of well capacity, loss or degradation of water supplies for smaller community water systems and domestic wells due to well failures, increased energy consumption due to lowered water levels, and the adverse economic consequences of the aforementioned effects such as increased energy usage to extract groundwater from deeper levels. The same effects occur with reductions in groundwater storage due to the proxy relationship with water levels.

3.2.3.2 Groundwater Storage

The potential effects to beneficial uses and users of reductions in groundwater storage are essentially the same as for declines in water levels. In most cases the direct correlation is with declines in levels; however, some beneficial uses may be tied more specifically to loss of groundwater in storage, such as a reduction in supply for areas not served by a surface water system.

3.2.3.3 Land Subsidence

Differential land subsidence may impact surface infrastructure such as building foundations, paved streets/highways, and water conveyance systems. Subsidence also increases flood risks to residence and critical facilities (hospitals, prisons, domestic and municipal well, etc..) in and around flood zones. While not considered alarming within the Kaweah Subbasin, subsidence along the Friant-Kern Canal elsewhere along its alignment has been an ongoing concern impacting beneficial users of that water supply source. Groundwater deep wells may be adversely impacted due to casing and column failures. Loss of groundwater storage space in the aquifer system can occur with compaction of clay layers within; however, the volume of dewatered and available space existing within the aquifer system is considered extensive and adequate for future recharge during GSP implementation.

3.2.3.4 Degraded Water Quality

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.

3.2.3.5 Interconnected Surface Waters

Water bodies, primarily stream channels, which become temporally disconnected throughout the year from the underlying water table may experience the disappearance of adjacent vegetative habitat which may be considered as a beneficial use of groundwater. Such occurrences are generally restricted to the upper reaches of applicable channels in the forebay region of the aquifer system near the Sierra foothills. The consensus among Subbasin GSAs and stakeholders is that the intermittent nature of this vegetative habitat is such that its temporary loss does not rise to the level of an undesirable result.

3.2.3.6 Seawater Intrusion

Given the conclusion that seawater intrusion will not be an undesirable result for the Subbasin and no sustainability indicator need be applied, there are no effects upon beneficial uses or users due to seawater intrusion.

The undesirable results as generally described in this section are more broadly summarized as referenced in the Kaweah Subbasin Coordination Agreement.

Section 3 – Sustainability Goal and Undesirable Results

The development of this MKGSA Sustainability Goal and Undesirable Results Section was informed by DWR's Sustainable Management Criteria BMP, which is provided in **Appendix 3B**.

4. Monitoring Networks

The following chapter describes both the existing groundwater monitoring within the MKGSA area, and the representative monitoring required by SGMA. In areas where existing monitoring does not meet the SGMA requirements, this chapter identifies data gaps and proposed measures to address these data gaps during the SGMA implementation period, so the representative monitoring improves over time. Plan updates will reflect new information regarding improvements to representative monitoring. This Section 4 includes all information in compliance with §354.32 through §354.40 of the Regulations.

4.1 Existing Monitoring Networks and Programs

Within the MKGSA boundaries, there are local, regional, state, and federal programs to monitor groundwater levels, groundwater and surface water quality, surface water inflow, weather and precipitation, and land subsidence. A brief description of these programs and their applicability to groundwater management are provided below.

4.1.1 *Existing Groundwater Level Monitoring*

Groundwater elevations are monitored by local agencies (e.g., water districts) and regional agencies. **Table 4-1** presents a summary of the groundwater monitoring in the MKGSA. The data collected by these agencies and historical trends are described in the Kaweah Subbasin Basin Setting Report (**Appendix 2A**).

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
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
City of Tulare	Monthly to bi-annually	1992 – 2018	Municipal	30	11	None
Dept of Water Resources	Bi-annually	1930 – 2016	Various	182	7	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 ID	Bi-annually	2012 – 2017	Agricultural	33	2	Unknown
Tulare ID	Bi-annually	1945 – 2018	Agricultural	128	5	4

In addition to the local agency monitoring, the Kaweah Delta Water Conservation District (KDWCD) and TID participate in the CASGEM program. CASGEM was established by 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.

4.1.2 *Existing Groundwater Quality Monitoring*

Groundwater quality monitoring and reporting is currently conducted through numerous public agencies and programs which are summarized in **Table 4-2**. These programs are further described in the Kaweah Subbasin Basin Setting Report (**Appendix 2A**).

Table 4-2: Existing Groundwater Quality Monitoring Programs

Water Quality Monitoring Program	Participating Agencies	Parameters	Frequency
AB 3030 & SB 1938	KDWCD, Lakeside ID, Tulare ID	Ag suitability analysis (Selected constituents from general minerals suite)	Annually to Every 3 Years
State of California – Drinking Water Program for Large Public Community Water Systems	City of Tulare, City of Visalia	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.
State of California – Drinking Water Program for Public Non-Community Water Systems And State Small Water Systems	Non-Community Water Systems such as gas stations, food processing facilities, schools, and motels	Subset of Title 22, varies by system, but typically include frequent analyses of coliform and nitrate.	Frequency could not be determined and will be updated in the annual reports and 5-year update as information becomes available.
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

Water Quality Monitoring Program	Participating Agencies	Parameters	Frequency
Groundwater Ambient Monitoring and Assessment (GAMA)	State Water Resources Control Board (SWRCB), Central Valley Regional Water Quality Control Board (RWQCB), DWR DPR, National Water Information System, Lawrence Livermore National Laboratory	Constituents vary by Program Objectives. U.S. Geological Survey (USGS) is typically the technical lead in conducting the studies and reporting data	Priority Basin Project performed baseline and trend assessments, sampling 2,900 public and domestic wells statewide. Domestic Well Project sampled over 180 wells in Tulare County (29 wells were in the Kaweah Subbasin).
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)
USGS California Water Science Center	USGS	Multiple Groundwater Quality studies in Kaweah Subbasin	Studies used for Basin Setting: Groundwater Quality in the Shallow Aquifer (2017) Status and Understanding (2012) Groundwater Quality in Southeast San Joaquin Valley (SESJ) (2012) Groundwater Quality Data in the SESJ (2008) Environmental Setting (1998)

4.1.3 *Existing Surface Water Inflow Monitoring in the Basin and MKGSA*

Section 2.3.4 of the Basin Setting document provided as **Appendix 2A** describes all the surface water flow monitoring in the Kaweah Subbasin and Figure 21 of that document shows the locations of flow monitoring stations. TID's main sources of surface water come from the San Joaquin and the Kaweah rivers. Surface water is provided from the San Joaquin River through a U.S. Bureau of Reclamation (USBR) contract which delivers water to TID from the Friant Dam via the Friant-Kern Canal. Kaweah River water is delivered to TID and is administered by the Kaweah & St. Johns River Association (KSJRA). TID can also obtain surface water from several small surface streams which pass through TID's service area. **Figure 4-1** (at the end of this Section) shows the surface water monitoring stations upstream and within MKGSA. Water from the Kaweah River is delivered via Pre-1914 water rights and administered by the KSJRA. Seasonal streams originating in the eastern portion of the Kaweah Subbasin that flow through the EKGSA and GKGSA also contribute to the surface water inflow to MKGSA but are not currently measured.

4.1.4 *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 state's CIMIS network, are listed in **Table 4-3** below.

Table 4-3: CIMIS Stations in Kaweah Subbasin

Station Number	Station Name
43747	Hanford *
42012	Corcoran *
49367	Visalia *
44957	Lindsay
44890	Lemon Cove
48917	Three Rivers Edison
* Located in close proximity to the MKGSA jurisdictional area	

4.1.5 *Existing Land Subsidence Monitoring*

As described in Section 2.3.3 of the Basin Setting Report (**Appendix 2A**), land subsidence monitoring includes both the monitoring of land elevation changes and groundwater level changes. Land elevation survey monitoring includes National Geodetic Survey 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 Sections 4.1.1 and 2.3.1 of **Appendix 2A**. **Table 4-4** below is a summary of historic and recent land subsidence monitoring programs in the MKGSA and the Kaweah Subbasin, at large.

Table 4-4: 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 and USGS and others (InSAR and UAVSAR programs)	2007 – 2010 2015 – 2018

4.2 Monitoring Network Objectives

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: groundwater levels, groundwater storage, groundwater quality, and land subsidence. While they are listed in SGMA, seawater intrusion and interconnected streams are not considered in this Plan because they do not apply to the MKGSA area. As described in the Subbasin Basin Setting Report (**Appendix 2A**), the location of the Kaweah Subbasin precludes the possibility of seawater intrusion and historic groundwater depletion has also caused enough separation between surface water and groundwater to eliminate interconnected streams from consideration for the MKGSA.

4.2.1 *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 are adequate to obtain acceptable data required to monitor the Sustainability Indicator levels against minimum thresholds and interim milestones. Where necessary, revisions will be made every five years.

4.2.2 *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 providing information about groundwater conditions necessary to evaluate the effectiveness of this Plan in achieving the sustainability goal. The frequency at which data will be collected for each network is described in the following sections.

4.2.3 *Representative Monitoring*

As referenced in Regulations §354.36, representative monitoring sites may be designated where site results reflect the general conditions in the area, and where quantitative values for minimum thresholds and interim milestones are defined.

Representative monitoring will also include the use of groundwater elevations as proxy measurements for other sustainability indicators such as groundwater storage and land subsidence. The USGS and DWR have utilized changes in groundwater elevations to estimate changes in storage and have demonstrated a correlation between groundwater elevation and subsidence. A reasonable margin of operational flexibility with groundwater elevations will be taken to avoid undesirable results for the other sustainability indicators.

The Kaweah Subbasin Basin Setting (**Appendix 2A**) presents spatial distribution of groundwater quality, groundwater levels, and land subsidence data. representative monitoring sites for each Management Area are described in their respective section.

4.3 Monitoring Rationales

As discussed in the Basin Setting Report (**Appendix 2A**), the overall trend for groundwater levels is declining basinwide, including MKGSA, 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 significant a confining layer(s). Seawater intrusion, due to the Subbasin's distance from the Pacific Ocean, is not under consideration as a Sustainability Indicator (Chapter 3: sustainability goal and undesirable results). Due to its location within the central to westerly side of the Kaweah Subbasin, depletion of interconnected streams is also not under consideration in this Plan.

Groundwater level monitoring is the key parameter that will inform progress made by the MKGSA in meeting the interim milestones and measurable objectives set in this Plan. The other Sustainability Indicators will also be monitored using the existing monitoring systems and programs and can be evaluated concurrently with 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 (4.4 through 4.9) describe how MKGSA will monitor each sustainability indicator.

4.4 Groundwater Level Monitoring Network

4.4.1 *Management Areas for Groundwater Level Monitoring*

A Management Area (MA) is 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. The MAs will preserve groundwater management practices and implement additional requirements set forth in this GSP.

The MKGSA portion of the Kaweah Subbasin can be characterized with zones or regimes in which water quality, groundwater levels, and land subsidence characteristics are similar. The MAs are based on the jurisdictional boundaries of the MKGSA member agencies: Tulare Irrigation District, the City of Tulare, and the City of Visalia. The rationale for these MAs is explained in Section 2.

4.4.2 *Groundwater Level Monitoring Frequency*

At a minimum, groundwater level monitoring will occur in the spring and fall each year. TID collects groundwater level measurements in January and October each year. The cities collect water level data much more frequently (monthly or continuously). 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.

4.4.3 *Groundwater Level Monitoring Spatial Density*

Figure 4-2 (at the end of this Section) provides the current distribution of wells throughout the entire Subbasin with available data through CASGEM, local and regional agencies, and Management Areas. **Figure 4-3** (at the end of this Section) shows the current groundwater level monitoring wells in the MKGSA only, with aquifer designations if known. Based on the BMP for monitoring networks, the well density goal is 4 to 10 wells per 100 square miles. The MKGSA area is 170 square miles. Based on the BMP, the MKGSA monitoring network will require a minimum of 6 to 16 monitoring wells.

4.4.4 *Maps of Grid for Each Aquifer/Management Area*

Figure 4-4 (at the end of this Section) presents the representative groundwater level monitoring program wells for the MKGSA. The 43 key wells will be used for the representative monitoring wells relative to their respective sustainable management criteria. Criteria considered in selecting wells for the representative groundwater level monitoring program included the following:

Long record of historical data

Current data

Well accessibility

Well construction information

Total well depth

Uniform geographical distribution

Table 4-5 summarizes known well construction information and, unfortunately for many of these wells, construction information was not available (noted as NA in the Table 4-5) during the

development of this initial GSP. **Table 4-5** also lists the monitoring entity and the frequency at which water level data is collected.

Table 4-5: Groundwater Level Monitoring Network

Well Construction Information					
Well Summary Well ID	Monitoring Entity	Total Depth (fbgs)	Top of Screen (fbgs)	Bottom of Screen (fbgs)	Monitoring Frequency
KSB-0922	Tulare Irrigation District	428	322	420	semi-annual (oct, feb)
KSB-0946	Tulare Irrigation District	NA	NA	NA	semi-annual (oct, feb)
KSB-0948	Tulare Irrigation District	NA	NA	NA	semi-annual (oct, may)
KSB-0976	Tulare Irrigation District	NA	NA	NA	semi-annual (oct, feb)
KSB-0994	Tulare Irrigation District	NA	NA	NA	semi-annual (oct, feb)
KSB-1071	Tulare Irrigation District	NA	NA	NA	semi-annual (oct, feb)
KSB-1129	Tulare Irrigation District	NA	NA	NA	semi-annual (oct, feb)
KSB-1168	Tulare Irrigation District	331	178	190	semi-annual (oct, jan)
KSB-1206	Tulare Irrigation District	NA	NA	NA	semi-annual (oct, jan)
KSB-1226	Tulare Irrigation District	NA	NA	NA	semi-annual (oct, jan)
KSB-1320s	Tulare Irrigation District	540	80	250	semi-annual (oct, jan)
KSB-1320d	Tulare Irrigation District	540	330	540	semi-annual (oct, jan)
KSB-1384	Kaweah Delta Water Conservation District	121	91	121	semi-annual (oct, jan)
KSB-1408s	Tulare Irrigation District	490	80	200	semi-annual (oct, jan)
KSB-1408d	Tulare Irrigation District	490	230	490	semi-annual (oct, jan)
KSB 1427	Kaweah Delta Water Conservation District	NA	NA	NA	semi-annual (oct, jan)
KSB-1431	Tulare Irrigation District	229	170	210	semi-annual (oct, jan)
KSB-1447	Tulare Irrigation District	NA	NA	NA	semi-annual (oct, jan)
KSB-1477	Tulare Irrigation District	NA	NA	NA	semi-annual (oct, jan)
KSB-1506	Tulare Irrigation District	720	300	720	semi-annual (oct, jan)
KSB-1526	Kaweah Delta Water Conservation District	NA	NA	NA	semi-annual (oct, jan)
KSB-1536s	Tulare Irrigation District	500	80	250	semi-annual (oct, jan)
KSB-1536d	Tulare Irrigation District	500	350-420	500-540	semi-annual (oct, jan)
KSB-1538	Tulare Irrigation District	NA	157	357	semi-annual (oct, jan)
KSB-1545s	Tulare Irrigation District	450	80	255	semi-annual (oct, jan)
KSB-1545d	Tulare Irrigation District	450	340	450	semi-annual (oct, jan)
KSB-1628	Tulare Irrigation District	720	320	720	semi-annual (oct, jan)
KSB-1689	City of Tulare	110	70	110	Monthly
KSB-1690	Kaweah Delta Water Conservation District	123	83	123	semi-annual (oct, jan)
KSB-1695	City of Tulare	774	348	756	Monthly
KSB-1696	City of Visalia (Cal Water)	NA	NA	NA	semi-annual (oct, jan)
KSB -1699	City of Visalia (Cal Water)	NA	NA	NA	Monthly
KSB-1706	Tulare Irrigation District	NA	NA	NA	semi-annual (oct, jan)
KSB-1709	Tulare Irrigation District	NA	NA	NA	semi-annual (oct, jan)
KSB-1770	City of Tulare	715	300	700	Monthly
KSB-1819	Kaweah Delta Water Conservation District	123	83	123	semi-annual (oct, jan)
KSB-1862	Kaweah Delta Water Conservation District	124	84	124	semi-annual (oct, jan)
KSB-1884	City of Visalia (Cal Water)	NA	NA	NA	Monthly
KSB-1903	City of Tulare	620	320	620	Monthly
KSB-1905	Tulare Irrigation District	NA	NA	NA	semi-annual (oct, jan)
KSB-1977	City of Visalia (Cal Water)	NA	NA	NA	Monthly
KSB-2014	Kaweah Delta Water Conservation District	100	60	100	semi-annual (oct, jan)

Access agreements to collect and report groundwater level monitoring data are pending 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*."

In addition to the wells shown on **Figure 4-4**, the City of Visalia also measures groundwater levels in 52 municipal production wells each month. Groundwater levels are collected under both static and pumping conditions. City of Tulare measures groundwater levels monthly in 28 municipal production wells. Although these wells are not included in the representative monitoring program, groundwater level data collected will be reviewed in preparing potentiometric surface maps for the annual reports. The City of Visalia also administers a groundwater monitoring program at their WWTP located in the southwest area of the City. A detailed groundwater monitoring report for the City of Visalia, showing the well locations, well construction details, groundwater levels, and groundwater quality results is provided as **Appendix 4A.**

4.4.5 *Groundwater Level Monitoring Protocols*

As referenced in § 352.4 of the GSP Regulations, "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 monitoring entity will create a Well Identification Sheet, which will be used to track the monitoring

at each well site. The following information will be recorded on the Well Identification Sheet: well number, date of survey, latitude and longitude, RP elevation and description, 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 MKGSA data management system (DMS) as soon as possible. Care will be taken to avoid data entry mistakes and the entries will be checked by a second person for accuracy.

TID follows a monitoring plan in collecting groundwater elevation data for local groundwater management and for reporting to DWR as required by the CASGEM program. A copy of TID's groundwater level monitoring plan is attached as **Appendix 4B**.

4.4.5.1 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.

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, which requires commensurate logging of barometric pressures.

Transducers will be able to record groundwater levels with an accuracy of at least 0.1 feet. 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.

Follow manufacturer specifications for installation, calibration, battery life, correction procedure (for non-vented cables), and anticipated life expectancy to ensure optimal use of the equipment.

Secure the cable to the wellhead 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 and entered the DMS following the QA/QC program established for the GSP. Data from non-vented cables will be corrected for atmospheric barometric pressure changes, as appropriate. After ensuring the transducer data have been downloaded and stored in the data management system (DMS), the data will be deleted from the data logger to ensure that adequate data logger memory remains for future measurements.

4.5 Groundwater Storage Monitoring Network

Change in groundwater storage is correlated with the change in groundwater levels. Therefore, the MKGSA 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 Land Subsidence Monitoring Network

4.6.1 *Management Areas for Land Subsidence Monitoring*

For the purposes of this Plan, the MKGSA will not have management areas for the purposes of evaluating subsidence, and subsidence will be evaluated during the first five years of SGMA implementation to determine the necessity for management areas specific for monitoring subsidence.

4.6.2 *Land Subsidence Monitoring Frequency*

The monitoring network will be capable of collecting sufficient data to demonstrate short-term (1 to 5 years) and long-term (5 to 10 years) trends in subsidence and yield representative information about land surface elevation changes to evaluate Plan implementation. This data will be used in

conjunction with NASA InSAR imagery. NASA's InSAR data is generally precise to within an inch (Farr, 2015 and 2016). In general, land surface elevation monitoring data will be collected annually within an assigned 15-day period.

4.6.3 *Land Subsidence Monitoring Spatial Density*

Figure 4-5 provides the current distribution of monitoring stations with available data through local and regional agencies. The Kaweah Delta Water Conservation District (KDWCD) Land Surface Elevation monitoring network consists of 31 monitoring stations throughout the Kaweah Subbasin and in the neighboring subbasins. Additional sites will be incorporated by the 2021 network update. These station elevations are and will continue to be monitored annually for the purpose of measuring subsidence rates. Vertical measurement accuracy is within +/- 0.01 feet. A total of nine stations are located within the MKGSA area and four stations are located just beyond the MKGSA boundary (< 0.5 mile). In addition, two continuous GPS stations are located on either side of the MKGSA area, including one on the east side within 0.5 miles of the boundary and one near the southwestern corner within 2 miles. Moreover, these two GPS stations are located in proximity to two KDWCD stations (~1 mile or less). Another subsidence station is located at the office of TID and is being monitored by KDWCD and CALTRANS and information from this station will be incorporated into MKGSAs annual reporting and 5-year plan updates.

4.6.4 *Land Subsidence Monitoring Protocols*

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

4.6.4.1 Static Occupation

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 NGS 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. Commensurately, dilution of precision (DOP) and combined error also tend to be more favorable.
>
> The preferred outcome at each station is to acquire one 4.0+ hour autonomous dataset from one (1) setup. The average of two 2.0+ hour autonomous datasets from two 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. High wind and blowing debris will be avoided. In cases where environmental elements or man-made conditions threaten observer safety, equipment functionality, or data integrity operations will cease, recommencing only when practicable for at least two 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, ready to take appropriate action.

4.6.4.2 Data Processing

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, differentially 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.

4.7 Seawater Intrusion Monitoring Network

As stated previously, the Kaweah Subbasin is not located near the Pacific Ocean which precludes the consideration of seawater intrusion as a sustainability indicator. Therefore, a monitoring network and monitoring is not required for the Subbasin and GSAs therein.

4.8 Depletions of Interconnected Surface Water Monitoring Network

As stated previously, the interconnection of surface water and groundwater was disrupted many decades ago in the MKGSA. Therefore, a monitoring network and monitoring is not required for this GSA.

4.9 Groundwater Quality Monitoring Network

Figure 4-6 (at the end of this Section) shows the location of current public drinking water system wells dedicated agricultural monitoring wells currently used to monitor groundwater quality, sorted by aquifer where information is available. Please refer to **Figure 1-2** for the small water system identifiers. **Table 4-6** provides a listing of wells, the public water system associated with the well, location, construction information, principal aquifer monitored and type (public water system or agricultural monitoring well). As the largest public water systems in the MKGSA, the City of Visalia and City of Tulare monitor groundwater quality for compliance with Title 22 for municipal and industrial uses. Both Visalia and Tulare have protocols that they follow for the collection, handling, transport and analysis of groundwater samples. These protocols are included as **Appendix 4C**. **Figure 4-6** includes four multi-level piezometers located within the TID services area. These wells will be monitored annually during the SGMA implementation period of 2020 to 2040 and these data will be reported to DWR in the MKGSAs annual report. Samples collected annually from these wells will be analyzed for the agricultural suitability suite of constituents including:

pH

Ec (Conductivity)

TDS (Total Dissolved Solids)

Boron

SAR (Sodium Adsorption Ratio)

Cations
- Calcium
- Magnesium
- Sodium

- Potassium

Anions

- Bicarbonate (HCO_3)
- Chloride
- Nitrate as N
- Sulfate-Sulfur

MKGSA will plot trends to show how these constituents may be changing over time during the SGMA implementation period and these time series plots will be provided to DWR in the annual reports required by the GSP Regulations.

Table 4-6: Mid-Kaweah GSA Water Quality Monitoring Network

Well ID	Well Type	System Name	Well Name	Latitude	Longitude	Top of Screen (feet bgs)	Bottom of Screen (feet bgs)	Aquifer System	Type of Threshold	
									Public Drinking Water	Agricultural
5400679-001	Public Drinking Water	99 Palms Inn and Suites	WELL 01	36.2709	-119.36636	175	300	Both	X	
5400538-001	Public Drinking Water	Accelerated Charter High School	WELL 01	36.25236	-119.30941	168	320	Both	X	
5400816-002	Public Drinking Water	Bedel Mutual Water Co	WELL 02	36.32347	-119.26517	NA	NA	Single	X	
5400816-003	Public Drinking Water	Bedel Mutual Water Co	WELL 03	36.32349	-119.26528	NA	NA	Single	X	
5400919-001	Public Drinking Water	Buena Vista School	WELL 01	36.18212	-119.43825	240	350	Both	X	
5400919-002	Public Drinking Water	Buena Vista School	WELL 02	36.18167	-119.43857	NA	NA	Unknown	X	
1610004-003	Public Drinking Water	Corcoran, City Of	WELL 03A	36.12465	-119.52906	250	470	Both	X	
1610004-015	Public Drinking Water	Corcoran, City Of	WELL 06A	36.11987	-119.5287	590	1130	Lower	X	
1610004-016	Public Drinking Water	Corcoran, City Of	WELL 07A	36.12425	-119.52878	515	1000	Lower	X	
5410016-010	Public Drinking Water	CWS - Visalia	WELL 07-01	36.32889	-119.28169	175	270	Single	X	
5410016-014	Public Drinking Water	CWS - Visalia	WELL 11-02	36.32281	-119.28684	310	440	Single	X	
5410016-015	Public Drinking Water	CWS - Visalia	WELL 12-01	36.34049	-119.28692	186	246	Single	X	
5410016-016	Public Drinking Water	CWS - Visalia	WELL 13-01	36.32044	-119.31236	214	265	Upper	X	
5410016-017	Public Drinking Water	CWS - Visalia	WELL 14-01	36.335	-119.30782	222	280	Single	X	
5410016-018	Public Drinking Water	CWS - Visalia	WELL 15-01	36.32802	-119.26052	280	334	Single	X	
5410016-023	Public Drinking Water	CWS - Visalia	WELL 19-01	36.31061	-119.28716	192	225	Single	X	
5410016-024	Public Drinking Water	CWS - Visalia	WELL 20-01	36.34502	-119.30138	245	257	Single	X	
5410016-026	Public Drinking Water	CWS - Visalia	WELL 22-01	36.33086	-119.25627	78	300	Single	X	
5410016-027	Public Drinking Water	CWS - Visalia	WELL 23-01	36.30859	-119.31249	196	304	Both	X	
5410016-028	Public Drinking Water	CWS - Visalia	WELL 24-01	36.33842	-119.27757	198	275	Single	X	
5410016-029	Public Drinking Water	CWS - Visalia	WELL 25-01	36.32263	-119.33147	274	282	Upper	X	
5410016-030	Public Drinking Water	CWS - Visalia	WELL 26-01	36.32649	-119.32533	269	373	Both	X	
5410016-031	Public Drinking Water	CWS - Visalia	WELL 27-01	36.31444	-119.29889	175	328	Both	X	
5410016-035	Public Drinking Water	CWS - Visalia	WELL 30-01	36.33112	-119.27397	130	330	Single	X	

Well ID	Well Type	System Name	Well Name	Latitude	Longitude	Top of Screen (feet bgs)	Bottom of Screen (feet bgs)	Aquifer System	Type of Threshold	
									Public Drinking Water	Agricultural
5410016-036	Public Drinking Water	CWS - Visalia	WELL 31-01	36.30212	-119.30928	208	245	Upper	X	
5410016-037	Public Drinking Water	CWS - Visalia	WELL 32-01	36.30652	-119.31853	119	257	Upper	X	
5410016-040	Public Drinking Water	CWS - Visalia	WELL 34-01	36.29796	-119.29742	120	250	Upper	X	
5410016-043	Public Drinking Water	CWS - Visalia	WELL 36-01	36.35028	-119.29544	120	282	Single	X	
5410016-044	Public Drinking Water	CWS - Visalia	WELL 37-01	36.33424	-119.32651	150	290	Upper	X	
5410016-045	Public Drinking Water	CWS - Visalia	WELL 38-01	36.33076	-119.35002	175	295	Both	X	
5410016-046	Public Drinking Water	CWS - Visalia	WELL 39-01	36.31612	-119.34474	190	310	Both	X	
5410016-047	Public Drinking Water	CWS - Visalia	WELL 40-01	36.31607	-119.33142	96	192	Upper	X	
5410016-048	Public Drinking Water	CWS - Visalia	WELL 41-01	36.30235	-119.31605	148	296	Both	X	
5410016-053	Public Drinking Water	CWS - Visalia	WELL 45-01	36.30588	-119.3006	150	280	Upper	X	
5410016-054	Public Drinking Water	CWS - Visalia	WELL 46-01	36.33605	-119.33569	170	300	Both	X	
5410016-055	Public Drinking Water	CWS - Visalia	WELL 47-01	36.30344	-119.33124	168	292	Upper	X	
5410016-056	Public Drinking Water	CWS - Visalia	WELL 48-01	36.34657	-119.31396	200	330	Single	X	
5410016-057	Public Drinking Water	CWS - Visalia	WELL 49-01	36.31316	-119.26975	160	290	Single	X	
5410016-058	Public Drinking Water	CWS - Visalia	WELL 50-01	36.3455	-119.26326	150	270	Single	X	
5410016-059	Public Drinking Water	CWS - Visalia	WELL 51-01	36.31173	-119.35196	160	286	Upper	X	
5410016-060	Public Drinking Water	CWS - Visalia	WELL 52-01	36.27095	-119.31122	180	300	Both	X	
5410016-061	Public Drinking Water	CWS - Visalia	WELL 53-01	36.34706	-119.27199	190	300	Single	X	
5410016-064	Public Drinking Water	CWS - Visalia	WELL 56-01	36.34804	-119.28745	280	420	Single	X	
5410016-065	Public Drinking Water	CWS - Visalia	WELL 57-01	36.31764	-119.26898	292	350	Single	X	
5410016-066	Public Drinking Water	CWS - Visalia	WELL 57-02	36.31771	-119.26898	252	265	Single	X	
5410016-067	Public Drinking Water	CWS - Visalia	WELL 58-01	36.31889	-119.26785	272	290	Single	X	
5410016-069	Public Drinking Water	CWS - Visalia	WELL 61-01	36.30172	-119.34474	220	440	Both	X	
5410016-070	Public Drinking Water	CWS - Visalia	WELL 62-01	36.31654	-119.26465	200	460	Single	X	
5410016-080	Public Drinking Water	CWS - Visalia	WELL 70-01	36.33315	-119.35828	220	400	Both	X	
5410016-081	Public Drinking Water	CWS - Visalia	WELL 64-01	36.34004	-119.34695	190	400	Both	X	

Well ID	Well Type	System Name	Well Name	Latitude	Longitude	Top of Screen (feet bgs)	Bottom of Screen (feet bgs)	Aquifer System	Type of Threshold	
									Public Drinking Water	Agricultural
5410016-087	Public Drinking Water	CWS - Visalia	WELL 77-01	36.32501	-119.39351	175	355	Both	X	
5410016-089	Public Drinking Water	CWS - Visalia	WELL 72-01	36.33809	-119.25954	280	450	Single	X	
5410016-090	Public Drinking Water	CWS - Visalia	WELL 78-01	36.31296	-119.256	220	250	Single	X	
5410016-091	Public Drinking Water	CWS - Visalia	WELL 79-01	36.35366	-119.31398	180	290	Single	X	
5410016-092	Public Drinking Water	CWS - Visalia	WELL 80-01	36.30502	-119.35831	290	555	Lower	X	
5410016-093	Public Drinking Water	CWS - Visalia	WELL 81-01	36.31938	-119.24915	245	620	Single	X	
5410016-094	Public Drinking Water	CWS - Visalia	WELL 82-01	36.31902	-119.29002	280	450	Single	X	
5410016-098	Public Drinking Water	CWS - Visalia	WELL 91-01	36.35365	-119.2982	180	390	Single	X	
5410016-154	Public Drinking Water	CWS - Visalia	WELL 16-02	36.32956	-119.31309	260	480	Both	X	
5410016-156	Public Drinking Water	CWS - Visalia	WELL 83-01	36.30411	-119.27493	370	680	Single	X	
5410016-158	Public Drinking Water	CWS - Visalia	WELL 93-01	36.34649	-119.34068	NA	NA	Unknown	X	
5410016-159	Public Drinking Water	CWS - Visalia	WELL 60-01	36.27059	-119.2937	NA	NA	Unknown	X	
5410016-166	Public Drinking Water	CWS - Visalia	WELL 55-02	36.29472	-119.32229	196	570	Both	X	
5410016-167	Public Drinking Water	CWS - Visalia	WELL 94-01	36.3567	-119.32098	230	590	Single	X	
5410016-185	Public Drinking Water	CWS - Visalia	WELL 97-01	36.33575	-119.24997	NA	NA	Single	X	
5401033-001	Public Drinking Water	Horizon Nut LLC	WELL 01	36.27279	-119.36578	NA	NA	Unknown	X	
5403074-002	Public Drinking Water	Kraft Heinz Foods Co	WELL 01	36.13242	-119.32923	360	700	Lower	X	
5403074-004	Public Drinking Water	Kraft Heinz Foods Co	WELL 01	36.13016	-119.32604	NA	NA	Unknown	X	
5403146-001	Public Drinking Water	Liberty Elementary School	WELL 01	36.24517	-119.3216	NA	NA	Unknown	X	
5402050-001	Public Drinking Water	Milk Specialties Global	WELL 01	36.33601	-119.31067	NA	NA	Single	X	
5402050-002	Public Drinking Water	Milk Specialties Global	WELL 01	36.33594	-119.31071	NA	NA	Single	X	
5400951-003	Public Drinking Water	Mooney Grove Park	WELL 01	36.27932	-119.30842	NA	NA	Unknown	X	
5400951-004	Public Drinking Water	Mooney Grove Park	WELL 01	36.28044	-119.30818	NA	NA	Unknown	X	
5400713-001	Public Drinking Water	Oak Valley School	WELL 01	36.23272	-119.4201	610	660	Lower	X	
5403217-001	Public Drinking Water	Okieville Highland Acres Mwc	WELL 01	36.2047	-119.4666	NA	NA	Unknown	X	
5402031-001	Public Drinking Water	Preet Market	WELL 01	36.20295	-119.49257	260	300	Both	X	

Well ID	Well Type	System Name	Well Name	Latitude	Longitude	Top of Screen (feet bgs)	Bottom of Screen (feet bgs)	Aquifer System	Type of Threshold	
									Public Drinking Water	Agricultural
5403118-001	Public Drinking Water	Saputo Dairy Food USA	WELL 01	36.21476	-119.34787	240	440	Both	X	
5403208-002	Public Drinking Water	Soults Pump & Equipment Co	WELL 02	36.20312	-119.38544	NA	NA	Unknown	X	
5400880-001	Public Drinking Water	The Lakes Association	WELL 01	36.34482	-119.35018	180	360	Both	X	
5400880-002	Public Drinking Water	The Lakes Association	WELL 02 - South	36.34543	-119.35014	NA	NA	Unknown	X	
5401039-001	Public Drinking Water	Tulare County Civic Center	WELL 01 - AG Bldg.	36.3289	-119.3206	NA	NA	Unknown	X	
5401039-002	Public Drinking Water	Tulare County Civic Center	WELL 02 - Motorpool	36.32847	-119.31827	NA	NA	Unknown	X	
5401039-003	Public Drinking Water	Tulare County Civic Center	WELL 03 - Courthouse	36.32887	-119.31528	NA	NA	Unknown	X	
5410015-001	Public Drinking Water	Tulare, City Of	WELL 01	36.20966	-119.35737	382	520	Lower	X	
5410015-011	Public Drinking Water	Tulare, City Of	WELL 11	36.20363	-119.33155	348	756	Lower	X	
5410015-012	Public Drinking Water	Tulare, City Of	WELL 12	36.21816	-119.35218	312	708	Lower	X	
5410015-013	Public Drinking Water	Tulare, City Of	WELL 13	36.2077	-119.32192	300	700	Lower	X	
5410015-014	Public Drinking Water	Tulare, City Of	WELL 14	36.16261	-119.33796	300	700	Lower	X	
5410015-015	Public Drinking Water	Tulare, City Of	WELL 15	36.22191	-119.31546	300	700	Lower	X	
5410015-017	Public Drinking Water	Tulare, City Of	WELL 17	36.18549	-119.33858	300	396	Lower	X	
5410015-021	Public Drinking Water	Tulare, City Of	WELL 22	36.22403	-119.33683	300	702	Lower	X	
5410015-025	Public Drinking Water	Tulare, City Of	WELL 26	36.21799	-119.37162	300	720	Lower	X	
5410015-026	Public Drinking Water	Tulare, City Of	WELL 27	36.23654	-119.34513	320	720	Lower	X	
5410015-033	Public Drinking Water	Tulare, City Of	WELL 31	36.23258	-119.33051	400	700	Lower	X	
5410015-047	Public Drinking Water	Tulare, City Of	WELL 33	36.20002	-119.37576	321	764	Lower	X	
5410015-048	Public Drinking Water	Tulare, City Of	WELL 34	36.21494	-119.33492	450	663	Lower	X	
5410015-051	Public Drinking Water	Tulare, City Of	WELL 35	36.19635	-119.31145	390	760	Lower	X	
5410015-052	Public Drinking Water	Tulare, City Of	WELL 36	36.24002	-119.32245	320	600	Lower	X	
5410015-055	Public Drinking Water	Tulare, City Of	WELL 37	36.2047	-119.31274	320	680	Lower	X	
5410015-056	Public Drinking Water	Tulare, City Of	WELL 38	36.21622	-119.32173	280	620	Lower	X	
5410015-057	Public Drinking Water	Tulare, City Of	WELL 39	36.23227	-119.32199	320	590	Lower	X	

Well ID	Well Type	System Name	Well Name	Latitude	Longitude	Top of Screen (feet bgs)	Bottom of Screen (feet bgs)	Aquifer System	Type of Threshold	
									Public Drinking Water	Agricultural
5410015-061	Public Drinking Water	Tulare, City Of	WELL 40	36.18542	-119.35347	380	725	Lower	X	
5410015-065	Public Drinking Water	Tulare, City Of	WELL 42	36.18491	-119.3769	310	690	Lower	X	
5410015-073	Public Drinking Water	Tulare, City Of	WELL 45	36.20433	-119.34884	NA	NA	Unknown	X	
5410015-075	Public Drinking Water	Tulare, City Of	WELL 46	36.22436	-119.35128	NA	NA	Unknown	X	
5410015-077	Public Drinking Water	Tulare, City Of	WELL 47	36.24399	-119.31532	NA	NA	Unknown	X	
5400795-001	Public Drinking Water	Waukena Elementary School	WELL 01	36.13611	-119.5104	NA	NA	Unknown	X	
5402030-002	Public Drinking Water	Waukena Market	WELL 02	36.13826	-119.51044	NA	NA	Unknown	X	
NA	Monitoring	Tulare Irrigation District	KSB-1408s[1]	36.26165	-119.39435	80	200	Upper		X
NA	Monitoring	Tulare Irrigation District	KSB-1408d[2]	36.26165	-119.39435	230	490	Lower		X
NA	Monitoring	Tulare Irrigation District	KSB-1545s[1]	36.26204	-119.36237	80	255	Upper		X
NA	Monitoring	Tulare Irrigation District	KSB-1545d[2]	36.26204	-119.36237	340	450	Lower		X
NA	Monitoring	Tulare Irrigation District	KSB-1536s[1]	36.23973	-119.36606	80	250	Upper		X
NA	Monitoring	Tulare Irrigation District	KSB-1536d[2]	36.23973	-119.36606	350-420	500-540	Lower		X
NA	Monitoring	Tulare Irrigation District	KSB-1320s[1]	36.21066	-119.41640	80	250	Upper		X
NA	Monitoring	Tulare Irrigation District	KSB-1320d[2]	36.21066	-119.41640	330	540	Lower		X

NOTES:
[1] “s" designates shallow meaning this monitoring wells is screened above the corcoran clay
[2] "d" designates deep meaning this well is screened below the Corcoran clay

4.10 Monitoring Network Improvement Plan

4.10.1 *Data Gaps*

The following section describes data gaps for groundwater elevations and storage, groundwater quality, and land subsidence.

4.10.1.1 Groundwater Elevation and Storage 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. 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 five-year update.

4.10.1.2 Groundwater Quality Data Gaps

Groundwater quality information is currently collected for public water systems, primarily Visalia and Tulare. The groundwater quality 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. DWR will be constructing new multilevel monitoring wells at the locations shown on **Figure 4-7** (at the end of this Section) as part of their Technical Support Services program. These wells will be used for both groundwater level and quality monitoring.

4.10.1.3 Land Subsidence Data Gaps

For the preparation of this initial plan, MKGSA lacked sufficient data to effectively correlate changes in groundwater levels within the MKGSA with historical land surface subsidence. This was problematic in developing accurate projections of potential future subsidence that may occur during the implementation period. Additionally, there was not sufficient data to find a good correlation between pumping and land surface subsidence. The implementation of KDWCD's Land Surface Elevation Monitoring Plan will provide additional data for future subsidence monitoring and evaluation of Sustainability Indicators. The MKGSA will explore other options for a secondary data source, especially where surface infrastructure in the southwestern portion of the subbasin could be affected.

Section 4 – Monitoring Networks

The development of this MKGSA Monitoring Networks Section was informed by DWR's Monitoring Protocols Standards and Sites BMP and Monitoring Networks and Identification of Data Gaps BMP. These documents are provided in **Appendix 4D**.

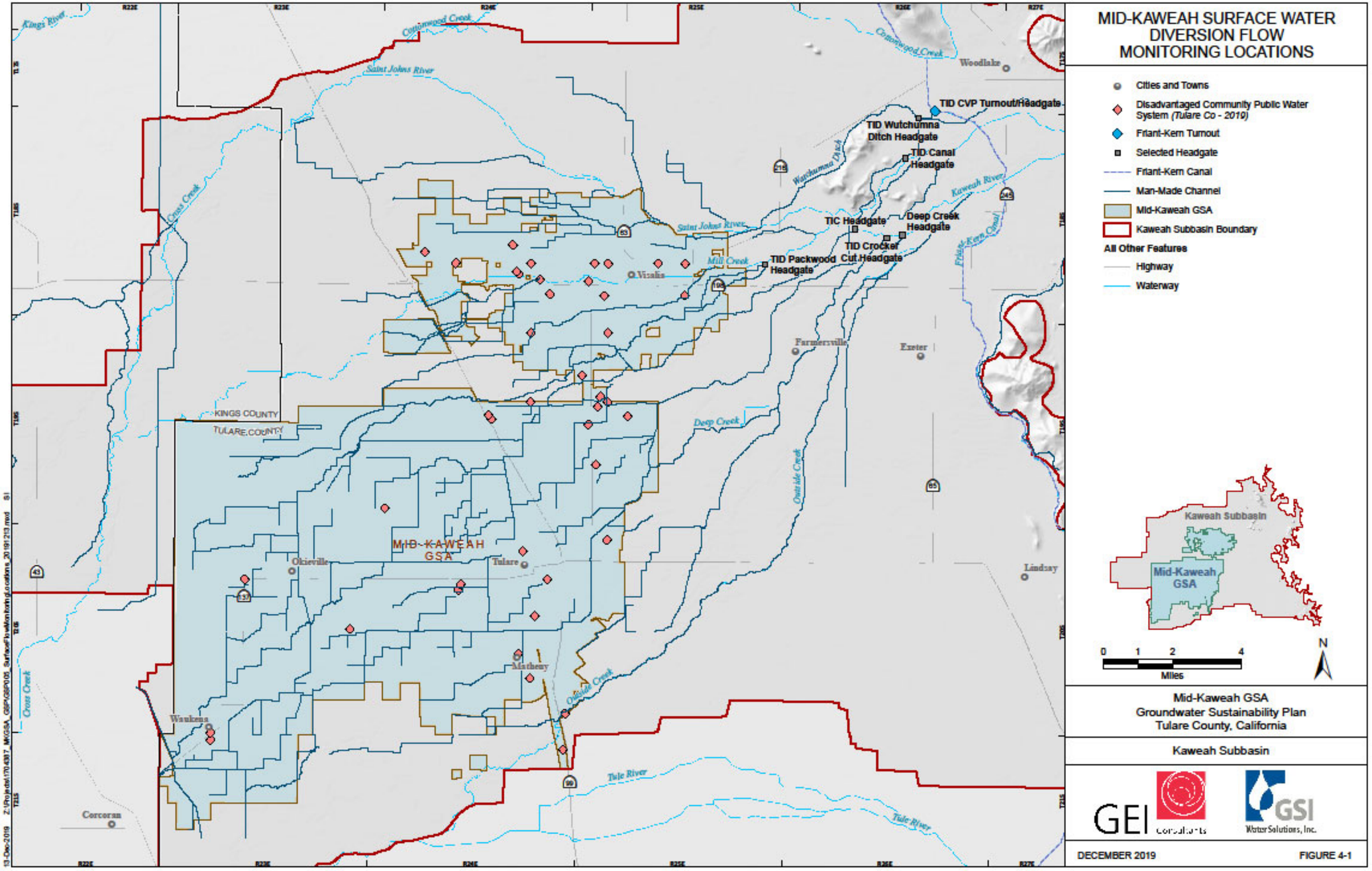


Figure 4-1: Surface Water Diversion Flow Monitoring Locations

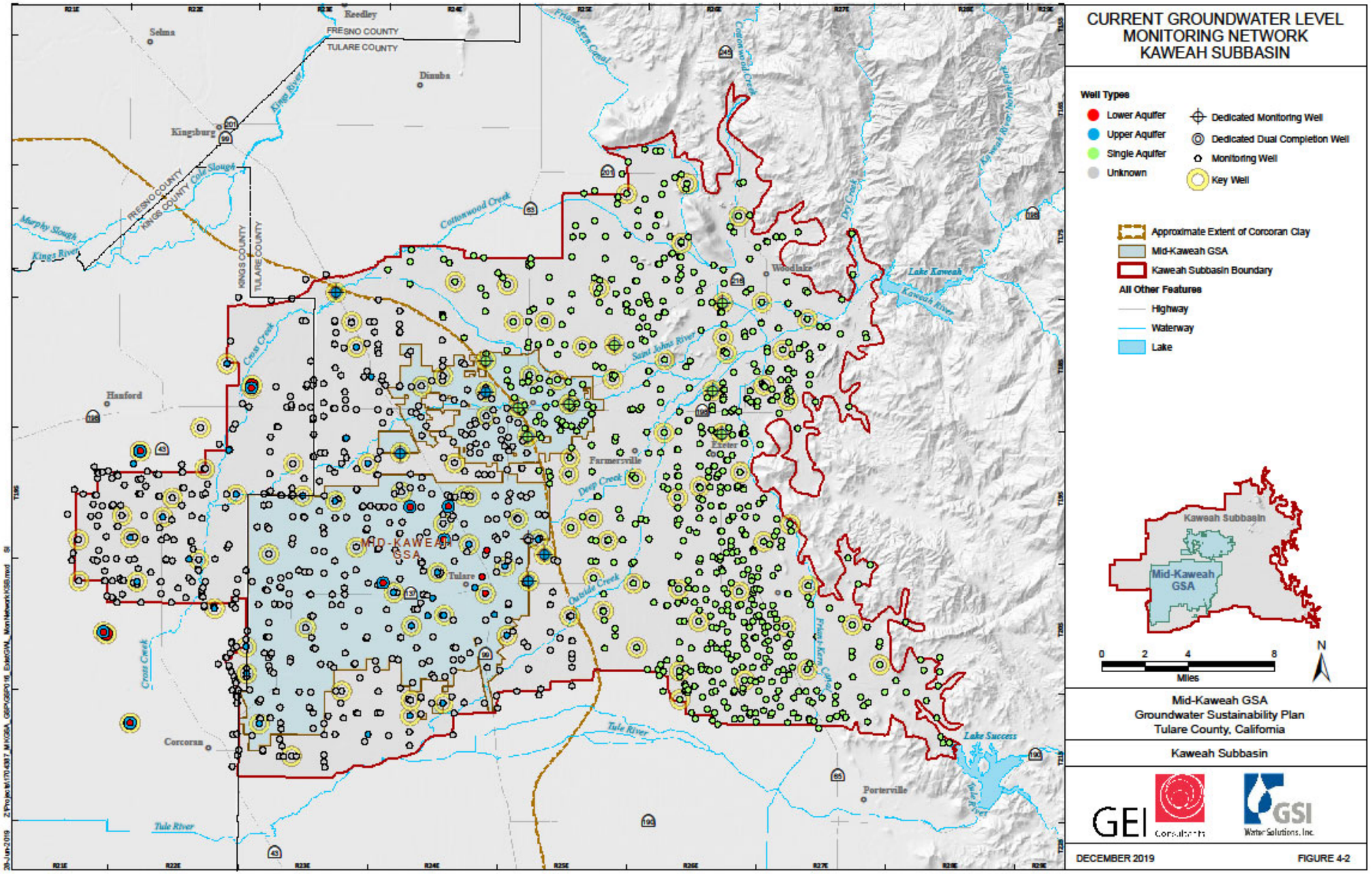


Figure 4-2: Current Groundwater Level monitoring network for Kaweah Subbasin

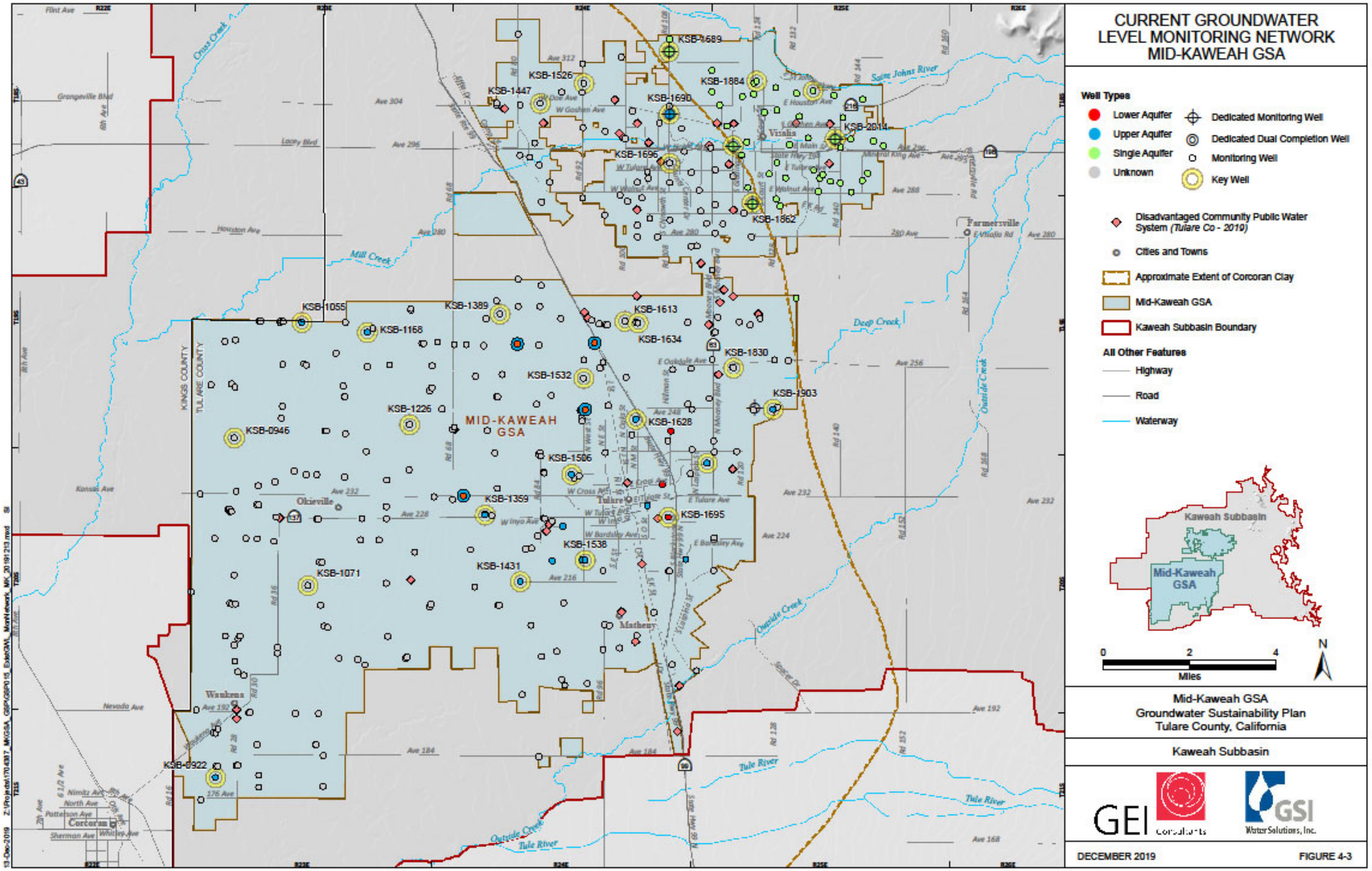


Figure 4-3: Current Groundwater Level monitoring network for MKGSA

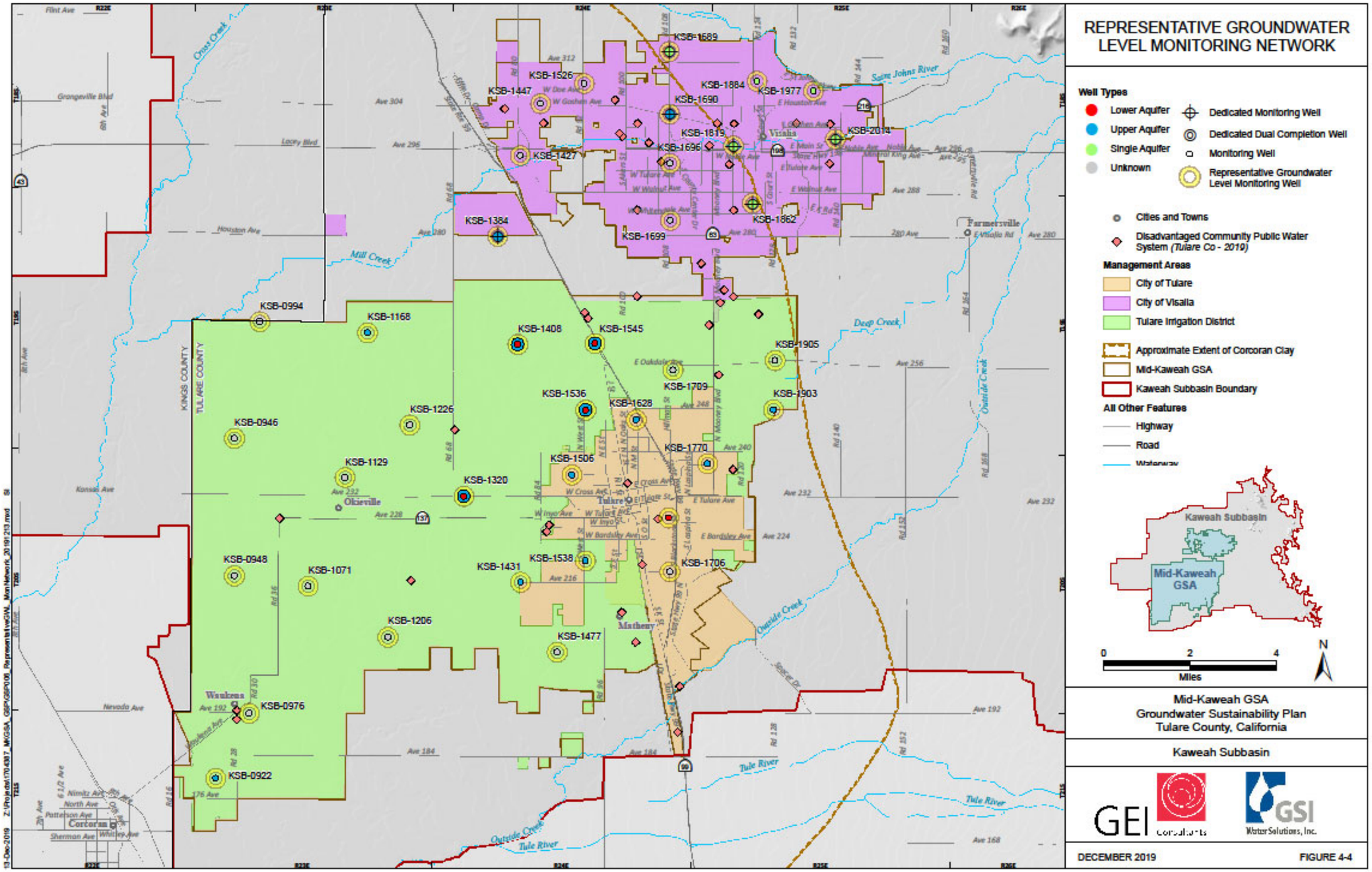


Figure 4-4: Representative Groundwater Level monitoring network

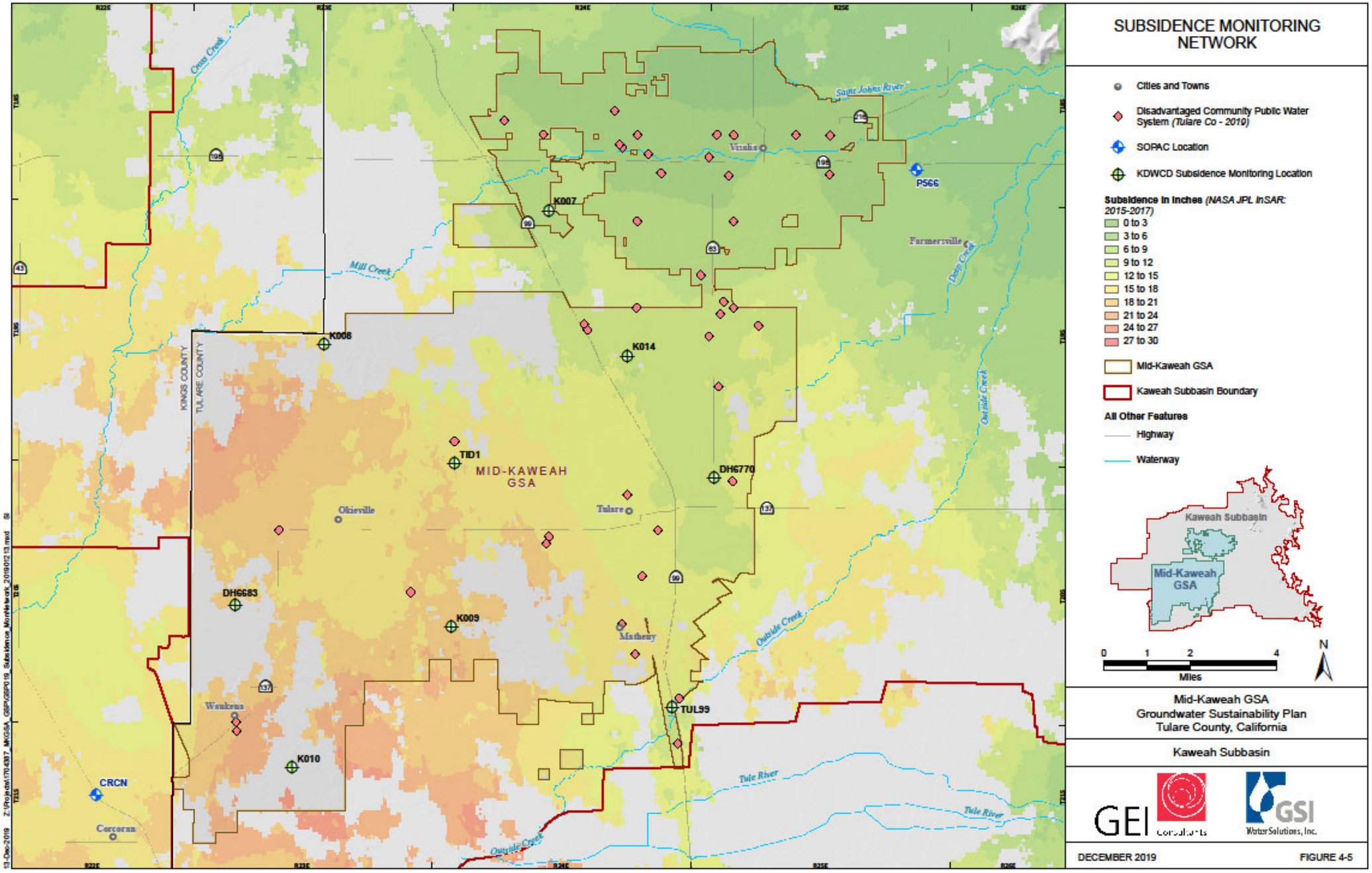


Figure 4-5: Subsidence monitoring network

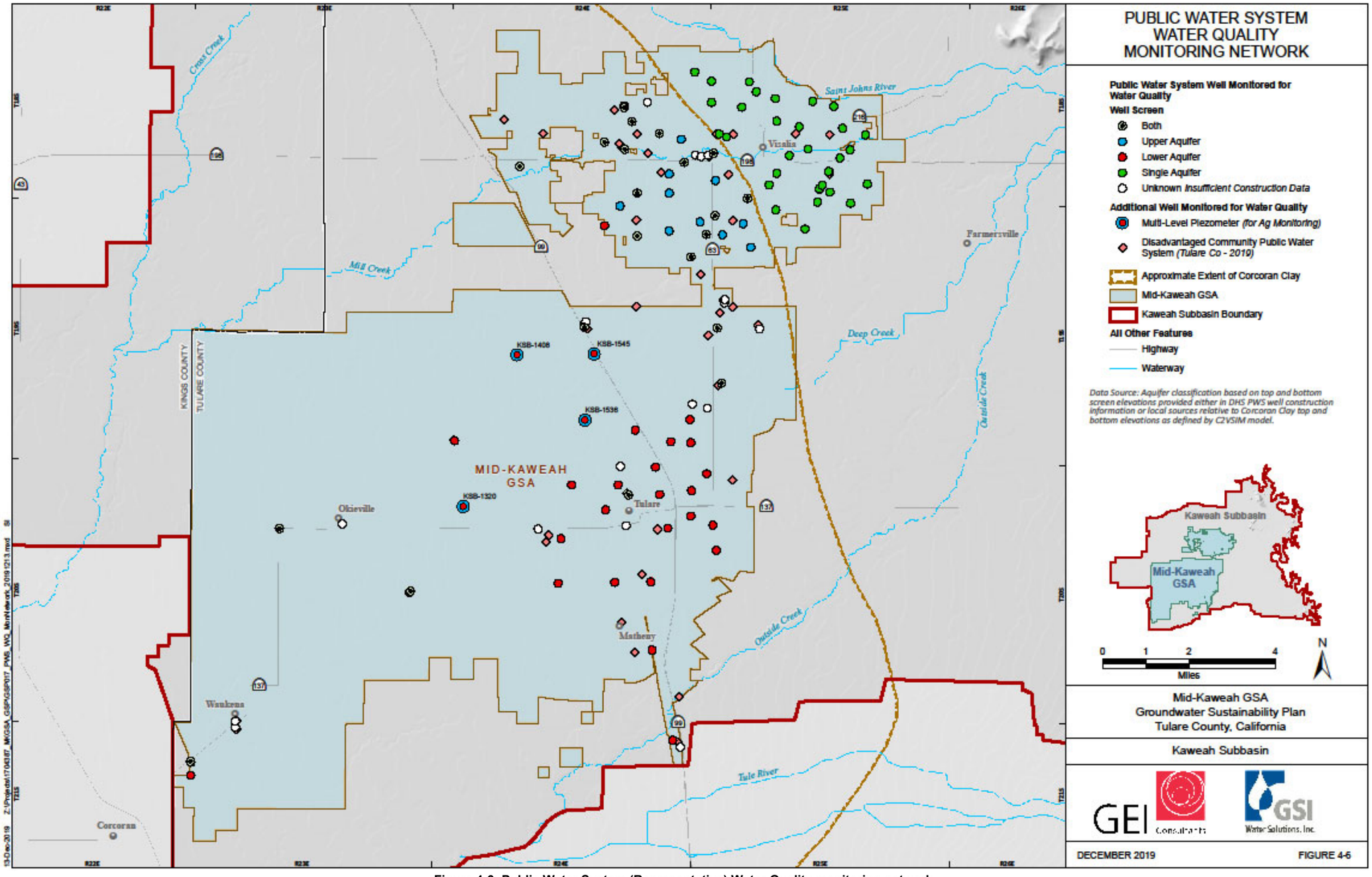


Figure 4-6: Public Water System (Representative) Water Quality monitoring network

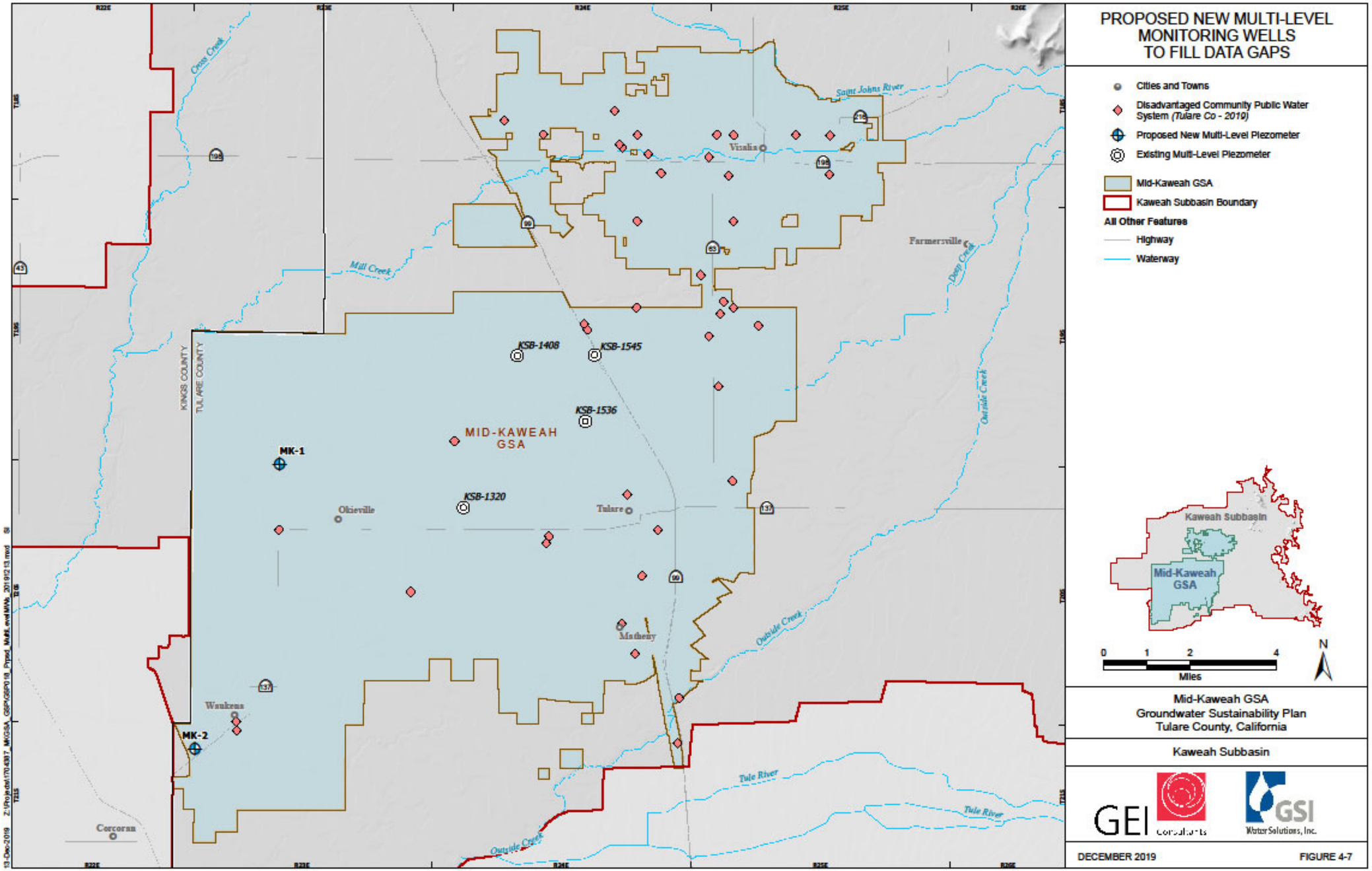


Figure 4-7: Proposed New Multilevel Monitoring Wells to Fill Data Gaps

5. SMC – Minimum Thresholds, Measurable Objectives

5.1 Introduction

Section 5 discusses the general approach taken in setting GSA-specific sustainable management criteria (SMC), establishes minimum thresholds and measurable objectives with interim milestones, and describes mutual influences between neighboring GSAs during GSP implementation. This section builds upon the Subbasin-scale SMC components presented earlier with Section 3: the sustainability goal and a complete listing of undesirable results, including their causes, criteria and effects on uses and users.

5.2 General Approach

As described later in this Section, MKGSA identified minimum thresholds, based on groundwater level (hereinafter "water level" or "level") trends, that would otherwise occur during SGMA's 20-year implementation phase devoid of any GSP projects and management actions. This was accomplished by first evaluated trends through areas or zones of the MKGSA that had similar hydrogeology characteristics. A technical overview of the application of hydrogeologic zones for the development of groundwater level minimum thresholds is provided in **Appendix 5A**. The impact of dewatering wells based on the average threshold levels across the hydrogeologic zones is provided in **Appendix 5C**. The results of well impacts was fully vetted in numerous meetings with the MKGSA Advisory Committee and the Board and the general approach to setting thresholds agreed too. This general methodology was then applied to each of the specific wells in the representative groundwater level monitoring network and the results by well are provided in **Appendix 5B**. MKGSA's measurable objectives are similarly established using trend line extrapolations from the empirical data. The six components comprising the basis for and selection of minimum thresholds as identified in §354.28(b) of the Regulations are all addressed in the following subsections. Lastly, the relationship of this GSA's measurable objectives and long-term success in achieving them is discussed in the context of neighboring GSAs in the Subbasin and their respective actions undertaken during GSP implementation.

The metrics and approaches to be employed by MKGSA for the six sustainability indicators are shown in **Table 5-1**:

Table 5-1: Sustainable Management Criteria by Sustainability Indicator

SMC Summary for MKGSA			
Sustainability Indicators	**Minimum Threshold**	**Measurable Objective**	**Optimal Objective [1]**
Water Level Declines	Pre-SGMA floor [2]	2030 Intercept [3]	Water Added (P&MA) [4]
Reduction in Storage	Calculated based on water levels[5]	Calculated based on water levels [5]	Calculated based on water levels [5]
Land Surface Subsidence	Benchmark Surveys	Benchmark Surveys	NA
Water Quality	Ref. other regulators	Ref. other regulators	NA
Seawater Intrusion	Establish non-applicability	Establish non-applicability	NA
Interconnected Surface Waters	Establish non-applicability	Establish non-applicability	NA

[1] Per section 354.30(g) of the GSP Regulations re improving basin conditions
[2] Pre-SGMA floor as determined by representative monitoring sites in Hydrogeologic Zones
[3] 2030 intercept of Pre-SGMA floor projection as determined by representative monitoring sites in GSA
[4] Estimated with the application of numerical model or empirical analysis incorporating projects & mgt. actions
[5] Storage volume changes and associated SMC determined as function of water level changes

5.3 Minimum Thresholds

5.3.1 *Minimum Threshold – Lowered Groundwater Levels*

5.3.1.1 Overview

The minimum thresholds for groundwater levels were determined by identifying undesirable results and then establishing minimum thresholds that would protect against such undesirable results. The minimum thresholds are specific groundwater elevations set at representative monitoring sites. If any of the representative monitoring wells fall below the minimum threshold (MT) groundwater elevation, undesirable results could occur, as discussed further herein.

5.3.1.2 Undesirable Results in MKGSA

SGMA defines undesirable results for groundwater elevations as the:

> *Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.*

Based on this definition, MKGSA worked with its advisory committee and stakeholders to determine which factors would locally constitute a "significant and unreasonable depletion of supply." Coordination with the stakeholder committees of the other Subbasin GSAs culminated in the listing of undesirable results in Section 3 of this Plan. What was evident, from stakeholder input, as the largest impact of declining groundwater levels historically was the dewatering of some wells, forcing homeowners, businesses, farmers, and other groundwater well owners to drill new replacement wells. Based on the well impact analysis described in **Appendix 5C**, the consensus of the MKGSA Advisory Committee was that one-third of the Subbasin's representative monitoring sites exceeding minimum thresholds for water levels would constitute an undesirable result, an approach generally consistent with East and Greater Kaweah GSAs. This consensus was reached with the understanding that these undesirable results are a broad starting point due to the current high level of uncertainty associated with this initial monitoring network (in relation to well construction details, late of information on the exact location, depth and volume of pumping relative to the well network) and will later be refined as uncertainty is reduced and data gaps are filled during GSP implementation. Data gaps and the plans to address them were presented in the Monitoring Network Improvement Plan in Chapter 4 of this GSP.

5.3.1.3 Minimum Thresholds

SGMA requires the minimum threshold for groundwater levels be set by using measured groundwater elevations at representative monitoring sites. Consistent with this requirement, the minimum elevation thresholds in this Plan are set at specific levels beginning with an analysis of four different hydrogeologic zones (**see Appendix 5A**) and the historical groundwater trends in each. The starting value for minimum thresholds at each well is a result of the water level projections for 2040 as described in **Appendix 5A**.

During GSP implementation, pumping costs will rise due to higher lifts and higher energy pricing, but this condition is considered by the MKGSA as a manageable impact that has been occurring for many years and is comparable to inflationary costs experienced by agricultural businesses, municipalities, and small-system and domestic households.

MKGSA concludes that undesirable results will not occur at water levels above these 2040 projections, barring significant and unreasonable impacts on existing wells and freshwater in storage within the Kaweah Subbasin.

Minimum thresholds have been established **for each monitoring well included in the representative groundwater level monitoring program,** presented in Section 4 of the GSP, beginning with the zone analysis described in **Appendix 5A**. For demonstrative purposes, **Figure 5-1** below shows the application of the minimum threshold approach to an individual well (KSB-922) within the MKGSA. **Appendix 5B** includes similar plots for each well for which minimum thresholds have been developed for this Plan. Additional details regarding these plots and their application in establishing measurable objectives is further described in Section 5.4.1.

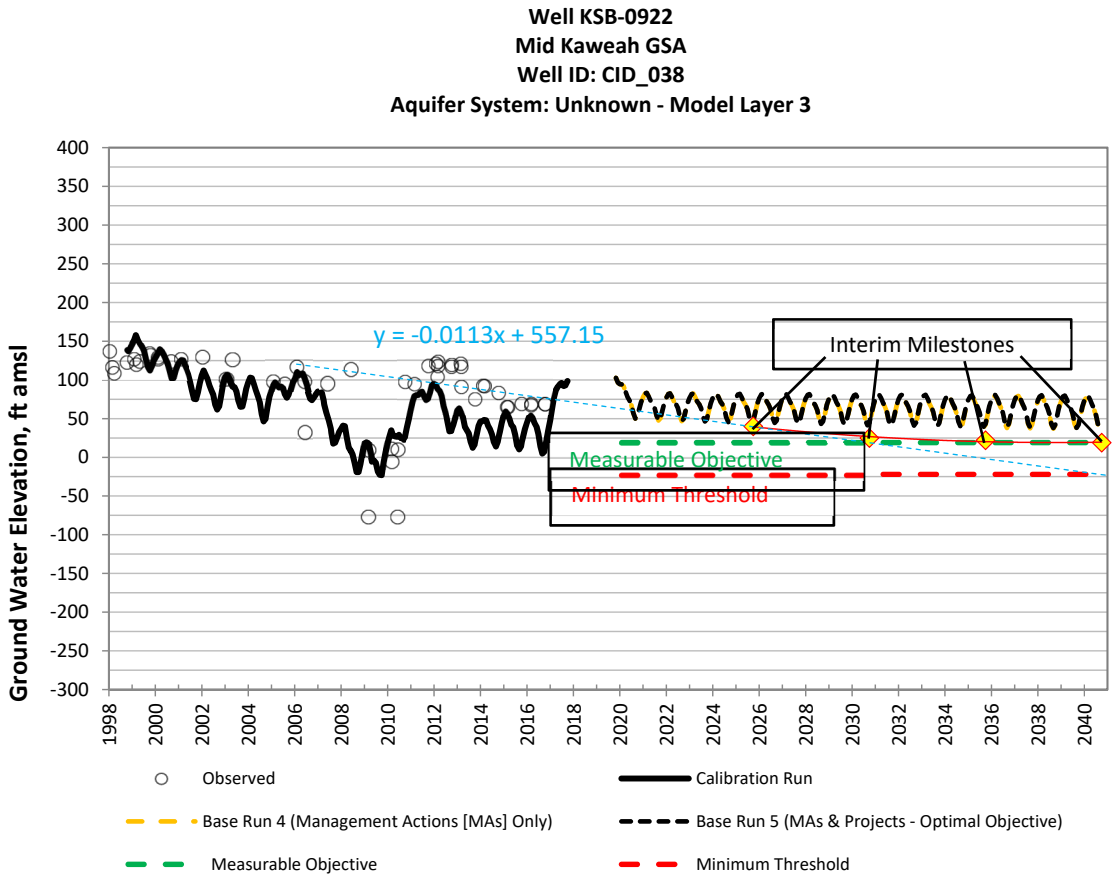


Figure 5-1: Groundwater Level Minimum Thresholds and Measurable Objectives Established at KSB-0922

Table 5-2 summarizes minimum thresholds for wells in the representative groundwater level monitoring network. The minimum thresholds allow MKGSA to implement projects and management actions in a phased approach to allow for SGMA's 20-year time period within which to reach sustainable yield and avoid the occurrence of undesirable results in terms of further chronic lowering of groundwater levels. Accomplishment of projects as gauged by water budget supplementation are identified in Section 7 of this Plan.

There are four multi-level representative monitoring wells for which minimum thresholds could not be established because the wells are new and empirical groundwater level data was not available for the period 2006 to 2016. Because these wells are within MKGSA's representative monitoring program, MKGSA will establish minimum thresholds and measurable objectives at these wells for the 2025 GSP assessment report informed by groundwater level observations at these wells during the first five years of GSP implementation.

There are no known governmental standards in the Tulare County region for water elevations as a sustainability indicator. The GSA intends to rely on the monitoring network as identified in Section 4 of this Plan to measure spring and fall season water levels and to document the same. Principal aquifer layers to be monitored are the unconfined zone above the E-clay layer and the semi-confined layers below.

Table 5-2: Summary of Groundwater Level Sustainable Management Criteria for MKGSA

		Sustainable Management Criteria (fmsl)						
Well ID	**Monitoring Entity**	**Minimum Threshold**	**Measurable Objective**	**Optimal Objective**	**Interim Milestones 2025**	**Interim Milestones 2030**	**Interim Milestones 2035**	**Interim Milestones 2040**
KSB-0922	Tulare Irrigation District	-22	19	41	40	25	22	19
KSB-0946	Tulare Irrigation District	-72	-6	27	30	15	0	-6
KSB-0948	Tulare Irrigation District	-173	-90	88	-50	-65	-80	-90
KSB-0976	Tulare Irrigation District	-141	-65	52	-25	-38	-51	-65
KSB-0994	Tulare Irrigation District	71	93	104	110	100	95	93
KSB-1071	Tulare Irrigation District	-126	-52	18	20	-10	-25	-52
KSB-1129	Tulare Irrigation District	-81	-9	88	55	25	0	-9
KSB-1168	Tulare Irrigation District	30	72	190	110	95	85	72
KSB-1206	Tulare Irrigation District	-20	21	56	50	35	25	21
KSB-1226	Tulare Irrigation District	-101	-17	72	28	10	0	-17
KSB-1320s	Tulare Irrigation District	NA	NA	NA	NA	NA	NA	NA
KSB-1320d	Tulare Irrigation District	NA	NA	NA	NA	NA	NA	NA
KSB-1384	Kaweah Delta Water Conservation District	38	89	135	120	110	100	89
KSB-1408s	Tulare Irrigation District	NA	NA	NA	NA	NA	NA	NA
KSB-1408d	Tulare Irrigation District	NA	NA	NA	NA	NA	NA	NA
KSB-1427	Tulare Irrigation District	33	75	159	110	95	80	75
KSB-1431	Tulare Irrigation District	88	110	149	125	120	117	110
KSB-1447	Tulare Irrigation District	60	96	120	120	110	100	96
KSB-1477	Tulare Irrigation District	60	96	173	120	110	100	96
KSB-1506	Tulare Irrigation District	-39	9	96	35	25	15	9
KSB-1526	Kaweah Delta Water Conservation District	-139	-21	115	35	15	-5	-21

		Sustainable Management Criteria (fmsl)						
Well ID	Monitoring Entity	Minimum Threshold	Measurable Objective	Optimal Objective	Interim Milestones 2025	Interim Milestones 2030	Interim Milestones 2035	Interim Milestones 2040
KSB-1536s	Tulare Irrigation District	NA	NA	NA	NA	NA	NA	NA
KSB-1536d	Tulare Irrigation District	NA	NA	NA	NA	NA	NA	NA
KSB-1538	Tulare Irrigation District	62	83	93	100	90	85	83
KSB-1545s	Tulare Irrigation District	NA	NA	NA	NA	NA	NA	NA
KSB-1545d	Tulare Irrigation District	NA	NA	NA	NA	NA	NA	NA
KSB-1628	Tulare Irrigation District	-92	-21	94	15	0	-15	-21
KSB-1689	City of Tulare	75	130	134	158	145	135	130
KSB-1690	Kaweah Delta Water Conservation District	161	176	NA	180	179	177	176
KSB-1695	City of Tulare	-121	-40	96	0	-15	-25	-40
KSB-1696	City of Visalia (Cal Water)	13	72	112	100	90	80	72
KSB -1699	City of Visalia (Cal Water)	157	167	NA	175	172	160	157
KSB-1706	Tulare Irrigation District	-287	-133	185	-35	-70	-100	-133
KSB-1709	Tulare Irrigation District	-6	55	198	95	75	60	55
KSB-1770	City of Tulare	-41	13	104	35	28	20	13
KSB-1819	Kaweah Delta Water Conservation District	34	101	130	140	125	112	101
KSB-1862	Kaweah Delta Water Conservation District	35	103	129	140	130	115	103
KSB-1884	City of Visalia (Cal Water)	27	98	139	130	125	110	98
KSB-1903	City of Tulare	-43	17	132	48	35	25	17
KSB-1905	Tulare Irrigation District	90	136	193	170	158	146	136
KSB-1977	City of Visalia (Cal Water)	56	121	176	150	135	128	121
KSB-2014	Kaweah Delta Water Conservation District	69	141	162	175	165	150	141

In summary, between 4 percent and 32 percent of the wells in Hydrogeologic Zone 2, where most small-system and domestic wells within MKGSA are located, may experience reduction or loss of production capacity by 2040 if water levels were to continue downward as they have historically.

To establish the minimum threshold for groundwater levels, the GSA's Advisory Committee deliberated over several months to define what constituted an undesirable result. Similar discussions were ongoing among stakeholder committees of the other two Subbasin GSAs (East Kaweah and Greater Kaweah). Committee members investigated the impacts of lowering groundwater levels, and considered the impacts recently experienced in the last historic drought from 2012 to 2016. Some impacts, such as declining groundwater levels causing increases in pumping costs, were deemed to be insignificant as they were viewed by the Committee as typical for public water systems and rural residential homes during drought periods and a nominal increase in the business costs for agriculture.

A small-system and domestic well owner assistance program is described in Section 7.4 of this Plan, which will aid stakeholders as the GSA implements measures over time to achieve sustainable yield by 2040. Stakeholders have been apprised of the threshold-setting process through the GSA's outreach program as articulated in Section 1.5.2 of this Plan, and input to the design of these criteria has been obtained through regular meetings of this GSA's Advisory Committee and the Kaweah Subbasin Management Team Committee.

Importantly, MKGSA will not be managing to these minimum thresholds but, rather, to the measurable objectives established in Section 5.4. The hydrogeologic zone data sets used to study well impacts, which exist for all hydrogeologic zones and also for agricultural and municipal wells, will be considered when identifying the assistance program outlined in Section 7.4.

5.3.2 *Minimum Threshold – Reduction in Storage*

5.3.2.1 Overview

A minimum threshold for reductions in groundwater storage is to be determined as a function of changes in water levels. Water levels are not serving as a proxy for this minimum threshold but, rather, as a means to calculate changes in storage using estimated hydrogeologic parameters.

5.3.2.2 Undesirable Results in MKGSA

SGMA defines undesirable results for groundwater storage as the:

> *"Significant and unreasonable reduction of groundwater storage."*

The Subbasin GSAs have determined that future reductions in groundwater storage by 2040 will not constitute an undesirable result. Fundamental to this conclusion are estimates made by USGS, the WRI reports of the Kaweah Delta WCD, and the Basin Setting information in Section 2 of this Plan that a volume of fresh water in storage currently exists in the range of 15 to 30 MAF within the Subbasin. At an average overdraft rate of 78 TAF per year for the water budget (current conditions) expressed in Section 2, many years of productive capacity remain, well beyond 2040 or even the full

planning and implementation horizon out to 2070. It is understood that this historic trend, should it continue further in time, would result in some sustainability indicators, such as land subsidence or possibly water quality, to exhibit undesirable results. However, adherence to the measurable objectives established in Section 5.4 should prevent such occurrences.

Nevertheless, a minimum threshold for storage is determined herein by direct correlation to changes in water levels over time. The water-level sustainability indicator is used as the driver for calculated changes in groundwater storage. As such, when one-third of the Subbasin representative monitoring sites for water levels exceed their respective minimum thresholds, an undesirable result for storage will be deemed to occur. This threshold will aid in tracking the performance of future recharge projects and effectiveness of future management actions.

5.3.2.3 Minimum Threshold

MKGSA incorporates the use of water levels as a means to estimate the reduction in groundwater storage over time. The specific metrics to be applied for storage changes (additions or reductions) will be acre-feet per year and estimated groundwater in storage above the minimum threshold groundwater levels, or floor. **Figure 5-2** shows the minimum threshold volume as zero on the vertical axis. This zero value represents a loss of 1.59 MAF of storage over the 2017 condition, well below the total storage estimate (15-30 MAF) sited earlier in this section.

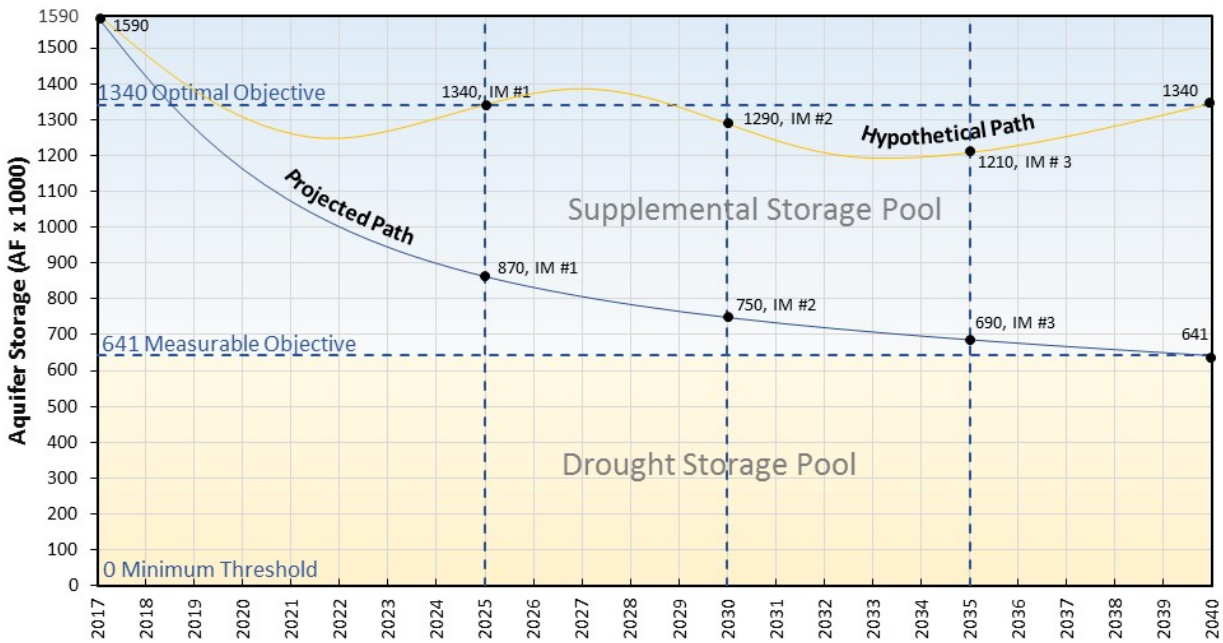


Figure 5-2: MKGSA Groundwater Storage Sustainable Management Criteria

Each year, storage changes will be calculated from changes in water levels for the representative wells within the MKGSA and then by computing volumetric changes between potentiometric surfaces, corrected for specific yield estimates for the aquifer material between these surfaces. As an annual cross-check on this determination, the MKGSA will also track storage changes using the water budget inventory method using the same methodology described in the Basin Setting Report

(**Appendix 2A**) and adding another year of data onto the MKGSA-specific water budget summary presented in Section 2 of this Plan each year during development of the annual report.

For the development of a minimum threshold for reduction in storage, the MKGSA did the following:

Prepared a 2017 groundwater elevation map of the MKGSA representing "current conditions"

Prepared a projected 2040 groundwater elevation map of MKGSA by contouring the projected groundwater level minimum thresholds for each representative monitoring well

Calculated the total volume between the two surfaces described above

Multiplied total volume by specific yield

The result of this analysis shows that, as of Spring 2017, the MKGSA had 1.59 MAF in aquifer storage above the minimum threshold groundwater levels. Using this information, each year **Figure 5-2** will be updated to show the total groundwater in storage within the MKGSA above the minimum threshold floor. This threshold applies in monolithic fashion across the GSA and is not established at each representative monitoring site as with water level minimum thresholds.

There are no known governmental standards in the Tulare County region for groundwater storage volumes as a sustainability indicator. The base of fresh water within the Subbasin is not definitively known, as existing wells have historically been drilled to depths well above the presumed base.

5.3.3 *Minimum Threshold– Degraded Water Quality*

5.3.3.1 Overview

Groundwater quality is currently regulated by multiple state and local governmental agencies. Water quality objectives and the enforcement of these objectives is the responsibility of the State Water Resources Control Board (SWRCB), the Division of Drinking Water, and the Central Valley Regional Water Quality Control Board. The SWRCB and these supporting agencies all enforce Federal Environmental Protection Agency (EPA) water quality standards for both surface and groundwater. There are also agricultural suitability standards (Agricultural Water Quality Objectives as referenced herein) for water quality protection of agriculture that require irrigation water standards by crop type. SGMA does not provide the MKGSA with the regulatory tools or authority to enforce water quality violations or otherwise take abatement actions. Rather, MKGSA is charged with avoiding the degradation of water quality and the migration of contaminant plumes.

In order to comply with the SGMA requirements, the MKGSA supports the protection of groundwater quality by coordinating with agencies and programs such as those listed above that are already established to maintain and improve the groundwater quality in the Kaweah Subbasin. All future projects and management actions implemented by the MKGSA will be designed to avoid causing further groundwater quality degradation. The avoidance of groundwater quality degradation

will be supported by groundwater sampling and reports demonstrating the conditions pre-SGMA and any changes in groundwater quality that occur through the period 2020 to 2040.

5.3.3.2 Undesirable Results in MKGSA

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. MKGSA 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 MKGSA will also avoid degradation above the Agricultural Water Quality Objectives (Ag WQO) presented and described in the Basin Setting report (**Appendix 2A**).

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. MKGSA'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, is provided as **Appendix 3A**. MCLs change as new rules are promulgated by the Federal EPA and SWRCB. MKGSA will provide updates including the addition of any new constituents in its five-year GSP assessments.

5.3.3.3 Minimum Thresholds

The minimum thresholds shall be set at the MCLs or the Agricultural WQOs, whichever is applicable at the representative monitoring site. As summary of constituents to be monitored and tracked by the MKGSA is provided as **Table 5-3.**

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 MKGSA.
- 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.
- The above assistance programs are as summarized in Section 7.4 of this Plan.

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.

Table 5-3 MKGSA Groundwater Quality Constituent List, Minimum Thresholds and Measurable Objectives.

Type	Constituent	Minimum Threshold		Measurable Objective	
Public Drinking Water	As	10	ug/L	7.5	ug/L
	NO_3 (as N)	10	mg/L	7.5	mg/L
	Cr-VI	(10) [1]	ug/L	(7.5) [1]	ug/L
	DBCP	0.2	ug/L	0.15	ug/L
	TCP	0.005	ug/L	0.0038	ug/L
	PCE	5	ug/L	3.8	ug/L
	ClO_4	6	ug/L	4.5	ug/L
	Na	no drinking water MCL		no drinking water MCL	
	Cl	500 [2]	mg/L	375	mg/L
	TDS	1000 [2]	mg/L	750	mg/L
Agricultural [3]	pH (upper)	8.4	pH units	7.9 [4]	pH units
	pH (lower)	6.5	pH units	7.0 [4]	pH units
	Conductivity	700	uS/cm	525	uS/cm
	TDS	450	mg/L	338	mg/L
	Boron	700	ug/L	525	ug/L
	Ca	No established Ag Water Quality Goal		No established Ag Water Quality Goal	
	Mg	No established Ag Water Quality Goal		No established Ag Water Quality Goal	
	Na	69	mg/L	52	mg/L
	K	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	
	Cl	106	mg/L	80	mg/L
	NO_3 (as N)	No established Ag Water Quality Goal		No established Ag Water Quality Goal	
	SO_4 (as SO4)	No established Ag Water Quality Goal		No established Ag Water Quality Goal	

[1] As of the date of adoption of this document, there is no MCL for Hexavalent Chromium. The previously established MCL of 10 ug/l was invalidated (redacted) in 2017. The state water resources control board is currently working to re-establish an MCL. Once the MCL is re-established, the MCL will become the Minimum Threshold. In the meantime, Hexavalent Chromium will continue to be monitored and tracked by the Mid Kaweah GSA as data is available, but no Minimum Threshold will be enforced.

[2] 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 Minimum Thresholds use the upper limit of consumer acceptance MCL.

[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/

[4] Measurable Objective for pH calculated as 75% of the difference between the upper and lower Ag Water Quality goals.

The groundwater quality monitoring network is presented in Section 4 of this Plan.

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 MKGSA is not responsible for remediating. However, MKGSA will work cooperatively with water quality agencies charged with addressing these conditions.

As described in Section 4, MKGSA 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. MKGSA 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 as addressed in Section 5.4.3.

5.3.4 *Minimum Threshold – Land Subsidence*

5.3.4.1 Overview

The metric to be applied for land subsidence will be expressed as a rate of annual decline in land surface elevation measured in feet or inches. Land subsidence will be measured from the representative land subsidence monitoring network shown on **Figure 4-5** and, as such, the minimum thresholds values are different for each monitoring location.

While the basin setting and other reference information in the plan relates subsidence to water levels, in evaluating historic field-measured groundwater elevation data with field-measured subsidence data, an acceptable correlation was not evident. Such a technically defensible correlation was intended for the purpose of estimating the magnitude of future subsidence if groundwater levels were ever to reach minimum thresholds throughout the Subbasin. It was notable that an acceptable correlation did not emerge, since the mechanism for subsidence is declining groundwater levels below historic lows and the associated compaction of clay units in response to the reduction in pore pressure. We believe the inability to establish this correlation stems from a high level of uncertainty due to:

Incomplete subsidence records from existing monitoring stations.

Insufficient number of subsidence monitoring stations.

Complete lack of pumping records by well. In some cases, pumping estimates were available by management area, but in most cases, there was no pumping data by well by year.

Insufficient well construction information to correlate pumping depth with observed subsidence.

These causes represent significant data gaps that will be filled through management actions during Plan implementation.

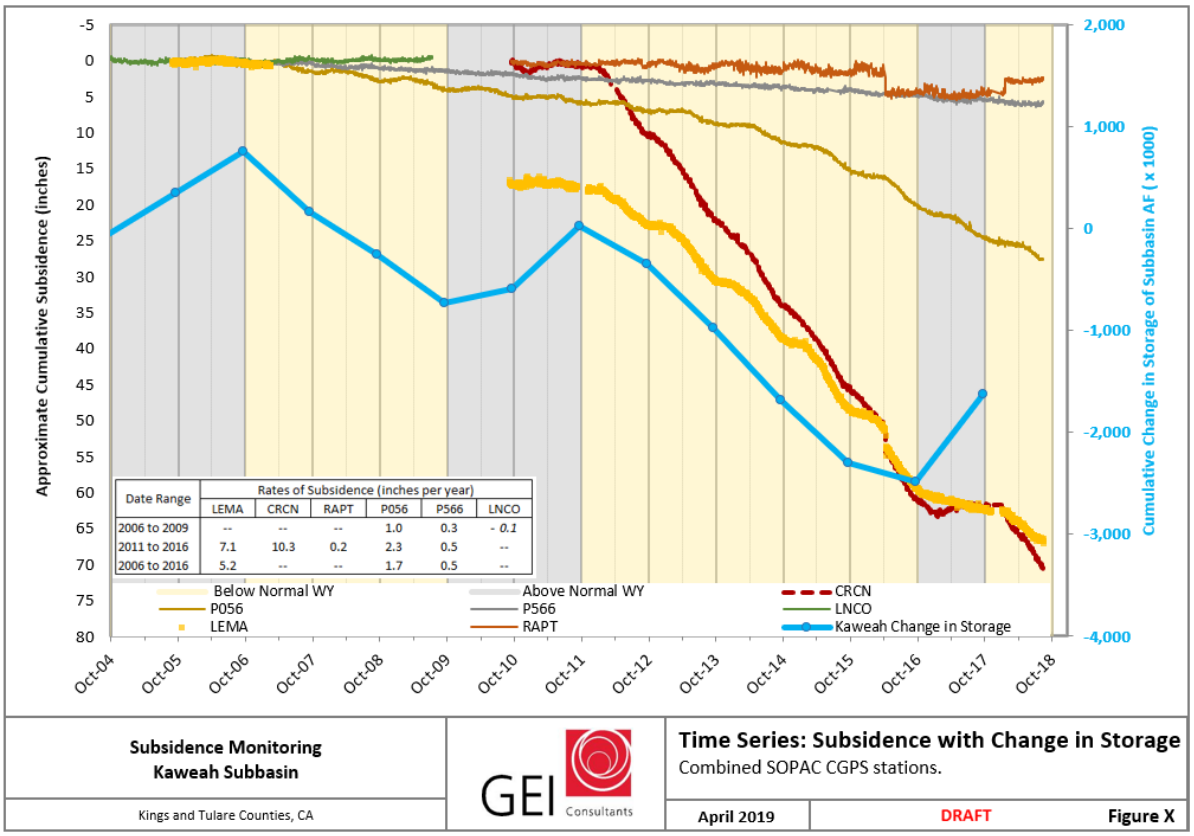
Subsidence occurs in areas underlain by aquifers interbedded with clay layers and/or by notable aquitards between aquifers due to the compaction of the clays when groundwater levels decline significantly. During these periods of decline, groundwater stored in the clays moves into the

aquifer to compensate for the loss of groundwater storage in the aquifer. **Figure 5-3** shows the relationship between cumulative subsidence at the CRCN GPS station, located just west of the Subbasin in Corcoran, and cumulative groundwater storage within the Subbasin between October 2009 and September 2018.

The figure shows that subsidence was minimal at CRCN (dotted red line) during the above-normal water year (WY) of 2011 but began a relatively steep and steady decline midway through the next year (2012) and continued for the next four years (2013 to 2016, inclusive). This decline coincided with the historic five-year drought and averaged about 12 inches per year (range: 9.5 to 15.4 inches per year). Subsidence stabilized during the above-normal WY of 2017 but continued at a rate similar (13.7 inches per year) to the drought period during much of the below-normal WY of 2018.

The figure shows that groundwater storage (blue line with annual dots) increased during the above-normal WYs of 2010, 2011, and 2017 but decreased during the five-year drought period due to less surface water for irrigation and recharge and greater pumping from groundwater storage, specifically in the confined aquifer below the Corcoran Clay.

The P566 GPS station is located within the northeastern area of the Subbasin, on the east side of the MKGSA area, and this station shows a relatively small rate of subsidence (0.5 inches per year) that is steady regardless of above- or below-normal WY conditions. This location is east of the Corcoran Clay area and may be affected by groundwater production or could represent a 'background' level of downward movement due to tectonic forces.



Date Range	Rates of Subsidence (inches per year)					
	LEMA	CRCN	RAPT	P056	P566	LNCO
2006 to 2009	--	--	--	1.0	0.3	- 0.1
2011 to 2016	7.1	10.3	0.2	2.3	0.5	--
2006 to 2016	5.2	--	--	1.7	0.5	--

Figure 5-3: Relationship between Kaweah Basin Storage Change and Subsidence

5.3.4.2 Undesirable Results in MKGSA

SGMA defines unreasonable results for land subsidence as the:

> *"Significant and unreasonable land subsidence that substantially interferes with surface land uses."*

While land subsidence has been occurring within the southwestern portion of the Subbasin, substantial interference with surface land uses are not currently known to occur.

Potential subsidence values were distributed across the western and central portions of the Subbasin (underlain by Corcoran Clay) by interpolating values between CRCN and P566 (7.2 and 1.0 inches per year, respectively) and then projecting values laterally northwest and southeast to the KDWCD subsidence monitoring stations (right-angle projections from interpolation line).

Infrastructure damage as the result of subsidence in the region has occurred to the south of the Kaweah Subbasin in the Tule Subbasin. The Kaweah GSAs have been coordinating with Tule Subbasin representatives and, as a result of these discussions, the cause of damage to the Friant-Kern Canal near Terra Bella appears to primarily be localized pumping proximate to the Canal. Significant and unreasonable infrastructure damage in the western area of the Kaweah Subbasin, including MKGSA, has not been reported.

Subsidence becomes a land-surface problem when it is differential in nature i.e., elevation shifts across the areal extent of infrastructure deemed of high importance. For example, subsidence linearly along a major highway is manageable if gradual in its occurrence. In contrast, localized subsidence traversing across a highway, if sizable, would cause major cracking of the pavement surface and become a significant hazard to vehicles. The same comparisons may be made for other infrastructure as well. For this reason, whether an undesirable result occurs with the exceedance of a minimum threshold will be a determination made within MKGSA and perhaps individual Management Areas within. With such an exceedance, GSA representatives will reach out and inquire as to any infrastructure damages which may be occurring to determine a corrective course of action if deemed necessary. The primary criteria and metric will be the annual rate of reduction in land surface elevation and areal extent of such elevation changes. An undesirable result will occur when one-third of the Subbasin's subsidence monitoring sites exceed their respective minimum thresholds.

A broad areal extent of land subsidence thus may not be of major concern, with the exception of the associated loss of aquifer system water storage capacity. However, the large volume of dewatered space currently existing is deemed by MKGSA as more than sufficient to accept additional recharge water as planned with new projects during GSP implementation.

5.3.4.3 Minimum Thresholds

Using the correlation established by evaluating the data presented on **Figure 5-3**, an estimate of future subsidence was calculated. Groundwater levels were utilized from nearly 80 wells throughout the basin, located in hydrologic zones 1 through 9, for the time period of 2006 to 2016 (11 years) for the calculation. The trends of the fall elevation values were projected through 2040 and resulted in a

potentiometric surface that was subtracted from the potentiometric surface for 2017. The volume of groundwater within these surfaces was estimated to be four million acre-feet based on the specific yield data from the groundwater model (average: 8 percent). The withdrawal of this volume of groundwater during the implementation period would result in an additional 87 inches of subsidence at CRCN or 3.6 inches per year (average) which is considerably less than what occurred during the recent drought period, which was approximately 12 inches.

Due to the uncertainties in understanding of subsidence MKGSA, in consultation with the GSA managers in the Subbasin, elected to add an uncertainty factor of 100% from the calculations above to arrive at the minimum thresholds. The resulting subsidence rates more closely reflect those that have been occurring in southwestern area in the recent past. The results of this analysis are shown on **Figure 5-4** which provides the minimum thresholds in both rate and total subsidence estimates at each of the 9 representative monitoring stations in the MKGSA. The minimum thresholds were developed with the understanding that subsidence will stabilize throughout GSP implementation but will continue to occur until groundwater storage stabilizes at the end of our 20 year implementation period at or just before 2040, unless we experience wetter than normal hydrogeology, in which case groundwater levels would stabilize earlier in the implementation period, thus stabilizing land surface subsidence earlier.

There are no known governmental standards in the Tulare County region for differential land subsidence rates or areal extent as a Sustainability Indicator. Any such regulatory standards would need to be specific as to the type and importance of surface infrastructure under consideration.

5.3.5 *Minimum Thresholds – Interconnected Surface Waters*

The MKGSA jurisdictional area is located on the valley floor portion of the Subbasin, many miles west of the aquifer forebay area along the Sierra foothills. As such, all reaches of the Kaweah River, slough channels, and distributaries, both natural and man-made, have been disconnected from the underlying water table for many decades and current depth to groundwater in the upper principal aquifer is 60 to 220 feet bgs in the MKGSA as presented in Section 2 of this document and in the Kaweah Subbasin Report (**Appendix 2A**)For this reason, there are no interconnected surface waters in the MKGSA management area and such interconnection is not likely to occur in the future.

MKGSA reviewed the "Natural Community Dataset Viewer" maps for the Kaweah Subbasin to evaluate the possibility of whether groundwater dependent ecosystems could exist in the MKGSA management area. The mapping system identifies stream reaches supporting habitat that *may* rely on groundwater. Collections of Valley Oak and Cottonwood populate some reaches of the St. Johns River, which traverses along the northern boundary of the City of Visalia. The same habitat species reside along reaches of Mill Creek and Packwood Creek, which traverse through Visalia and to the southwest into Tulare ID in the case of Packwood. Certain reaches of the St. Johns River are indicated to be wetlands of the type "Palustrine, Scrub-Shrub, Seasonally Flooded." However, this river (the northern fork of the Kaweah River) carries water primarily during releases from Terminus Dam at Lake Kaweah, and flows occur on an average of four to five months annually within this river channel as well as Mill and Packwood creeks fed by the same releases from the dam.

The water table lies some 60 to 150 feet below the invert of all three of these channel reaches, which is generally 40 to 130 feet below the root zone of the Valley Oak, which represent the deepest root zone of the native trees in MKGSA, which is an alluvial environment. Valley Oaks have a rooting depth that has been measured to as much as 80 feet below ground surface in a fractured-rock environment. However, the MKGSA is underlain by alluvial deposits rather than fractured rock (Lewis and Burgy, 1964; Braatne, et.al., 1996). Because the water table is not connected to the systems and the root zones do not reach the groundwater elevations, the aforementioned habitat species depend on bank seepage and not groundwater. Because there are no interconnected surface waters in the MKGSA jurisdictional area, and such interconnection is not likely to occur in the future, MKGSA did not develop minimum thresholds for interconnected surface waters.

There are no known governmental standards in the Tulare County region for any occurrence of interconnected surface waters with groundwater as a Sustainability Indicator. Insufficient information and flow data exist with which to gauge seasonal connections and relative importance of any vegetative habitat known to intermittently exist along stream channel banks.

5.3.6 *Minimum Thresholds – Seawater Intrusion*

The Kaweah Subbasin (No. 5-22.11) of the San Joaquin Valley Basin resides in the interior part of the state, 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 fresh water aquifers above. This GSA, therefore, has determined that seawater intrusion is not present and is not likely to be able to physically occur. For this reason, MKGSA did not develop minimum thresholds for seawater intrusion.

5.4 Measurable Objectives

The following sub-sections are intended to address §354.30(a)-(g) of the Regulations regarding the establishment and function of MKGSA's measurable objectives.

Measurable objectives reflect the path to sustainability that MKGSA chooses to take. MKGSA's path to sustainability is "Path A" presented by DWR in the Draft Sustainable Management Criteria BMP (DWR, 2017), shown below as **Figure 5-5**. Path A acknowledges the current rate of decline in the subbasin and sets a goal to slow the decline and stabilize the groundwater basin, reaching its measurable objectives by 2040. This path was discussed and agreed to by the three subbasin GSAs.

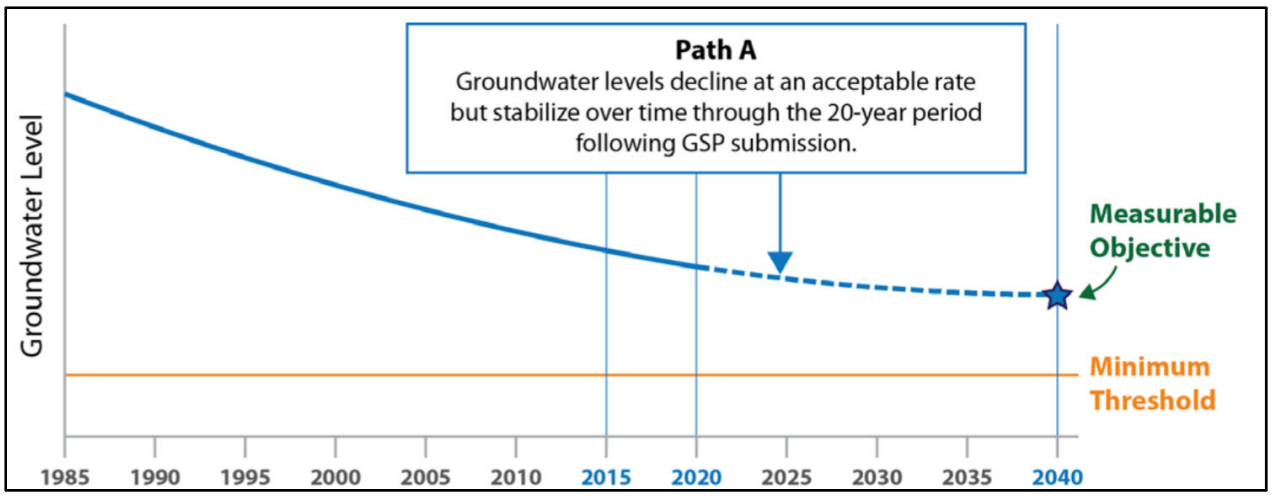


Figure 5-5: DWR's Potential Paths to Sustainability, Path A. ***(DWR, 2017)***

5.4.1 *Groundwater Level Measurable Objectives*

As discussed in Section 7.5.2, this Plan calls for groundwater level declines to diminish and potentially improve (depending on future hydrology) in response to recharge provided by new projects and management actions. Implementation of some projects may result in improvements to water quality as well. These benefits, however, depend on other hydrogeologic factors and, in the case of water levels, are less discernible on an individual project basis. In addition, water level responses will depend on the implementation efforts of neighboring GSAs as further discussed in Section 5.5.

The Subbasin numerical simulation model, described in Section 2 of this Plan, has been utilized for examining future groundwater management scenarios. The initial scenario was to simulate future groundwater level conditions in Kaweah Subbasin without SGMA. Under this initial scenario, MKGSA considered the impact of future demands and climate change as described in the Basin Setting Report (**Appendix 2A**), without any projects or management actions. Next MKGSA, via another scenario, assessed the changes in groundwater levels through 2040 if only pumping reductions and other management actions as planned by each of the three GSAs were put in place. Another model run considered added benefits in arresting groundwater level declines by adding projects and management actions

MKGSA evaluated these model results and considered them in establishing measurable objectives, interim milestones, and also an optimal objective (or stretch goal) for groundwater level management assuming favorable hydrology between 2020 and 2040. Optimal objectives for water levels are estimated herein based on projected groundwater elevations indicated by the aforementioned initial model runs.

Ultimately, the MKGSA elected to apply an approach for setting measurable objectives at monitoring wells that utilized existing groundwater level trend data, considered the inherent uncertainty of the Subbasin and regional basin understandings and future hydrology, and also used the predictive capability of the numerical groundwater model. This approach is summarized in the bullet list that follows and is illustrated on **Figures 5A-2, -3, and -4** of **Appendix 5A**:

The same minimum threshold linear projection line fitting the 2006 to 2016 groundwater level data was used.

A groundwater level corresponding to the intersection of this projection and 2030, a point midway through the implementation period, was selected. Using this 2030 intersection, the groundwater level measurable objective was set at that value. This level was selected as being achievable in light of the uncertainties described above.

The groundwater model output accounting for both projects and management actions was used to set an optimal objective of groundwater levels. Again, this level could be achieved if the Subbasin experiences favorable hydrology and local groundwater level management is not negatively impacted by pumping in adjacent GSAs within or outside the Subbasin.

Interim milestones (IM) were established in 2025, 2030, and 2035 to measure progress at these time intervals regarding groundwater level trends and to determine if corrective action is required to achieve the groundwater-level measurable objective by 2040. The 2025 and 2030 IMs fall on the straight-line projection described above and shown on each well hydrograph included in **Appendix 5B**. The 2035 IM falls along the project water level line between 2030 with 2040 (shown on **Appendix 5B** hydrographs) and this pathway along with the 2035 IM were determined by considering the benefit of projects and management actions in stabilizing groundwater levels. The shape and slope of the pathway between 2030 and 2040 was influenced by the groundwater modeling results. If groundwater levels at these interim milestones are more than 10% below these five-year goals on a rolling-average basis, MKGSA will take corrective action by either reducing pumping or increasing recharge (if water is available) to reverse the trend.

Table 5-2 lists the measurable objectives, interim milestones and optimal objectives for each well in MKGSAs representative groundwater level monitoring program. **Figure 5-1** shows these criteria at a single well in the southwest area of MKGSA and **Appendix 5B** includes these criteria for each well. As discussed in Section 7, the trend toward the measurable objective begins to diverge from the minimum threshold projection in 2025 due to the implementation schedule and beneficial impacts of projects and management actions in stabilizing groundwater levels.

As a double check on the methodology described above, an empirical relationship was developed to relate water level responses to groundwater recharge for the general MKGSA region. Tulare Irrigation District (TID) occupies the northwestern portion of the MKGSA and utilizes managed groundwater recharge at various locations. Historical water level response is plotted against annual recharge and, when plotted using a five-year moving average, a relationship becomes evident, as shown on **Figure 5-6**. This delayed relationship is due to the lag time between surface infiltration and the effect on the water table or potentiometric surface. Although the relationship is somewhat scattered and produces a correlation coefficient of 0.75, it helps provide supporting evidence that our measurable objectives are achievable by 2040.

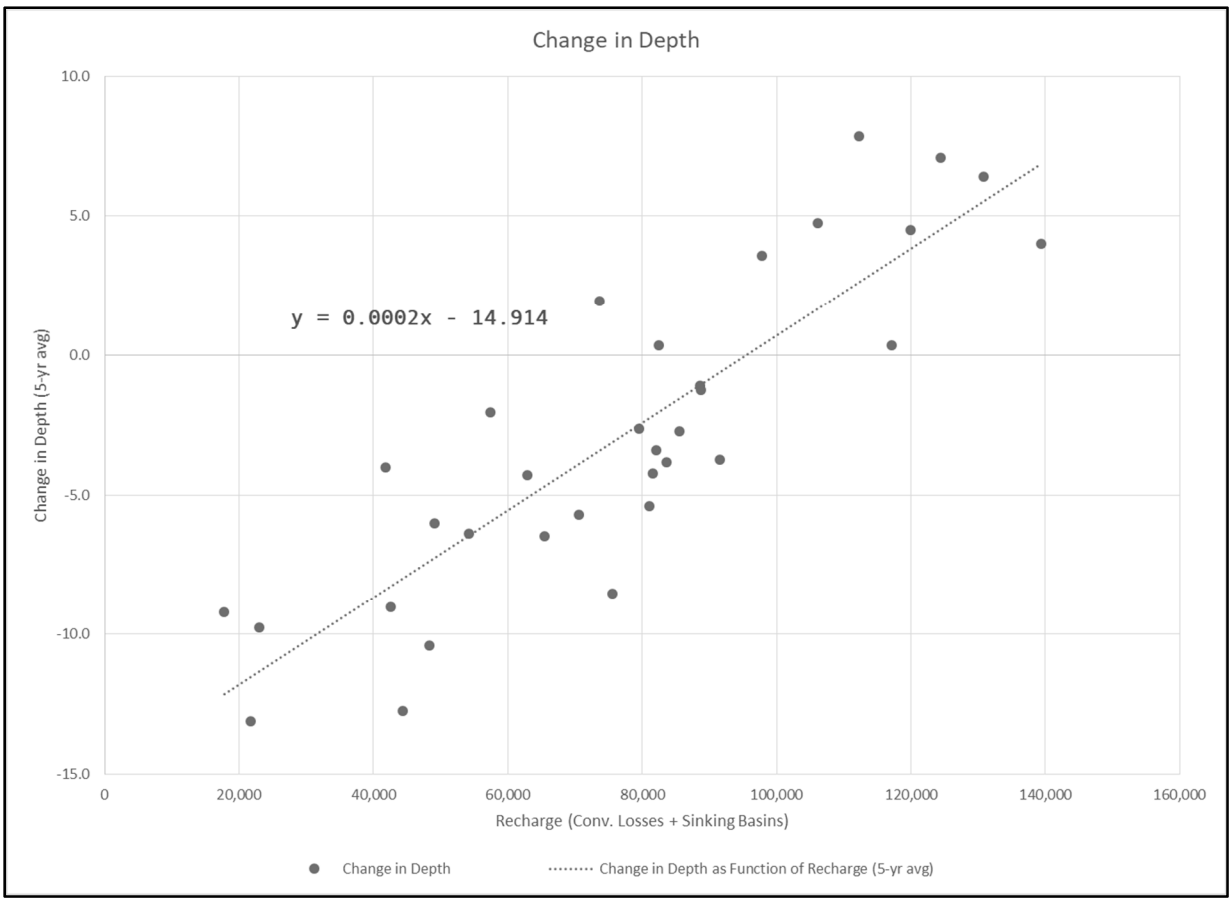


Figure 5-6: Change in depth to groundwater as a function of recharge in TID

This empirical relationship may be used to colligate MKGSA's project accomplishments as estimated in Section 7 with water level improvements over time. This causal connection is further discussed in **Appendix 5D**.

Continued coordination among the three Subbasin GSAs and the adjacent subbasins across which significant groundwater fluxes exist is expected to occur during implementation of projects and management actions. This coordination begins with periodic updates to local and regional water budgets to include added recharge and extraction reductions then in place. MKGSA anticipates that coordination will focus on the Management Areas where water budgets remain in deficit, depending on degree. These areas would likely be subject to further extraction reductions to deal with water budget deficits. Appropriate water level triggers to activate additional management actions will be defined as these coordination discussions are held.

5.4.2 *Groundwater Storage Measurable Objectives and Interim Milestones*

Like the approach used in setting a minimum threshold for reductions in groundwater levels, MKGSA set a measurable objective and optimal objective for groundwater storage as following:

Prepare projected measurable objective and interim milestone groundwater surfaces by using the groundwater level measurable objectives and interim milestones described in Section 5.4.1.

Calculate the total volume between the minimum threshold surface and the measurable objective and interim milestone surfaces.

Multiply total volume by specific yield to calculate total aquifer storage between the floor and the measurable objective and interim milestones for groundwater level.

Prepare a projected optimal objective groundwater surface by using the groundwater level optimal objectives described in Section 5.4.1.

Calculate the total volume between the minimum threshold surface and the optimal objective surface.

Multiply total volume by specific yield to calculate total aquifer storage between the floor and the optimal objective for groundwater level.

These objectives apply in monolithic fashion across the GSA and are not established at each representative monitoring site as with water level objectives. **Figure 5-2** shows the results of this analysis indicating that the measurable objective has 641,000 AF in storage at 2040, and the optimal objective has 1,340,000 AF in storage at 2040. Following the projected path shown on **Figure 5-2**, basin storage target at the 2025 IM is 870,000 AF, at the 2030 IM is 750,000 AF, and at the 2035 IM is 690,000, MKGSA's goal is to manage groundwater basin storage between the optimal and measurable objectives levels and considers this as supplemental storage. If during the implementation period, the Subbasin experiences severe drought similar or worse than to the 2011 to 2016 period, the rolling-average triggers as previously described should accommodate additional storage reductions.

MKGSA is also mindful of its imputed groundwater budget as discussed in Section 6 and its obligations in mitigating for reductions in groundwater storage during Plan implementation. With this in mind, MKGSA will additionally evaluate changes in storage as a function of new projects (via water recharged) and management actions (via water not extracted). This evaluation, while not established or represented as a measurable objective per se, is generally described in **Appendix 5D**.

5.4.3 *Water Quality Measurable Objectives*

As explained in Section 5.3.4, the MKGSA supports the protection of groundwater quality by coordinating with other agencies and programs established to maintain and improve the groundwater quality in the Kaweah Subbasin. All future projects and management actions implemented by the MKGSA are designed to avoid causing further groundwater quality degradation.

To protect against causing a water quality degradation (exceedance of MCLs or Agricultural WQOs), the MKGSA will establish measurable objectives at 75% of the MCLs or Agricultural WQOs. This stricter objective will alert MKGSA to any constituent's concentration that is approaching the MCL or water quality objective. Using water quality data provided by other agencies, as well as data

collected from the MKGSA representative groundwater quality monitoring network, MKGSA 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 water quality objective as the result of a GSA project, MKGSA will immediately implement corrective measures (i.e., halting recharge operations, reducing pumping, etc.) to avoid an exceedance in the event that such concentrations be as a result of GSA actions.

As progress towards improving water quality rests largely with other regulatory agencies, interim milestones for water quality will not be explicitly applied.

MKGSA will also coordinate with the entities responsible for complying with existing groundwater quality regulatory programs. Many of these programs are still in the early stages of implementation (i.e., Irrigated Lands, Dairy Program, CV-Salts) and groundwater quality measurable objectives have yet been established. Once established, MKGSA will reflect these levels in the GSP periodic assessments outlined in Section 8 of this Plan.

5.4.4 *Land Subsidence Measurable Objectives*

The measurable objectives for land subsidence were generated using the relationship between storage change and land surface subsidence described in Section 5. 3.6. and using the projected 2030 groundwater level measurable objectives levels as a floor. The subsidence rates and totals shown on **Figure 5-7** represent best estimates of subsidence that will result as the MKGSA manages groundwater levels to the measurable objectives described above. These rates constitute the measurable objectives for each region depicted on the figure. Monitoring-point specific sustainable management criteria, including interim milestones, is shown in **Table 5-4**. Interim milestones, summarized in **Table 5-4**, were determine by multiplying the estimated rate of subsidence by each 5-year increment between 2020 and 2040. Optimal objectives for land surface subsidence have not been established for this GSP.

Table 5-4: Summary of Minimum Thresholds, Measurable Objectives and Interim Milestones for Land Subsidence

Subsidence Monitoring Point	Minimum Threshold		Measurable Objective	Interim Milestones (inches)		
	Rate (inches/year)	Total at 2040 (inches)		2025	2030	2035
CRCN	7.3	174.0	87.0	21.75	43.50	65.25
K010	6.2	148.9	74.4	18.60	37.20	55.80
DH6683	5.9	141.2	70.6	17.65	35.30	52.95
K009	4.9	118.1	59.0	14.75	29.50	44.25
K008	4.5	108.0	54.0	13.50	27.00	40.50
TID1	4.3	103.3	51.6	12.90	25.80	38.70
TUL99	4.1	99.5	49.7	12.43	24.85	37.28

Subsidence Monitoring Point	Minimum Threshold		Measurable Objective	Interim Milestones (inches)		
	Rate (inches/year)	Total at 2040 (inches)		2025	2030	2035
DH6770	3.1	74.4	37.2	9.30	18.60	27.90
K014	3.1	73.8	36.9	9.23	18.45	27.68
K007	2.9	70.1	35.1	8.78	17.55	26.33
P566	1.2	24.0	12.0	3.00	6.00	9.00

5.4.5 *Interconnected Surface Water Measurable Objectives*

As noted in Section 5.3.5, the MKGSA jurisdictional area does not exhibit interconnected surface waters nor will it include such interconnected waters in the future. For this reason, the GSP does include measurable objectives for interconnected surface waters.

5.4.6 *Seawater Intrusion Measurable Objectives*

The Kaweah Subbasin resides in the interior part of the state, far removed from any seawaters. 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. Therefore, this GSP does not include measurable objectives for seawater intrusion.

5.5 Mutual Influences

The three GSAs within the Subbasin will, commencing in 2020, implement the projects and management actions contained in their respective GSPs, monitoring depth to groundwater at representative well sites for chronic lowering of water levels, and gauging the effectiveness of their implementation relative to measurable objectives. Should groundwater levels and reductions in groundwater storage decline below their measurable objectives, the triggers identified in Section 5.4 will require further management actions to correct the trends.

However, it will remain a challenge as to why downward trends may occur and which projects and management actions undertaken by the GSAs are falling short. As identified in the Subbasin Coordination Agreement, a forum has been established in which the GSAs will discuss and agree on the relative trigger activations within each GSA. Groundwater budgets for each GSA will be estimated and used in this discussion forum. The Subbasin numerical model will be employed to aid in determining where triggers are to be activated in an effort to adhere to the measurable objectives and interim milestones set by each GSA.

As described for this Subbasin, this process will extend outwardly into neighboring subbasins over time as implementation continues. This regional discussion may result in inter-basin coordination agreements; however, emphasis now is centered on ensuring that the Kaweah Subbasin GSAs

embrace a mechanism to ensure adherence with their measurable objectives and efforts to achieve sustainable yield by 2040.

Section 5 – SMC – Minimum Thresholds, Measurable Objectives

The development of this MKGSA Minimum Thresholds and Measurable Objectives Section was informed by DWR's Sustainable Management Criteria BMP. This document is provided in **Appendix 3B**.

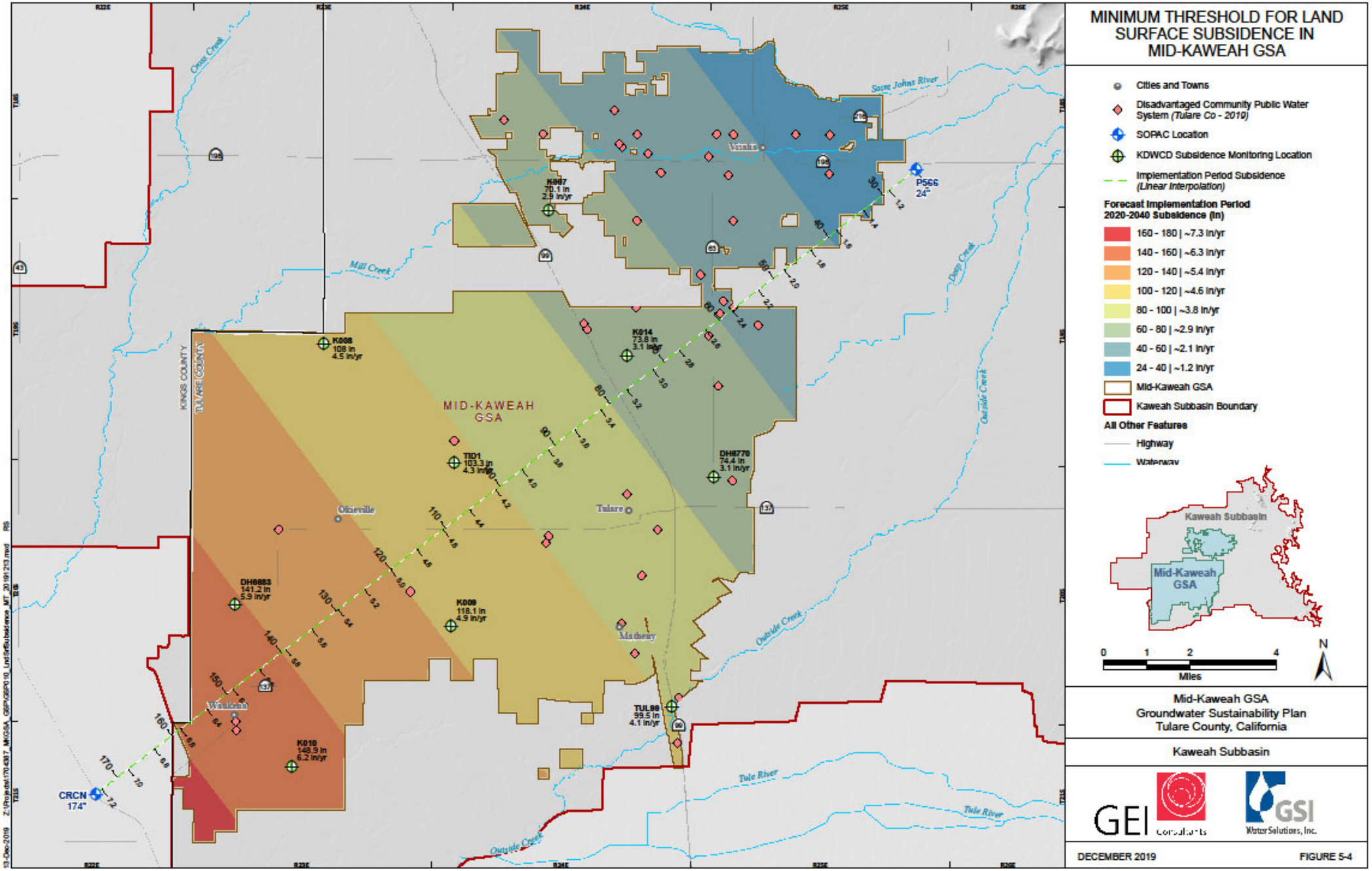


Figure 5-4: Minimum Thresholds for Land Surface Subsidence in the MKGSA

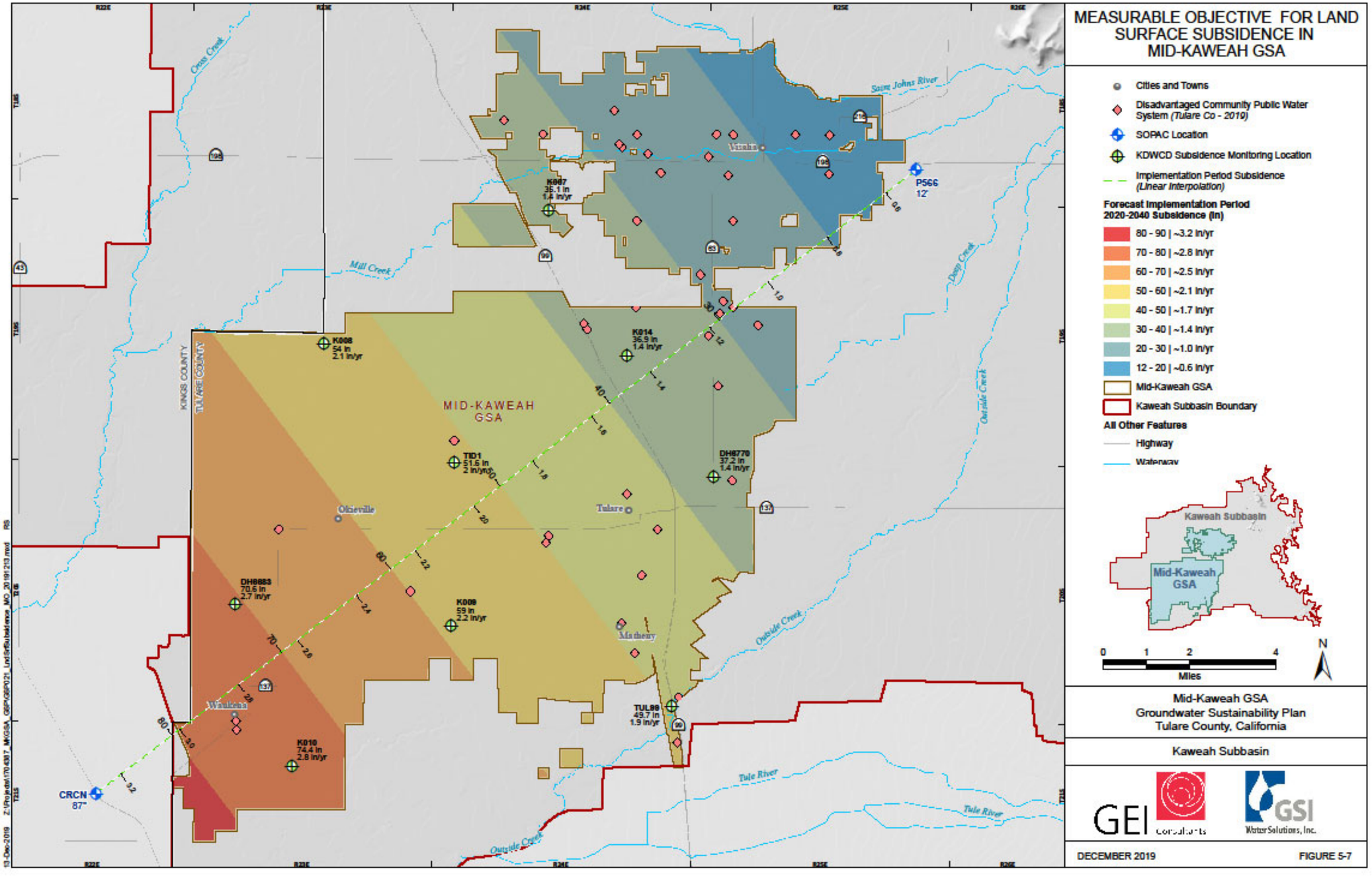


Figure 5-7: Measurable Objectives for Land Surface Subsidence in MKGSA

6. Water Supply Accounting

6.1 Application of Basin Setting Water Budget

Table 32 of the Kaweah Basin Setting (**Appendix 2A**) contains the Subbasin hydrogeologic water budget for the current period 1997-2017. **Table 2-1** of Section 2 is based on this water budget and depicts the hydrogeologic water budget for MKGSA, showing all components of inflow to and outflow from the MKGSA region. The hydrogeologic water budgets are recognized in the Subbasin numeric model and its application to future scenarios incorporating groundwater pumping projections and planned projects and management actions of each GSA. These water budgets do not mandate the process by which the GSAs will achieve sustainability by 2040.

6.2 Water Accounting Framework Allocation

The Subbasin GSAs have discussed water budgets in the context of groundwater law and have developed a means to account for various components of the water budget 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 (reflected in the Subbasin Coordination Agreement) 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 as shown in **Table 6-1**.

Table 6-1: Groundwater Inflow Components

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**.

Table 6-2: GSA Apportionment

(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 GW	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	1,050	14,305	**15,355**
Irrigation Returns 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**
WWTP 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

Comparing these resulting groundwater inflow assignments to MKGSA to annual groundwater pumping for the same current period (1997-2017), as identified in **Table 6-3**, results in an imputed water balance surplus for MKGSA of about 38,000 AF on an average basis. Yet, as acknowledged in Section 2 of this Plan, MKGSA, like the balance of the Subbasin, experiences a historical decline in groundwater levels and attendant depletion of groundwater in storage within its jurisdictional region.

Table 6-3: Imputed Water Balance (1997-2017)

(values in 1,000 AF)

	MKGSA
Groundwater Inflow Balance	230.0
GSA Total Pumping Extraction (*)	192.2
Imputed Balance	37.8

(*) Obtained from data furnished by the Subbasin consultant to the three Subbasin GSAs which was supplemental to the Basin Setting report

Figure 6-1 is a graphical depiction of both the annual hydrogeologic water budget and water accounting framework water balance during this current period for MKGSA. The correlation is quite evident, with both showing positive responses during wet cycles and negative responses during droughts. Whereas the average water accounting framework water balance is positive, the comparable hydrogeologic water budget is negative by about 13,000 AF. This reduction in storage is to be expected, as water levels decline in the range of 3 feet per year over much of the GSA region. The relative contributions of multiple causes of these declines is the subject of further study and hydrogeologic analyses.

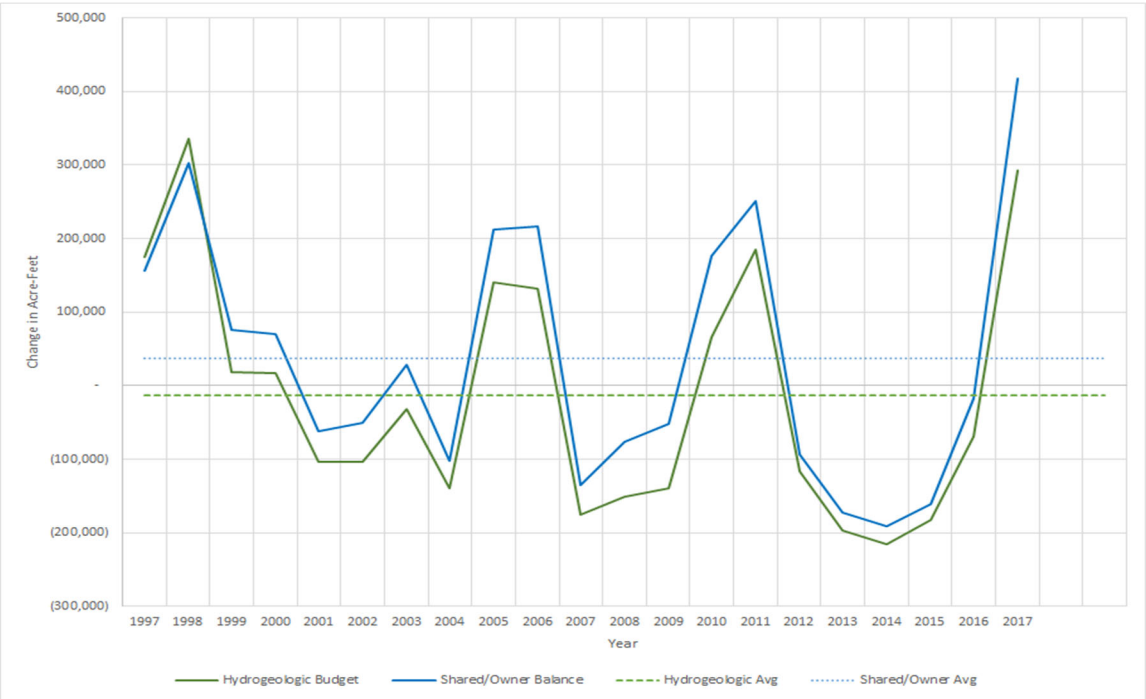


Figure 6-1: MKGSA Hydrogeologic Water Budget and Shared/Owner Water Balance

It is the intent of the Subbasin GSAs, as stipulated in the Coordination Agreement, to continue to discuss water balances 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. Therefore, 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 five-year GSP assessments as submitted to DWR. Likewise, the individual GSA water balances will also be reviewed as this reevaluation occurs at the Subbasin level.

6.3 Water Budget Reconciliation

The shared/owner water balance as defined in Section 6.2 may be reconciled as against the hydrogeologic water budget set forth in Section 2.3, as both methods of quantifying the groundwater inflow components necessarily arrive at the same volume in acre-feet. The reconciliation for the Kaweah Subbasin is as shown following:

Groundwater inflow budget (avg. of 1997-2017):

Total inflow = 814 taf (Table 32 of **Appendix 2A**)

Mountain front recharge = 56 taf (**Table 6-2**)

Sub-surface inflow = 209 taf (Table 32 of **Appendix 2A)**

The shared/owner balance excludes the sub-surface inflow from other adjacent subbasins, as this estimated quantity and accounting therefor 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 2A**.

6.3 GSA Member Allocation Strategy

MKGSA Members (City of Visalia, City of Tulare and Tulare Irrigation District) recognize that the GSA water budget as discussed in Section 6.2 may be further apportioned across the three Management Areas as established in Section 2 of this Plan. This segregation will take into consideration the existing water management and associated facility ownership agreements among the MKGSA Members as they relate to groundwater recharge activities. This apportionment will aid in determining Member participation in the various projects as well as shape the extent of management actions such as pumping restrictions, all as outlined in Section 7. Any allocation strategy will give due consideration to the Sustainability Plan Cooperative Statement adopted by the MKGSA Board as stated in Section 7.3.19.

Section 6 – Water Supply Accounting

The development of this MKGSA Water Supply Accounting Section was informed by DWR's Water Budget BMP. This document is provided in **Appendix 2B**.

7. Projects and Management Actions

7.1 Summary

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.

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, 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 MKGSA will work to create and enhance ecosystem benefits through the development and implementation of the projects and programs selected to achieve sustainable groundwater management in the MKGSA and described in this section.

Table 7-1: MKGSA Project Benefits and Cost

Project/Management Action	**GW Levels**	**Reduction in Storage**	**Water Quality**	**Land Subsidence**	**Estimated**
Projects:					**Cost (Millions)**
Cordeniz Recharge Basin	✓	✓	✓	✓	$3.38 M O&M $10K/yr
Okieville Recharge Basin	✓	✓	✓	✓	$2.9 M O&M $10K/yr
Tulare ID/GSA Recharge Basin	✓	✓	✓	✓	$6.4 M O&M $10K/yr
On-Farm Recharge Program	✓	✓	✓	✓	TBD
McKay Point Reservoir	✓	✓	✓	✓	$4.5 M O&M $10K/yr
Kaweah Subbasin Recharge Project	✓	✓	✓	✓	$1.6 M O&M $10K/yr
Vadose Zone Well Battery (*TBD*)	Not Applicable				GSA share only
River Siphon Rehabilitation	✓	✓	✓	✓	$2 - 2.6 M
Visalia/Tulare ID Exchange Program	✓	✓	✓	✓	N/A
Sun World/Tulare ID Exchange Program	✓	✓	✓		N/A
Friant/Tulare ID Exchange Programs (*TBD*)	Not Applicable				N/A
Temperance Flat Reservoir (*TBD*)	Not Applicable				
Tulare/Tulare ID Catron Basin	✓	✓	✓		$1.5 M O&M $10K/yr
Visalia/Tulare ID Cameron Creek Project	✓	✓	✓		TBD
Visalia/KDWCD Packwood Creek Project	✓	✓	✓		$1.6 M

Project/Management Action	GW Levels	Reduction in Storage	Water Quality	Land Subsidence	Estimated Cost (Millions)
Projects:					
Visalia Eastside Regional Park	✓	✓	✓		$1.74 M
Groundwater Recharge Assessment Tool	Not Applicable				N/A
Tulare ID Existing Recharge Facility Report	Not Applicable				N/A
Management Actions:					
Extraction Measurement Program	Not Applicable				
Extraction Allocation Implementation	✓	✓	✓	✓	
Groundwater Marketing Program	Not Applicable				
Geophysical Data Survey Project	Not Applicable				
Well Characterization Project	Not Applicable				
Urban Water Conservation Program	✓	✓			
Agricultural Water Conservation and Management Program	Not Applicable				
Small Systems/Domestic Well Owner Assistance	Not Applicable				
Regulatory Agency Collaboration	Not Applicable				

Where applicable, the locations of these Projects are depicted on ***Figure 7-1*** *at the end of this Section.*

7.2 Water Supply Considerations

Most of the projects and management actions listed in Section 7.1 will provide added water supply benefits, either in the form of groundwater storage or regulation of surface flows otherwise leaving the Kaweah Subbasin. Importantly, 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. Such an assessment is included herein in Section 7.6.

For the groundwater recharge projects, an analysis of available surplus water supplies to the MKGSA Members, coupled with estimated capacities of each project, has been conducted to determine the associated benefits. This analysis is further described in Section 7.6.1. For the surface water storage projects, an analysis of local or regional flood flows otherwise leaving the Subbasin that would be diverted into storage for later in-lieu deliveries has been conducted as summarized in Section 7.6.2. For the applicable exchange programs, the Friant supplies available to TID coupled with local supplies of the exchanging entities are analyzed to determine the additional exchange water to be delivered into the GSA region, the results of which are shown in Section 7.6.3. For the Packwood Creek recharge facilities now in operation, an estimation of groundwater benefits is presented in Section 7.6.4. These analyses are used to determine the projected water supply benefits (in terms of added groundwater storage) for a number of the afore said projects.

7.3 Projects

The projects as described below are arranged in the order as listed in Section 7.1, beginning with those that are being pursued by TID, then those sponsored by Tulare and Visalia, and then efforts to provide guidance for project design and refinement. The project description, its implementation circumstances and status, public noticing, permitting and regulatory compliance, water sources and legal authority, and project costs are all discussed for each project individually and address §354.44(a) and (b)(1)-(8) of the Regulations.

Anticipated benefits of the recharge facilities/programs are discussed both individually herein and in the aggregate in Section 7.5.2 using the methodology set forth in Section 7.6.1; benefits of other projects/programs are discussed individually herein and, in the case of the local reservoir storage projects, with application of the methodology set forth in Section 7.6.2. Similarly, benefits of the exchange programs are articulated in Section 7.6.3, and for the Packwood Creek channel recharge project, in Section 7.6.4. These sections address 354.44(b)(5) of the Regulations.

Funding for project implementation and associated costs are also discussed individually for projects currently underway, and collectively in Section 7.3.19 for planned projects to be implemented later, to address §354.44(b)(8) of the Regulations.

7.3.1 *Cordeniz Recharge Basin*

7.3.1.1 Description

The Cordeniz Basin is a 60-acre groundwater recharge facility being constructed on the northwest corner of Road 84 and Avenue 248 within the TID service area. The project involves the construction of a five-foot-deep basin, which will be served by the Serpa Ditch. It is anticipated that the project will add additional recharge infiltration capacity of approximately 25 AF per day based on bore-hole soil samples collected during the pre-construction phase. Four groundwater monitoring wells adjacent to the facility are included in the project. Federal funding has been provided under Part III of the San Joaquin River Restoration Settlement.

Cordeniz Basin Under Construction by TID Field Staff

7.3.1.2 Status of Implementation

Construction commenced in the fall of 2013, and the project is anticipated to be operational by March 2020 and is anticipated to have a 100-year life expectancy.

7.3.1.3 Permitting and Regulatory Compliance

The project's design and approval complied with NEPA (a FONSI was determined) and CEQA (a Mitigated Negative Declaration was submitted). All public noticing requirements were satisfied as part of this compliance process.

7.3.1.4 Water Sources and Legal Authority

All water re-diverted into the facility from the Serpa Ditch stems from TID's appropriative rights to Kaweah River water and contract rights to CVP water from the Friant Unit thereof and, as such, does not impose impacts on third parties. The projected allotments available from these sources, which vary from year to year, are described in Section 7.6.1. In addition, surplus water from Kaweah or CVP sources has historically been available for purchase, and TID or other GSA Members will continue to purchase supplies, as they have historically, as a source for this new project. These supplies are not, however, being quantified nor assumed herein due to their uncertainty.

As an irrigation district under Division 11 of the California Water Code, TID has authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its landowners. To the degree that any recharge benefits from this project will accrue to other GSA Members, they too, by virtue of the authorities granted to a GSA and by extension to the Members in accordance with the JPA Agreement referenced in Section 1, have legal authority to participate in the project insofar as its benefits are concerned.

7.3.1.5 Project Costs and Funding

The Cordeniz Basin project's capital cost was $3.38 million, and its annual maintenance cost is $10,000. Construction funding was, in part, provided by the USBR under a grant program, with the balance funded by TID.

7.3.1.6 Expected Benefits and Targeted Measurable Objectives

Constrained only by the frequency of surplus flow conditions as referenced in Section 7.2 and its intake capacity, the project's accrued benefits (via increased groundwater in storage) through the 50-year Planning and implementation horizon are estimated at 80,500 AF with average annual benefits at 1,610 AF/year. Maximum recharge in wet years is estimated to be 3,600 AF. The measurable objectives/optimal objectives (see Section 5 of this GSP) to be partially met with this project include groundwater level stabilization and, by proxy, groundwater storage stabilization and reduction in land subsidence rates. Slowing of water quality degradation is anticipated as well, as it is generally accepted that high quality, low-TDS runoff from the Sierra Nevada sources (Kaweah and San

Joaquin Rivers) provides improvements to groundwater quality and has historically had a dilution effect to both the unconfined and semi-confined aquifer layers.

As described in the Coordination Agreement, the Kaweah Subbasin computer model has been used to simulate the water-level rise afforded by a generic representation of projects and management actions of the Subbasin GSAs. Future simulations will aid with assessing water-level benefits of this project, both locally and regionally within the GSA. These model simulations may be done in conjunction with other planned projects and management actions to better ascertain benefits in the aggregate.

While not a SGMA-defined measurable objective, this project will also provide new habitat associated with surface water periodically ponded in the recharge facility. Water would typically be present during the winter and early spring months, and presumably during times when both migrating and local water fowl would benefit from the water and vegetative habitat around the facility's perimeter.

7.3.2 *Okieville Recharge Basin*

7.3.2.1 Description

The Okieville Recharge Basin involves the construction of a 20-acre recharge facility, and supporting infrastructure, adjacent and up-gradient of the disadvantaged community of Okieville (a DAC). The project's purpose is two-fold: one, to increase the availability of wet-year recharge capacity and, two, to provide water quality benefits to the residents of Okieville. It is anticipated that the project, fed by an irrigation canal known as Packwood Creek, will add additional recharge infiltration capacity of approximately 10 AF per day. Application of high-quality Sierra watershed surface supplies dedicated to recharge up-gradient of the community should improve the quality of local groundwater pumped by the Okieville-Highland Acres Mutual Water Company well and delivery system. The District also intends to implement a monitoring program, including monitoring wells, to determine the empirical benefits of groundwater recharge on both the quantity and quality of groundwater available to the community.

7.3.2.2 Status of Implementation

Design of this project's facilities commenced in January 2018 and construction is anticipated to be completed by August 2020 or later in that year. NEPA/CEQA compliance will be undertaken in 2019 with the goal of environmental review completion to allow construction by early 2020.

7.3.2.3 Permitting and Regulatory Compliance

The project will be complying with the provisions of CEQA and NEPA due to the use of CalOES and FEMA grant funding.

7.3.2.4 Water Sources and Legal Authority

All water re-diverted into the facility from Packwood Creek stems from TID's appropriative rights to Kaweah River water and contract rights to CVP water from the Friant Unit thereof and, as such, does not impose impacts on third parties. The projected allotments available from these sources, which vary from year to year, are as determined in Section 7.6.1. In addition, water for purchase from Kaweah or CVP sources belonging to others has historically been available, and TID or other GSA Members will continue to purchase supplies as a source for this new project. These additional supplies are not, however, being quantified nor assumed herein due to their uncertainty.

As an irrigation district under Division 11 of the California Water Code, TID has authority to manage, regulate and engage in groundwater recharge operations for the benefit of its landowners. To the degree that any recharge benefits from this project will accrue to other GSA Members, they too, by virtue of the authorities granted to a GSA and by extension to the Members in accordance with the JPA Agreement referenced in Section 1, have legal authority to participate in the project insofar as its benefits are concerned.

7.3.2.5 Project Costs and Funding

The Okieville Recharge Basin Project's capital cost, including its appurtenant facilities and monitoring wells, is estimated at $2.9 million, and its annual maintenance cost is $10,000. Construction funding in part is to be provided jointly by CalOES and FEMA under a grant program, with the balance (approximately 25 percent) paid by TID.

7.3.2.6 Expected Benefits and Targeted Measurable Objectives

Constrained only by the frequency of surplus flow conditions as referenced in Section 7.2 and its intake capacity, the project's accrued benefits (via increased groundwater in storage) through the 50-year Planning and implementation horizon are estimated at 31,500 AF, with average annual benefits at 630 AF/year. Maximum recharge in wet years is estimated to be 1,400 AF. The measurable/optimal objectives to be partially met with this project include groundwater level stabilization and, by proxy, groundwater storage stabilization and reduction in land subsidence rates. Slowing of water quality degradation is anticipated as well, as it is generally accepted that high quality, low-TDS runoff from the Sierra Nevada sources (Kaweah and San Joaquin Rivers) improves groundwater quality and has historically had a dilution effect on both the unconfined and semi-confined aquifer layers.

As described in the Coordination Agreement, the KSB computer model has been used to simulate the water-level rise afforded by a generic representation of projects and management actions of the Subbasin GSAs. Future simulations will aid with assessing water-level benefits of this project, both locally and regionally within the GSA. These model simulations may be done in conjunction with other planned projects and management actions to better ascertain benefits in the aggregate.

While not a SGMA-defined measurable objective, this project will also provide new habitat associated with surface water periodically ponded in the recharge facility. Water would typically be present during the winter and early spring months, and presumably during times when both

migrating and local water fowl would benefit from the water and vegetative habitat around the facility's perimeter.

7.3.3 *TID/GSA Recharge Basin*

7.3.3.1 Description

TID currently owns and/or operates some 1,350 acres of "sinking" (recharge) basins for canal flow regulation and groundwater recharge purposes. These basins are kept full in surplus water seasons and, based on historical operations and the analysis described in Section 7.2.1, it is known that more basin capacity could be utilized in the wet years. As a function of agricultural land for sale exhibiting optimal infiltration characteristics and proximity to district conveyance facilities, as much as another 160 acres may be acquired for GSA Members, removed from agricultural use, and converted to a recharge basin.

7.3.3.2 Status of Implementation

Using the Groundwater Recharge Assessment Tool (GRAT) as described in Section 7.3.17, TID will continue to pursue suitable parcels for acquisition and to the degree compatible with its on-farm programs. Due to high capital costs, the development of new basins is currently considered less desirable than on-farm programs and, only with very nominal landowner participation would the District aggressively pursue additional sinking basins. With the on-farm program anticipated to be fully functional by 2025, any new recharge basin project would be identified and pursued for operational capability by 2030.

7.3.3.3 Permitting and Regulatory Compliance

Project planning will include compliance with CEQA, an Air Quality Impact Assessment and Dust Control Plan as required by the San Joaquin Air Pollution Control District, and a Storm Water Pollution permit as called for by the SWRCB. In the event that federal funds are utilized for development of this project, compliance with NEPA will also be pursued.

7.3.3.4 Water Sources and Legal Authority

All water re-diverted into the facility from the TID canal system stems from TID's appropriative rights to Kaweah River water and contract rights to CVP water from the Friant Unit and, as such, does not impose impacts on third parties. The projected allotments available from these sources, which vary from year to year, are as determined in Section 7.6.1. In addition, water for purchase from Kaweah or CVP sources belonging to others has historically been available, and TID or other GSA Members will continue to purchase supplies as a source for this new project. These supplies are not, however, being quantified nor assumed herein due to their uncertainty.

As an irrigation district under Division 11 of the California Water Code, TID has authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its landowners. To the degree that any recharge benefits from this project will accrue to other GSA Members, they too, by virtue of the authorities granted to a GSA and by extension to the Members in accordance

with the JPA Agreement referenced in Section 1, have legal authority to participate in the project insofar as its benefits are concerned.

7.3.3.5 Project Costs

Based on recent experiences of TID in acquiring land and constructing recharge basins, an estimated cost per acre is $40,000, which amounts to $6.4 million for a 160-acre facility. As with other recharge basins under its control, annual maintenance costs are expected to be in the range of $10,000.

7.3.3.6 Expected Benefits and Targeted Measurable Objectives

Constrained only by the frequency of surplus flow conditions as referenced in Section 7.2 and its intake capacity, the project's accrued benefits (via increased groundwater in storage) through the 50-year Planning and implementation horizon are estimated at 255,000 AF, with average annual benefits at 5,090 AF/year. Maximum recharge in wet years is estimated to be 11,400 AF. The measurable/optimal objectives to be partially met with this project include groundwater level stabilization and, by proxy, groundwater storage stabilization and reduction in land subsidence rates. Slowing of water quality degradation is anticipated as well, since it is generally accepted that high-quality, low-TDS runoff from the Sierra Nevada sources (Kaweah and San Joaquin Rivers) improves groundwater quality and has historically had a dilution effect on both the unconfined and semi-confined aquifer layers.

As described in the Coordination Agreement, the Kaweah Subbasin computer model has been used to simulate the water-level rise afforded by a generic representation of projects and management actions of the Subbasin GSAs. Future simulations will aid with assessing water-level benefits of this project, both locally and regionally within the GSA. These model simulations may be done in conjunction with other planned projects and management actions to better ascertain benefits in the aggregate.

While not a SGMA-defined measurable objective, this project will also provide new habitat associated with surface water periodically ponded in the recharge facility. Water would typically be present during the winter and early spring months, and presumably during times when both migrating and local water fowl would benefit from the water and vegetative habitat around the facility's perimeter.

7.3.4 *On-Farm Recharge Programs*

7.3.4.1 Description

On-farm recharge in surplus flow seasons has historically been informally practiced within TID and other areas in the San Joaquin Valley. Nominal incentives existed in the past, with most growers avoiding interference to cropping plans and possible yield impacts. Now, with SGMA mandates, a shift in grower receptivity to these types of programs is occurring. By incorporating targeted incentives to growers and landowners, this historical and informal practice can be formalized and greatly expanded as part of the GSP. For example, in 2017 (a year where Kaweah watershed runoff

was 193 percent of average) TID achieved participation by 12 farmers to over-irrigate 540 acres and fill on-site regulation ponds. As a result, about 6,900 AF was ultimately infiltrated into groundwater storage over and above TID's routine recharge operations.

Four types of on-farm programs are being designed, partly in response to the 2017 pilot program. These are (a) a crop buy-out program where planted fields are flooded and associated growers are compensated for crop damages; (b) a shallow-basin program where parcels are deepened for optimum recharge, and associated growers may continue planting forage crops and can receive monetary compensation in the event of flooding; (c) an over-irrigation program where growers take delivery of water for over-irrigation of permanent plantings or open-ground crops on a voluntary basis with reduced water costs, and;(d) a mandatory program where landowners may ultimately be required to dedicate a designated percentage of their lands for winter/spring recharge in surplus supply years.

The combined four approaches are being designed to achieve the optimal amount of participating lands in the overall program. It is projected that as many as 600 acres of participating parcels may be enrolled in the voluntary programs depending on the level of need determined by TID and as dictated by surplus flow availability.

7.3.4.2 Status of Implementation

Beginning with the winter of 2019, solicitations are being made to TID growers to accept surplus flows should the wet conditions continue into the early spring. Land use agreements are being signed and water will be furnished at no cost for participants. By the winter of 2020, at the inception of GSP implementation, more formal programs incorporating the aforementioned four options will be better defined. The GRAT, as described in Section 7.3.17, will be relied upon to help determine the ideal parcels to include in the overall program as a function of soil type, proximity to conveyance facilities, and other parameters. It is anticipated that by 2025, the program may be fully developed.

7.3.4.3 Permitting and Regulatory Compliance

Concerning the pilot on-farm programs implemented thus far, TID concluded that legally no permitting or CEQA compliance need to be pursued. The delivery of water, allotted to the District under its appropriative and contract water rights, to parcels within its service area has long been practiced. Should it be concluded differently for any of the formalized programs in the future, CEQA, likely in the form of a Negative Declaration, will be pursued and complied with.

7.3.4.4 Water Sources and Legal Authority

All water re-diverted to parcels within TID stems from TID's appropriative rights to Kaweah River water and contract rights to CVP water from the Friant Unit and, as such, does not impose impacts on third parties. The projected allotments available from these sources, which vary from year to year, are as determined in Section 7.6.1. In addition, water for purchase from Kaweah or CVP sources belonging to others has historically been available, and TID or other GSA Members will

continue to purchase supplies as a source for this new program. They are not, however, being quantified nor assumed herein due to their uncertainty.

As an irrigation district under Division 11 of the California Water Code, TID has authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its landowners. To the degree that any recharge benefits from this program will accrue to other GSA Members, they too, by virtue of the authorities granted to a GSA and by extension to the Members in accordance with the JPA Agreement referenced in Section 1, have legal authority to participate in the program insofar as its recharge benefits are concerned.

7.3.4.5 Project Costs

On-farm programs primarily involve the delivery of TID water to farm fields, and operational and maintenance costs are anticipated to be similar to what the district has historically experienced. Some operational costs my increase with additional canal deliveries; however, this is anticipated to be nominal. Any financial incentives offered to growers to accept water on their properties will become a cost component as well.

7.3.4.6 Expected Benefits and Targeted Measurable Objectives

Constrained only by the frequency of surplus flow conditions as referenced in Section 7.2 and the intake capacity, the project's accrued benefits (via increased groundwater in storage) through the 50-year Planning and implementation horizon are estimated at 180,000 AF, with average annual benefits at 3,610 AF/year. Maximum recharge in wet years is estimated to be 8,900 AF. The measurable/optimal objectives to be partially met with this project include groundwater level stabilization and, by proxy, groundwater storage stabilization and reduction in land subsidence rates. Reduced water quality degradation is anticipated as well, as it is generally accepted that high-quality, low-TDS runoff from the Sierra Nevada sources (Kaweah and San Joaquin Rivers) improves groundwater quality and has historically had a dilution effect on both the unconfined and semi-confined aquifer layers.

There are concerns that on-farm recharge efforts may accelerate the downward movement of nitrates accumulating below the root zone in agricultural fields through the vadose zone into the aquifer and degrade water quality, particularly for potable uses by domestic well owners. Researchers at UC Davis and others have been looking at this issue and preliminary conclusions are that there can be a spike in nitrate concentrations at the water table initially; however, repeated recharge will have a flushing effect and nitrate concentrations will be lowered. It has been preliminarily recommended that an on-farm program make use of the same land parcels over an extended period of time to ensure the benefits of this flushing effect.

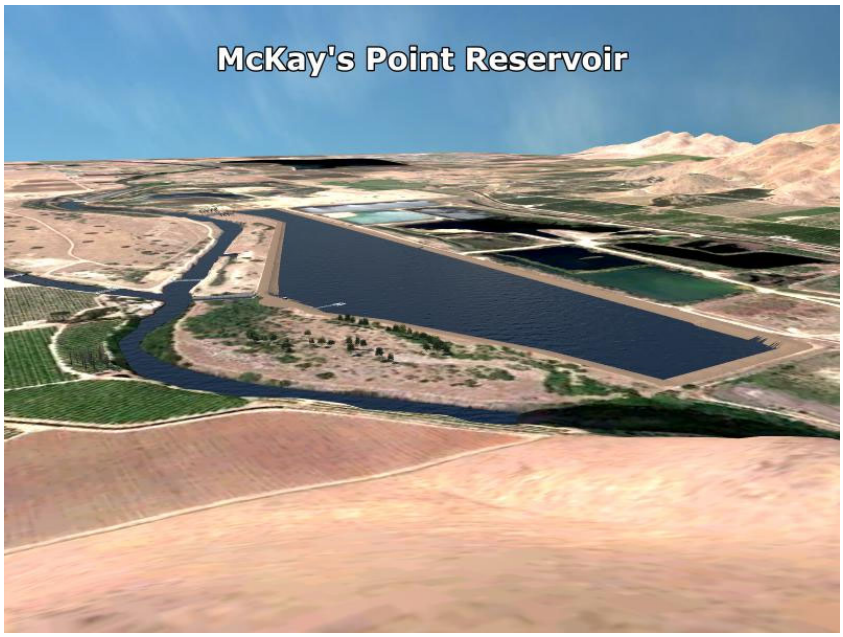
As described in the Coordination Agreement, the Kaweah Subbasin computer model has been used to simulate the water-level rise afforded by a generic representation of projects and management actions of the Subbasin GSAs. Future simulations will aid with assessing water-level benefits of this project, both locally and regionally within the GSA. These model simulations may be done in conjunction with other planned projects and management actions to better ascertain benefits in the aggregate.

7.3.5 *McKay Point Reservoir*

7.3.5.1 Description

McKay Point Reservoir is a partnership between the TID, Visalia & Kaweah Water Co., and the Consolidated Peoples Ditch Co. (collectively called the Owners) to construct a 4,000 acre-foot off-stream storage reservoir adjacent to the St. Johns River at McKay Point. TID will have access to at least one-third of the available storage space, i.e., about 1,500 AF, based on its joint ownership of the property and project along with the other Owners. The reservoir would be utilized to manage and regulate Kaweah River water otherwise lost in flood release operations to meet irrigation needs and groundwater recharge operations, under appropriation by the Owners. For TID, the Reservoir also allows flood water to be captured at the McKay Point Reservoir while imported supplies from the Friant-Kern Canal can be diverted into the District for groundwater recharge. Once the McKay Point Reservoir is at capacity, imported Friant supply diversions would be reduced or eliminated and releases from the reservoir would convey water into recharge facilities within TID.

Adjacent to the McKay Point Reservoir site are existing mining pits from which a majority, if not all, extractable aggregates have been removed in past years. TID may be able to utilize these pits to expand the storage available for the reservoir project; however, this will require additional planning and CEQA compliance.



Artist Rendering – McKay Point Reservoir

7.3.5.2 Status of Implementation

Site excavation and facility construction are anticipated to commence in early 2021 and be finished by early 2031. Agreements have been executed with an aggregate processing contractor, West Coast Sand and Gravel, Inc., to excavate the site to reservoir design specifications.

7.3.5.3 Permitting and Regulatory Compliance

Project planning is currently in the CEQA phase with the preparation of an EIR; the public review draft is anticipated to be completed by December 2019 and will include a requisite public review process and hearing(s). Tulare County is also providing a conditional use permit in the form of a Surface Mining and Reclamation Act (SMARA) permit, which will include a separate public hearing process.

7.3.5.4 Water Sources and Legal Authority

All water re-diverted into the reservoir from the St. Johns branch of the river stems from the Owners' appropriative rights to Kaweah River water and, as such, does not impose impacts on third parties. The projected allotments available from this source, which vary from year to year, are as determined in Section 7.6.2. In addition, water for purchase belonging to others has historically been available, and TID or other GSA Members will continue to purchase supplies as a source for this new project. These supplies are not, however, being quantified nor assumed herein due to their uncertainty.

As an irrigation district under Division 11 of the California Water Code, TID has authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its landowners. To the degree that any recharge benefits from this project will accrue to other GSA Members, by virtue of the authorities granted to a GSA and by extension to the Members in accordance with the JPA Agreement referenced in Section 1, they too have legal authority to participate in the project insofar as its benefits are concerned.

7.3.5.5 Project Costs and Funding

The total project cost, including reservoir excavation, appurtenant facilities, perimeter cut-off walls, and inlet/outlet structures is estimated at $12 to $14 million, and TID's share thereof would be one-third, or about $4.5 million. Much of this cost will be offset by payments from the excavation contractor for its access to aggregate materials to be processed and sold to the local construction industry.

7.3.5.6 Expected Benefits and Targeted Measurable Objectives

As described in Section 7.3.5.1, TID's share of the project's storage capacity is about 1,500 AF. Using the methodology referenced in Section 7.2 and overlaying this storage capacity against the historical hydrologic period, the facility would retain (new yield) about 730 AF per year on average to be devoted to summer re-diversions into the TID/MKGSA delivery system for downstream recharge or to offset groundwater pumping, i.e., in-lieu recharge. The reservoir expansion project, by similar analysis, is expected to add another 480 AF of yield on average. These estimates assume only one fill of the off-stream reservoirs per year; however, in many years Terminus Dam on the Kaweah River must enter into a short-duration flood space evacuation several times, so the yield estimates are conservative.

As described in Section 7.6.2, the project is anticipated to provide about 730 AF of new stored water to be devoted to in-lieu or direct recharge within the TID service area. Projected over the 50-year SGMA Planning and implementation horizon, this would amount to 36,500 AF on an accrual basis. The measurable/optimal objectives to be partially met with this project include groundwater level stabilization and, by proxy, groundwater storage stabilization and reduction in land subsidence rates. Reduced water quality degradation is anticipated as well, as it is generally accepted that high-quality, low-TDS runoff from the Sierra Nevada sources (Kaweah and San Joaquin Rivers) improves groundwater quality and has historically had a dilution effect on both the unconfined and semi-confined aquifer layers.

While not a SGMA-defined measurable objective, this project will also provide new habitat associated with surface water periodically stored in the reservoir. Water would typically be present during the winter and early spring months, and presumably during times when both migrating and local water fowl would benefit from the water and vegetative habitat around the facility's perimeter.

7.3.6 *Kaweah Subbasin Recharge Facility*

7.3.6.1 Description

This project consists of the acquisition and development of new groundwater recharge facilities within the Kaweah Subbasin and is intended to be a partnership with other adjacent GSAs or other public agencies to facilitate additional groundwater recharge capabilities within the Subbasin. At least 160 acres are to be acquired in a location exhibiting good infiltration capacity and nearby a TID-operated feeder canal for re-diversion of Kaweah River supplies in surplus years. The TID/MKGSA share of the project is assumed to be 25 percent, and recharge accomplished by the facility would be credited to TID and its parent GSA in like percentage. The project, targeted for that portion of the Subbasin immediately upgradient of the GSA, would also help to raise groundwater levels for groundwater users within the Mid-Kaweah area.

7.3.6.2 Status of Implementation

Discussions are ongoing between TID and the two other subbasin GSAs as to participation, location, and funding options for the project. Once identified, more specific planning and CEQA compliance will commence. At this time, it is projected that suitable land identification, planning, and construction would be completed by 2030.

7.3.6.3 Permitting and Regulatory Compliance

Project planning will include compliance with CEQA, an Air Quality Impact Assessment and Dust Control Plan as required by Tulare County, and a Storm Water Pollution Permit as called for by the RWQCB.

7.3.6.4 Water Sources and Legal Authority

All water re-diverted into the facility from the TID canal system stems from TID's appropriative rights to Kaweah River water and contract rights to CVP water from the Friant Unit and, as such,

does not impose impacts on third parties. Likewise, other project participants may possess their own water rights for re-diversion into the facility. The projected allotments available from these sources for TID, which vary from year to year, are as determined in Section 7.6.1. In addition, water for purchase from Kaweah or CVP sources belonging to others has historically been available, and TID or other GSAs may continue to purchase supplies as a source for this new project. These supplies are not, however, being quantified nor assumed herein due to their uncertainty.

As an irrigation district under Division 11 of the California Water Code, TID has authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its landowners. To the degree that any recharge benefits from this project will accrue to other GSAs, by virtue of the authorities granted to them as public entities, they too have legal authority to participate in the project.

7.3.6.5 Project Costs

Based on recent experiences of TID in acquiring land and constructing recharge basins, an estimated cost per acre is $40,000, which amounts to $6.4 million for a 160-acre facility. As with other recharge basins under its control, annual maintenance costs are expected to be in the range of $10,000. TID/MKGSA's share would be 25 percent of these costs based on the shared percentage assumed herein.

7.3.6.6 Expected Benefits and Targeted Measurable Objectives

Constrained only by the frequency of surplus flow conditions as referenced in Section 7.2 and its intake capacity, the project's accrued benefits (via increased groundwater in storage) through the SGMA 50-year Planning and implementation horizon are estimated at 381,500 AF, with average annual benefits at 7,630 AF/year. Maximum recharge in wet years is estimated to be 17,100 AF. TID/MKGSA's share at 25 percent would thus be an annual recharge benefit of 1,910 AF, accruing to 95,500 AF during the 50-year Planning and implementation horizon. The measurable/optimal objectives to be partially met with this project include groundwater level stabilization and, by proxy, groundwater storage stabilization and reduction in land subsidence rates. Reduced water quality degradation is anticipated as well, as it is generally accepted that high-quality, low-TDS runoff from the Sierra Nevada sources (Kaweah and San Joaquin Rivers) improves groundwater quality and has historically had a dilution effect on both the unconfined and semi-confined aquifer layers.

As described in the Coordination Agreement, the Kaweah Subbasin computer model has been used to simulate the water-level rise afforded by a generic representation of projects and management actions of the Subbasin GSAs. Future simulations will aid with assessing water-level benefits of this project, both locally and regionally within the GSA. These model simulations may be done in conjunction with other planned projects and management actions to better ascertain benefits in the aggregate.

While not a SGMA-defined measurable objective, this project will also provide new habitat associated with surface water periodically ponded in the recharge facility. Water would typically be present during the winter and early spring months, and presumably during times when both

migrating and local water fowl would benefit from the water and vegetative habitat around the facility's perimeter.

7.3.7 *Vadose Zone Injection Well Battery*

7.3.7.1 Description

This project would consist of shallow injection wells that extend a sufficient distance below grade into the vadose zone to ensure that water quality, as a result of the injected recharge water, is not a concern. These wells may also aid in bypassing restricting clay layers near the surface. Small wells would be drilled, and a perforated casing inserted to allow for water to flow into the pore spaces of soil under gravity head pressure. Similar systems have been widely used in the storm water capture and recharge industry and the district has investigated utilizing these as linear recharge systems along District canals and ditches. They would be placed within the right-of-way to depths that vary from 35 to 50 feet below ground surface. In surplus years, water would be delivered to these injection wells for groundwater recharge. The injection recharge flow rate is not presently known; however, the District anticipates the recharge rates to be in the range of 300 to 500 gallons per minute. Over time these systems may clog due to water quality, so the system would require increased maintenance and replacement costs.

7.3.7.2 Status of Implementation

Research is ongoing as to the feasibility of injection wells in the southern San Joaquin Valley given its somewhat common aquifer characteristics. It is therefore not known whether these wells will play a role in future groundwater recharge operations and, as such, any water balance benefits from such future programs are not included herein nor counted in the benefits accomplishments identified in Section 7.5.2. Given this limited information, further details concerning future injection well projects are omitted in this section; however, any such projects that materialize in the future will be identified during the GSP five-year assessment periods.

7.3.8 *TID River Siphon Rehabilitation Projects*

7.3.8.1 Description

TID is pursuing the repair/replacement of two reinforced concrete box siphons, each connecting to its primary intake canal (maximum capacity about 700 cubic feet per second (cfs) at each end. The inverted siphon structures each convey water under a river, namely the St. Johns River and the Lower Kaweah River, both located about five miles east of Visalia in Tulare County. The reinforced concrete siphons have become badly cracked due to erosive forces and perhaps internal head pressures and air entrainment. There is visible (from the river beds during low flows) and probably significant leakage from the siphons that should be eliminated if at all possible.

The siphons are sizable, ranging in cross-sectional area from 64 to 92 ft^2 and in length from 300 to 400 feet. Rehabilitation would consist of the placement of an interior liner to greatly reduce the friction losses by up to 30 percent in each siphon barrel. The current flow capacity would thus

increase by about 100 cfs. The liner would also reduce or eliminate any leakage now occurring from each siphon. Should this not prove feasible, full replacement of one or both siphons may be pursued.

Currently TID has adequate unused conveyance capacity during the winter and spring months to convey additional water for groundwater recharge purposes. Climate change studies generally predict more intense and short-duration storm events and capturing flood flows resulting therefrom could prove challenging. Should such predictions bear out, the siphon projects afford the opportunity to significantly increase capacity during peak flow events.

Inlet Structure – Lower Kaweah River Siphon

7.3.8.2 Status of Implementation

TID has been conducting reconnaissance-level studies of the siphons to determine wear, concrete strength, cavitation, leakage, expected life, and risk of failure. The structures have been determined to pose no immediate risk of failure; however, head pressures and undermining during high river flows are problematic. An acceleration of planning to rehabilitate or replace the siphons could occur if it is concluded that conveyance capacity to transport Kaweah or Friant water sources into the area needs to be increased to optimize capture of peak flood release flows from Terminus Dam or Friant Dam. It is not known when the project would be completed; however, the project status will be further addressed in the first five-year GSP assessment submitted to DWR.

7.3.8.3 Permitting and Regulatory Compliance

All required permits, CEQA, and other regulatory compliance measures will be adhered to as planning proceeds. This may include pursuit of a Section 404 of the Clean Water Act permit as administered by USACE and a Lake and Streambed Alteration permit from CDFW, if required.

7.3.8.4 Water Sources and Legal Authority

All water re-diverted into and through the siphon structures from the TID Main Intake Canal is supported by TID's appropriative rights to Kaweah River water and contract rights to CVP water from the Friant Unit and, as such, does not impose impacts on third parties.

As an irrigation district under Division 11 of the California Water Code, TID has authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its landowners. To the degree that any recharge benefits from this project will accrue to other GSA Members, by virtue of the authorities granted to a GSA and by extension to the Members in accordance with the JPA Agreement referenced in Section 1, they too have legal authority to participate in the project insofar as its benefits are concerned.

7.3.8.5 Project Costs and Funding

The capital cost to rehabilitate both siphon structures is in the range of $2 million or more, and full replacement in the range of $26 million. Annual maintenance costs for these structures are minimal. Funding for this project would come from TID and its landowners as well as any applicable federal or state grant programs from which an award would be forthcoming.

7.3.8.6 Expected Benefits and Targeted Measurable Objectives

It is premature now to quantify expected benefits of these projects, except to note that an increase of 100 cfs over multiple days of a flood release event would amount to a significant volume of water otherwise being forced into the historic Tulare Lake Bed or released down the San Joaquin River. The measurable/optimal objectives to be partially met with this project include groundwater level stabilization and, by proxy, groundwater storage stabilization and reduction in land subsidence rates. Reduced water quality degradation is anticipated as well, as it is generally accepted that high-quality, low-TDS runoff from the Sierra Nevada sources (Kaweah and San Joaquin Rivers) improves groundwater quality and has historically had a dilution effect on both the unconfined and semi-confined aquifer layers.

7.3.9 *City of Visalia/TID Exchange Program*

7.3.9.1 Description

Under this agreement executed in 2013, the City of Visalia delivers tertiary-treated waste water to the district in exchange for excess surface water in wet years diverted by the district to specific recharge locations that benefit the groundwater pumping system serving the city. This leveraged exchange provides for one AF of surplus water returned to the city on average for every two AF of waste water effluent delivered to TID. Per the agreement, the city commits to provide at least 11,000 AF of treated water annually for delivery to TID's canal system for groundwater recharge on an in-lieu basis by virtue of the supply to growers.

7.3.9.2 Status of Implementation

The city's $132 million in upgrades to its existing waste water treatment plant (WWTP) were completed in the fall of 2018 and the exchange is anticipated to fully commence in 2019. Deliveries of recent wet-season flows to Visalia for recharge have already occurred.

7.3.9.3 Permitting and Regulatory Compliance

The City Council adopted an EIR and Notice of Determination for the plant upgrades in February 2013. All other permits related to the water exchange with the RWQCB have been obtained by the City. To address delivery of treated waste water into the district's canal system and then to growers, TID sought agreements with landowners desiring to take delivery of the water, and the city will be submitting all requisite delivery and other operational information to the RWQCB on an annual basis. Further, TID obtained NEPA compliance with USBR for the exchange, acknowledging the delivery of CVP water for groundwater recharge purposes for Visalia's benefit. In summary, the program is fully permitted and now in full operation.

7.3.9.4 Water Sources and Legal Authority

All water delivered to city recharge locations is supported by TID's appropriative rights to Kaweah River water and contract rights to CVP water from the Friant Unit and, as such, does not impose impacts on third parties. TID complied with NEPA by developing an Environmental Assessment and the USBR adopted a FONSI in 2014 for the devotion of CVP water toward this exchange program. Considered legally as "salvaged" water, the city's WWTP effluent conveyed to the TID canal system is under their ownership and likewise poses no issues with third parties.

7.3.9.5 Project Costs and Funding

Aside from the capital cost already incurred for the city's upgrades to its WWTP and various costs for permitting and environmental compliance, there are no costs associated with this exchange.

7.3.9.6 Expected Benefits and Targeted Measurable Objectives

Because the city effectively provides for additional recharge capacity not previously accessible by TID, one-half of the average delivery to TID (i.e., 5,500 AF) annually will be included as additional recharge within the MKGSA area. This supply will consist primarily of imported water from the CVP into the Kaweah Subbasin. The WWTP effluent deliveries to TID do not amount to new water since this source of groundwater recharge currently occurs within the GSA area. A projected operation of this exchange over a 90-year hydrologic record is as shown in Section 7.6.3.

There are, however, water quality benefits associated with the upgrades to the city's WWTP to tertiary levels. The measurable/optimal objectives to be partially met with this project include groundwater level stabilization and, by proxy, groundwater storage stabilization and reduction in land subsidence rates. Reduced water quality degradation is anticipated as well, as it is generally accepted that high-quality, low-TDS runoff from the Sierra Nevada sources (Kaweah and San

Joaquin Rivers) improves groundwater quality and has historically had a dilution effect on both the unconfined and semi-confined aquifer layers.

As described in the Coordination Agreement, the Kaweah Subbasin computer model has been used to simulate the water-level rise afforded by a generic representation of projects and management actions of the Subbasin GSAs. Future simulations will aid with assessing water-level benefits of this project, both locally and regionally within the GSA. These model simulations may be done in conjunction with other planned projects and management actions to better ascertain benefits in the aggregate.

7.3.10 *Sun World Int'l./TID Exchange Program*

7.3.10.1 Description

In 2014, TID executed an exchange agreement with Sun World International, which calls for an exchange of Sun World's local Kaweah River supply for TID's CVP Friant supply. Sun World is a company with landholdings in the San Joaquin Valley and elsewhere in California; however, none are currently within the Kaweah Subbasin. The company does, however, possess a contractual right to Kaweah River water via one of the local ditch companies. Sun World's local supply, which would have otherwise been transferred directly or indirectly out of the subbasin, is now committed for diversion into TID, and TID owes back water on a leveraged basis ranging from 2:1 to 3.5:1 depending on year type, i.e., 2 to 3.5 AF to TID for every 1 AF provided to Sun World.

7.3.10.2 Status of Implementation

The exchange is now underway and TID is tracking the delivery balances to each entity.

7.3.10.3 Permitting and Regulatory Compliance

The delivery of additional Kaweah River water to TID requires no additional approvals from the local river Watermaster, as TID is already an appropriator on the river. TID's exchange water from the CVP is being directed by Sun World to the Lower Tule River Irrigation District within which it has land holdings and the district is a fellow Friant contractor. Annual exchange notices are required by USBR to document these deliveries as among Friant contractors, and TID complies with this long-standing protocol.

7.3.10.4 Water Sources and Legal Authority

All water re-diverted into TID's canal system for in-lieu or direct recharge stems from Sun World's contractual rights to Kaweah River water and, as such, does not impose impacts on third parties. TID's transfers of its CVP water to another Friant Unit contractor as allowed for under its USBR contract also poses no impacts to third parties.

7.3.10.5 Project Costs

Aside from costs to construct the exchange agreement by the parties, there are no additional costs to TID to effectuate the exchange from year to year. Sun World continues to pay the charges associated with its Kaweah contract supply; TID receives remuneration from Sun World by way of exchange fees and water cost reimbursements, all of which are intended to assist in the purchase of surplus water in wetter years.

7.3.10.6 Expected Benefits and Targeted Measurable Objectives

Based on a 90-year analysis of the exchange using historical Kaweah River hydrology depicting Sun World's average annual supply and resulting exchange supplies inuring to TID, the exchange arrangement is projected to supply new yield (net exchange amount) on the order of 3,400 AF annually and, over the 50-year Planning and implementation horizon, would accrue to 170,000 AF. This analysis is shown in Section 7.6.3. The measurable/optimal objectives to be partially met with this project include groundwater level stabilization and, by proxy, groundwater storage stabilization and reduction in land subsidence rates. Reduced water quality degradation is anticipated as well, as it is generally accepted that high-quality, low-TDS runoff from the Sierra Nevada sources (Kaweah and San Joaquin Rivers) improves groundwater quality and has historically had a dilution effect to both the unconfined and semi-confined aquifer layers.

As described in the Coordination Agreement, the Kaweah Subbasin computer model was used to simulate the water-level rise afforded by a generic representation of projects and management actions of the Subbasin GSAs. Future simulations will aid with assessing water-level benefits of this project, both locally and regionally within the GSA. These model simulations may be done in conjunction with other planned projects and management actions to better ascertain benefits in the aggregate.

7.3.11 *TID/Friant Leveraged Exchange Programs*

7.3.11.1 Description

Similar to the recently instituted exchange agreement with Sun World, TID continues to evaluate other exchange arrangements with entities within the CVP Place of Use. The fundamental concept applied in such evaluations is for TID to provide some degree of firm dry-year water supply to entities with permanent crops in exchange for a larger volume of return water. In this way, TID adds new water into the GSA region for either direct or in-lieu groundwater recharge. Exchanges of this nature could be year-to-year or over a specified period of years. TID has a long practice of engaging in such exchange arrangements.

7.3.11.2 Status of Implementation

New exchange opportunities may arise from time to time, but their specific implementation and duration cannot be projected at this stage. Therefore, any water balance benefits from such future programs are not included herein nor counted in the benefits accomplishments identified in Section

7.5.2. Given this limited information, further details concerning future exchange opportunities are omitted in this section; however, those that materialize in the future will be identified during the GSP five-year assessment and update periods.

7.3.12 *Temperance Flat Reservoir*

7.3.12.1 Description

The Temperance Flat Reservoir is an on-stream 1.2 MAF storage reservoir designed to impound water upstream of Millerton Reservoir on the upper San Joaquin River.

The reservoir is intended to capture excess wet-year water that would have traditionally spilled from Millerton Reservoir and been sent down the San Joaquin River and out to the Delta. Temperance Flat Reservoir is being developed based upon participation in specific storage levels, therefore allowing participants to manage their storage based upon individual assets and needs. This allows participants to not only capture flood releases, but to also manipulate Class 1 and Class 2 supplies for better utilization.

7.3.12.2 Status of Implementation

This project is still early in the planning stages in terms of participation and many of the specific details, particularly in terms of financing, have yet to be determined. Under the auspices of the San Joaquin Valley Water Infrastructure Authority, a considerable volume of feasibility analyses and design/construction cost determinations were made as part of an application to the California Water Commission under the state's Water Storage Investment Program. An award of $171 million was garnered and, while insufficient for full design and construction, planning for the project continues at the federal, state, and local levels.

Given this status and the fact that any yield to entities in the Kaweah Subbasin would not be realized for at least 25 years due to the lengthy planning/construction time needed for such a major project, the project is not assumed to aid in realizing sustainable yield by 2040 but may have relevance for the SGMA 50-year planning and implementation horizon. Thus, its cumulative benefits are not estimated in Section 7.5.2. Given this limited information, further details concerning Temperance Flat Reservoir are omitted in this section; however, the project may be reassessed during the GSP five-year update periods.

7.3.13 *City of Tulare/TID Catron Basin*

7.3.13.1 Description

The City of Tulare currently owns a 100-acre agricultural parcel surrounding its WWTP. This project proposes to turn the property into a storm water detention/ groundwater recharge basin. The city currently distributes a majority of their storm water through the district canal system that runs adjacent to the property. During large storm events, the district canal system can become overwhelmed with storm water and flooding events have occurred in the area just upstream of the proposed project site. The project would be designed to pump storm water into the proposed basin

for subsequent infiltration or release it back to the canal system as capacity is made available when the storm passes. The project would also be used to accept surface water that the district can make available for recharge purposes. The site is anticipated to accept and infiltrate up to 50 AF per day. The use of higher-quality district surface water should help the current nitrate concentration residing under the WWTP holding ponds near the proposed project site.

7.3.13.2 Status of Implementation

The project is in its early planning and design stages; however, the proposed site has been secured for this purpose. It is anticipated that the project would be completed and operational by 2026.

7.3.13.3 Permitting and Regulatory Compliance

Project planning will include compliance with CEQA, an Air Quality Impact Assessment and Dust Control Plan as required by Tulare County, and a Storm Water Pollution permit as called for by the RWQCB.

7.3.13.4 Water Sources and Legal Authority

Storm water diverted into the site from Tulare's storm sewer system is considered salvaged water from a legal standpoint, and the city has the right to utilize this water as owner/operator of the storm water collection system. Recaptured storm water supplies are abandoned flows that, if not recaptured and treated, would not be usable water supplies. For these reasons, the recapture does not impose impacts on third parties. All water re-diverted into the site from the TID canal system stems from TID's appropriative rights to Kaweah River water and contract rights to CVP water from the Friant Unit and, as such, does not impose impacts on third parties. The projected allotments available from these sources, which vary from year to year, are as determined in Section 7.6.1. In addition, water for purchase from Kaweah or CVP sources belonging to others has historically been available, and TID or other GSA Members, will continue to purchase supplies as a source for this new project. These supplies are not, however, being quantified nor assumed herein due to their uncertainty.

As an irrigation district under Division 11 of the California Water Code, TID has authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its landowners. To the degree that any recharge benefits from this project will accrue to other GSA Members, such as the City of Tulare, by virtue of the authorities granted to a GSA and by extension to the Members in accordance with the JPA Agreement referenced in Section 1, they too have legal authority to participate in the project insofar as its benefits are concerned.

7.3.13.5 Project Costs

Based on recent experiences of TID in constructing recharge basins, an estimated cost per acre is at least $15,000, which amounts to $1.5 million for a 100-acre facility. As with other recharge basins under its control, annual maintenance costs are expected to be in the range of $10,000.

7.3.13.6 Expected Benefits and Targeted Measurable Objectives

Constrained only by the frequency of surplus flow conditions as referenced in Section 7.2 and its intake capacity, the project's accrued benefits (via increased groundwater in storage) through the 50-year Planning and implementation horizon are estimated at 80,000 AF with average annual benefits at 1,600 AF/year. Maximum recharge in wet years is estimated to be 3,500 AF. Recharge estimates exclude water diverted into the facility for detention purposes, assumed to be half of all water diverted. The measurable/optimal objectives to be partially met with this project include groundwater level stabilization and, by proxy, groundwater storage stabilization and reduction in land subsidence rates. Reduced water quality degradation is anticipated as well, as it is generally accepted that high-quality, low-TDS runoff from the Sierra Nevada sources (Kaweah and San Joaquin Rivers) improves groundwater quality and has historically had a dilution effect on both the unconfined and semi-confined aquifer layers.

As described in the Coordination Agreement, the Kaweah Subbasin computer model has been used to simulate the water-level rise afforded by a generic representation of projects and management actions of the Subbasin GSAs. Future simulations will aid with assessing water-level benefits of this project, both locally and regionally within the GSA. These model simulations may be done in conjunction with other planned projects and management actions to better ascertain benefits in the aggregate.

While not a SGMA-defined measurable objective, this project will also provide new habitat associated with surface water periodically ponded in the recharge facility. Water would typically be present during the winter and early spring months, and presumably during times when both migrating and local water fowl would benefit from the water and vegetative habitat around the facility's perimeter.

7.3.14 *City of Visalia/TID Cameron Creek Recharge Project*

7.3.14.1 Description

This project involves the development of check structures and automated gates to create a linear recharge facility within the Cameron Creek system. This project is based upon the nearby Packwood Creek recharge system completed in 2016 as a partnership between the City of Visalia and TID. Several structures would be built to hold upstream water levels in the creek and create large pools of water to take full advantage of the high infiltration characteristics of the channel. The initial reach of Cameron Creek is located just east of Visalia at its diversion structure off of TID's Main Intake Canal and travels along the southern boundary of the City of Visalia.

7.3.14.2 Status of Implementation

Visalia and TID entered into an agreement in 2001 to provide, among other things, the development of recharge facilities and placement of structures within Cameron Creek to enhance recharge for the benefit of both parties. This project is in furtherance of this agreement. Over the intervening time, temporary earthen berms were placed in the creek to enhance recharge in wet seasons.

Reconnaissance-level field surveys were conducted to identify suitable locations for permanent check structures, and preliminary design work using the Packwood Creek Project (see Section 7.3.15) as a model will be underway by 2022. Operational status is anticipated by 2025 and any changes to this projection will be addressed in the first five-year assessment to be furnished to DWR.

7.3.14.3 Permitting and Regulatory Compliance

Cameron Creek is a man-made channel with easements under ownership of TID. As such, no streambed alteration permits, or dredge/fill permits will be needed from state and federal agencies. CEQA will be complied with, likely under a Negative Declaration for the project.

7.3.14.4 Water Sources and Legal Authority

All water diverted into the channel from the TID's Main Intake Canal is supported by TID's appropriative rights to Kaweah River water and contract rights to CVP water from the Friant Unit and, as such, does not impose impacts on third parties. In addition, water for purchase from Kaweah or CVP sources belonging to others has historically been available, and TID or other GSA Members will continue to purchase supplies as a source for this new project. These supplies are not, however, being quantified nor assumed herein due to their uncertainty.

As an irrigation district under Division 11 of the California Water Code, TID has authority to manage, regulate, and engage in groundwater recharge operations for the benefit of its landowners. To the degree that any recharge benefits from this project will accrue to other GSA Members, by virtue of the authorities granted to a GSA and by extension to the Members in accordance with the JPA Agreement referenced in Section 1, they too have legal authority to participate in the project insofar as its benefits are concerned.

7.3.14.5 Project Costs

The project will be similar in its key features and operations to the Packwood Creek Project described in Section 7.3.15. Depending on the number of automated check structures to be placed in the creek, the capital cost could be similar as well. As project design proceeds, the costs will be better known.

7.3.14.6 Expected Benefits and Targeted Measurable Objectives

Based on TID's operational records of historical diversions into Cameron Creek, conveyance losses (seepage infiltration) upwards of 25 percent have been recorded. With the presence of check structures and more frequent use of the channel for recharge purposes, higher seepage rates and resulting groundwater recharge can be anticipated. As design and operations analyses become more refined, project benefits can be better estimated. The measurable/optimal objectives to be partially met with this project include groundwater level stabilization and, by proxy, groundwater storage stabilization and reduction in land subsidence rates. Reduced water quality degradation is anticipated as well, as it is generally accepted that high-quality, low-TDS runoff from the Sierra Nevada sources

(Kaweah and San Joaquin Rivers) improves groundwater quality and has historically had a dilution effect on the unconfined aquifer layer over which Cameron Creek traverses.

7.3.15 *Packwood Creek Water Conservation Project*

7.3.15.1 Description

This project, a joint effort of the City of Visalia, TID, and the KDWCD, consists of improvements to the existing Oakes Basin for habitat enhancement and the placement of four automated check structures within Packwood Creek northeasterly of Visalia. Supervisory Control and Data Acquisition (SCADA) retrofits to an existing check structure are also part of this project. The creek can be fed with flows re-diverted from the Lower Kaweah River and from the Friant-Kern Canal farther upstream into the river system. The check structures operate to maintain a designated flow while keeping water levels higher to maximize streambed and bank pools' recharge surface area between structures.

New Automated Check Structure in Packwood Creek

7.3.15.2 Status of Implementation

The project was completed in 2015 and has been utilized for recharge purposes since that time.

7.3.15.3 Permitting and Regulatory Compliance

All environmental permits and other necessary compliance actions have been completed. For CEQA purposes, the project was approved under a Mitigated Negative Declaration; for NEPA purposes under a FONSI.

7.3.15.4 Water Sources and Legal Authority

The project proponent KDWCD, as a water conservation district in California, has the authority to pursue projects for groundwater management purposes. Water re-diverted into the creek stems from either the Kaweah River system or the Friant Unit of the CVP. Both KDWCD and TID possess appropriative rights to Kaweah River water and contract entitlements to CVP water. The city can and has, from time to time, purchased local Kaweah River water and CVP water for recharge purposes. TID possesses the rights-of-way for the Packwood Creek channel, and KDWCD and the city maintain the various reaches of the creek channel along its upper reaches. When not in use by the city for recharge purposes, KDWCD, a member of a neighboring GSA, may also use the channel and appurtenant facilities for groundwater recharge.

7.3.15.5 Project Costs and Funding

The entire project, including the habitat improvements to the Oakes Basin and all SCADA equipment and appurtenances, cost $1.6 million. Of this total, $800,000 was provided by a USBR WaterSMART grant and the balance from Visalia/KDWCD/TID funding sources. Ongoing O&M costs are anticipated to be minimal and within the associated budget of TID for SCADA system maintenance.

7.3.15.6 Expected Benefits and Targeted Measurable Objectives

Constrained only by the frequency of surplus flow conditions as referenced in Section 7.2 and its intake capacity, the project's total accrued benefits (via increased groundwater in storage) through the 50-year Planning and implementation horizon are estimated at 73,250 AF, with average annual benefits at 1,465 AF/year. It is assumed that half of these benefits are commingled with the benefits being achieved under the Visalia/TID exchange described in Section 7.3.9, thus the net benefits of this project would amount to 36,620 AF over the Planning and implementation horizon and 730 AF/year. The measurable/optimal objectives to be partially met with this project include groundwater level stabilization and, by proxy, groundwater storage stabilization and reduction in land subsidence rates. Reduced water quality degradation is anticipated as well, since it is generally accepted that high-quality, low-TDS runoff from the Sierra Nevada sources (Kaweah and San Joaquin Rivers) improves groundwater quality and has historically had a dilution effect on the unconfined aquifer layer over which the creek generally traverses.

As described in the Coordination Agreement, the KSB computer model has been used to simulate the water-level rise afforded by a generic representation of projects and management actions of the Subbasin GSAs. Future simulations will aid with assessing water-level benefits of this project, both locally and regionally within the GSA. These model simulations may be done in conjunction with other planned projects and management actions to better ascertain benefits in the aggregate.

7.3.16 *Visalia Eastside Regional Park & Groundwater Recharge*

7.3.16.1 Description

This project to be built by the City of Visalia consists of a 250-acre park featuring diverse recreational opportunities, native plants, wildlife habitat, and integrated groundwater replacement and storm water retention facilities. The dedicated groundwater recharge element is planned to encompass upwards of 50 acres. The park is sited in the northeast region of the city and is traversed by several ditches and channels that will feed the recharge element of the facility. A groundwater education center is planned for the park.

7.3.16.2 Status of Implementation

A park master plan is being developed through the input of a task force of a diverse group of stakeholders. The park is anticipated to be completed by 2022. Public workshops have been held to vet the park concepts and various features.

7.3.16.3 Permitting and Regulatory Compliance

Visalia will be pursuing all necessary permits and compliance with CEQA needed for a functioning park and recharge facility.

7.3.16.4 Water Sources and Legal Authority

The water to be devoted to the park's recharge facility will come from both the exchange return flows from TID's CVP supplies (see Section 7.3.9) as well as Kaweah River sources acquired on an annual basis by the city. As a chartered city, Visalia has all necessary authorities to construct the park facility and acquire water for recharge purposes.

7.3.16.5 Project Costs and Funding

The entire project is estimated to cost $1.74 million, with $1.57 million awarded to the city from the Watershed and Urban Rivers allocation from Prop 1 and the balance from the city. Additional funding may also come from the state's Land and Water Conservation Fund administered by California State Parks.

7.3.16.6 Expected Benefits and Targeted Measurable Objectives

Constrained only by the frequency of surplus flow conditions as referenced in Section 7.2 and its intake capacity, the project's accrued benefits (via increased groundwater in storage) through the 50-year Planning and implementation horizon are estimated at 95,000 AF, with average annual benefits at 1,910 AF/year. It is assumed that half of these benefits are commingled with the benefits being achieved under the Visalia/TID exchange described in Section 7.3.9, and thus the net benefits of this project would amount to 47,500 AF over the planning and implementation horizon and 950 AF/year. Maximum recharge capability in wet years is estimated to be 4,300 AF. The measurable/optimal objectives to be partially met with this project include groundwater level

stabilization and, by proxy, groundwater storage stabilization and reduction in land subsidence rates. Reduced water quality degradation is anticipated as well, as it is generally accepted that high-quality, low-TDS runoff from the Sierra Nevada sources (Kaweah and San Joaquin Rivers) improves groundwater quality and has historically had a dilution effect on the unconfined aquifer layer over which the park resides.

As described in the Coordination Agreement, the Kaweah Subbasin computer model has been used to simulate the water-level rise afforded by a generic representation of projects and management actions of the Subbasin GSAs. Future simulations will aid with assessing water-level benefits of this project, both locally and regionally within the GSA. These model simulations may be done in conjunction with other planned projects and management actions to better ascertain benefits in the aggregate.

While not a SGMA-defined measurable objective, this project will also provide new habitat associated with surface water periodically ponded in the recharge facility. Water would typically be present during the winter and early spring months, and presumably during times when both migrating and local water fowl would benefit from the water and vegetative habitat around the facility's perimeter.

7.3.17 *Groundwater Recharge Assessment Tool*

7.3.17.1 Description

Since 2016, TID, along with Madera ID, has been working with Sustainable Conservation in the development of its GRAT. GRAT is an online tool that helps assess the potential for various recharge activities and locations within an area of study. The tool allows for assessment of on-farm recharge, fallowing, and recharge basin development based on various criteria, such as access to conveyance facilities, soil types, recharge potential, and retention for continued usage. TID intends to use this tool to enhance the capabilities of the various projects and programs for groundwater recharge, irrigation demand reduction, and SGMA compliance. Shown on **Figure 7-2** is a home screen of the GRAT computer software application.

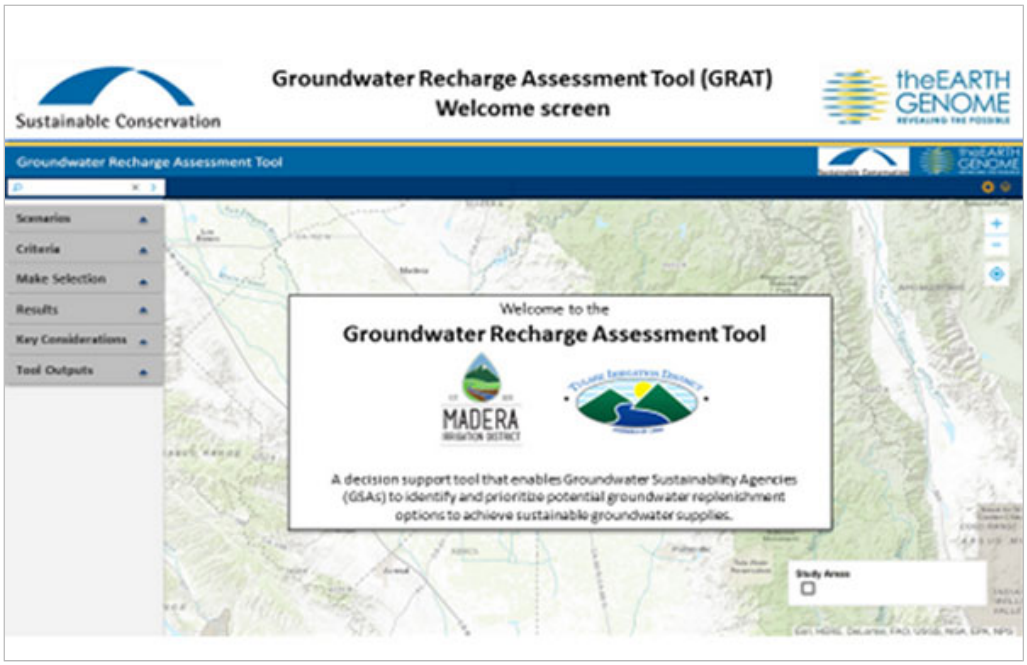


Figure 7-2: Groundwater Recharge Assessment Tool

7.3.17.2 Status of Implementation

GRAT is essentially complete, with periodic updates to add additional features being considered by Sustainable Conservation.

7.3.17.3 Permitting and Regulatory Compliance

No permits or other regulatory considerations are necessary for application of GRAT, since it is an aid for reconnaissance purposes only.

7.3.17.4 Water Sources and Legal Authority

GRAT does not involve the commitment or diversion of water.

7.3.17.5 Project Costs

Being one of two pilot project locations for the development of GRAT, no costs have been incurred to-date. However, an annual subscription fee upwards of $10,000 may be required in the future as Sustainable Conservation continues to expand upon and refine the tool.

7.3.17.6 Expected Benefits and Targeted Measurable Objectives

Use of GRAT in the identification, prioritization, and optimization of numerous on-farm participants and potential recharge basins is expected to identify those locations that offer maximum delivery conveyance capacity and optimal infiltration characteristics. The individual projects selected using GRAT will determine the estimated benefits to be provided, along with the associated measurable objectives to be met with their implementation.

7.3.18 *TID Existing Recharge Capacity Evaluation*

7.3.18.1 Description

TID from time to time has considered alternative maintenance practices for its sinking basins utilized throughout the district for canal flow regulation and groundwater recharge. A total of 15 basins encompassing some 1,400 acres represent the extent of these facilities. A series of reports has been compiled in the recent past by the district to more formally address ways by which recharge in these existing facilities may be increased and optimal infiltration rates be sustained over time.

With the passage of SGMA, a more robust analysis of this valuable recharge capacity within the district was undertaken and culminated in the report "Groundwater Recharge Capacity Evaluation Phase III: Hydrogeologic Investigations to Maximize Recharge Capacity," (Report) completed in February 2018 and included herein as **Appendix 7A**. In addition to recharge basins, the Report looked at optimizing the district's extensive system of unlined conveyance facilities and on-farm programs to increase aquifer recharge in wet seasons.

7.3.18.2 Status of Implementation

TID is evaluating the extensive recommendations of the subject Report and addressing the timing and funding needs to proceed with implementing some or all of the recommendations. Given this situation, the implementation of chosen system improvements will be identified during the GSP five-year assessment and annual update periods where appropriate.

7.3.18.3 Permitting and Regulatory Compliance

Most of the recommendations contained in the Report deal with maintenance efforts and operational actions for existing facilities. TID routinely undertakes O&M practices on a regular basis on all its facilities, and it has concluded that no additional permits or regulatory compliance are necessary. For any basin expansions or extensions to such facilities, any necessary construction permits and CEQA compliance will be pursued prior to construction.

7.3.18.4 Water Sources and Legal Authority

Like other projects described in Section 7.3, all water diverted into existing facilities stems from TID's appropriative rights to Kaweah River water and contract rights to CVP water from the Friant Unit and, as such, does not impose impacts on third parties.

7.3.18.5 Project Costs and Funding

As specific maintenance practices or facility improvements are identified, the associated costs will be estimated as well, and a determination will be made as to whether they can be absorbed as part of the District's ongoing annual O&M budget funding practices or whether capital funding is necessary.

7.3.18.6 Expected Benefits and Targeted Measurable Objectives

As specific O&M recommendations are selected and ready for implementation, estimates will be made of the additional groundwater recharge that may result therefrom. The measurable/optimal objectives to be partially met with this project include groundwater level stabilization and, by proxy, groundwater storage stabilization and reduction in land subsidence rates. Reduced water quality degradation is anticipated as well, since it is generally accepted that high-quality, low-TDS runoff from the Sierra Nevada sources (Kaweah and San Joaquin Rivers) improves groundwater quality and has historically had a dilution effect on both the unconfined and semi-confined aquifer layers.

7.3.19 *Future Project Funding by Members*

The MKGSA Members, by policy, have agreed to pay for administration and planning activities on a one-third basis through June 2020, the end of the GSA's fiscal year immediately following the plan's submittal deadline. During GSP implementation, and in recognition of MKGSA's water budget role and its segregation into the respective Member Management Areas as described in Section 2.5 of this Plan, the GSA Board adopted the following "Sustainability Plan Cooperative Statement" at its August 2018 regular meeting:

> *"Objectives: In compliance with SGMA, the MKGSA Members will strive to (a) identify strategies to avoid agricultural land retirement, (b) create opportunities for city Members to satisfy water demands in UWMPs and in General Plan/RHNA obligations, (c) preserve adequate groundwater supplies for unincorporated communities and schools and (d) define responsibilities for Projects & Management Actions in their GSP.*
>
> *In furtherance of these Objectives, the Members will support a Kaweah Sub-Basin and internal Management Area water budget apportionment, as well as sustainable management criteria and associated projects and management actions for its GSP, to provide the most opportune ability to both realize the urban General Plan growth projections of the cities of Visalia and Tulare and ensure the sustainability of agricultural production acreage and supporting communities within the Tulare Irrigation District. Notwithstanding their differing water rights, supplies and apportionment of the Kaweah Sub-Basin water budget as among the East, Greater and MKGSAs, the Members are committed to shape and distribute this water budget in a fashion to achieve these Objectives."*

The MKGSA water budget as set forth in Section 2.2 has been further apportioned among the Members (City of Visalia, City of Tulare and Tulare Irrigation District) and described in Section 6.3 elsewhere in this Plan. The Member jurisdictional areas are identified as Management Areas as delineated in Section 2.5. In addition, the Members have negotiated the role that the various water management agreements among them, all executed prior to the passage of SGMA and identified in Section 1.2, play in this apportionment. As of January 2020, the preliminary participation level by the Members in each of the future projects and programs as summarized herein in Section 7.3 is set forth as follows:

Tulare ID	33.3%
City of Tulare	33.3%

City of Visalia 33.3%

The participation levels as indicated may change during implementation pending further discussions among the Members. Each Member will determine the nature of its capital funding needs for the Projects and whether Prop 26 or Prop 218 provisions are to be complied with.

In addition to local Member financial contributions to projects, additional grant funds may be forthcoming. Both cities and TID remain attentive to upcoming state and federal grant funding opportunities. Prop 68 contains some $100 million for GSP implementation efforts, and it is the intent of this GSA and the Subbasin GSAs as a whole to pursue this upcoming opportunity. TID has had success in the past in garnering federal grant funding for water management projects, and USBR's WaterSMART program continues to be available to federal contractors for groundwater recharge and other water management/efficiency projects. Other grant funding sources include USBR's Part III Investment Strategy Program as part of the Water Management Goal of the San Joaquin River Restoration Program and state funding to be made available in the future from the IRWM and possibly Flood-MAR programs.

7.4 Management Actions

The management actions as described below are arranged in the following order: An extraction measurement, allocation, and marketing programs; geophysical survey project; urban and agricultural conservation programs; and a well-owner assistance program. The description, its implementation circumstances and status, public noticing, permitting and regulatory compliance, water sources and legal authority, program costs and funding, and benefits are all discussed for each Action individually and address §354.44(a) and (b)(1)-(8) of the Regulations.

7.4.1 *Extraction Measurement Program*

7.4.1.1 Description

Within the GSA, all extractions by two of the Members, i.e., the cities of Tulare and Visalia, are fully metered and groundwater extractions and associated constituent levels are reported at least annually to the SWRCB. However, extraction measurements by private well owners within TID, the third GSA Member, have not been heretofore required. Extractions from these wells, primarily for irrigated agricultural operations, must now be reported in the aggregate annually to the state according to §10728 and measured according to §10725.8 of SGMA.

TID plans to initiate a pilot program to determine the most feasible means of complying with SGMA's measurement provision. The measurement alternatives and data processing methods to be evaluated are as depicted on **Figure 7-3**.

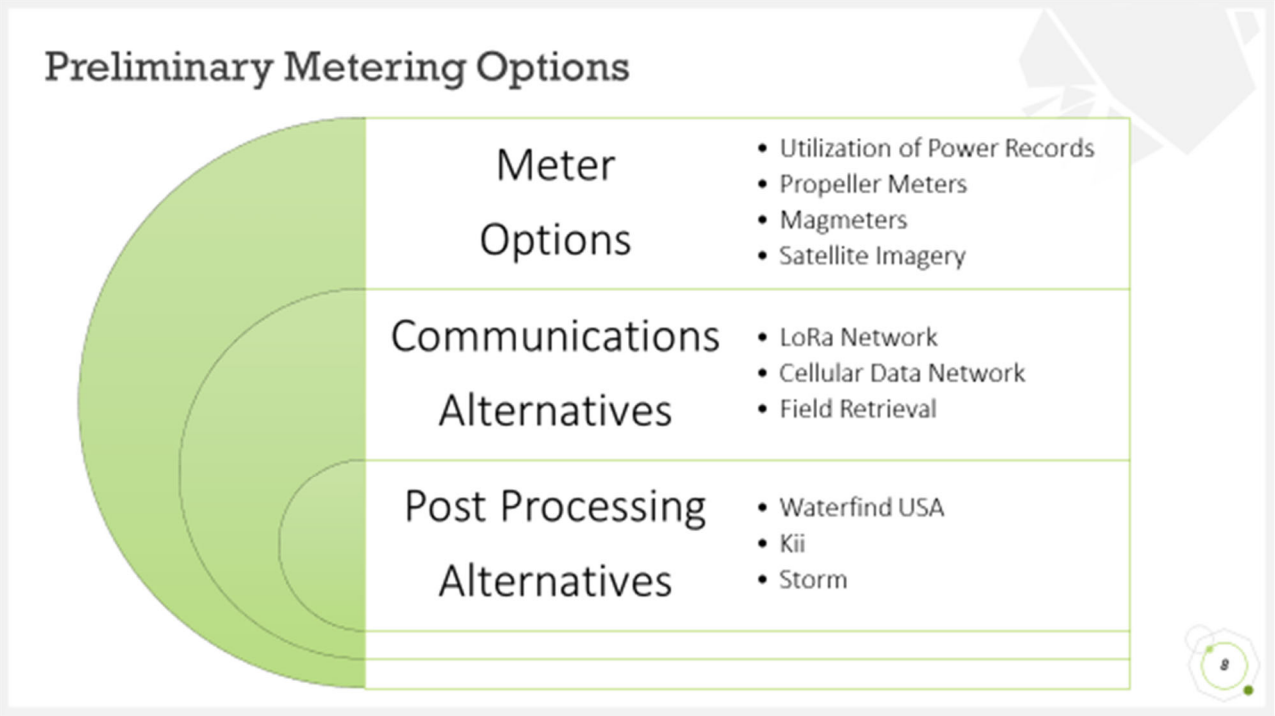


Figure 7-3: Data Measurement Alternatives

7.4.1.2 Status of Implementation

Commencing in July 2017 TID conducted a survey of all agricultural wells within the District. The survey was conducted from the vantage point of public roads; access on private property to obtain a more accurate count was not undertaken. The survey results are summarized below:

Table 7-2: Summary of TID Well Survey Results, July 2017

	6”	8”	10”	12”	Unknown	Total
Groundwater Well Discharge Sizing (estimated)	92	292	204	12	177	777

Given the large number of deep wells, TID intends to assess the optimal and cost-effective means to measure extractions during the period 2020 to2022. The four fundamental options identified are (a) satellite imagery for evapotranspiration (ET) measurements, (b) utilization of energy records and pump/motor characteristics, (c) propeller meters, and (d) Magmeters. Options for data acquisition from the field data include visual readings by District staff or use of LoRa or cellular networks for remote access. Post-processing of collected data may be done by utilization of one of several vendor software applications, including Waterfind USA, Kii, or STORM.

With results in hand by 2022, and in conjunction with grower/stakeholder outreach on the findings, TID plans on initiating a measurement installation program with the intended completion date of 2025.

7.4.1.3 Permitting and Regulatory Compliance

Authority for groundwater measurement collection and processing resides within SGMA as previously cited. It is not anticipated that additional permitting or regulatory reliance will be necessary to implement a pilot-level program or to scale up to full coverage within the GSA by 2025.

7.4.1.4 Water Sources and Legal Authority

Legal authority for this program is as previously cited in Section 7.4.1.1. In addition, this program will be in compliance with the monitoring protocols required by Water Code §10727.2 and § 354.32-354.34 of the Regulations.

7.4.1.5 Program Costs and Funding

Costs for a chosen means to measure groundwater extractions within TID 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 associated with individual measurement devices are to be borne by the well owner/operator, so the cost exposure to TID and/or the GSA in implementing a measurement program is not known. Since the city GSA Members already fund and operate extraction metering facilities, the costs associated with an extraction measurement program as described herein lie primarily with TID.

7.4.1.6 Expected Benefits and Targeted Measurable Objectives

The primary benefit of any measurement program will be for compliance with SGMA mandates. Further, improved knowledge regarding extraction volumes and their seasonal timing will add to the knowledge base of the aquifer and should aid in improving the Subbasin numeric model's predictive capabilities and future groundwater management in general.

7.4.2 *Groundwater Extraction Allocation Implementation*

7.4.2.1 Description

In accordance with SGMA §10726.4, a GSA has the authority to regulate groundwater extractions and impose an allocation mechanism. This will be a major step to be undertaken by any GSA, and the ability to monitor and enforce such an allocation program must first be in place. As has been implemented in adjudicated basins elsewhere in the state, allocations may be done in various ways and based on key well water levels or by other means. As set forth in Section 5, allocation limits may be triggered by deviation from the GSA's measurable objectives as defined therein.

7.4.2.2 Status of Implementation

As identified in GSP Section 2.4, the MKGSA's water budget shortfall is estimated to be fairly negligible. Using the current conditions historical period of 1997 to 2017, a surplus water balance as described in Section 6.2 is in fact inferred based on preliminary water accounting framework analyses summarized in that section. Despite the water balance surplus, as evidenced in Section 2

(Basin Setting **Appendix 2A**), groundwater levels and storage have been in decline within the Mid-Kaweah area, and hydrogeologic evaluations will continue to determine the reason(s) for the differences between the water balance surplus and the conditions of decline. Accordingly, discussions with neighboring GSAs in the subbasin are ongoing and an arrangement to apportion responsibilities in achieving sustainable yield will continue during the first five-year GSP assessment.

Most of the project descriptions identified in Section 7.3 include a target completion date and supportable estimation of benefits, i.e., future projects that will improve the GSA water balance. Those quantified benefits, on average, amount to at least 18,000 AF per year by the year 2025, and over 20,000 AF by 2031. Since these accumulated additions to groundwater in storage over time exceed the shortfall, it is not known at present if and when an allocation program will be necessary and to what degree. However, during the period 2020 to 2025, MKGSA will develop its most significant management action, i.e., implement a pumping allocation program to the degree necessary to achieve, in concert with neighboring GSAs, the Subbasin's sustainable yield by 2040. The design effort will include an educational component, whereby GSA officials will learn more from those adjudicated and managed basins in Southern California on their allocation and pumping restriction policies as they relate to safe yield. It will also entail a full stakeholder outreach program such that well owners will be afforded the opportunity to provide input on the proposed implementation of the program.

By 2025, improved monitoring will be in place, a measurement program will be ready for use, and an enforcement program, including civil penalty authorities as granted in SGMA §10732 may likewise be adopted by the GSA Board along with the associated capabilities for its implementation. This five-year time interval is needed as well to plan, design, and permit the several recharge projects and programs identified in Section 7.3. By 2026, it is anticipated that any necessary allocation plan and its operation across wet, average, and dry years would be ready for implementation depending on the success of the aforementioned projects and programs.

These numerous projects/programs are prioritized to serve as the first means to achieve sustainability and minimize any adverse economic impacts, and to better address the four applicable undesirable results named in Section 3. However, the GSA and its numerous stakeholders are well aware that, with the onset of an extended drought or other limitation imposed on available surface water supplies, an allocation program that imposes limits on extractions will need to be established and implemented in order to maintain the measurable objectives set forth in this Plan's Section 5.

7.4.2.3 Permitting and Regulatory Compliance

Any permitting or other regulatory compliance needs, all in furtherance of SGMA §10726.4, will be identified and pursued during the first five years of GSP implementation. Consistent with SGMA 10730(a), this initial phase of an allocation program shall exclude those well owners who extract less than two AF per year (i.e., de minimis extractors).

7.4.2.4 Water Sources and Legal Authority

Legal authority for a groundwater allocation or pumping restriction program is grounded in SGMA §10726.4 and further articulated in §354.44(b)(2) of the Regulations.

7.4.2.5 Program Costs and Funding

Costs to implement an allocation program are not known at this time; however, it is likely that enforcement of such a program will require increased GSA staffing. Funding would be provided by each GSA Member implicated in an allocation mechanism and its implementation.

7.4.2.6 Expected Benefits and Targeted Measurable Objectives

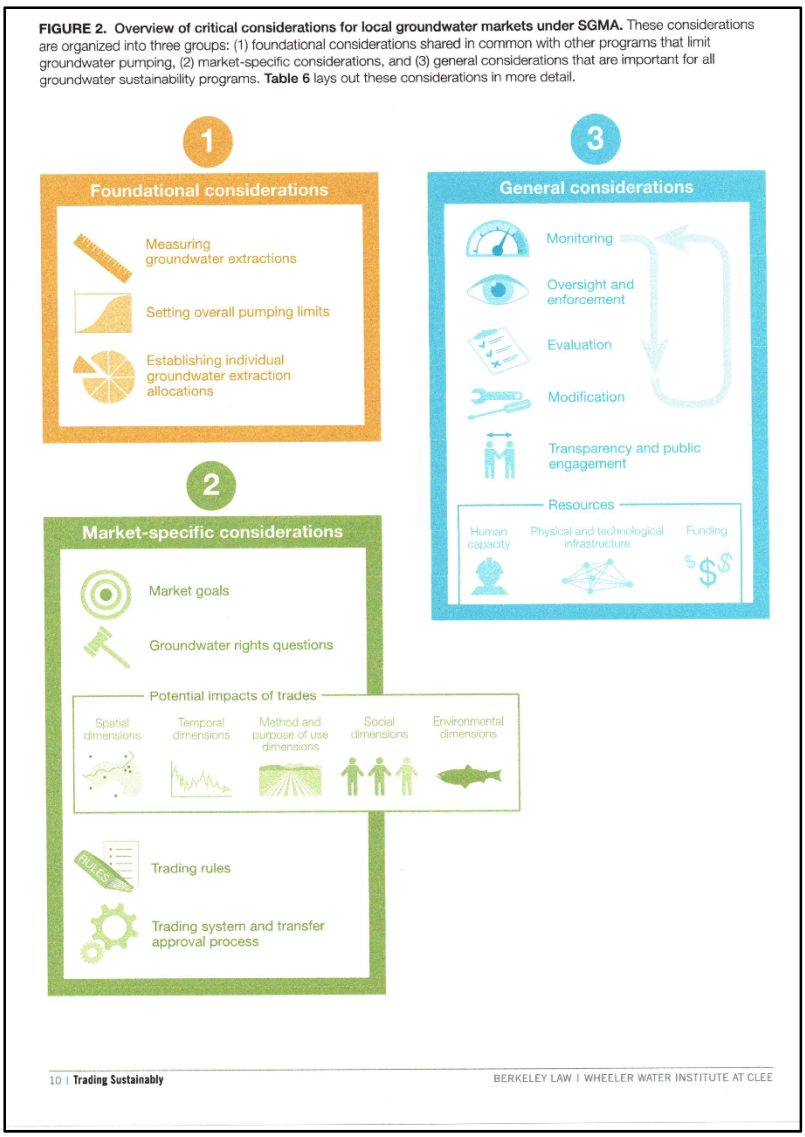
The primary benefit of this program will be the achievement of sustainable yield by 2040, thereby eliminating all undesirable results by that time. The measurable objectives to be fully met with this allocation program, along with the projects identified in Section 7.3, include groundwater level stabilization and, by proxy, groundwater storage stabilization and reduction in land subsidence rates. Reduced water quality degradation is anticipated as well, since it is generally accepted that high-quality, low-TDS runoff from the Sierra Nevada sources (Kaweah and San Joaquin Rivers) improves groundwater quality and has historically had a dilution effect on both the unconfined and semi-confined aquifer layers.

7.4.3 *Groundwater Marketing Program*

7.4.3.1 Description

During the planning phase for certain of the projects identified in Section 7.3 and a groundwater allocation program outlined in this section, MKGSA intends to consider the acceptance and feasibility of a voluntary marketing program. With the existence of a groundwater allocation program and suitable measurement program, MKGSA would then be in a position of administering the marketing program within the confines of the GSA. The program could consist of temporary or permanent transfers of 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.

A number of academic and Non-Governmental Organization (NGO) evaluations of feasible marketing mechanisms are ongoing, and an example schematic of considerations for such a market is articulated in Figure 2 of UC Berkeley's Center for Law, Energy and the Environment's report "Trading Sustainably: Critical Considerations for Local Groundwater Markets Under the Sustainable Groundwater Management Act" (UC Berkeley, 2017).



Source: UC Berkeley

It is these various types of considerations that must be vetted with groundwater rights holders and other stakeholders for a marketing program to be successfully implemented.

7.4.3.2 Status of Implementation

During the period of 2020 to 2025, the GSA will continue with its consideration of a functioning groundwater market within the GSA. Stakeholder involvement will be key to this endeavor, particularly among agricultural pumpers, thought to be the primary sellers/lessors in such a program. While smaller in volume and participation levels, the two city Members of the GSA may be involved as well.

Prior to any marketing program's implementation, a fine-scale extraction measurement data collection protocol will be needed, as will an allocation determination per well owner to establish water volumes with which to trade or sell among groundwater rights holders.

The GSA and its Members will continue the dialogue initiated with several entities who possess experience in water markets to determine how they may assist in its design, including communications and outreach with stakeholders. Considerations will include mechanisms to ensure that non-participating stakeholders are not adversely impacted by the existence of the program. By 2027, any marketing program so devised would be ready for implementation.

7.4.3.3 Permitting and Regulatory Compliance

Any permitting or other regulatory compliance needs deemed necessary to implement and administer a marketing/transfer program, all in furtherance of SGMA §10726.4, will be identified and pursued during the first five years of GSP implementation.

7.4.3.4 Water Sources and Legal Authority

Legal authority for a groundwater marketing and transfer program is grounded in SGMA §10726.4. The water source will be limited to groundwater allocations as assigned on an annual or permanent share basis.

7.4.3.5 Program Costs and Funding

Detailed costs to implement a marketing/transfer program are not known at this time; however, it is likely that administration of such a program will require increased GSA staffing. Funding for the program would be provided by all Members given the current assumption that all may be participants.

7.4.3.6 Expected Benefits and Targeted Measurable Objectives

The primary benefit of this program will be to provide groundwater rights holders options in the management of their groundwater assets. With the ultimate cessation of unlimited access to groundwater for beneficial uses (notwithstanding quality or depth considerations), these water rights holders may find that alternatives allowing for the transfer of limited allocations may prove attractive in a robust and properly functioning market. While such a program will not add to the GSA's overall groundwater balance/budget, it may well encourage the distribution of allocations in the most economically efficient manner. Adding no new supply or additional pumping restrictions within the GSA as a whole, it is assumed that this program will not measurably aid in meeting any of the measurable objectives as defined in this GSP.

7.4.4 *Subbasin Geophysical Data Survey Project*

7.4.4.1 Description

TID served as a pilot program for hydrogeological subsurface data collection using electromagnetic geophysical methods (via a company called SkyTEM) in the fall of 2015. This innovative airborne survey method acquires deep aquifer resistivity data to better ascertain its characteristics and geology. The work was arranged and funded by Stanford University with some administrative oversight by TID staff. The data collection was done by means of helicopter fly-overs along pre-

selected flight lines within TID, a process known as airborne electromagnetic surveying (AEM). 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 has developed. The instrumentation used in the fly-over transects is depicted on **Figure 7-4**.

TID and Stanford University are collaborating on the acquisition of a towable electromagnetic imaging system called TowTEM that measures the resistivity of soils at shallow depths of 100 ft or less. The resistivity information that is gathered is correlated to soil types and the output is a three-dimensional model of sediment textures.

The district is planning on using this information, in partnership with Stanford University, to determine areas that are best suited for groundwater recharge activities. This would take the form of identifying areas where potential recharge basins could be constructed or where on-farm recharge programs would yield the highest infiltration rates.

Stanford has also obtained a grant from National Academy of Sciences to integrate InSAR ground displacement data with AEM techniques to improve groundwater modeling tools for the Kaweah Subbasin (see Stanford proposal in **Appendix 7B**).

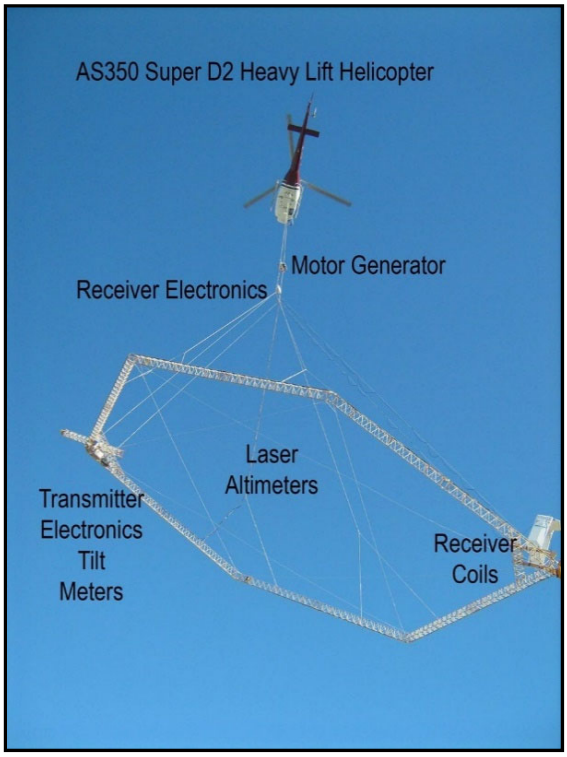


Figure: 7-4: Airborne survey instrumentation

Additional data collection has now been completed (November 2018) for the Kaweah Subbasin under a new pilot program, one of four in the state proposed by Stanford University. As with the 2015 effort, data processing is being undertaken by Aqua Geo Frameworks in partnership with SkyTEM.

It is recognized that this additional data collected will enhance the understanding of the Kaweah Subbasin and its underlying aquifer characteristics, assist with the Basin Setting and Hydrogeologic Conceptual Model as necessary elements of GSPs, and provide new calibration parameters for the Subbasin numerical simulation model. The project will also provide direct benefits to the GSAs and landowners that overlie the proposed new flight lines, providing detailed subsurface information not previously available to those areas and landowners.

7.4.4.2 Status of Implementation

The fly-over data collection effort has been completed. Post-processing of the electromagnetic data into depictions of aquifer layers and geology is now underway, and the final report compiling all data and mapping is included as **Appendix 7C**.

Regarding the TowTEM Project, Stanford University has identified about 50 percent of the funding necessary to acquire the equipment and TID is working on the remaining 50 percent. TID and Stanford hope to purchase the equipment by the end of 2019 and have staff trained to operate the system by early 2020.

7.4.4.3 Permitting and Regulatory Compliance

All necessary permits for the project, including an FCC license due to electromagnetic wave signals, were acquired by SkyTEM.

7.4.4.4 Water Sources and Legal Authority

Not applicable.

7.4.4.5 Project Costs and Funding

The costs for the project are being 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 consultant(s)

7.4.4.6 Expected Benefits and Targeted Measurable Objectives

The anticipated benefits of this project include enhanced knowledge of the subbasin's geology and a more robust hydrogeologic conceptual model (HCM) description as a result. It is further anticipated that the data and resultant three-dimensional mapping will aid with the subbasin numerical model's predictive accuracy and in siting recharge projects and dedicated monitoring wells across the region for optimal and targeted recharge benefits. 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. Measurable objectives anticipated to be better met by virtue of this improved knowledge and resulting project planning would include groundwater level stabilization and, by

proxy, groundwater storage stabilization and reductions in land subsidence rates; reduced water quality degradation may result as well.

7.4.5 *Well Characterization Project*

7.4.5.1 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 local lithography and well production zones. Well flow/quality profiling would be used where appropriate to help determine vertical distribution of flows from aquifer zones contributing to pumping and associated water quality.

7.4.5.2 Status of Implementation

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.

7.4.5.3 Permitting and Regulatory Compliance

Not applicable.

7.4.5.4 Water Sources and Legal Authority

SGMA, in §10725.2, allows GSAs to pursue various means to improve its understanding of the subbasin and producing wells therein. It is this general authority under which this project will be undertaken.

7.4.5.5 Project Costs and Funding

Costs associated with this project will be defined during the early stages of GSP implementation. An appropriate fee collection structure from GSA members will be determined during that time.

7.4.5.6 Expected Benefits and Targeted Measurable Objectives

Expected benefits from this project include improved understanding of groundwater production from wells within the GSA 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. Measurable objectives are anticipated to be better met by virtue of this improved knowledge and incorporation into the Subbasin numeric model would include groundwater level stabilization and, by proxy, groundwater storage stabilization and reduced water quality degradation.

7.4.6 *Urban Water Conservation*

7.4.6.1 Description

As referenced in Section 2.5.1.4 of the subbasin Basin Setting document, 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 is to be capped at 55 gallons per capita per day (gpcd) in 2019 and ramped down to 50 gpcd by 2030, and outdoor residential use is to be capped in the future based on local climate and size of landscaped areas. Standards for outdoor usage are to be defined in a SWRCB rule-making process to be completed by June 2022.

7.4.6.2 Status of Implementation

The cities of Tulare and Visalia 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 two cities presently are complying with the 20X2020 mandates contained in SB 7X-7 and as embodied in their respective Urban Water Management Plans (UWMPs). As the SWRCB establishes its compliance deadlines for both indoor and outdoor usage, anticipated to occur by 2025, the two city GSA Members will have a clearer picture of an implementation schedule.

7.4.6.3 Permitting and Regulatory Compliance

Urban water conservation compliance currently derives from SB7X-7 passed in 2009 (Water Conservation Act of 2009), and the UWMPs of both Tulare and Visalia, along with associated ordinances, reflect that Act's mandates of a 20 percent reduction in urban per capita water usage by 2020. 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 ordinances of both cities will eventually embody these recent laws.

7.4.6.4 Water Sources and Legal Authority

As stated in Section 7.4.6.3, legal authorities for any additional urban water conservation will be as derived from the passage of AB 1668 and SB 606.

7.4.6.5 Program 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.

7.4.6.6 Expected Benefits and Targeted Measurable Objectives

Given the early implementation stages of AB 1668 and SB 606, its benefits in terms of reduced groundwater pumping by Tulare and Visalia can only be roughly approximated. The Pacific Institute, in its 2014 report "Urban Water Conservation and Efficiency Potential in California"

estimated 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 values are on a statewide basis and likely unrealistic in some regions; however, the report postulates that total urban water usage could be reduced by as much as 30 to 60 percent. Savings of this magnitude would represent a significant reduction in groundwater pumping by both cities. The measurable objectives to be partially met with additional urban conservation include groundwater level stabilization and, by proxy, groundwater storage stabilization.

7.4.7 *Agricultural Water Conservation and Management*

7.4.7.1 Description

TID, as the single member of the GSA providing agricultural water service, complies with all provisions of SB 7 (amending Division 6, Part 2.55 of the Water Code) passed into law in November 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.

7.4.7.2 Status of Implementation

Most provisions of the conservation laws are being complied with by TID. 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 the district for submittal to DWR. The District is in conformity with accuracy limits as established by the state based on a measurement verification program conducted by the Irrigation Training & Research Center (ITRC) at Cal Poly San Luis Obispo.

7.4.7.3 Permitting and Regulatory Compliance

Regulatory compliance resides with those provisions of SB7, AB 1668, and SB 606 now codified into state law.

7.4.7.4 Water Sources and Legal Authority

As an irrigation district per Division 11 of the California Water Code, TID is empowered with ensuring the beneficial use of all water thereby furnished.

7.4.7.5 Program Costs and Funding

Costs for water management plan report preparation and submittals are ongoing for TID, and any future costs related to surface water measurement compliance and associated funding would be borne by that district.

7.4.7.6 Expected Benefits and Targeted Measurable Objectives

There are no direct benefits to be derived and quantified from compliance with the aforementioned agricultural conservation laws at the present time. TID will continue to divert for beneficial use all local and imported water supplies to which it is entitled. Should agricultural demands for irrigation water diminish as a result of some of the conservation provisions, a larger portion of diverted supplies by TID will be devoted to groundwater recharge in the future.

7.4.8 *Assistance for Small Water Systems, Domestic Wells*

7.4.8.1 Description

As discussed in Section 5 of this Plan, the measurable objectives for groundwater levels infer a lowering of levels over time until the sustainable yield has been achieved by this GSA, the Kaweah Subbasin, and interconnected subbasins by 2040. These objectives should result in a significant reduction in the rates of decline during the GSP implementation phase as compared to pre-SGMA conditions; however, some shallow wells may experience reduced production capacity or may go dry altogether during this intervening time period. This is not something new to this subbasin or other such basins within the San Joaquin Valley and the deepening or replacement of wells over several decades has been the norm, particularly during drought periods. Nor is it an undesirable result, consistent with Section 3 of this plan, or the result of an exceedance of the minimum threshold as established for water levels in Section 5. In that section, data are presented and referred to regarding agricultural, municipal, and domestic well depths and the projected percentages thereof whose well screen intervals could end up above the minimum threshold water levels by 2040 in the unlikely event levels were to recede to such a degree.

The implementation of SGMA sets in motion the alleviation of overdraft over time and stakeholder interest in helping small-system and domestic well owners without the financial wherewithal to service or replace their pump and well facilities, particularly those that provide potable water. To address this situation, several measures are being considered by the GSA's Advisory Committee and governing board for implementation during the early stages of implementation, to wit:

Annual SGMA progress report to domestic well owners with offer of technical assistance

Funds to provide technical assistance and consultation for well repairs and/or replacements

Education on RO installation options

Periodic and targeted water quality testing for selected domestic wells with owner permission

A determination by the GSA to not regulate any de minimis extractor, i.e., any well owner pumping two acre-feet or less annually

For rural school district wells and small community water systems, a fund to aid with well rehab/replacement for continued access to groundwater

None of the aforementioned assistance measures have been approved to be carried out. Further, an economic analysis to evaluate these and any other assistance measures that may be envisioned in the future will be forthcoming prior to any actions being taken by the GSA Board to effectuate any of them. The Advisory Committee has agreed to the following to begin within the early years (before 2025) of implementation:

- Complete a well identification and characterization study. This study will locate active wells, determine total well depth and depth to groundwater and should be given a high priority for completion.
- Implement a well registration program and only owners of registered wells would be eligible for assistance. Registration would allow staff to access wells to verify well depth and depth to groundwater which will be required information to eligible for reimbursement and would also require that well owners self-report total annul pumping volume.
- Mitigation may include financial assistance in providing short-term water supply.
- Long-term water supply could include financial and technical support.
- Preference for connecting current domestic well users to a public water system where technically and economically feasible.

7.4.8.2 Status of Implementation

A database composed largely of information from Tulare County Public Works of small-system and domestic wells is being assembled and evaluated as to depth of casing and screen depth intervals. This database may be supplemented with a survey of well owners to ascertain more detailed information regarding the well and to confirm information contained in the database. Well depths are being juxtaposed with water-level trend analyses using the measurable objectives in Section 5 of this Plan to create a projection of wells that could be adversely affected during the 20-year implementation phase and candidates for technical or other assistance. This, along with an economic analysis of costs to provide such assistance, should be completed by early 2022.

7.4.8.3 Permitting and Regulatory Compliance

Some of the assistance measures described herein, e.g., installation of RO systems or water quality sampling protocol, may require certain county or other permits to be put into effect.

7.4.8.4 Water Sources and Legal Authority

Legal authority to implement any of the aforementioned assistance measures resides with the GSA's and its Members' ability to implement such actions deemed necessary to achieve its specific and limited purposes as stated in the joint powers agreement referenced in Section 1.2 of this Plan.

7.4.8.5 Assistance Costs and Funding

An economic analysis of assistance measures will be undertaken as described in Section 7.4.8.1. It is the purpose of this analysis to estimate costs associated with any such assistance measure. Funding for any assistance measure as described herein would be provided by the GSA members in a contributory fashion yet to be determined.

7.4.8.6 Expected Benefits and Targeted Measurable Objectives

The primary benefit of an assistance program for small-system and domestic well owners is to achieve broad stakeholder support for the GSA's minimum thresholds, measurable objectives, and implementation plan for projects and management actions, all as outlined in this and other sections of this Plan.

7.4.9 *Collaboration with Other Agencies*

MKGSA intends to collaborate and partner with other regulatory agencies during GSP implementation to ensure that its minimum thresholds and measurable objectives as set forth in Section 5 of this Plan are maintained and that the water quality objectives of these other entities are achieved. The means to achieve such collaboration include:

1. Provide Education and Information

    Groundwater Basin Conditions

    Funding Opportunities

    Remediation/Treatment Technologies

2. Active GSA Coordination with Water Quality Agencies and Coalitions

    Participate in meetings (salinity prioritization & optimization study, management zones) as a contributor of information, but also seeking information

    Exchange/Share groundwater quality data and information between GSAs and other groundwater quality leads

    Request information to better inform 5-year GSP updates, include data in DMS as it becomes publicly available

3. Identify, Pursue, Administer Grants in Partnership with Water Quality Agencies

Other forms of collaboration are underway as well, to and including that with NASA's Airborne Snow Observatory (ASO). Information from the ASO program centered on the Kaweah and San

Joaquin River watersheds will aid with surface water management in ways to optimize reservoir releases for irrigation demand and groundwater recharge. Having greatly improved data regarding snow pack and water content will assist surface water managers with avoiding untimely reservoir releases and spills out of the subbasin and Tulare Lake regional watershed and subsequent loss of water otherwise available for recharge.

7.5 Implementation Plan

7.5.1 *Implementation Schedule*

Shown on **Figure 7-5** is a bar chart depicting completion/implementation dates for the relevant projects and management actions as identified in this Section 7.

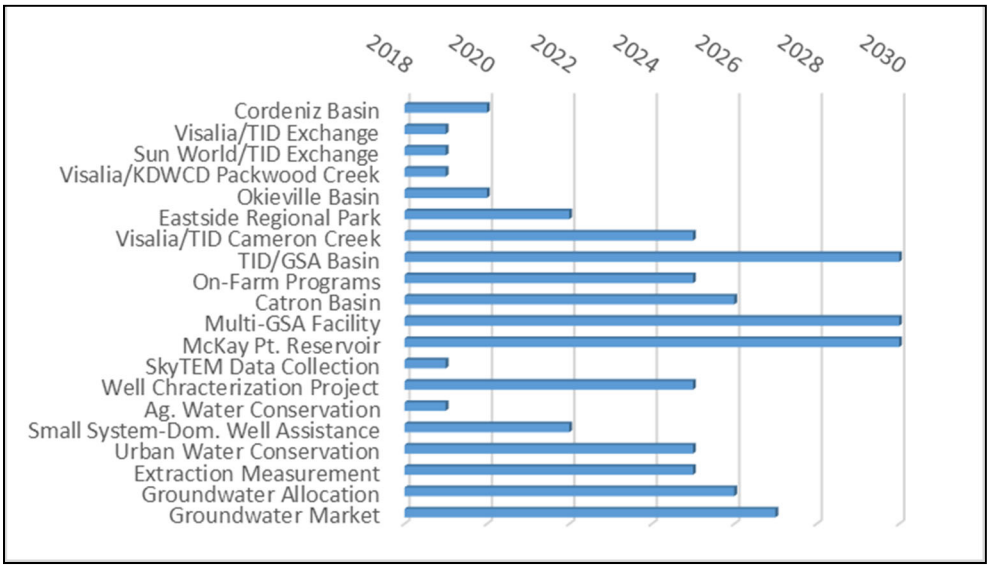


Figure 7-5: Project and Management Action Implementation Dates

As highlighted in Section 7.2 and further articulated in Section 7.5.2, the water supply availability of the Members within this GSA, coupled with this GSA's assigned share of the Subbasin water budget as articulated in Section 6 of this Plan, is such that it is reasonable to assume that implementation of targeted recharge projects as summarized in Section 7.3 will address most, if not all, of the undesirable results identified by this and other Subbasin GSAs. It is, therefore, the objective of the MKGSA that preference be given to the development and implementation of projects prior to implementation and enforcement of an extraction allocation program to achieve sustainable yield by 2040 and to ensure achievement of the sustainability goal in concert with other Subbasin GSAs during the 50-year planning and implementation horizon as called for in §354.42 of the Regulations.

In addition, it is the intent of the Members to pursue all projects described in Section 7.3 with the understanding that each will exhibit specific and targeted benefits to individual Members as well as generalized added water benefits to the GSA region. Notwithstanding this intent, some of the more facility-intensive and thus costly projects may be given a lesser priority in terms of completion

timeframes as compared to, for example, the on-farm recharge programs under evaluation by TID. Refinement of project selection criteria will occur as GSP implementation commences in 2020.

Upon implementation of this Plan and via annual reporting thereon and at five-year assessments to be provided to DWR (per §356.2(c) and 356.4 of the Regulations, respectively), this assumption regarding projects and associated objectives will be re-evaluated. Should some projects not be on-line and/or future hydrology prove inadequate to provide needed recharge supplies, the measurable objective and interim milestone triggers defined in Section 5 of the Plan will dictate more aggressive implementation of a groundwater allocation program as summarized in Section 7.4.2, in accordance with §354.44(b)(1)(A) of the Regulations.

As planning and permitting for applicable projects and management actions proceeds, the GSA shall use its Advisory Committee input, Communications and Engagement Plan, and existing stakeholder outreach efforts (all as summarized in Section 1.5 of this Plan) to inform the general public and stakeholders of the intent to pursue said projects and management actions. Similar public notification processes will be adhered to as required for CEQA and NEPA compliance where applicable for projects. The public notification process is to address §354.44(b)(1)(B) of the Regulations.

7.5.2 *Cumulative Accomplishments*

The focus of the groundwater benefits as quantified in Section 7.3 relate to water added to the groundwater budget. Commensurate increases in water levels and, for many of the projects, water quality would occur. These benefits, however, depend on other hydrogeologic factors and, in the case of water levels, are less discernable on an individual project basis. Section 5 of this Plan discusses how the MKGSA intends to address minimum thresholds and measurable objectives using empirical data, computer model output and a proxy relationship between water recharge and water level changes. Further study of these hydrogeologic factors across the Subbasin will be pursued with application of the Subbasin numerical model presented in the Basin Setting.

Based on the anticipated completion schedule and average annual groundwater benefits provided by the applicable projects, the graph on **Figure 7-6** depicts the accrual of said benefits to the GSA's water budget. Accrued benefits amount to about 25,000 AF annually by 2030 based on the assumptions employed coupled with surplus water supply availability with the projects' planned capacities which is deemed realistic as Tulare ID has access to 141,000 AF of Class 2 supplies and even in wet year is not able to fully utilize this contract supply. This is depicted in the figure by the "Cumulative Added Storage" line and reflects all projects operating at maximum capacity during wet years, which amounts to nearly 360 cfs. TID's current diversion capacity is 1,000 CFS and during the wet years our demand/recharge programs have been running about 700 CFS during the winter months. This flowrate may at times exceed the available diversion capacity (not needed for irrigation demand) of TID's intake conveyance system into the MKGSA region, and therefore it cannot be assumed that all projects could receive water at their respective design capacities during such times of limitation.

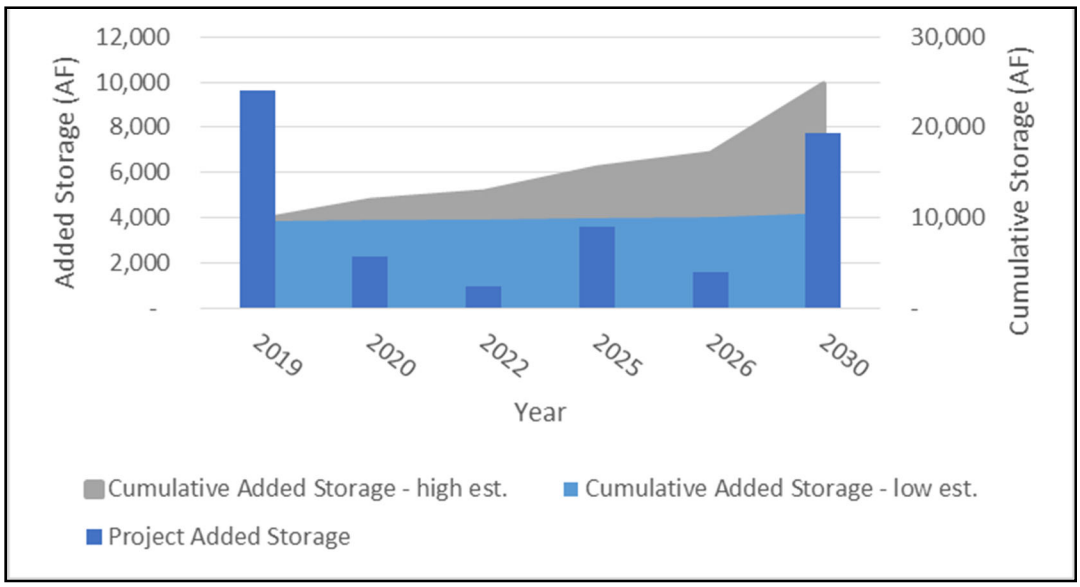


Figure 7-6: Estimated Cumulative Added Storage

These annual and aggregate benefits expressed on an average basis may, of course, be significantly different as a function of future hydrology. The five-year assessments and associated information related to project benefits to be submitted to DWR will make apparent any such runoff patterns.

With all planned projects on line, it may well be the case that surplus water diversion allotments on a daily basis from the Kaweah River and/or the Friant Unit of the CVP are insufficient to sustain full project capacity. This might occur due to other Kaweah appropriators claiming larger shares of flow allocations historically turned down or conveyance capacity limitations within the upper reaches of the Friant-Kern Canal causing a pro-rate among those competing for diversion capacity. However, this may be tempered somewhat for the foreseeable future due to the fact that the Kaweah Subbasin diversion structures along the canal are all upstream of the subsidence reaches causing severely limited access to water in lower reaches such as in the Tule Subbasin region.

The Friant WA report referenced in Section 7.6 includes estimated volumes of surplus flows to each Friant contractor for five-year types ranging from wet to critically dry. These assumed volumes coupled with the depiction of surplus days from Table 1 in that section result in an implicit assumption of a surplus flow diversion rate in the range of only 225 cfs from the Friant-Kern Canal as shown in **Table 7-3**, some of which may be taken up to meet irrigation demands if not met by Kaweah supplies during these surplus periods.

Table 7-3: Surplus Flow Diversion Rate from the Friant-Kern Canal

Year Type	Category	Surplus Water (*) (taf)	No. Days Occurrence	Diversion Rate (cfs)
I	Critical-Dry	0	0	
II	Dry	16.2	35	233
III	Normal-Dry	13.9	32	219
IV	Normal-Wet	37.7	86	221
V	Wet	49.8	111	226

*Friant surplus water includes Class 2, Other, 16(b) and Recirc. (by exchange) as determined in FWA report "Estimate of Future Friant Division Supplies for Use in Groundwater Sustainability Plans" (see Appendix 2A in Basin Setting report)

To refine surplus water availability any further is beyond the scope of this analysis, and the adaptive management approach utilized in the GSP five-year assessments will reveal a clearer picture of the projects' accomplishments. In the interim it is assumed that the projects' recharge capabilities could range from a high of 25,000 AF per year to a low of 10,000 AF per year. This range of recharge accomplishments is depicted in the "Cumulative Added Storage" bandwidth on **Figure 7-6** and is a more conservative and suppositional estimate of the water storage benefits of the projects as described in Section 7.3.

Using the methodologies summarized in Section 7.2 and detailed in Section 7.6, the projects for which quantifiable water-added benefits will operate so as to build groundwater in storage over time can be assumed. These benefits are expressed on an average annual basis, and the detailed analyses indicate that depletions in storage during droughts, such as those that occurred during the 90-year historical hydrologic period of simulation, are more than replenished during the wet-year recharge cycles. As stated in Section 7.4.2, should actual projects' operations dictate otherwise during the implementation phase, groundwater extraction allocations will be initially employed across non-de minimis well owners such that extractions in dry periods do not exceed the projects' recharge capabilities in wet periods, all in accordance with §354.44(b)(9) of the Regulations.

7.5.3 *Relationship to Measurable Objectives*

The approach utilized in setting measurable and optimal objectives, as explained in Section 5 of this Plan, reflects the realistic completion schedule for the projects in Section 7.3 and their respective groundwater benefits on an average basis. As a worst case, an additional scenario where only management actions would be employed to achieve sustainability is described as well. The projects' collective ability to add to the GSA's water budget deficit thus dictates an optimal objective for the sustainability indicator keyed to reductions in groundwater storage, and the more conservative measurable objective is based on management actions to adhere to historical trends for a limited duration (2030). Also as discussed in Section 5 of this Plan, a numeric model simulation is used to develop an optimal objective for the sustainability indicator keyed to lowering of groundwater levels. In addition, an empirical relationship based on historical data is summarized in this section to also add credence to the anticipated water level gains with the advent of additional groundwater recharge afforded by the projects.

Gains in storage achieved by the projects will be better ascertained than commensurate water level increases. Water levels are significantly influenced by the implementation efforts of neighboring GSAs, both on an intra- and inter-basin level. The application of the Kaweah Subbasin numerical model, as previously noted, will be used to aid in determining water level changes as a result of project implementation by this and surrounding GSAs.

7.6 Benefits Analyses

7.6.1 *Surplus Water Recharge Analysis*

As described in Section 1 of this Plan, the MKGSA region, primarily via the conjunctive-use operations of TID, has benefited from historical practices of groundwater recharge. There are,

however, wet seasons and years during which local Kaweah River flows and surplus entitlements from the Friant Unit are not imported into the area because all such facilities are at capacity. TID's allotments from these sources 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, **Table 7-4** has been utilized both by TID and the MKGSA to assess the future availability of CVP/Friant and Kaweah River surplus sources.

Table 7-4: Surplus CVP Availability

Uncontrolled Season Months[1]								
Year Type	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Total**	**Frequency of Occurrence**
I				0			**0**	0.35
II		0	4	25	7		**36**	0.15
II		0	9	16	7		**32**	0.2
IV		10	15	30	31	0	**86**	0.15
V	5	10	20	30	31	15	**111**	0.15
Wt. Avg.							**41**	

[1] The numerical entry denotes # days in months during which Uncontrolled Season Class 2 supplies are assumed to be available under climate change scenarios as projected by Friant WA's Technical Memorandum Dec. 2018

Surplus Kaweah River Availability[2]								
Year Type	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Total**	**Frequency of Occurrence**
I	0	0	0	0	0	0	**0**	0.35
II	0	0	0	0	0	0	**0**	0.15
II	2	2	2	2	4	4	**16**	0.2
IV	4	6	10	11	9	9	**49**	0.15
V	10	9	6	10	6	8	**49**	0.16
Wt. Avg.							**18**	

[2] The numerical entry denotes # days of spill to Tulare Lake Bed from Lower Kaweah and St. Johns channels under climate change projections for 2030 and 2070

Combined SVP Surplus + Terminus Flood Release Months								
Year Type	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Total**	**Frequency of Occurrence**
I	0	0	0	0	0	0	**0**	0.35
II	0	0	4	25	7	0	**36**	0.15
II	2	2	11	18	11	4	**48**	0.2
IV	4	16	25	30	31	9	**115**	0.15
V	15	19	26	30	31	23	**144**	0.16
Wt. Avg.							**54**	

As indicated in **Table 7-4**, between the two sources there exist about 54 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. That some of these surplus diversion capacity estimates during the months of

January to June may be taken up with limited irrigation demands may be the case; however, it is beyond the scope of this analysis to assume future irrigation patterns as they relate to surplus flow availability. For the on-farm programs described in Section 7.3, only the months of January to March were assumed for delivery of surplus flows to participating grower lands, bringing the average number of surplus flow days down to about 20 on average.

Under the auspices of USBR, in 2011, TID conducted a System Optimization Review (**Appendix 7D**), and in it an estimation of surplus flows from the Kaweah River was made. This analysis (shown in **Table 7-5**) indicated 70 such days on average but acknowledged that the 1996 to 2006 period of analysis was wetter than average and was determined on a watershed basis, not just for TID's particular service area. The analysis nevertheless corroborated the use of a conservative count of 19 days of Kaweah surplus flows, on average accessible by TID which, unlike the empirical analysis, is based on operational history. Furthermore, it may be assumed that other water rights holders along the Kaweah River system and members of other Kaweah Subbasin GSAs may, for purposes of SGMA compliance, incorporate projects to take advantage of flood release flows to which they are entitled (the Kaweah River is designated as a "fully appropriated stream system" by the SWRCB) but have historically allowed to be reallocated to others, including TID, by policy of the KSJRA Watermaster. Thus, the use of a more conservative estimate of surplus flows accessible to TID is warranted for this analysis and the projected water budget.

Table 7-5: Estimated Surplus Flow from the Kaweah River

Surplus Flow Analysis for Kaweah River						
CY	**Dates**		**Duration (days)**	**Volumes (AF)**	**Avg. Rate (AF/Day)**	**Annual Total (AF)**
1996	1/18	4/11	84	-	-	-
1997	2/15	3/22	35	384,000	10,970	
	11/16	11/22	6	2,000	333	
	12/12	12/19	7	12,000	1,710	398,000
1998	1/16	7/19	184	663,000	3,600	
	11/15	11/16	11	19,000	1,730	
	12/9	12/17	8	9,800	1,230	691,800
1999	1/21	3/1	39	39,000	1,000	39,000
2000	2/15	3/22	36	68,000	1,890	
	11/16	11/22	6	7,000	1,170	
	12/12	12/19	7	8,000	1,140	83,000
2001	3/1	3/9	8	9,600	1,200	
	5/19	5/26	7	26,000	3,710	
	12/6	12/16	10	13,000	1,300	48,600
2002	12/31	1/11	11	25,600	2,330	
	2/11	2/25	14	20,378	1,460	
	11/10	11/22	12	49,000	4,080	
	12/10	12/22	12	15,000	1,250	109,978
2003	1/9	1/18	9	16,000	1,780	
	2/10	2/23	13	22,500	1,730	
	5/19	6/6	18	96,000	5,330	
	12/15	12/22	7	7,300	1,040	141,800
2004	1/6	1/13	7	15,000	2,140	
	3/29	4/6	8	18,000	2,250	
	11/16	11/23	7	8,300	1,190	

Surplus Flow Analysis for Kaweah River						
CY	Dates		Duration (days)	Volumes (AF)	Avg. Rate (AF/Day)	Annual Total (AF)
	12/15	12/21	6	7,800	1,300	49,100
2005	1/5	2/1	27	56,600	2,100	
	3/28	4/25	28	55,000	1,960	
	5/16	6/2	17	92,300	5,430	
	12/12	12/22	10	15,600	1,560	
2006	1/3	1/21	18	51,600	2,870	
	2/14	2/24	10	19,000	1,900	
	3/21	6/14	85	320,000	3,760	390,600
Avg.			69.7			

Utilization of these flows by TID/MKGSA is entirely within the water rights hierarchy as administrated by the local Watermaster and CVP contract entitlement allotments made by the USBR. Surplus CVP availabilities as indicated in **Table 7-5** are derived from application of the Technical Memorandum (TM) "Estimate of Future Friant Division Supplies for use in Groundwater Sustainability Plans," Friant Water Authority, December 2018, included as an appendix to the Basin Setting report (**Appendix 2A**). The TM reflects an assumed climate change scenario for the San Joaquin River Watershed. Kaweah River flood month data are as adjusted by the climate change treatise contained in that report (an appendix to Section 2 of the GSP), and as summarized in Section 2 of this Plan. Peak flows are projected to decrease by about five percent and shift in occurrence from May back to March. TID's historical data summarizing surplus flow days by month were adjusted accordingly.

Shown on **Figure 7-7** is a graphical depiction of **Table 7-5**, in which the colored bars indicate the number of surplus days in each of the months January to June for dry, average, and wet year types.

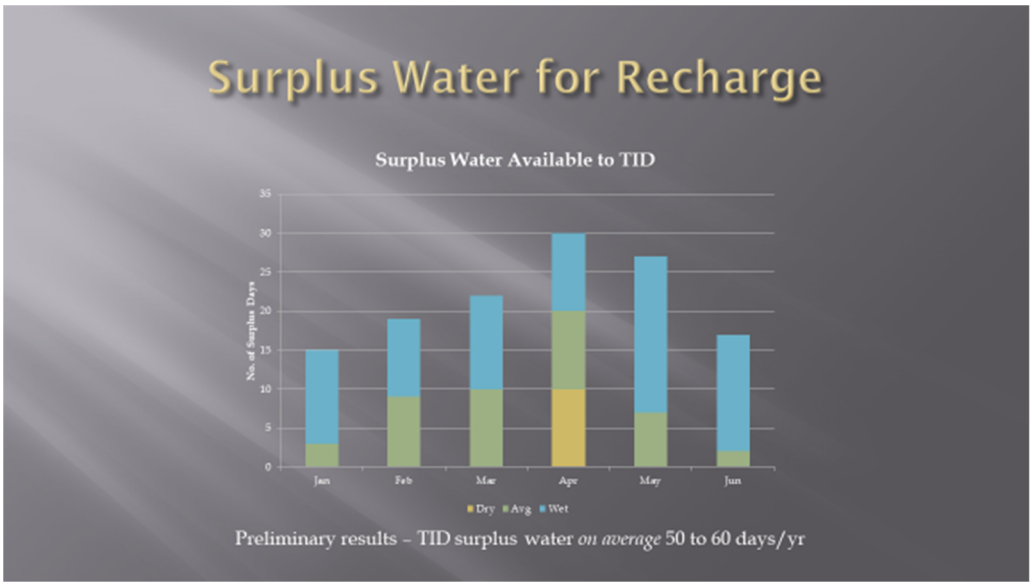


Figure 7-7: Surplus Water for Recharge

The data in **Table 7-5** have been overlaid against a 90-year historical period of record to determine, by year type I – V, the number of days in each year during which additional recharge may be conducted assuming the presence of new projects/programs.

For the new groundwater recharge projects listed in Section 7.3, an assumed infiltration rate of 0.5 feet per day has been assumed in this analysis, which is representative of an average across soil types found in the MKGSA region. For a few of the projects, specific soils information is available and other rates are utilized. Soil borings and other data collected during the detailed planning and permitting stages of these projects will help refine the anticipated recharge benefits. The on-farm programs assume a lesser infiltration rate of 0.25 feet per day given canal turnout and field capacity limitations. For the joint-participation facility within the Greater Kaweah GSA, an infiltration rate of 0.75 feet/day is assumed due to differing soil types in that easterly region of the Subbasin.

Diversion capacity in existing conveyance facilities serving TID and city recharge locations is generally under-utilized in the months of January through June. TID operators indicate that 200 to 300 cfs of unused intake capacity is available during these months and at times more, even in wet years when irrigation demands are low. More is expected to be available with construction of the St. Johns and Lower Kaweah River Siphon improvement projects listed in Section 7.1 and described further herein.

The recharge analysis combines the assumed surplus water availability data in **Table 7-5**, infiltration rates, and total acreage of the groundwater recharge projects listed in Section 7.1 to produce an average annual recharge benefit for these projects in the aggregate. Based on relative acreage of each, individual recharge benefits are determined as well. For an assumed diversion rate of 200 cfs dedicated to new projects, the graph shown on **Figure 7-8** below depicts the relationship between maximum recharge capacities needed vs. average annual recharge achievements.

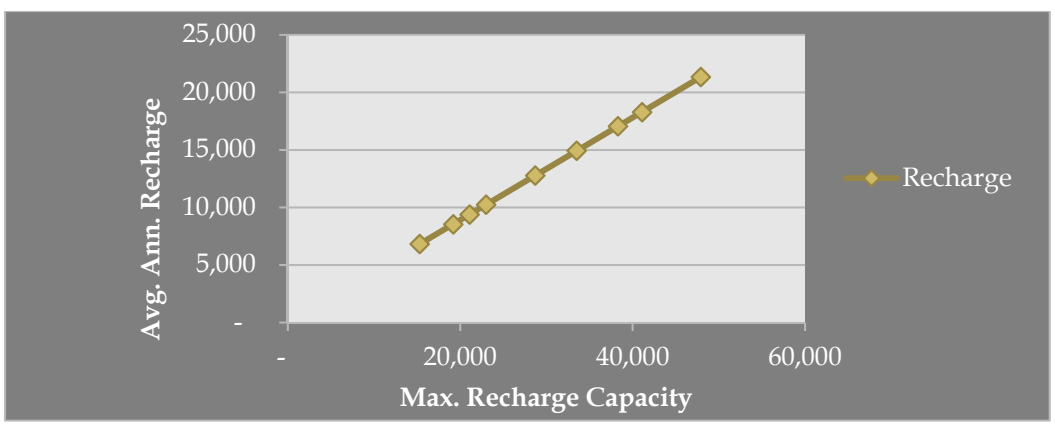


Figure 7-8: Recharge Capacities and Achievements
(values in AF)

The full spreadsheet analysis from which the graph is derived is included for each project in **Appendix 7E**. The spreadsheets contained therein depict, on a yearly time step, the operation of the several recharge projects and their capture of wet-year surplus flows for added water budget benefits to the GSA area.

7.6.2 *Flood Flow Capture Analysis*

For new local surface storage projects, an approach similar to that applied in Section 7.2.1 was utilized, and **Table 7-5** data for the Kaweah River system indicates 19 days (as adjusted by assumed climate change on Kaweah River runoff) on a weighted average basis during which surplus flows may be diverted into new surface storage. This surplus flow availability is overlaid against the historical hydrologic period to determine the frequency and storage volumes achievable for an assumed reservoir capacity. The full analysis over the aforementioned historical period of record is as depicted in **Appendix 7E**. The spreadsheets contained therein depict, on a yearly time step, the operation of the storage facility and its capture of flood waters over time to then be regulated for delivery into the GSA area.

For the Temperance Flat Reservoir Project on the San Joaquin River, a detailed yield analysis is premature since this project, if built, is not expected to be operational for another 20 years or so but could be completed within the SGMA 50-year planning and implementation horizon. TID, along with other public entities in Tulare County and within the Friant and larger CVP service areas, would determine its level of storage participation in the project and utilize this for improved management of river flows over and above San Joaquin River Restoration Project (SJRRP) requirements that otherwise leave the San Joaquin Valley and enter the Sacramento-San Joaquin Delta. As an approximation, preliminary design and operational simulations indicate an average annual yield of 150,000 AF and TID's participation level may be 10 percent thereof, or 15,000 AF.

7.6.3 *Water Exchange Analyses*

Similar to the determination of surplus water availability applied for recharge projects and as described in Section 7.6.1, this same methodology using TID's projected surplus CVP sources was coupled with the exchanging entity's projected local supply (WWTP treated effluent in the case of Visalia; local Kaweah water in the case of Sun World) to determine the net gains in water diverted into the GSA region and additive to its water budget over time. The full analysis over the aforementioned historical period of record for each of these exchange programs is depicted in **Appendix 7E**. The spreadsheets contained therein depict, on a yearly time step, the operation of the two-way exchanges providing additional water to the GSA area.

7.6.4 *Other Analyses*

One in-channel recharge project, i.e., the Packwood Creek Water Conservation Project, has associated with it a calculation of average annual recharge quantities determined as part of a USBR WaterSMART grant application submitted by the KDWCD. That calculation is included in **Appendix 7E**.

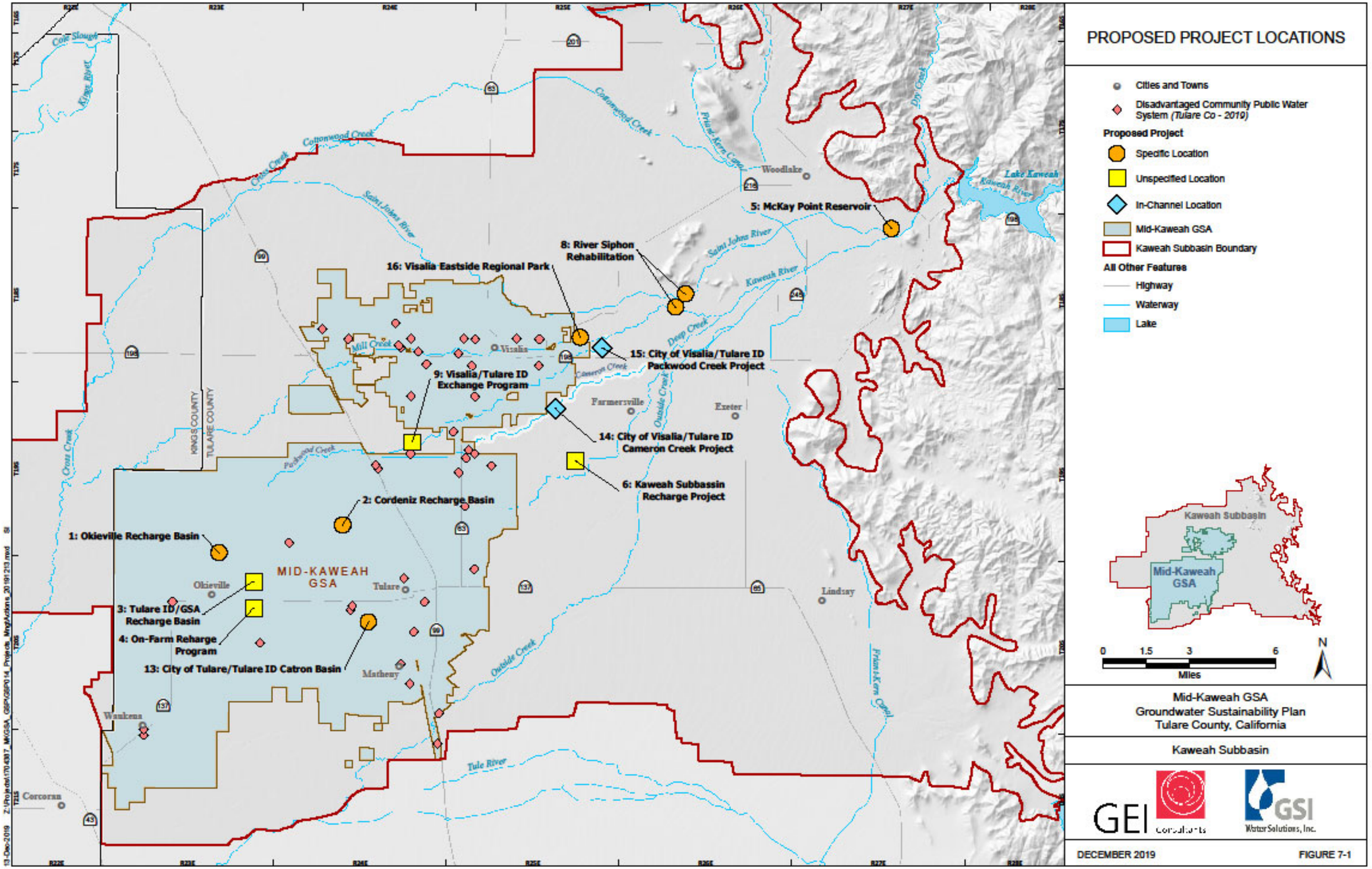


Figure 7-1: Proposed Project Locations

8. DWR Reporting

8.1 Annual Reporting Summary

According to §356.2 of the Regulations, the MKGSA is required to provide an annual report to DWR by April 1 of each year following the adoption of the first GSP. The first annual report will be provided to DWR on April 1, 2020 and will include data for the prior Water Year (WY), which will be WY 2019 (October 1, 2018 to September 30, 2019). The Annual Report will establish the current conditions of groundwater within the MKGSA, the status of the GSP implementation, and the trend towards achieving the interim milestones.

8.1.1 *General Information*

In accordance with §356.2(a), each Annual Report will include, at the front of the report, an executive summary that will summarize the activities and the condition of groundwater levels within the MKGSA for the prior year. The executive summary shall also include a map of the MKGSA, including the monitoring network.

8.1.1.1 Introduction

The annual report will include an introduction that will describe the following:

A description of the MKGSA and the three agencies that are members of the MKGSA

The general conditions of the MKGSA for the prior water year (precipitation, surface water allocations, crop demands, municipal demands, etc.)

Any significant activities or events that would impact the water supply and/or groundwater conditions for the MKGSA

8.1.2 *Basin Conditions*

Included in the annual report will be a discussion of specific local water supply conditions per §356.2(b). This section will provide a description of the water supply conditions for the preceding water year along with a graphical representation of the conditions. A water year shall be defined as the 12-month period starting October 1 through September 30 of the following year. For example, WY 2019 shall include water supply conditions from October 1, 2018 to September 30, 2019. Water supply conditions that will be discussed include:

Groundwater Elevations – elevation data from the monitoring network

Groundwater Extractions – groundwater pumping estimates and measurements for agricultural, municipal and domestic pumping

Surface Water Supply – data from surface water supplies to irrigation demand, conveyance losses, and groundwater recharge

Total Water Use – total water uses by agricultural, municipal and domestic sectors

Change in Groundwater Storage – a determination of the groundwater (volumetric) change

Below is a discussion of the individual MKGSA conditions that will be included in the Annual Report.

8.1.2.1 Groundwater Elevations in MKGSA

Groundwater elevation data for the MKGSA will be collected per Section 4.4 groundwater level monitoring network of this GSP. The Annual Report will include a description of the monitoring network, including any modifications that may have been made in the previous water year to the monitoring network. A graphical representation of the monitoring network will be provided in the map provided in the Executive Summary.

As outlined in Section 4.4.2 Monitoring Frequency, the MKGSA will monitor groundwater elevations seasonally, with a goal to take measurements in the spring (seasonal high before summer irrigation demands) and the fall (seasonal low after the summer irrigation demands). The Annual Report shall discuss the period in which measurements were taken and any observations about groundwater usage that would impact the groundwater elevation readings.

The annual report shall include figures that incorporate the groundwater elevations collected in the prior water year. The first set of figures shall be the development of groundwater contour maps that show the lines of equal elevation for groundwater for spring and fall readings of the current water year. The second set of figures shall be the individual hydrographs for each monitoring well showing the prior water year elevation reading and the historical readings for that monitoring well. The hydrographs shall show all historical data for each monitoring well.

Groundwater contour maps submitted during the first five years may reflect a composite of the principal aquifers within the subbasin due to data gaps as discussed in Section 2 of this Plan. As additional dedicated monitoring wells are installed, and as more knowledge is gained regarding subbasin hydrogeology, groundwater conditions within each separate aquifer will be better understood. The geophysical data collection project described in Section 7 will also aid in this regard.

8.1.2.2 Groundwater Extractions

Groundwater extractions for the MKGSA will be reported for the prior water year in the annual report. A summary discussion of the amount of groundwater pumped, the usage of the groundwater, and the percentage of the water supply for the MKGSA shall be included in the annual report. The Annual Report will provide a summary table that indicates the amount of groundwater per water use sector and the method of measurement (metered or estimate). A sample of the table is provided in **Table 8-1**.

Table 8-1: Sample Groundwater Extraction Summary

Water Use Sector	Measurement Method	City of Tulare	City of Visalia	Tulare Irrigation Dist.
M&I	Metered			
	Estimate			
Domestic	Metered			
	Estimate			
Agriculture	Metered			
	Estimate			
Total				

8.1.2.3 Surface Water Supplies

The MKGSA shall include a discussion of the surface water supplies diverted to the area for use by MKGSA members. The majority of surface water diversion and usage is by the TID. TID has a long history, over 100 years, of diverting and beneficially using surface water. The discussion shall include a general description of the surface water made available to the MGKSA and how the surface water was used. There shall also be a discussion of how the prior water year surface water supplies compared to historic supplies.

The annual report shall include a discussion of how surface water supplies were used to meet agricultural demand. This description shall include a graphical representation of the cropping patterns shown for the agricultural areas of the MKGSA.

The annual report shall also discuss how surface water was applied to groundwater recharge activities. The MKGSA partners conduct various groundwater recharge activities, and a description of what activities took place in the prior water year shall be provided.

8.1.2.4 Total Water Use

Total water use shall be reported in the annual report in a tabular format. A sample of the table is provided in **Table 8-2**.

Table 8-2: Sample Total Water Use Summary

Water Use Sector	Measurement Method	City of Tulare	City of Visalia	Tulare Irrigation Dist.
M&I	Groundwater			
	Surface Water			
Domestic	Groundwater			
	Surface Water			
Agriculture	Groundwater			
	Surface Water			
Total				

8.1.2.5 Change in Groundwater Storage

The Annual Report shall include a discussion and analysis of the change in groundwater storage for the prior water year compared to historical trends. The annual report will also describe the events and conditions that would have contributed to the increase or decrease in groundwater storage. A graphical representation of the change in groundwater storage for the prior water year will be included. This graph shall also show the historical change in groundwater storage.

8.1.3 *GSP Implementation Progress*

The annual report shall include a description of the GSP implementation progress in accordance with §356.2(c). This section will provide an update on progress for the prior water year in achieving the interim milestones as defined in Section 5 and the implementation of projects and management actions as described in Section 7.

8.1.3.1 Interim Milestones

Based on the interim milestones established in Section 5, the Annual Report shall determine if the prior water year had met, exceeded, or failed to reach the interim milestones. The Annual Report shall also discuss the conditions and actions that contributed to the interim milestones.

8.1.3.2 Implementation of Projects

The annual report shall include a list of projects from Section 7 that were anticipated to be implemented as of the prior water year. This section shall also include the status of those projects and note any completed projects or projects that were delayed. Lastly, a discussion shall be provided of projects that were implemented or developed in the prior water year that were not originally discussed or outlined in the GSP.

8.1.3.3 Implementation of Management Actions

The Annual Report shall include a list of management actions from Section 7 that were anticipated to be implemented as of the prior water year. This section shall also include the status of those management actions and note any completed management actions or those that were delayed. Lastly, a discussion shall be provided of management actions that were implemented or developed in the prior water year that were not originally discussed or outlined in the GSP.

8.1.3.4 Implementation of Adaptive Management Actions

Based on the ability of the MKGSA to achieve the interim milestones established in Section 5 of the GSP, MKGSA shall implement adaptive management actions to adjust projects and management actions to achieve future interim milestones.

In the event that an Annual Report establishes that the MKGSA has fallen short of a five-year Interim Milestone, the MKGSA shall implement adaptive management actions through each of the Management Area's projects and management actions to achieve the next five-year interim milestone. The adaptive management actions can come in the form of providing projects to

increase groundwater recharge, reduce water consumption, or reduce pumping through management actions. The Annual Report shall include a preliminary evaluation and estimation of the ability of the adaptive management actions to achieve the future Interim Milestone.

8.2 Five-Year Assessments

In accordance with §356.4 of the Regulations, the MKGSA will conduct a periodic evaluation of its Plan no less frequently than at five-year intervals and provide a written assessment to DWR of such evaluations. The assessments will include, but not be limited to, the following:

Overall summary of then-current groundwater conditions and descriptions of each Sustainability Indicator for applicable minimum thresholds, measurable objectives, and interim milestones

Summary of projects and management actions recently implemented and their localized and collective effect on groundwater conditions

Review of Plan elements subject to reconsideration and potential revision, including minimum thresholds and measurable objectives, based on significant new information acquired since the prior Plan assessment

Evaluation of the Basin Setting and any needed changes thereto based on new data and water budget assessments, including estimated overdraft conditions

Description of alterations to the monitoring network and its improvements to address data gaps

Description of any new information made available or developed since Plan adoption or prior five-year assessment, and whether such information warrants changes to the current Plan

Description of any completed or proposed Plan amendments

Summary of GSA actions regarding Plan implementation, including any relevant ordinances or regulations issued thereby, and any legal or enforcement actions against groundwater users or others

Summary of further collaboration and coordination between GSAs in the Kaweah Subbasin, GSAs in inter-connected subbasins, and land use agencies within Tulare County including Members of this GSA

8.2.1 *Monitoring Network Assessment and Improvement*

The MKGSA recognizes that its initial monitoring network as described in Section 4 of this Plan includes existing monitoring sites lacking sufficient information such as well depth, screen intervals, and reliable well-log records, thereby reflecting significant data gaps. Assessing these data gaps is a priority and will be conducted in accordance with §352.2 and §354.38 of the Regulations. Specific elements of such an assessment are to include:

Targeting GSA areas where an insufficient number of monitoring sites exist or where sites are considered unreliable or do not meet monitoring network standards

Identifying data gap locations and reasons for their occurrence and surrounding issues that restrict monitoring and data collection

Actions to be undertaken to close identified data gaps, including the addition and/or installation of new monitoring wells or surface-water measuring facilities, closure of inadequate well density areas, and needed adjustments to monitoring and measurement frequencies

Improvement to the monitoring program and network to provide sufficient information to gauge the effectiveness of projects and management actions, including an assessment of the network's ability to determine exceedance of minimum thresholds, capture spatial or temporal variation in groundwater conditions, and adverse impacts upon beneficial uses and users of the groundwater resource

The periodic assessment will also include a general determination of whether the monitoring network has been or is capable of evaluating groundwater conditions and impacts of GSA projects and management actions on the ability of adjacent subbasins to meet their sustainability goals or to implement their respective GSPs

8.2.2 *Review of Subbasin Coordination Agreement*

In accordance with §357.4(i) of the Regulations, the three GSAs encompassing the Kaweah Subbasin will review and, as necessary, revise their Coordination Agreement as part of the five-year assessments conducted by each. Any revisions to the Agreement will be incorporated therein as amendments or restatement and executed by each GSA.

8.3 Reporting Provisions

The MKGSA shall comply with the provisions of §353.4 of the Regulations, in submitting any and all annual reports and five-year Plan assessments. Materials will be submitted in the manner required by DWR and be accompanied by a transmittal letter signed by the designated Subbasin Plan Manager or other authorized person.

8.4 Reporting Standards

The MKGSA shall comply with the reporting standards provided in §353.4 of the Regulations in submitting annual reports and five-year Plan assessments.

9. 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.

___, 2017. Draft Best Management Practices for the Sustainable Management of Groundwater, Sustainable Management Criteria BMP.

___, 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

City of Tulare, 2014. 2035 General Plan Update for the City of Tulare. October 2014.

City of Tulare, 2015. *Draft 2015 Urban Water Management Plan.*

City of Visalia, 2014. *2030 General Plan Update for the City of Visalia.* October 2014.

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.

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.

Lewis, 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).

Malcolm Pirnie, Inc. 2001. Evaluation Monitoring Program Report, An Interim Report for Phase I Investigations, Visalia Solid Waste Disposal Site, Visalia, California, Volume 1 of 2, consultant's unpublished report prepared for the county of Tulare Resource Management Agency, Solid Waste Division. May 2001.

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.

Provost and Pritchard, 2010. *Groundwater Management Plan,* consultant's unpublished report prepared for the Tulare Irrigation District, September. (https://water.ca.gov/LegacyFiles/groundwater/docs/GWMP/TL-22_TulareID_GWMP_2010.pdf)

State Water Resources Control Board, 1995. *Water Quality Control Plan for the Tulare Lake Basin, Second Edition.* 1995.

The Nature Conservancy, 2019. Identifying GDEs Under SGMA, Best Practices for Using the NC Dataset. July, 2019.

Tulare County, 2012. *2030 Update Tulare County General Plan.* August 2012.

Tulare Irrigation District (TID), 2011. *Tulare ID System Optimization Review Study – 2011 Strategic Planning Initial Summary.* Prepared by Provost & Pritchard Consulting Group, March 2011

TID, 2012. *2012 Agricultural Water Management Plan.* PDF.

TID, 2018. Groundwater Recharge Capacity Evaluation Phase III: Hydrogeologic Investigations to Maximize Recharge Capacity". Prepared by Montgomery & Associates February 2018

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.

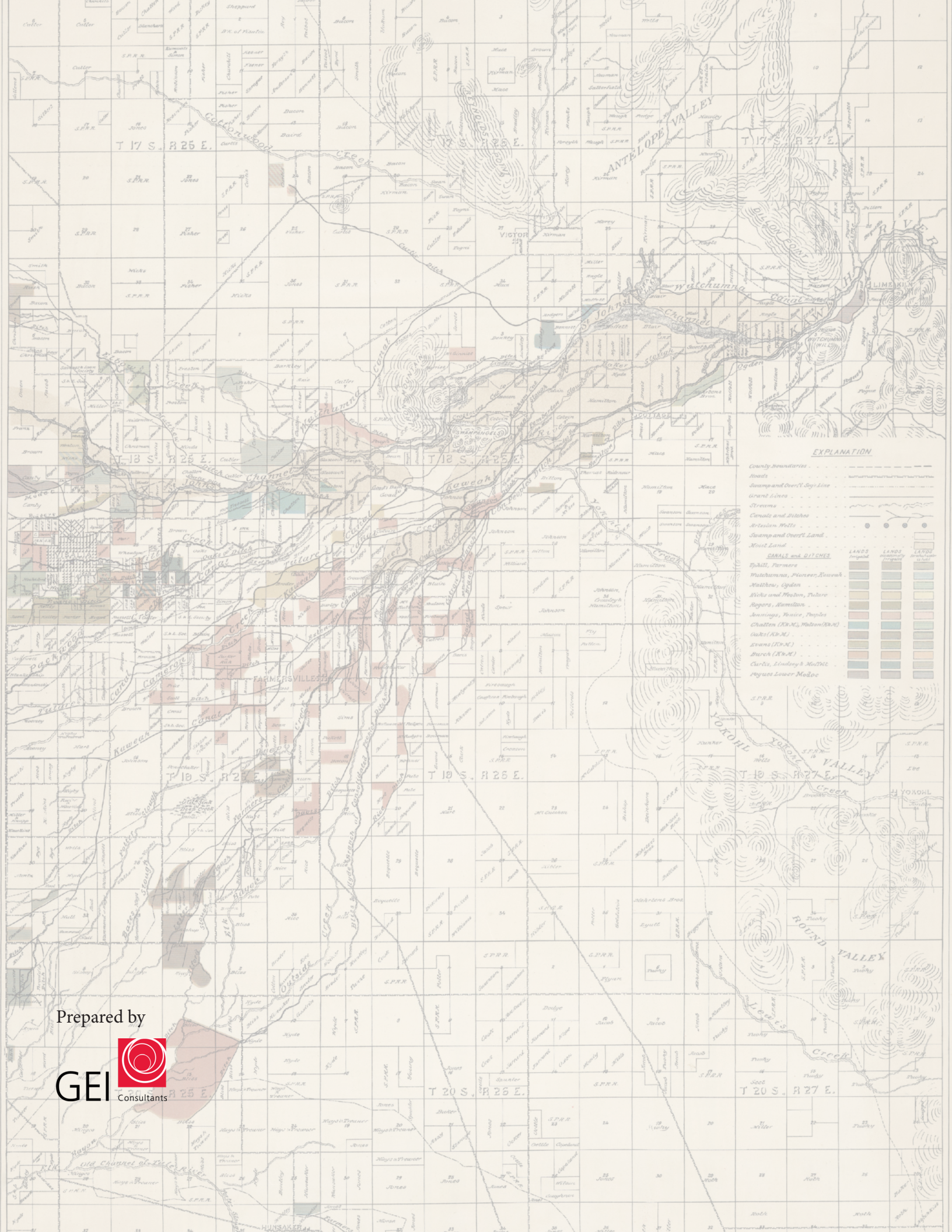
___, 1998. *Environmental Setting of the San Joaquin-Tulare Basins, California*. Water Resources Investigations Report 97-4205.

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.



Prepared by

GEI Consultants